REPORT

June 6, 2015

FOUNDATION INVESTIGATION AND DESIGN REPORT

HIGH FILL EMBANKMENTS OVER SWAMPS
HIGHWAY 17 FOUR-LANING EXTENSION FROM 20.5 KM WEST OF HIGHWAY 144, EASTERLY FOR 6.5 KM
MINISTRY OF TRANSPORTATION, ONTARIO
GWP 156-98-00

Submitted to:
D.M. Wills Associates Ltd.
150 Jameson Drive
Peterborough, Ontario
K9J 0B9

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PART A

FOUNDATION INVESTIGATION REPORT

HIGH FILL EMBANKMENTS OVER SWAMPS

HIGHWAY 17 FOUR-LANING EXTENSION FROM 20.5 KM WEST OF HIGHWAY 144, EASTERLY FOR 6.5 KM

MINISTRY OF TRANSPORTATION, ONTARIO

GWP 156-98-00

June 6, 2015
Report No. 11-1191-0007-01

Golder Associates

1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by D.M. Wills Associates Ltd. (DMW) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for high fill embankments crossing over swamp areas located within the limits of the new Highway 17 four-laning alignment. The proposed high fill embankments outlined in the project limits are part of the new Highway 17 interchange and extension of the existing four-laning at the West Junction of Sudbury Municipal Road 55, from 20.5 km west of Highway 144, easterly for 6.5 km. The general location of the Highway 17 four-laning extension is shown on the Site Location Plan on Drawing 1.

The Terms of Reference and the Scope of Work for the foundation investigation are outlined in MTO's Request for Proposal, dated March 2011. Golder's proposal for foundation engineering services associated is contained in Section 6.8 of DMW's Technical Proposal for this assignment. The work has been carried out in accordance with Golder's Supplementary Specialty Plan for foundation engineering services for this project, dated November 11, 2011. The base plan showing the proposed horizontal alignment and a drawing showing the proposed vertical alignment for the Highway 17 four-laning extension was provided to Golder by DMW in January 2012.

This report addresses the investigation carried out for the high fill embankments over swamps only. A detailed list of the locations of the high fill embankments is presented in Table 1. Separate reports detail the results of the foundation investigations for the culverts and bridge structures for this project.

Preliminary subsurface information for this project is available and was supplied by MTO, in the reports and subsequent appendices titled below:

- *Planning, Preliminary Design, and Environmental Assessment Report, Highway 17, Town of Walden,* GWP 156-98-00, dated August 2008 by Stantec Consulting Limited
    - Appendix N: Alternate Route Geotechnical Assessment Report, Highway 17, Town of Walden, GWP 156-98-00, Index No: 080FGR, PML Ref: 05TF059G dated July 29, 2008 by Peto MacCallum Ltd.
    - Appendix O: Alternate Route Foundation Assessment Report, Highway 17, Town of Walden, GWP 156-98-00, Index No: 072FFR, PML Ref: 05TF059F, dated May 20, 2008 by Peto MacCallum Ltd.
- *Planning, Preliminary Design, and Environmental Supplementary Report, Highway 17, Town of Walden,* GWP 156-98-00, dated March 2009 by Stantec Consulting Limited
    - Preliminary Geotechnical Investigation Report, Highway 17, Town of Walden, GWP 156-98-00, Index No: 102FGIR, PML Ref: 05TF059G1 dated March 3, 2009 by Peto MacCallum Ltd.

2.0 SITE DESCRIPTION

The overall project consists of the detail design for the four-laning of Highway 17 from the end of the existing four lanes at the west junction of Sudbury Municipal Road 55, from approximately 20.5 km west of Highway 144 easterly for 6.5 km, including a new interchange. The proposed highway alignment approximately follows the existing alignment of Highway 17 generally oriented in an east to west direction and south of the existing highway within the project limits.

In general, the topography of this area consists of rolling terrain, including sparsely populated treed areas and numerous bedrock outcrops separated by low-lying swamps containing areas of standing water and various vegetation types and organic soils. The land use in the general area includes residential and scattered rural farm use. The ground surface within the limits of the study area varies between about Elevation 248 m and Elevation 239 m. A detailed description of each investigated area of high fill embankment over a swamp is presented in Section 4.0.

3.0 INVESTIGATION PROCEDURES

The investigation for the Highway 17 high fill embankments crossing over swamp areas was carried out between March 7 and July 12, 2012, between August 27 and October 1, 2012, October 23 and 24, 2012, and January 8 and 9, 2014, during which time a total of one hundred and nineteen (119) boreholes and fifty-three (53) Dynamic Cone Penetration Tests (DCPTs) were advanced. The locations of the boreholes and DCPTs are summarized in Table 1 and are shown on Drawings A1 to C1 in Appendices A to C. In general, boreholes and DCPTs were advanced along the centreline and the toes of the proposed embankment alignment.

The field investigation was carried out using a variety of drilling equipment due to the varying nature of the terrain within the project limits. The details of the drilling equipment and supplier are listed below. Hand excavation methods were used as appropriate depending on the terrain.

Drilling Equipment	Supplied and Operated By
Track Mounted CME-55 Track Mounted CME-850 Portable Tripod Equipment	Landcore Drilling Inc. of Chelmsford, Ontario

The boreholes were advanced through the overburden using 108 mm inner diameter hollow-stem augers and/or NW casing with wash boring techniques and NQ size core barrel for bedrock coring, where applicable, to advance through obstructions. In general, soil samples were obtained at intervals of depth of about 0.75 m and 1.5 m, using a 50 mm outer diameter (O.D.) split-spoon sampler (operated by automatic hammers on the drill rigs), in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586, Standard Test Method for Standard Penetration Test and Split-Barrel Sampling of Soils). Boreholes advanced by portable equipment generally employed full weight hammers lifted manually and dropped from the SPT height; however, a limited number of boreholes employed half-weight hammers lifted manually to the SPT height and the 'N'-values were corrected for the lower energy drive. Samples of the cohesive soils were obtained using 76 mm O.D. thin-walled 'Shelby' tubes (ASTM D1587, Standard Practice for Thin-Walled Tube Sampling) for relatively undisturbed samples. Field vane shear tests were conducted in cohesive soils for assessment of undrained shear strengths (ASTM D2573, Standard Test Method for Field Vane Strength Shear Test) using MTO Standard 'N' size vanes. All boreholes were backfilled upon completion in accordance with Ontario Regulation 903 Wells (as amended).

The boreholes were advanced to depths up to about 31 m below existing ground surface, generally penetrating 3 m into competent material, which is defined as material that will provide resistance to settlement or instability of the embankments, or to refusal. Some boreholes and DCPTs were terminated on refusal to further dynamic cone penetration, auger, casing and/or split-spoon advancement. These depths to refusal do not confirm bedrock surface elevations, but may be inferred to indicate the potential proximity to the bedrock surface. At

various locations where refusal was encountered at shallow depth, the bedrock was exposed by hand shovel excavation to confirm the refusal condition.

The groundwater conditions and water levels in the open boreholes were observed during the drilling operations and are described on the Record of Borehole sheets provided in Appendices A to C. Groundwater elevations as encountered in the boreholes may not be representative of static groundwater levels since the groundwater levels in the boreholes may not have stabilized upon completion of drilling. Furthermore, groundwater elevations will vary depending on seasonal fluctuations, precipitation and local soil permeability.

The field work was observed by members of our engineering and technical staff, who located the boreholes, arranged for the clearance of underground services, observed the drilling, sampling and in situ testing operations, logged the boreholes and examined and cared for the soil samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Sudbury Geotechnical Laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected representative samples. In addition, one-dimensional consolidation (oedometer) tests were carried out on selected samples of the cohesive deposits and the results of the consolidation test results are presented in Table 2. The results of the laboratory testing for each of the high fill embankments are included in the associated appendices.

The proposed centreline of the new Highway 17 alignment was staked in the field by exp. prior to drilling. The as-drilled borehole locations, in stations and offsets, were measured in reference to the centreline alignment and were subsequently converted into coordinates in AutoCAD. Borehole elevations were surveyed by members of our technical staff in reference to the ground surface elevations at temporary benchmarks installed by exp. prior to the commencement of fieldwork. The borehole locations given in the Record of Borehole sheets and shown on the Drawings are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum.

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

As delineated in the NOEGTS[1] Mapping, the subsoils in this section of Highway 17 are comprised of undulating to rolling glaciolacustrine plain, alluvial plain and organic terrain deposits interspersed with numerous bedrock knobs, outcrops and ridges. In the lower-lying glaciolacustrine plain and alluvial plain areas the primary material consists of wet silts, sands and clays, while the organic terrain deposit the primary material consists of peat. The surface water drainage in the area varies from moderate to poor, corresponding to areas of moderate to low relief.

Based on geological mapping by the Ministry of Natural Resources (Map 2542)[2], the site is underlain by rocks of the Paleoproterozoic Era belonging to the Huronian Supergroup and Elliot Lake Group consisting of conglomerate, wacke, arkose, quartz arenite, argillite, limestone and dolostone. Areas of mafic and related intrusive rocks comprised of diabase sills, dykes and related granophyre are also present in the vicinity of the

[1]Northern Ontario Engineering Geology Terrain Study. Ontario Geological Society Digital Map Reference Number 41ISW.

[2] Ministry of Natural Resources. Bedrock Geology of Ontario – West Central Sheet, Ontario Geological Survey - Map 2542

site. Based on geological mapping by the Ontario Department of Mines (Map 2170) [3] this area is characterized by extensive faults from distinct time periods. The Murray Fault has been identified to run parallel to the approximate proposed alignment of Highway 17.

4.2 General Overview of Local Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the borings advanced during this investigation together with the results of the laboratory tests carried out on selected soil samples for the respective high fill areas are presented on the Record of Borehole sheets and the laboratory test figures provided in Appendices A to C. The results of the in situ field tests (i.e., SPT 'N'-values and undrained shear strengths from the field vanes) as presented on the Record of Borehole sheets and in Section 4 are uncorrected. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling, observations of drilling progress and the results of SPTs and in situ testing. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations. The thickness of the overburden in the investigated areas as inferred from resistance to DCPT results are shown on the Record of Penetration Test sheets in Appendices A to C, as applicable.

The locations of the boreholes and DCPTs advanced in the Highway 17 high fill embankment areas are shown in plan on Drawings A1 to C1, while the inferred soil stratigraphy as encountered shown in profile are shown on Drawings A2 to A4, B2 to B5 and C2 to C4 in Appendices A to C. It should be noted that the orientation (i.e., north, south, east, west) stated in the text of the report is typically referenced to project north and therefore may differ from the Magnetic North shown on the drawings.

In general, the stratigraphy encountered at the various areas investigated is similar. However the overburden (soil materials) thickness is variable, ranging from no cover (bedrock outcrops exposed at the ground surface) to about 31 m. The generalized stratigraphy can be described as follows:

- embankment fill where the existing and proposed alignments overlap;
- surficial layers of topsoil or fibrous peat outside the existing highway;
- cohesionless deposits of sand to sandy silt underlying the organics/fill deposits in some areas;
- cohesive deposits of clayey silt to clay, varved in some areas; and
- cohesionless deposits of silt to sand and gravel below the cohesive deposits to the inferred bedrock surface.

Detailed descriptions of the subsurface conditions encountered at each investigated high fill embankment are provided in the following sections of this report. Where relatively significant thicknesses of overburden were encountered, the various soil types are described in detail for each main deposit or stratum.

[3] Ontario Department of Mines (1969), Sudbury Mining Area, Sudbury District, Map 2170.

4.3 Highway 17 WBL – STA 12+220 to 12+570 (High Fill H1)

The plan and profiles along the centreline and toes of the proposed embankment of the new Highway 17 West Bound Lane (WBL) alignment showing the borehole locations and interpreted stratigraphy between STA 12+220 to STA 12+570 in the Township of Louise are shown in Drawings A1 to A3 in Appendix A. The southerly portion of the alignment extends across a low-lying swampy area with the proposed embankment up to 5.7 m high above the existing ground surface. The northerly portion of the alignment overlaps with the existing Highway 17 embankment. A total of seventeen (17) boreholes (Boreholes H1-1 to H1-9, H1-11 to H1-15, C1-1 to C1-3) and six (6) DCPTs (H1-DC1 to H1-DC6) were completed to investigate the subsurface conditions within this portion of High Fill Area H1.

The subsurface soils along the WBL alignment in High Fill Area H1 consist of embankment fill or a peat/topsoil deposit underlain by a sand and silt deposit and a cohesive deposit of varved, silty clay to clay transitioning into clayey silt, which in turn is underlain by deposits of silt, sand and silt to sand and sand and gravel to gravelly sand.

4.3.1 Asphalt

A 130 mm thick layer of asphalt was encountered at ground surface in Boreholes H1-1 and H1-3.

4.3.2 Fill

Underlying the asphalt in Boreholes H1-1 and H1-3, and from ground surface in Boreholes H1-2, H1-4, H1-5, H1-7, H1-8, H1-9 and H1-12, a stratum of sand to sand and gravel mixed with blast rock fill was encountered. In Borehole H1-8 the sand and gravel transitioned into sandy silt at 2.2 m depth. The surface of the fill stratum was encountered between Elevation 246.5 m and 241.6 m, and the thickness ranges between 0.2 m and 6.1 m. Boreholes H1-1, H1-2 and H1-4 were terminated within this stratum and were located in close proximity to an exposed bedrock cut.

The SPT ‘N’-values measured within the sand, sand and gravel and sandy silt fill stratum range from 19 blows to 79 blows per 0.3 m of penetration, indicating a compact to very dense relative density. In Borehole H1-9 a ‘N’-value of 113 blows per 0.3 m of penetration was encountered, however it was likely indicative of the frozen nature of the fill at the time of the field investigation. Some instances within the sand and gravel to gravelly sand portions of the fill deposit the split-spoon sampler did not penetrate the full sample depth due to inferred blast rock fill fragments within the fill and rock coring techniques were required to advance the borehole through these zones.

The grain size distributions of two samples of the fill deposit are shown on Figure A1 in Appendix A.

The natural water content measured on a sample of the sand and gravel fill is about 3 per cent. The natural measured water content for a sample of the sandy silt fill is about 13 per cent.

4.3.3 Peat/Topsoil

In Boreholes H1-6, H1-11, H1-13, H1-14, C1-1 and C1-3, a deposit of black fibrous peat was encountered from ground surface. In Boreholes H1-15 and C1-2 a surficial layer of topsoil was encountered at ground surface.

The top of the peat/topsoil layer varies in elevation from 244.6 m to 241.3 m, and the thickness ranges from about to 0.1 m to 0.9 m.

The SPT 'N'-values measured within the peat/topsoil deposit range from 0 blows (weight of hammer) to 11 blows per 0.3 m of penetration, indicating a very soft to stiff consistency, however, the higher 'N'-values are attributed to frost.

The natural water content measured on two samples of the peat are about 48 per cent and 157 per cent.

4.3.4 Sand and Silt

A deposit of sand and silt was encountered underlying the fill in Boreholes H1-3, H1-5 and H1-7 and underlying the peat deposit in Borehole H1-6. The top of the sand and silt deposit was encountered between Elevation 242.1 m and 240.2 m, and the thickness ranges between 1.1 m and 2.3 m. Borehole H1-3 terminated within this deposit.

The SPT 'N'-values measured within the sand and silt layer range from 5 blows to 14 blows per 0.3 m of penetration indicating a loose to compact relative density.

The grain size distributions of two samples of the sand and silt deposit are shown on Figure A2 in Appendix A.

The natural water content measured on two samples of the sand and silt deposit is about 21 per cent and 23 per cent.

4.3.5 Cohesive Deposit

In Boreholes H1-5 to H1-9, H1-11 to H1-15 and C1-1 to C1-3, a cohesive deposit was encountered beneath the peat/topsoil or fill or sand and silt deposits. In general the cohesive deposit consisted of an upper varved silty clay to clay zone transitioning into a lower clayey silt zone. The top of the cohesive deposit was encountered between Elevation 244.2 m and 238.8 m and the overall deposit ranged between 1.8 m and 7.9 m in thickness.

Silty Clay to Clay

Underlying the peat/topsoil in Boreholes H1-11, H1-13, H1-14, H1-15 and C1-1 to C1-3 and underlying the fill and or sand and silt deposits in Boreholes H1-5 to H1-9 and H1-12, a deposit of brown to grey silty clay to clay was encountered. In the majority of the boreholes, the silty clay to clay was observed to be varved, consisting of irregular layers of clayey silt/silty clay and silty clay/clay. The top of the silty clay to clay deposit ranges from Elevation 244.2 m to 238.8 m and the thickness ranges from 1.8 m to 7.9 m.

The SPT 'N'-values measured within this deposit range between 0 blows (weight of hammer) and 17 blows per 0.3 m of penetration, suggesting a very soft to very stiff consistency. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 16 kPa to 61 kPa, and the sensitivity is calculated to range from about 2 to 25, typically less than 9. The field vane tests results indicate that the silty clay to clay has a soft to stiff consistency.

The grain size distributions of three samples of the silty clay to clay are shown on Figure A3 in Appendix A.

Atterberg limits tests were carried out on sixteen samples of the silty clay to clay portion of the deposit and indicated liquid limits ranging from about 35 per cent to 61 per cent, plastic limits ranging from about 20 per cent to 26 per cent and plasticity indices ranging from about 13 per cent to 37 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A4 in Appendix A and indicate that the material is classified as silty clay of intermediate plasticity to clay of high plasticity.

The natural water content measured on twenty-two samples of the silty clay to clay ranges from about 23 per cent to 65 per cent.

Clayey Silt

Underlying the silty clay to clay portion of the deposit in Boreholes H1-6 and H1-15, the silty clay to clay transitioned into grey clayey silt. The top of the clayey silt portion of the deposit ranges from Elevation 241.2 m to 234.1 m and the thickness ranges from 0.9 m to 1.6 m.

The SPT 'N'-values measured within this deposit range between 1 blow and 12 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency. One in situ field vane test carried out within this deposit measured an undrained shear strength of about 44 kPa, and the sensitivity is calculated to be about 9. The field vane test result indicates that the clayey silt has a firm consistency.

An Atterberg limits test was carried out on one sample of the clayey silt portion of the deposit and indicated a liquid limit of about 35 per cent, plastic limit of about 20 per cent and a plasticity index of about 15 per cent. The results of the Atterberg limits test are shown on the plasticity chart on Figure A5 in Appendix A and indicate that the material is classified as clayey silt of low plasticity.

The natural water content measured on one sample of the clayey silt is about 42 per cent.

4.3.6 Silt

Underlying the cohesive deposit in Boreholes H1-5 to H1-9, H1-11, H1-12, H1-14 and C1-1 to C1-3, a deposit of grey silt was encountered. The top of this deposit ranges from about Elevation 241.0 m to 232.4 m, and ranges from 1.3 m to 4.4 m in thickness. A DCPT was advanced below the borehole termination depth in Borehole C1-1.

The SPT 'N'-values measured within the silt to sandy silt portion of the deposit range between 1 blow and 15 blows per 0.3 m of penetration, indicating a very loose to compact relative density. One SPT 'N'-value was measured to be 75 blows per 0.08 m of penetration, likely indicative of the close proximity of the bedrock surface.

The grain size distributions of eight samples of the silt are shown on Figure A6 in Appendix A.

An Atterberg limits test was carried out on one sample of the silt and indicated a liquid limit of about 28 per cent, a plastic limit of about 24 per cent and a plasticity index of just below 4 per cent. The results of the Atterberg limit test are shown on the plasticity chart on Figure A7 in Appendix A and indicate that the material is classified as silt of slight plasticity. The results of four additional Atterberg limits tests indicate that the material is non-plastic.

The natural water content measured on ten samples of the silt deposit ranges between about 23 per cent and 32 per cent.

4.3.7 Sand and Silt to Sand

Underlying the silt in Boreholes H1-4 to H1-9, H1-11 and H1-14 and underlying the cohesive deposit in Boreholes H1-13 and H1-15, a stratum of grey, sand and silt to sand was encountered. The surface of the stratum was encountered between Elevation 240.3 m and 228.5 m. Boreholes H1-5 to H1-9, H1-13 were terminated within this stratum.

The SPT 'N'-values measured within the sand and silt to sand portion of the deposit range between 0 blows (weight of hammer) and 49 blows per 0.3 m of penetration indicating a very loose to dense relative density. One SPT 'N'-value was measured to be 10 blows per 0.1 m of penetration likely indicative of the close proximity of the bedrock surface.

The grain size distributions of six samples of the sand and silt to sand are shown on Figure A8 in Appendix A.

The results of Atterberg limits testing on one sample indicated that the material is classified as non-plastic.

The natural water content measured on six samples of this deposit ranges between about 19 per cent and 24 per cent.

4.3.8 Sand and Gravel

In Boreholes H1-11, H1-13 and H1-15, a deposit of grey sand and gravel was encountered underlying the silty sand deposit. The top of the sand and gravel deposit was encountered between Elevation 239.0 m and 237.6 m and ranged from 1.7 m to 5.4 m in thickness.

The SPT 'N'-values measured within this portion of the deposit range between 3 blows and 24 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The grain size distributions of three samples of the sand and gravel are shown on Figure A9 in Appendix A.

The natural water content measured on three samples of this portion of the deposit ranges between about 8 per cent and 12 per cent.

4.3.9 Refusal

Refusal to split-spoon and dynamic cone penetration, indicating proximity to the inferred bedrock surface was encountered in Boreholes H1-1 to H1-6, H1-11 to H1-15, C1-1 and DCPTs H1-DC1, H1-DC5 and H1-DC6 at depths ranging from 0.2 m and 19.4 m below the ground surface or between Elevation 245.2 m and 223.8 m. In Boreholes C1-2 and DCPTs H1-DC2 to H1-DC4, the DCPT terminated upon recording greater than 100 blows per 0.3 m of penetration, indicative of proximity to the inferred bedrock surface, at depths up to about 17 m below the existing ground surface.

In Borehole H1-12, split-spoon refusal was encountered at 6.6 m depth (Elevation 239.7 m) within the silt stratum. In this instance, refusal is likely indicative of the presence of an obstruction.

4.3.10 Groundwater Conditions

In general, the soil samples taken in the boreholes were moist to wet. Boreholes H1-1 to H1-4 were dry upon completion of drilling. Groundwater levels observed upon completion of drilling in the remaining boreholes range from Elevation 242.7 m to 239.8 m, measured between ground surface and 6.2 m below ground surface. Borehole H1-6 measured a groundwater level of 0.3 m above ground surface (Elevation 241.6 m) upon completion of drilling. It should be noted that the groundwater levels in the area fluctuate seasonally as well as during precipitation events and snowmelt.

4.4 Highway 17 EBL – STA 12+220 to 12+570 (High Fill H1)

The plan and profiles along the centreline and toes of the proposed embankment of the new Highway 17 East Bound Lane (EBL) alignment showing the borehole locations and interpreted stratigraphy between about STA 12+220 to STA 12+570 in the Township of Louise are shown in Drawings A1 to A4 in Appendix A. The EBL extends across a low-lying swampy area with the proposed embankment up to 5.7 m high above the existing ground. A total of seventeen (17) boreholes (Boreholes H1-16 to H1-30, C1-3 and C1-4) and six (6) DCPTs (H1-DC7 to H1-DC12) were completed to investigate the subsurface conditions within this portion of High Fill Area H1.

The subsurface soils along the EBL alignment in High Fill Area H1 consist of a surficial layer of peat/topsoil underlain by a sandy silt deposit and a cohesive deposit of clayey silt to silt transitioning into varved, silty clay to clay transitioning back into clayey silt, which in turn is underlain by deposits of silt to sandy silt, sand and silt to sand and gravelly sand.

4.4.1 Peat/Topsoil

In all boreholes except H1-29 a deposit of black fibrous peat was encountered from ground surface. In Borehole H1-29 a surficial layer of topsoil was encountered at ground surface. The top of the peat/topsoil layer varies in elevation from 241.6 m to 241.0 m and the thickness ranges from 0.2 m to 1.4 m. In Borehole H1-23, a layer of brown to black organic clay was encountered below the peat at 0.3 m depth and was 1.0 m in thickness.

The SPT ‘N’-values measured within the peat/topsoil deposit range from 0 blows (weight of hammer) to 7 blows per 0.3 m of penetration, indicating a very soft to firm consistency, however, the higher ‘N’-values are typically attributed to frozen ground conditions.

The natural water content measured on seven samples of the peat ranges from about 39 per cent to 420 per cent.

4.4.2 Sandy Silt

A layer of sandy silt was encountered underneath the peat/organics layer in Boreholes H1-16 to H1-19, and H1-22. The top of the deposit was encountered between Elevation 241.0 m and 239.8 m and ranged from 0.2 m to 0.8 m in thickness.

The SPT ‘N’-values measured within the sandy silt layer range from 4 blows to 14 blows per 0.3 m of penetration indicating a loose to compact relative density.

The grain size distribution of one sample of the sandy silt is shown on Figure A10 in Appendix A.

The natural water content measured on two samples of the sandy silt deposit are about 23 per cent and 33 per cent.

4.4.3 Cohesive Deposit

In all boreholes, a cohesive deposit was encountered beneath the peat/organics deposit or beneath the sandy silt deposit. In general the cohesive deposit consisted of an upper clayey silt to silt zone transitioning into varved silty clay to clay, further transitioning back to a lower clayey silt to silt zone. The top of the cohesive deposit was encountered between Elevation 241.2 m and 239.0 m and the overall deposit ranged between 2.0 m and 9.4 m in thickness.

Clayey Silt to Silt

Underlying the sandy silt deposit in Borehole H1-17 and underlying the peat/organic clay deposit in Boreholes H1-23 and H1-25, a clayey silt to silt deposit was encountered. The top of the clayey silt to silt portion of the deposit was encountered between Elevation 240.6 m and 240.0 m and ranged from 0.9 m to 2.4 m in thickness.

The SPT ‘N’-values measured within this portion of the deposit range between 1 blow and 7 blows per 0.3 m of penetration, indicating a very soft to firm consistency.

The grain size distribution of one sample of the clayey silt to silt portion of the deposit is shown on Figure A11 in Appendix A.

Atterberg limits tests were carried out on three samples of the clayey silt to silt portion of the deposit and test results indicate liquid limits ranging from about 24 per cent to 32 per cent, plastic limits ranging from about 17 per cent to 21 per cent and plasticity indices ranging from about 7 per cent to 12 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A12 in Appendix A and indicate that the material is classified as clayey silt to silt of low plasticity.

The natural water content measured on three samples of this portion of the deposit ranges between about 26 per cent and 30 per cent.

Silty Clay to Clay

In all boreholes a deposit of grey, silty clay to clay was encountered underlying the peat and/or silt to sandy silt and/or the clayey silt deposit. In the majority of the boreholes, the silty clay to clay portion of the deposit was observed to be varved, consisting of irregular layers of clayey silt/silty clay and silty clay/clay. The top of the silty clay to clay portion of the deposit was encountered between Elevation 241.2 m and 238.2 m and ranged from 2.0 m to 8.2 m in thickness.

The SPT ‘N’-values measured within this portion of the deposit range between 0 blows (weight of hammer) and 15 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency. In situ field vane tests carried out within this portion of the deposit measured undrained shear strengths ranging from about 13 kPa to 82 kPa and

the sensitivity is calculated to range from about 2 to 18, typically less than 12. One in situ field vane in Borehole H1-21 was measured to be greater than 100 kPa. The field vane tests results indicate that the silty clay to clay has a soft to stiff consistency.

The grain size distributions of four samples of the silty clay to clay portion of the deposit are shown on Figure A3 in Appendix A.

Atterberg limits tests were carried out on twenty-four samples of the silty clay to clay portion of the deposit. The test results indicate liquid limits ranging from about 36 per cent to 76 per cent, plastic limits ranging from about 18 per cent to 30 per cent and plasticity indices ranging from about 17 per cent to 50 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A14 in Appendix A and indicate that the material is classified as silty clay of intermediate plasticity to clay of high plasticity.

The natural water content measured on thirty samples of this portion of the deposit ranges between about 21 per cent and 79 per cent.

Laboratory consolidation (oedometer) tests were carried out on two samples of the silty clay to clay, obtained from Shelby tube samples in Boreholes H1-19 and H1-25. The preconsolidation stress was estimated from the void ratio versus logarithmic pressure plot and from the total work versus pressure plot. A bulk unit weight of 16.3 kN/m^3 and 16.9 kN/m^3 and a specific gravity of 2.77 and 2.78 were measured on the consolidation test samples. The detailed results of the oedometer tests are shown on Figures A15 and A16 in Appendix A, and the test results are summarized below, and in Table 2.

Borehole/ Sample No.	Sample Depth / Elevation	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	e_o	C_c	C_r	c_v^* (cm^2/s)
H1-19/Sample 6	4.6 m/ 236.4 m	31	256	225	8.3	1.86	1.04	0.02	2.1 x 10^{-3}
H1-25/Sample 8	6.6 m/ 234.6 m	56	135	79	2.4	1.52	0.66	0.02	3.8 x 10^{-3}

*For the normally consolidated stress range

where: σ_{vo}' is the effective overburden stress in kPa
σ_p' is the preconsolidation stress in kPa
OCR is the overconsolidation ratio
e_o is the initial void ratio
C_c is the compression index
C_r is the recompression index
c_v is the coefficient of consolidation in cm^2/s

Clayey Silt

Underlying the silty clay to clay in Boreholes H1-19 to H1-21, H1-23, H1-27 and C1-4, a deposit of grey clayey silt was encountered between Elevation 238.0 m and 231.9 m and ranged from 1.0 m to 2.4 m in thickness.

The SPT 'N'-values measured within the clayey silt deposit range between 0 blows (weight of hammer) and 5 blows per 0.3 m of penetration, suggesting a very soft to firm consistency. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 23 kPa to 61 kPa and the sensitivity is calculated to range from about 2 to 11, typically less than 4. The field vane test results indicate that the clayey silt has a soft to stiff consistency.

Atterberg limits tests were carried out on three samples of the clayey silt and indicate liquid limits ranging from about 29 per cent to 33 per cent, plastic limits ranging from about 20 per cent to 21 per cent and plasticity indices ranging from about 9 per cent to 13 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure A17 in Appendix A and indicate that the material is classified as clayey silt of low plasticity.

The natural water content measured on three samples of the deposit ranges between about 33 per cent and 42 per cent.

4.4.4 Silt to Sandy Silt

Underlying the cohesive deposit is a deposit of grey, wet, silt to sandy silt which was encountered in all boreholes except H1-27. The top of the silt to sandy silt deposit was encountered between Elevation 239.0 m and 230.9 m and ranged from 0.8 m to 7.6 m in thickness, where the deposit was fully penetrated. Borehole H1-24 was terminated within this deposit.

The SPT 'N'-values measured within this portion of the deposit range between 0 blows (weight of hammer) to 26 blows per 0.3 m of penetration, indicating a very loose to compact relative density. Two SPT 'N'-values did not penetrate the full sample depth and were measured to be 22 blows per 0.15 m of penetration and 2 blows per 0.1 m of penetration, likely indicative of the close proximity of the bedrock surface.

The grain size distributions of twelve samples of the silt to sandy silt are shown on Figure A18 in Appendix A.

The results of Atterberg limits testing on five samples indicated that the material is classified as non-plastic.

The natural water content measured on fifteen samples of this deposit ranges between about 22 per cent and 42 per cent.

4.4.5 Sand and Silt to Sand

Underlying the silt to sandy silt deposit in Boreholes H1-17 to H1-23, H1-25, H1-26, H1-29, H1-30, C1-3 and C1-4, a deposit of grey sand and silt to sand was encountered between Elevation 237.5 m and 227.7 m and ranged from 0.4 m to 8.8 m in thickness where the deposit was fully penetrated. DCPTs were advanced below the borehole termination depth in Boreholes H1-26, H1-30, C1-3 and C1-4. Boreholes H1-17, H1-21 to H1-23, H1-26, H1-29, H1-30, C1-3 and C1-4 were terminated within this deposit.

The SPT 'N'-values measured within this portion of the deposit range between 0 blows (weight of hammer) and 60 blows per 0.3 m of penetration, indicating a very loose to very dense relative density.

The grain size distributions of eight samples of the sand and silt to sand are shown on Figure A19 in Appendix A.

The natural water content measured on nine samples of this portion of the deposit ranges between about 17 per cent and 28 per cent.

4.4.6 Gravelly Sand

In Boreholes H1-19, H1-25 and H1-27, a deposit of gravelly sand was encountered underlying the sand and silt to sand and/or the cohesive deposit. The top of the gravelly sand deposit was encountered between Elevation 235.6 m and 225.6 m and ranged from 2.8 m to 3.4 m in thickness where the deposit was fully penetrated. A DCPT was advanced below the borehole termination depth in Borehole H1-25. Boreholes H1-19 and H1-25 were terminated within this deposit.

The SPT 'N'-values measured within this portion of the deposit range between 13 blows and 28 blows per 0.3 m of penetration, indicating a compact relative density.

The grain size distributions of two samples of the gravelly sand are shown on Figure A20 in Appendix A.

The natural water content measured on two samples of this portion of the deposit are about 11 per cent and 19 per cent.

4.4.7 Refusal

Refusal to split-spoon and dynamic cone penetration, indicating proximity to the inferred bedrock surface was encountered in Boreholes H1-16, H1-18, H1-20, H1-25 to H1-30, C1-3 and C1-4 and DCPTs H1-DC7 and H1-DC10 to H1-DC-12 at depths ranging from about 4.0 m and 20.7 m below the ground surface or between Elevation 237.3 m and 220.5 m. In DCPTs H1-DC8 and H1-DC9, the DCPT terminated due to recording greater than 100 blows per 0.3 m of penetration, indicative of proximity to the inferred bedrock surface, at depths up to about 21 m below the existing ground surface.

4.4.8 Groundwater Conditions

In general, the soil samples taken in the boreholes were moist to wet. Water levels observed upon completion of drilling ranged from Elevation 241.3 m to 238.3 m, corresponding to depths between ground surface and 3.0 m below ground surface. In Boreholes H1-21 and H1-22, 0.2 m of ponded water was encountered at the ground surface. It should be noted that the groundwater levels in the area fluctuate seasonally as well as during precipitation events and snowmelt.

4.5 Highway 17 WBL – STA 13+140 to 13+390 (High Fill H2)

The plan and profiles along the centreline and toes of the proposed embankment of the new Highway 17 WBL alignment showing the borehole locations and interpreted stratigraphy between STA 13+140 and STA 13+390 in the Township of Louise are shown on Drawings B1 to B6 in Appendix B. The alignment extends across a low-lying swampy area with the proposed embankment up to 5.0 m high above the existing ground. A total of twenty-one (21) boreholes (Boreholes H2-1 to H2-21) and ten (10) DCPTs (DCPTs H2-DC1 to H2-DC10) were completed to investigate the subsurface conditions within this portion of High Fill Area H2.

The subsurface soils along the WBL alignment in High Fill Area H2 consist of a surficial layer of peat/organics, underlain by a cohesive deposit of clayey silt transitioning into varved, silty clay to clay transitioning to clayey silt to silt, which in turn is underlain by deposits of silt to sand to gravelly sand.

4.5.1 Peat/Organics

An approximate 0.1 m to 4.0 m thick deposit of black, fibrous to amorphous peat was encountered at the ground surface in Boreholes H2-2 to H2-20. In Borehole H2-1, a layer of organics was encountered at the ground surface. The surface of the peat/organic deposit varies between Elevation 240.7 m and 239.7 m.

The SPT 'N'-values measured within the peat/organic deposit are typically 0 blows (weight of hammer) to 1 blow per 0.3 m of penetration, suggesting a very soft consistency, however 'N'-values up to 31 blows per 0.3 m of penetration were noted through frozen peat/organic materials.

The natural water content measured on seventeen samples of the peat ranges from about 82 per cent to 670 per cent.

4.5.2 Cohesive Deposit

In all boreholes, a cohesive deposit was encountered beneath the peat/organics deposit or from ground surface in Borehole H2-21. In general, the cohesive deposit consisted of an upper clayey silt to silt zone transitioning into varved silty clay to clay, further transitioning to a lower clayey silt to silt zone. The top of the cohesive deposit was encountered between Elevation 240.6 m and 235.8 m and the overall deposit ranged between 1.7 m and 6.9 m in thickness.

Clayey Silt

In Boreholes H2-1, H2-2 and H2-21 a deposit of grey clayey silt, trace sand, trace organics was encountered underlying the peat/organics deposit. The surface of this portion of the deposit was encountered between Elevation 240.6 m and 238.9 m and ranged from 0.8 m to 4.3 m in thickness.

The SPT 'N'-values measured within this portion of the deposit range between 0 blows (weight of hammer) and 15 blows per 0.3 m of penetration, suggesting a very soft to very stiff consistency. Two in situ field vane tests carried out within this portion of the deposit measured undrained shear strengths of about 43 kPa and 57 kPa and the sensitivity is calculated to be about 5 and 6. The field test results indicate that this portion of the deposit has a firm to stiff consistency.

Atterberg limits tests were carried out on three samples of the clayey silt and indicate liquid limits ranging from about 31 per cent to 34 per cent, plastic limits ranging from about 19 per cent to 22 per cent and plasticity indices ranging from about 9 per cent to 14 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B1 in Appendix B and indicate that the material is classified as clayey silt of low plasticity.

The natural water content measured on five samples of this portion of the deposit ranges between about 20 per cent and 35 per cent.

Silty Clay to Clay

Underlying the peat/organic deposit in Boreholes H2-3 to H2-20 and underlying the clayey silt layer in H2-21, a deposit of grey to brown, silty clay to clay was encountered. In the majority of the boreholes, the silty clay to clay portion of the deposit was observed to be varved, consisting of irregular layers of clayey silt/silty clay and silty

clay/clay. The surface of this portion of the deposit was encountered between Elevation 240.1 m and 235.8 m and ranged from 1.7 m to 6.8 m in thickness.

The SPT 'N'-values measured within this portion of the deposit range between 0 blows (weight of hammer) and 12 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency. In situ field vane test carried out within this deposit measured undrained shear strengths ranging from about 14 kPa to 79 kPa and the sensitivity is calculated to be between about 2 and 16. The field test results indicate that the deposit has a soft to stiff consistency.

The grain size distributions of four samples of this portion of the deposit are presented on Figure B2 in Appendix B.

Atterberg limits tests were carried out on twenty-two samples of the silty clay to clay and indicate liquid limits ranging from about 38 per cent to 80 per cent, plastic limits ranging from about 21 per cent to 25 per cent and plasticity indices ranging from about 17 per cent to 54 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B3 in Appendix B and indicate that the material is classified as silty clay of intermediate plasticity to clay of high plasticity.

The natural water content measured on thirty samples of this portion of the deposit ranges between about 30 per cent and 73 per cent.

Clayey Silt to Silt

In Boreholes H2-7, H2-8, H2-11, H2-18, H2-19 and H2-20, the silty clay to clay transitioned into a grey, clayey silt. The surface of this portion of the deposit was encountered between Elevation 237.0 m and 231.0 m and ranged from 1.3 m to 3.8 m in thickness.

The SPT 'N'-values measured within this portion of the deposit range between 0 blows (weight of hammer) and 3 blows per 0.3 m of penetration, suggesting a very soft to soft consistency. In situ field vane test carried out within this portion of the deposit measured undrained shear strengths ranging from about 24 kPa to 53 kPa and the sensitivity is calculated to be between about 3 and 13. The field test results indicate that this portion of the deposit has a soft to stiff consistency.

A grain size distribution for one sample of this portion of the deposit is presented on Figure B4 in Appendix B.

Atterberg limits tests were carried out on four samples of the lower clayey silt to silt. The test results indicate liquid limits ranging from about 27 per cent to 29 per cent, plastic limits ranging from about 20 per cent to 23 per cent and plasticity indices ranging from about 6 per cent to 9 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B5 in Appendix B and indicate that the material is classified as clayey silt of low plasticity to silt of slight plasticity.

The natural water content measured on six samples of this portion of the deposit ranges between about 33 per cent and 44 per cent.

4.5.3 Silt to Sandy Silt

A deposit of grey silt to sandy silt, trace to some clay, trace to some sand was encountered beneath the cohesive deposit in all of the boreholes within this section of the project.

The surface of this deposit ranges from Elevation 238.5 m to 229.6 m and its thickness ranges from 0.5 m to 10.0 m where the deposit was fully penetrated. Boreholes H2-2 to H2-4, H2-9 to H2-11 and H2-13 were terminated within this deposit.

The SPT 'N'-values measured within this deposit range between 0 blows (weight of hammer) and 29 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The grain size distributions of nineteen samples of this deposit are presented on Figure B6 in Appendix B. The results of Atterberg limits testing on seven samples of the silt deposit indicated that the material is classified as non-plastic.

The natural water content measured on twenty-six samples of this deposit ranges between about 18 per cent and 37 per cent.

4.5.4 Sand and Silt to Sand

A deposit of grey sand and silt to sand, trace clay was encountered underlying the silt deposit in Boreholes H2-5, H2-6, H2-8, H2-14 to H2-18, H2-20 and H2-21. The surface of this deposit ranges from Elevation 233.3 m to 226.6 m. DCPTs were advanced below the borehole termination depth in Boreholes H2-5, to H2-7, H2-14 to H2-18 and H2-21. Borehole H2-8 was terminated within this deposit.

The SPT 'N'-values measured within this deposit range between 0 blows (weight of hammer) and 18 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The grain size distributions of six samples of this deposit are presented on Figure B7 in Appendix B.

The natural water content measured on six samples of this deposit ranges between about 10 per cent and 25 per cent.

4.5.5 Gravelly Sand

A 0.1 m to 2.5 m thick deposit of gravelly sand was encountered in Boreholes H2-1 and H2-19 underlying the silt to sandy silt deposit at Elevation 238.0 m and 226.9 m, respectively. Borehole H2-19 was terminated in this deposit.

The SPT 'N'-values measured within this portion of the deposit range between 6 blows and 17 blows per 0.3 m of penetration, indicating a loose to compact relative density.

A grain size distribution for one sample of the gravelly sand is presented on Figure B8 in Appendix B.

The natural water content measured on one sample of this portion of the deposit is about 10 per cent.

4.5.6 Refusal

Refusal to split-spoon, auger or casing advancement or dynamic cone penetration, indicating proximity to the inferred bedrock surface was encountered in Boreholes H2-1 to H2-6, H2-17, H2-18 and H2-20 and in DCPTs H2-DC1 to H2-DC3, H2-DC7 and H2-DC8 at depths ranging from 2.8 m to 20.3 m below the ground surface or between Elevation 237.9 m and 220.2 m. In Boreholes H2-7, H2-12, H2-14 and H2-21 and DCPTs H2-DC4 to

H2-DC6, H2-DC9 and H2-DC10, the DCPTs terminated upon recording greater than 100 blows per 0.3 m of penetration, indicative of proximity to the inferred bedrock surface, at depths up to about 23 m below the existing ground surface.

4.5.7 Groundwater Conditions

In general, the samples taken in the boreholes were wet. Artesian groundwater levels were measured in Borehole H2-6 and H2-8 with the groundwater level upon completion of drilling measured at 0.5 m and 0.8 m above ground surface, respectively, corresponding to Elevation 240.3 m and 239.9 m. In the remaining boreholes, the groundwater levels observed upon completion of drilling range from about Elevation 235.2 m to 239.9 m, typically measured at the ground surface up to 4.7 m below ground surface, except in Borehole H2-1, which was observed to be dry upon completion of drilling. It should also be noted that the groundwater levels in the area fluctuate seasonally, as well as during precipitation events and snowmelt.

4.6 Highway 17 EBL – STA 13+140 to 13+390 (High Fill H2)

The plan and profiles along the centreline and toes of the proposed embankment of the new Highway 17 EBL alignment showing the borehole locations and interpreted stratigraphy between about STA 13+140 to STA 13+390 in the Township of Louise are shown on Drawings B1 to B6 in Appendix B. The alignment extends across a low-lying swampy area with the proposed embankment up to 5.0 m high above the existing ground. A total of twenty-two (22) boreholes (Boreholes H2-22 to H2-43) and eleven (11) DCPTs (DCPTs H2-DC11 to H2-DC21) were completed to investigate the subsurface conditions within this portion of High Fill Area H2.

The subsurface soils along the EBL alignment in High Fill Area H2 consist of a surficial deposit of peat/organics underlain by a cohesive deposit of clayey silt transitioning into varved, silty clay to clay transitioning to clayey silt, which in turn is underlain by deposits of silt to sand to sand and gravel.

4.6.1 Peat/Organics

An approximately 0.1 m to 3.7 m thick layer of black, fibrous to amorphous peat was encountered at the ground surface in Boreholes H2-23 to H2-41. In Borehole H2-22, H2-42 and H2-43, a layer of organics was encountered at the ground surface. The top of the peat/organic deposit varies between Elevation 242.1 m and 239.6 m.

The SPT ‘N’-values measured within the peat/organic deposit range from 0 blows (weight of hammer) to 2 blows per 0.3 m of penetration, suggesting a very soft consistency, however ‘N’-values up to 14 blows per 0.3 m of penetration were noted through frozen peat.

The natural water content measured on eighteen samples of this portion of the deposit ranges from about 297 per cent to 774 per cent.

4.6.2 Cohesive Deposit

In all boreholes, a cohesive deposit was encountered beneath the peat/organics deposit. In general, the cohesive deposit consisted of an upper clayey silt to silt zone transitioning into varved silty clay to clay, further

transitioning back to a lower clayey silt to silt zone. The top of the cohesive deposit was encountered between Elevation 242.0 m and 236.0 m and overall deposit ranged between 0.5 m and 9.7 m in thickness.

Clayey Silt

In Boreholes H2-23, H2-30 to H2-35, H2-37, H2-39 and H2-43, a deposit of grey clayey silt trace sand, trace organics was encountered underlying the peat/organics deposit. The surface of this portion of the deposit was encountered between Elevation 242.0 m and 236.0 m and ranged from 0.5 m to 2.1 m in thickness.

The SPT 'N'-values measured within the clayey silt deposit range from 0 blows (weight of hammer) to 14 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency. One in situ field vane test carried out within this portion of the deposit measured an undrained shear strength of about 24 kPa and the sensitivity is calculated to be about 2. The field test results indicate that this portion of the deposit has a soft consistency.

Atterberg limits tests were carried out on four samples of the clayey silt. The test results indicate liquid limits ranging from about 28 per cent to 34 per cent, plastic limits ranging from about 18 per cent to 22 per cent and plasticity indices ranging from about 9 per cent to 13 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B9 in Appendix B and indicate that the material is classified as a clayey silt of low plasticity.

The grain size distribution of one sample of the clayey silt portion of the deposit is shown on Figure B10 in Appendix B.

The natural water content measured on six samples of this portion of the deposit ranges from about 22 per cent to 36 per cent.

Silty Clay to Clay

A deposit of silty clay to clay was encountered underlying the peat/organic deposit or the clayey silt deposit in Boreholes H2-25 to H2-42. In the majority of the boreholes, the silty clay to clay portion of the deposit was observed to be varved, consisting of irregular layers of clayey silt/silty clay and silty clay/clay. The surface of the silty clay to clay was encountered between Elevation 241.7 m to 234.1 m, and ranged in thickness between 2.1 m and 8.5 m.

The SPT 'N'-values measured within the silty clay to clay deposit range between 0 blows (weight of hammer) and 12 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 12 kPa to 91 kPa and the sensitivity is calculated to be between about 2 and 35 (typically less than 16). The field test results indicate that the deposit has a soft to stiff consistency.

The grain size distributions of four samples of the silty clay to clay portion of the deposit are shown on Figure B11 in Appendix B.

Atterberg limits tests were carried out on twenty-four samples of the silty clay to clay. The test results indicate liquid limits ranging from about 36 per cent to 80 per cent, plastic limits ranging from about 19 per cent to 27 per cent and plasticity indices ranging from about 14 per cent to 55 per cent. The results of the Atterberg

limits tests are shown on the plasticity chart on Figure B12 in Appendix B and indicate that the material is classified as silty clay of intermediate plasticity to clay of high plasticity.

The natural water content measured on thirty samples of this portion of the deposit ranges from about 30 per cent to 81 per cent.

Laboratory consolidation (oedometer) tests were carried out on two samples of the silty clay to clay obtained from Shelby tube samples in Boreholes H2-26 and H2-36. The preconsolidation stress was estimated from the void ratio versus logarithmic pressure plot and from the total work versus pressure plot. A bulk unit weight of 15.6 kN/m^3 and 16.6 kN/m^3 and a specific gravity of 2.77 and 2.78 were measured on the consolidation test samples. The detailed results of the oedometer tests are shown on Figures B13 and B14 in Appendix B, and the test results are summarized below, and in Table 2.

Borehole/ Sample No.	Sample Depth / Elevation	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	e_o	C_c	C_r	c_v^* (cm^2/s)
H2-26/Sa 7	6.4 m / 233.3 m	39	128	89	3.2	1.67	0.48	0.01	2.0 x 10^{-3}
H2-36/Sa 8A	7.1 m / 232.7 m	47	132	85	2.8	2.13	0.48	0.08	3.8 x 10^{-4}

*For the normally consolidated stress range.

where: σ_{vo}' is the effective overburden stress in kPa
σ_p' is the preconsolidation stress in kPa
OCR is the overconsolidation ratio
e_o is the initial void ratio
C_c is the compression index
C_r is the recompression index
c_v is the coefficient of consolidation in cm^2/s

Clayey Silt to Silt

In Boreholes H2-26, H2-32 to H2-34, H2-39 and H2-41, the silty clay to clay transitioned into grey, clayey silt to silt. The surface of this portion of the deposit was encountered between Elevation 237.2 m and 229.5 m and ranged from 1.4 m to 4.9 m in thickness.

The SPT 'N'-values measured within the clayey silt to silt deposit range from 0 blows (weight of hammer) to 6 blows per 0.3 m of penetration, suggesting a very soft to firm consistency. In situ field vane test carried out within this deposit measured undrained shear strengths ranging from about 19 kPa to 91 kPa and the sensitivity is calculated to be between about 2 and 19 (typically less than 7). The field test results indicate that the deposit has a soft to stiff consistency.

Atterberg limits tests were carried out on five samples of the clayey silt to silt. The test results indicate liquid limits ranging from about 26 per cent to 32 per cent, plastic limits ranging from about 20 per cent to 22 per cent and plasticity indices ranging from about 5 per cent to 12 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B15 in Appendix B and indicate that the material is classified as a clayey silt to silt of low plasticity.

The natural water content measured on six samples of this portion of the deposit ranges from about 36 per cent to 41 per cent.

4.6.3 Silt to Sandy Silt

A deposit of grey silt to sandy silt, trace to some clay, trace to some sand was encountered beneath the organics in Boreholes H2-22 and H2-24 and beneath the cohesive deposit in Boreholes H2-25, H2-28 to H2-38, H2-42 and H2-43. The surface of this deposit ranges from Elevation 240.6 m to 226.5 m and its thickness ranges from about 0.6 m to 10.4 m where the deposit was fully penetrated. Borehole H2-31 was terminated within this deposit.

The SPT 'N'-values measured within the silt to sandy silt deposit range from 0 blows (weight of hammer) to 28 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The grain size distributions of sixteen samples of the silt to sandy silt deposit are shown on Figure B16 in Appendix B. The results of Atterberg limits testing on ten samples of the silt to sandy silt deposit indicated that the material is classified as non-plastic.

The natural water content measured on twenty-two samples of the silt to sandy silt deposit ranges from about 19 per cent to 37 per cent.

4.6.4 Sand and Silt to Sand

A deposit of grey, sand and silt to sand, trace clay was encountered underlying the silt to sandy silt and/or the cohesive deposit in Boreholes H2-23, H2-28, H2-30, H2-32 to H2-35 and H2-37 to H2-43. The surface of this deposit ranges from Elevation 239.8 m to 217.3 m and ranges from 1.3 m to 4.7 m where fully penetrated. DCPTs were advanced below the borehole termination depth in Boreholes H2-30, H2-42 and H2-43. Boreholes H2-32 to H2-35 were terminated within this deposit.

The SPT 'N'-values measured within the sand and silt to sand deposit range from 0 blows (weight of hammer) to 34 blows per 0.3 m of penetration indicating a very loose to dense relative density.

The grain size distribution of thirteen samples of the sand and silt to sand deposit is shown on Figure B17 in Appendix B.

The natural water content measured on fourteen samples of the sand and silt to sand deposit ranges from about 10 per cent to 27 per cent.

4.6.5 Gravelly Sand to Sand and Gravel

In Boreholes H2-24, H2-25, H2-27, H2-29, and H2-36 to H2-41, a deposit of gravelly sand to sand and gravel was encountered beneath the silt to sandy silt and/or the sand and silt to sand deposit. The surface of this deposit ranges between Elevation 235.9 m and 222.0 m, with thickness ranging between 0.3 m and 4.2 m where fully penetrated. A DCPT was advanced below the borehole termination depth in Borehole H2-24. Boreholes H2-36, H2-37, H2-40 and H2-41 were terminated within this deposit.

The SPT 'N'-values measured within the gravelly sand to sand and gravel deposit range from 8 blows to 31 blows per 0.3 m of penetration indicating a loose to dense relative density.

The grain size distributions of four samples of the gravelly sand to sand and gravel deposit are shown on Figure B18 in Appendix B.

The natural water content measured on six samples of the gravelly sand to sand and gravel deposit ranges from about 8 per cent to 23 per cent.

4.6.6 Refusal

Refusal to split-spoon, auger or casing advancement or dynamic cone penetration, indicating proximity to the inferred bedrock surface was encountered in Boreholes H2-22 to H2-29, H2-38 and H2-39 and in DCPTs H2-DC11 to H2-DC13 at depths ranging from 3.2 m to 18.6 m below the ground surface or between Elevation 240.3 m and 221.2 m. In DCPTs H2-DC15 to H2-DC21, the DCPTs terminated upon recording greater than 100 blows per 0.3 m of penetration, indicative of proximity to the inferred bedrock surface, at depths up to about 25 m below the existing ground surface. In DCPT H2-DC14, the rods were observed to be bent at the refusal depth.

4.6.7 Groundwater Conditions

In general, the samples taken in the boreholes were wet. Artesian groundwater levels were measured in Boreholes H2-27 to H2-31 with the groundwater level upon completion of drilling measured between 0.3 m and 1.5 m above ground surface (Elevation 241.2 m to 240.0 m). In the remaining boreholes, the groundwater levels observed upon completion of drilling range from Elevation 240.2 m to 239.9 m, typically measured at the ground surface to 1.7 m below ground surface. It should also be noted that the groundwater levels in the area fluctuate seasonally, as well as during precipitation events and snowmelt.

4.7 St. Pothier Road – STA 9+400 to 9+600 (High Fill H2)

The plan and profiles along the centreline and toes of the proposed embankment of the new St. Pothier Road alignment showing the borehole locations and interpreted stratigraphy between STA 9+400 to STA 9+600 in the Township of Louise are shown on Drawings B1 to B6 in Appendix B. The alignment extends across a low-lying swampy area with the proposed embankment up to 4.4 m high above the existing ground. A total of seventeen (17) boreholes (Boreholes H2-44 to H2-60) and eight (8) DCPTs (DCPTs H2-DC22 to H2-DC29) were completed to investigate the subsurface conditions within this portion of High Fill Area H2.

The subsurface soils along the St. Pothier alignment in High Fill Area H2 consist of a surficial layer of peat underlain by a cohesive deposit of clayey silt transitioning into silty clay to clay transitioning to clayey silt, which in turn is underlain by deposits of silt to sand to sand and gravel.

4.7.1 Peat

A 0.5 m to 3.7 m thick deposit of black, fibrous to amorphous peat was encountered at the ground surface in Boreholes H2-44 to H2-60. The surface of the peat deposit ranges from Elevation 239.8 m to 239.5 m.

The SPT ‘N’-values measured within the peat deposit typically range from 0 blows (weight of hammer) to 1 blow per 0.3 m of penetration suggesting a very soft consistency, however ‘N’-values up to 6 blows per 0.3 m of penetration were noted through frozen peat in Borehole H2-55.

The natural water content measured on eighteen samples of the peat deposit ranges from about 100 per cent to 902 per cent.

4.7.2 Silty Sand

Beneath the peat deposit in Borehole H2-60, a 0.6 m thick layer of silty sand was encountered at Elevation 239.3 m. One SPT 'N'-value measured of 5 blows per 0.3 m of penetration indicates a loose relative density.

One natural water content measured in the silty sand deposit was about 42 per cent.

4.7.3 Cohesive Deposit

In all boreholes, a cohesive deposit was encountered beneath the peat or silty sand deposit. In general, the cohesive deposit consisted of an upper clayey silt to silt zone transitioning into a varved silty clay to clay deposit, further transitioning to clayey silt (in two boreholes). The surface of the cohesive deposit was encountered between Elevation 238.7 m and 235.8 m and the overall deposit ranged between 2.5 m and 10.1 m in thickness.

Clayey Silt

Underlying the peat in Boreholes H2-44, H2-49 and H2-51 to H2-53, a deposit of grey, clayey silt was encountered. The top of the clayey silt was encountered between Elevation 236.2 m and 235.9 m and the thickness ranges from 0.7 m to 3.8 m.

The SPT 'N'-values measured within the clayey silt portion of the deposit typically range from 0 blows (weight of hammer) to 9 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency. Two in situ field vane test carried out within this deposit measured undrained shear strengths of about 65 kPa and 77 kPa and the sensitivity is calculated to be about 7 and 9. The field test results indicate that the deposit has a stiff consistency.

The grain size distribution of three samples of the clay deposit is shown on Figure B19 in Appendix B.

Atterberg limits tests were carried out on five samples of the clayey silt and the test results indicate liquid limits ranging from about 29 per cent to 34 per cent, plastic limits ranging from about 16 per cent to 25 per cent and plasticity indices ranging from about 4 per cent to 16 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B20 in Appendix B and indicate that the material is classified as a clayey silt of low plasticity.

The natural water content measured on six samples of the clayey silt deposit ranges from about 29 per cent to 36 per cent

Silty Clay to Clay

A deposit of silty clay to clay was encountered, underlying the peat or clayey silt in Boreholes H2-45 to H2-60. In the majority of the boreholes, the silty clay to clay portion of the deposit was observed to be varved, consisting

of irregular layers of clayey silt/silty clay and silty clay/clay. The surface of the silty clay to clay was encountered between Elevation 238.7 m to 233.6 m, and ranged in thickness between 2.5 m and 9.8 m.

The SPT 'N'-values measured within the silty clay to clay deposit range from 0 blows (weight of hammer) to 11 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 12 kPa to 69 kPa and the sensitivity is calculated to be between about 2 and 54 (typically less than 16). The field test results indicate that the deposit has a soft to stiff consistency.

The grain size distribution of six samples of the silty clay to clay deposit is shown on Figure B21 in Appendix B.

Atterberg limits tests were carried out on twenty-four samples of the silty clay to clay. The test results indicate liquid limits ranging from about 35 per cent to 64 per cent, plastic limits ranging from about 19 per cent to 25 per cent and plasticity indices ranging from about 12 per cent to 40 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figures B22 in Appendix B and indicate that the material is classified as silty clay of intermediate plasticity to clay of high plasticity.

The natural water content measured on twenty-eight samples of the silty clay to clay portion of the deposit ranges from about 30 per cent to 69 per cent.

Clayey Silt

The silty clay to clay transitioned into grey, clayey silt at Elevation 230.8 m and 232.2 m in Boreholes H2-45 and H2-46, respectively. The deposit is between 3.6 m and 3.8 m in thickness.

The SPT 'N'-values measured within the clayey silt deposit are 1 and 5 blows per 0.3 m of penetration, suggesting a very soft to firm consistency. In situ field vane tests carried out within this deposit measured undrained shear strengths of about 21 kPa and 37 kPa and the sensitivity is calculated to be about 4 and 20. The field test results indicate that the deposit has a soft to firm consistency.

A grain size distribution for one sample of the clayey silt is shown on Figure B19 in Appendix B.

Atterberg limits tests were carried out on two samples of the clayey silt. The test results indicate liquid limits of about 29 per cent and 33 per cent, plastic limits of about 22 per cent and 24 per cent and plasticity indices of about 7 per cent and 10 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure B20 in Appendix B and indicate that the material is classified as a clayey silt of low plasticity.

The natural water content measured on two samples of this portion of the deposit are about 31 per cent and 45 per cent.

4.7.4 Silt to Sandy Silt

A deposit of grey silt to sandy silt was encountered underlying the cohesive deposit in Boreholes H2-45 and H2-7 to H2-60. The surface of the silt to sandy silt deposit was encountered between Elevation 236.2 m and 226.0 m, and the thickness ranged from 0.6 m to 11.6 m. Boreholes H2-50 and H2-54 were terminated within this deposit.

The SPT 'N'-values measured within the silt to sandy silt deposit range from 1 blow to 13 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The grain size distributions of twenty samples of the silt to sandy silt deposit are shown on Figure B23 in Appendix B. The results of Atterberg limits testing on ten samples of the silt to sandy silt deposit indicated that the material is classified as non-plastic.

The natural water content measured on twenty-one samples of the silt to sandy silt deposit ranges from about 23 per cent to 41 per cent.

In Borehole H2-50, a 3.1 m thick interlayer of silty sand to sand was encountered within the sandy silt to silt deposit at Elevation 220.2 m. The natural water content measured on one sample is about 27 per cent.

4.7.5 Sand and Silt to Sand

A deposit of sand and silt to sand was encountered underlying the silt to sandy silt deposit in Boreholes H2-48, H2-49, H2-51 to H2-53 and H2-56 to H2-60 and underlying the cohesive deposit in Borehole H2-46. The surface of the sand and silt to sand deposit was encountered between Elevations 234.2 m and 218.7 m, with the thickness ranging from 0.8 m to 6.1 m, where it was fully penetrated. Boreholes H2-49, H2-51, H2-53, H2-56 and H2-60 were terminated within this deposit.

The SPT 'N'-values measured within the sand and silt to sand deposit range from 1 blow to 70 blows per 0.3 m of penetration, indicating a very loose to very dense relative density. Typically, the values were less than 18 blows indicating that generally, the deposit is very loose to compact. In four samples, the spilt spoon did not penetrate the full sample depth and these higher values are likely associated with the underlying refusal conditions.

The grain size distributions of eight samples of the sand and silt to sand deposit are shown on Figure B24 in Appendix B.

The natural water content measured on eight samples of the sand and silt to sand deposit ranges from about 15 per cent to 26 per cent.

4.7.6 Sand and Gravel

In Boreholes H2-44, H2-45, H2-52, H2-55 and H2-58, a deposit of sand and gravel was encountered underlying the silt to sandy silt or the sand and silt to sand deposits. The surface of this deposit was encountered at Elevation 232.4 m and 217.7 m, with thicknesses ranging between 0.1 m and 1.8 m where the deposit was fully penetrated. Boreholes H2-52, H2-55 and H2- 58 were terminated within this deposit.

The SPT 'N'-values measured within the gravelly sand to sandy gravel deposit range from 14 blows to 30 blows per 0.3 m of penetration which indicates a compact to dense relative density.

4.7.7 Refusal

Refusal to split-spoon, auger or casing advancement or dynamic cone penetration, indicating proximity to the inferred bedrock surface was encountered in Boreholes H2-44 to H2-48, H2-57 and H2-59 and in DCPTs

H2-DC22 and H2-DC23 at depths ranging from 8.3 m to 20.2 m below the ground surface or between Elevation 231.3 m and 219.3 m. In DCPTs H2-DC25 and H2-DC27 to H2-DC29, the DCPTs terminated upon recording greater than 100 blows per 0.3 m of penetration, indicative of proximity to the inferred bedrock surface, at depths up to about 24 m below the existing ground surface.

4.7.8 Groundwater Conditions

In general, the samples taken in the boreholes were wet. The groundwater levels observed upon completion of drilling range from about Elevation 239.8 m to 238.6 m, typically measured at the ground surface up to 0.9 m below ground surface. It should also be noted that the groundwater levels in the area fluctuate seasonally, as well as during precipitation events and snowmelt.

4.8 Highway 17 WBL – STA 13+900 to 14+200 (High Fill H3)

The plan and profiles along the centreline and toes of the proposed embankment of the new Highway 17 WBL alignment showing the borehole locations and interpreted stratigraphy between about STA 13+900 to STA 14+200 in the Township of Denison are shown on Drawings C1 to C4 in Appendix C. The alignment extends across a low-lying swampy area with the proposed embankment up to 3.8 m high above the existing ground. In this area, the existing four-lane highway transitions into a two-lane undivided highway from east to west. A total of thirteen (13) boreholes (Boreholes H3-1 to H3-13) and six (6) DCPTs (DCPTs H3-DC1 to H3-DC6) were completed to investigate the subsurface conditions within this portion of High Fill Area H3.

The subsurface soils along the WBL alignment in High Fill Area H3 consist of surficial layers of peat/topsoil or asphalt and embankment fill, underlain by an upper deposit of sand to sandy silt. These upper deposits are underlain by the main cohesive deposit of clayey silt transitioning into varved silty clay to clay transitioning to clayey silt to silt underlain by a silt deposit, which further is underlain by deposits of sand to sand and silt.

4.8.1 Asphalt

In Boreholes H3-1, H3-3 to H3-5, H3-8 and H3-13 between 100 mm and 370 mm of asphalt was encountered at ground surface.

4.8.2 Fill

Embankment fill was encountered underlying the asphalt in Boreholes H3-1, H3-3 to H3-5, H3-8 and H3-13, from ground surface in Boreholes H3-7, H3-9 and H3-11, and beneath the peat/topsoil in Boreholes H3-2, H3-6, H3-10 and H3-12. The embankment fill was comprised of varying layers of sandy gravel to gravelly sand, silty sand to silt, in some areas clayey silt to silty clay, and sandy gravel to sand. The embankment fill was encountered between Elevation 247.8 m and 240.9 m, and the total thickness ranges between 0.9 m and 6.0 m. In Boreholes H3-1, H3-7, H3-9, H3-11 and H3-13, the clayey silt to silty clay fill was between 0.5 m and 1.3 m thick.

The SPT ‘N’-values measured within the clayey silt to silty clay portion of the fill range from 8 blows to 29 blows per 0.3 m of penetration, indicating a stiff to very stiff consistency. The SPT ‘N’-values measured within the

sand, sandy gravel to gravelly sand and sandy silt to silt fill range from 2 blows to 94 blows per 0.3 m of penetration, indicating a very loose to very dense relative density. Some instances within this portion of the fill, the split-spoon sampler did not penetrate the full sample depth due to inferred blast rock fill fragments within the fill and rock coring techniques were required to advance the borehole through these zones.

The grain size distributions of five samples of the fill deposit are shown on Figure C1 in Appendix C.

The natural water content measured on ten samples of the sand, sandy gravel to gravelly sand and sandy silt to silt fill range from about 2 per cent to 25 per cent.

4.8.3 Peat/Topsoil

In Boreholes H3-6 and H3-10 a deposit of black fibrous peat was encountered from ground surface. In Boreholes H3-7 and H3-11, the peat was encountered beneath the embankment fill. In Boreholes H3-2 and H3-12 a surficial layer of topsoil was encountered at ground surface. The top of the peat/topsoil layer varies from Elevation 243.5 m to 239.2 m, and the thickness ranges from 0.1 m to 1.9 m.

The natural water content measured on one sample of the peat is about 46 per cent.

4.8.4 Sand to Sandy Silt

A deposit consisting of sand to sandy silt was encountered underlying the fill deposit in Boreholes H3-1, H3-3, H3-4, H3-7 and H3-10. The surface of the sand to sandy silt deposit was encountered between Elevation 242.6 m and 239.1 m, and the thickness ranges from 0.6 m to 1.6 m.

The SPT ‘N’-values measured within the sand to sandy silt deposit range from 1 blow to 19 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

A grain size distribution for one sample of the sand to sandy silt deposit is shown on Figure C2 in Appendix C.

The natural water content measured on two samples of the sand to sandy silt deposit are about 20 per cent.

4.8.5 Cohesive Deposit

In all boreholes a cohesive deposit was encountered beneath the peat/topsoil, embankment fill or sand to sandy silt deposits. In some cases the cohesive deposit consisted of an upper clayey silt zone transitioning into a varved silty clay to clay zone further transitioning into a lower clayey silt to silt zone in some areas. The surface of the cohesive deposit was encountered between Elevation 241.0 m and 238.5 m and the overall deposit ranged between 4.7 m and 14.1 m in thickness.

Clayey Silt

In Boreholes H3-2, H3-4, H3-5 and H3-8 to H3-13, the clayey silt portion of the deposit containing trace sand, trace organics was encountered underlying the peat/topsoil, embankment fill or sand to sandy silt deposits. The surface of this portion of the deposit was encountered between Elevation 240.3 m and 238.8 m and ranges from 0.9 m to 3.4 m in thickness.

The SPT 'N'-values measured within the clayey silt deposit range from 0 blows (weight of hammer) to 8 blows per 0.3 m of penetration, suggesting a very soft to firm consistency. In situ field vane tests carried out within this portion of the deposit measured undrained shear strengths ranging from about 25 kPa to 58 kPa (with one field vane noted to be greater than 100 kPa in Borehole H3-10) and the sensitivity is calculated to be between about 3 and 8. The field test results indicate that this portion of the deposit has a firm to stiff consistency.

Atterberg limits tests were carried out on two samples of the clayey silt. The test results indicate liquid limits ranging from about 33 per cent to 34 per cent, plastic limits of about 18 per cent and plasticity indices of about 15 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C3 in Appendix C and indicate that the material is classified as a clayey silt of low plasticity.

The natural water content measured on four samples of this portion of the deposit ranges from about 35 per cent to 45 per cent.

Silty Clay to Clay

In all boreholes, a deposit of grey, silty clay to clay was encountered underlying the peat and/or silt to sandy silt deposits or the upper clayey silt portion of the deposit. In the majority of the boreholes, the silty clay to clay portion of the deposit was observed to be varved, consisting of irregular layers of clayey silt/silty clay and silty clay/clay. The top of the silty clay to clay portion of the deposit was encountered between Elevation 241.0 m and 236.6 m and ranges from 4.6 m to 10.9 m in thickness. Borehole H3-9 was terminated within this deposit, likely on an obstruction.

The SPT 'N'-values measured within this portion of the deposit range between 0 blows (weight of hammer) and 11 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency. It was noted that the 11 blows per 0.3 m was likely due to gravel caved in the borehole. In situ field vane tests carried out within this portion of the deposit measured undrained shear strengths ranging from about 18 kPa to 80 kPa and the sensitivity is calculated to range from about 2 to 12. The field vane tests results indicate that the silty clay to clay has a soft to stiff consistency. Typically, the undrained shear strengths measured were less than 50 kPa suggesting the deposit is generally soft to firm.

The grain size distributions of three samples of the silty clay to clay portion of the deposit are shown on Figure C4 in Appendix C.

Atterberg limits tests were carried out on eighteen samples of the silty clay to clay portion of the deposit. The test results indicate liquid limits ranging from about 35 per cent to 71 per cent, plastic limits ranging from about 17 per cent to 24 per cent and plasticity indices ranging from about 15 per cent to 47 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C5 in Appendix C and indicate that the material is classified as silty clay of intermediate plasticity to clay of high plasticity.

The natural water content measured on twenty-two samples of this portion of the deposit ranges between about 31 per cent and 72 per cent.

A laboratory consolidation (oedometer) test was carried out on one sample of the silty clay to clay portion of the deposit obtained from a Shelby tube sample in Borehole H3-12. The preconsolidation stress was estimated from the void ratio versus logarithmic pressure plot and from the total work versus pressure plot. A bulk unit weight of 18.1 kN/m^3 and a specific gravity of 2.78 was measured on the consolidation test sample. The

detailed results of the oedometer test is shown on Figure C6 in Appendix C, and the test result is summarized below, and in Table 2.

Borehole/ Sample No.	Sample Depth / Elevation	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	e_o	C_c	C_r	c_v^* (cm^2/s)
H3-12/Sa 7	11.0 m / 231.4 m	97	129	32	1.3	1.13	0.41	0.02	1.3×10^{-3}

*For the normally consolidated stress range.

where: σ_{vo}' is the effective overburden stress in kPa
σ_p' is the preconsolidation stress in kPa
OCR is the overconsolidation ratio
e_o is the initial void ratio
C_c is the compression index
C_r is the recompression index
c_v is the coefficient of consolidation in cm^2/s

Clayey Silt to Silt

In Boreholes H3-4, H3-6 to H3-8 and H3-13 the cohesive deposit transitions into grey clayey silt to silt, trace sand. The surface of this portion of the deposit was encountered between Elevation 232.7 m and 227.6 m and ranges from 0.9 m to 2.2 m in thickness.

The SPT 'N'-values measured within the clayey silt to silt portion of the deposit range from 0 blows (weight of hammer) to 9 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency. In situ field vane tests carried out within this portion of the deposit measured undrained shear strengths ranging from about 35 kPa to 58 kPa and the sensitivity is calculated to be between about 1 and 5. The field test results indicate that this portion of the deposit has a firm to stiff consistency.

The grain size distribution of one sample of the clayey silt to silt is shown on Figure C7 in Appendix C.

Atterberg limits tests were carried out on a sample of the clayey silt to silt. The test result indicates a liquid limit of about 25 per cent, a plastic limit of about 19 per cent and a plasticity index of about 5 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C8 in Appendix C and indicate that the material is classified as a clayey silt to silt of slight plasticity.

The natural water content measured on two samples of this portion of the deposit ranges from about 29 per cent to 31 per cent.

4.8.6 Silt to Sandy Silt

A deposit of grey, wet, silt to sandy silt was encountered underlying the cohesive deposit in all boreholes except Borehole H3-9. The surface of the silt to sandy silt deposit was encountered between Elevation 236.3 m and 225.9 m and ranges from 1.4 m to 7.0 m in thickness, where the deposit was fully penetrated. Boreholes H3-4 to H3-6 and H3-13 were terminated within this deposit.

The SPT 'N'-values measured within the silt to sandy silt deposit range between 0 blows (weight of hammer) and 29 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The grain size distributions of six samples of the silt to sandy silt are shown on Figure C9 in Appendix C.

The results of Atterberg limits testing on two samples indicated that the material is classified as non-plastic.

The natural water content measured on six samples of this deposit range between about 29 per cent and 32 per cent.

Sand to Sand and Silt (Interlayer)

In Boreholes H3-3 to H3-6, an interlayer comprised of sand to sand and silt was encountered within the silt to sandy silt deposit. The surface of the sand to sand and silt interlayer was encountered between Elevation 231.4 m and 228.0 m and ranges from 1.5 m to 2.3 m in thickness.

The SPT 'N'-values measured within this portion of the deposit range between 2 and 41 blows per 0.3 m of penetration, indicating a very loose to dense relative density.

The grain size distributions of three samples of the sand to sand and silt interlayer are shown on Figure C10 in Appendix C.

The natural water content measured on three samples of this deposit range between about 24 per cent and 27 per cent.

4.8.7 Sand to Sand and Silt

Underlying the cohesive deposit and/or the silt to sandy silt deposit in Boreholes H3-1 to H3-3 H3-7, H3-8 and H3-10 to H3-12, a deposit of sand to gravelly sand was encountered. The top of the sand to sand and silt deposit was encountered between Elevation 234.9 m and 219.2 m. These boreholes were terminated within this deposit.

The SPT 'N'-values measured in this deposit range between 13 and 33 blows per 0.3 m of penetration, indicating a compact to dense relative density. In one instance the split-spoon did not penetrate the full sample depth indicating proximity to a very dense stratum or inferred bedrock.

The grain size distributions of three samples of the gravelly sand to sand and silt are shown on Figure C11 in Appendix C.

The natural water content measured on four samples of this deposit range between about 11 per cent and 24 per cent.

4.8.8 Refusal

Refusal to split-spoon and dynamic cone penetration, indicating proximity to the inferred bedrock surface was encountered in Borehole H3-1 and in DCPTs H3-DC1 and H3-DC2 at depths ranging from 12.4 m and 20.8 m below the ground surface or between Elevation 232.9 m and 222.1 m. In DCPTs H3-DC3 to H3-DC6, the DCPTs terminated upon recording greater than 100 blows per 0.3 m of penetration, indicative of proximity to the inferred bedrock surface, at depths up to about 28 m below the existing ground surface.

In Borehole H3-9, split-spoon refusal was encountered at 16.0 m depth (Elevation 227.9 m) within the silty clay to clay stratum. In this instance, refusal is likely indicative of the presence of an obstruction.

4.8.9 Groundwater

In general, the samples taken in the boreholes were moist to wet. The groundwater levels observed upon completion of drilling range from Elevation 242.9 m to 240.7 m, typically measured from 0.5 m to 6.0 m below ground surface. It should also be noted that the groundwater levels in the area fluctuate seasonally as well as during precipitation events and snowmelt.

4.9 Highway 17 EBL – STA 13+900 to 14+200 (High Fill H3)

The plan and profiles along the centreline and toes of the proposed embankment of the new Highway 17 EBL alignment showing the borehole locations and interpreted stratigraphy between about STA 13+900 to STA 14+200 in the Township of Denison are shown on Drawings C1 to C4 in Appendix C. The alignment extends across a low-lying swampy area with the proposed embankment up to 3.8 m high above the existing ground. In this area, the existing four-lane highway transitions into a two-lane undivided highway from east to west. A total of thirteen (13) boreholes (Boreholes H3-14 to H3-26 inclusive) and six (6) DCPTs (DCPTs H3-DC7 to H2-DC12) were completed to investigate the subsurface conditions within this portion of High Fill Area H3.

The subsurface soils along the EBL alignment in High Fill Area H3 consist of surficial layers of peat/topsoil or asphalt and embankment fill, underlain by an upper deposit of sand to sandy silt. These upper deposits are underlain by the main cohesive deposit of clayey silt transitioning into varved silty clay to clay transitioning to clayey silt to silt underlain by a silt to sandy silt deposit, which further is underlain by deposits of sand to sand and silt.

4.9.1 Asphalt

In Boreholes H3-14, H3-16, H3-18, H3-20, H3-22, H3-24 and H3-26, between 50 mm and 350 mm of asphalt was encountered at ground surface.

4.9.2 Fill

Embankment fill was encountered in all boreholes except Borehole H3-19. The fill was encountered underlying the asphalt in Boreholes H3-14, H3-16, H3-18, H3-20, H3-22, H3-24 and H3-26, from ground surface in Boreholes H3-17 and H3-21, and beneath the peat/topsoil in Boreholes H3-15, H3-23 and H3-25. The embankment fill was comprised of varying layers of silty sand to gravelly sand, silty sand to silt, in some areas clayey silt to silty clay and sand to sand and gravel. The surface of the fill stratum was encountered between Elevation 247.8 m and 241.4 m, and the total thickness ranges between 1.5 m and 7.2 m. In Boreholes H3-16 to H3-18, H3-20, H3-21, H3-24 and H3-26, the clayey silt to silty clay fill was between 0.9 m and 2.9 m thick.

The SPT ‘N’-values measured within the clayey silt to silty clay portion of the fill range from 0 blows (weight of hammer) to 21 blows per 0.3 m of penetration, indicating a soft to very stiff consistency. The SPT ‘N’-values measured within the silt to silty sand to sand and gravel fill stratum range from 1 blow to 66 blows per 0.3 m of penetration, indicating a very loose to very dense relative density. For one sample interval within the lower sand to sand and gravel portion of the fill stratum, the split-spoon sampler did not penetrate the full sample depth due

to blast rock fill fragments within the fill and rock coring techniques were required to advance the borehole through these zones.

The grain size distributions of eight samples of the fill deposit are shown on Figure C12 in Appendix C.

An Atterberg limits test was carried out on a sample of the silty clay. The test results indicate a liquid limit of about 42 per cent, a plastic limit of about 18 per cent and a plasticity index of about 24 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C13 in Appendix C and indicate that the fill material is classified as silty clay of intermediate plasticity.

The natural water content measured on eight samples of the silt to silty sand to sand and gravel fill range from about 4 per cent to 22 per cent. The natural water content measured on one sample of the silty clay fill is about 21 per cent.

4.9.3 Peat/Topsoil

In Boreholes H3-15, H3-19 and H3-23 a deposit of black fibrous peat was encountered from ground surface. In Borehole H3-25 a surficial layer of topsoil was encountered at ground surface. The surface of the peat/topsoil layer varies in Elevation from 243.1 m to 241.8 m, and the thickness ranges from about to 0.3 m to 2.0 m.

The SPT ‘N’-values measured within the peat deposit range from 0 blows (weight of hammer) to 3 blows per 0.3 m of penetration, indicating a very soft to soft consistency.

The natural water content measured on one sample of the peat is about 390 per cent.

4.9.4 Sand to Sandy Silt

A deposit of sand to sandy silt was encountered underlying the fill deposit in Boreholes H3-14, H3-16 and H3-18. The surface of the deposit was encountered between Elevation 244.0 m and 239.7 m, and the thickness ranges from 1.7 m to 3.1 m.

The SPT ‘N’-values measured within the sand to sandy silt deposit range from 7 blows to 10 blows per 0.3 m of penetration, indicating a loose to compact relative density.

A grain size distribution of one sample of the silty sand deposit is shown on Figure C14 in Appendix C.

The natural water content measured on two samples of the sand to sandy silt deposit are about 18 per cent and 23 per cent.

4.9.5 Cohesive Deposit

In all boreholes a cohesive deposit was encountered beneath the peat/topsoil, embankment fill or sand to sandy silt deposits. In some cases the cohesive deposit consisted of an upper clayey silt zone transitioning into a varved silty clay to clay zone further transitioning into a lower clayey silt to silt in some areas. The top of the cohesive deposit was encountered between Elevation 240.9 m and 238.0 m and the overall deposit ranged between 4.4 m and 16.8 m in thickness.

Clayey Silt

In Boreholes H3-20, H3-21 and H3-23 a deposit of grey clayey silt trace sand was encountered underlying the embankment fill. The surface of this portion of the deposit was encountered between Elevation 239.7 m and 238.8 m and ranged from 0.8 m to 1.8 m in thickness.

The SPT 'N'-values measured within the clayey silt deposit range from 4 blows to 7 blows per 0.3 m of penetration, indicating a firm consistency.

Silty Clay to Clay

In all boreholes a deposit of grey, silty clay to clay was encountered underlying the peat, embankment fill, sand to sandy silt or the upper clayey silt portion of the cohesive deposit. In the majority of the boreholes, the silty clay to clay portion of the deposit was observed to be varved, consisting of irregular layers of clayey silt/silty clay and silty clay/clay. The surface of the silty clay to clay portion of the deposit was encountered between Elevation 240.9 m and 237.1 m and ranged from 3.0 m to 15.2 m in thickness. Borehole H3-23 was terminated within this deposit, likely on an obstruction.

The SPT 'N'-values measured within this portion of the deposit range between 0 blows (weight of hammer) and 8 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency. In situ field vane tests carried out within this portion of the deposit measured undrained shear strengths ranging from about 14 kPa to 84 kPa and the sensitivity is calculated to range from about 1 to 17, typically less than 9. The field vane test results indicate that the silty clay to clay has a soft to stiff consistency. Typically, the undrained shear strengths measured were less than 50 kPa suggesting the deposit is generally soft to firm.

A grain size distribution for one sample of the silty clay to clay portion of the deposit is shown on Figure C15 in Appendix C.

Atterberg limits tests were carried out on eighteen samples of the silty clay to clay portion of the deposit. The test results indicate liquid limits ranging from about 36 per cent to 70 per cent, plastic limits ranging from about 19 per cent to 25 per cent and plasticity indices ranging from about 16 per cent to 45 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C16 in Appendix C and indicate that the material is classified as silty clay of intermediate plasticity to clay of high plasticity.

The natural water content measured on twenty samples of this portion of the deposit ranges between about 19 per cent and 70 per cent.

Laboratory consolidation (oedometer) tests was carried out on one sample of the silty clay to clay portion, obtained from a Shelby tube sample in Borehole H3-24. The preconsolidation stress was estimated from the void ratio versus logarithmic pressure plot and from the total work versus pressure plot. A bulk unit weight of about 18.4 kN/m^3 and a specific gravity of about 2.76 were measured on the consolidation test sample. The detailed results of the oedometer test are shown on Figure C17 in Appendix C, and the test result is summarized below, and in Table 2.

Borehole/ Sample No.	Sample Depth / Elevation	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	e_o	C_c	C_r	c_v^* (cm^2/s)
H3-24/Sa 9	12.5 m / 231.3 m	149	149	0	1.0	1.14	0.36	0.05	1.2×10^{-3}

*For the normally consolidated stress range.

where: σ_{vo}' is the effective overburden stress in kPa
σ_p' is the preconsolidation stress in kPa
OCR is the overconsolidation ratio
e_o is the initial void ratio
C_c is the compression index
C_r is the recompression index
c_v is the coefficient of consolidation in cm^2/s

Clayey Silt to Silt

In Boreholes H3-14, H3-19, H3-21, H3-22, H3-25 and H3-26, the cohesive deposit transitions into grey clayey silt to silt, trace sand. The surface of this portion of the deposit was encountered between Elevation 237.9 m and 224.4 m and ranged from 0.9 m to 1.7 m in thickness.

The SPT 'N'-values measured within the clayey silt to silt deposit range from 0 blows (weight of hammer) to 6 blows per 0.3 m of penetration, suggesting a very soft to firm consistency. In situ field vane tests carried out within this portion of the deposit measured undrained shear strengths ranging from about 36 kPa to 65 kPa and the sensitivity is calculated to be between about 2 and 4. The field test results indicate that this portion of the deposit has a firm to stiff consistency.

The grain size distribution of one sample of the clayey silt to silt is shown on Figure C18 in Appendix C.

Atterberg limits tests were carried out on three samples of the clayey silt to silt portion of the deposit. The test results indicate liquid limits ranging from about 28 per cent to 34 per cent, plastic limits ranging from about 19 per cent to 21 per cent and plasticity indices ranging from about 8 per cent to 14 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C19 in Appendix C and indicate that the material is classified as a clayey silt of low plasticity.

The natural water content measured on four samples of this portion of the deposit ranges from about 30 per cent to 39 per cent.

4.9.6 Silt to Sandy Silt

A grey, wet, silt to sandy silt deposit was encountered underlying the cohesive deposit in all Boreholes except H3-14 and H3-23. The surface of the silt to sandy silt deposit was encountered between Elevation 235.9 m and 222.8 m and ranged from 1.6 m to 6.6 m in thickness, where the deposit was fully penetrated. A DCPT was advanced below the borehole termination depth in Borehole H3-13. Boreholes H3-16, H3-18 and H3-25 were terminated within this deposit.

The SPT 'N'-values measured within this portion of the deposit range between 2 blows to 26 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The grain size distributions of ten samples of the silt to sandy silt are shown on Figure C20 in Appendix C.

The results of Atterberg limits testing on one sample indicated that the material is classified as non-plastic.

The natural water content measured on ten samples of this deposit range between about 29 per cent and 33 per cent.

Sand (Interlayer)

In Borehole H3-18 a 1.5 m thick sand interlayer was encountered within the silt to sandy silt deposit. The top of the sand interlayer was encountered at Elevation 228.9 m.

One SPT 'N'-value measured within the sand interlayer was 9 blows per 0.3 m of penetration, indicating a loose relative density.

4.9.7 Sand to Sand and Silt

Underlying the cohesive deposit or the silt to sandy silt deposit in Boreholes H3-14, H3-15, H3-17, H3-19 to H3-22, H3-24 and H3-26, a deposit of sand to sand and silt was encountered. The surface of the sand to sand and silt deposit was encountered between Elevation 236.3 m and 220.1 m. All boreholes were terminated within this deposit after penetrating a minimum of 1.1 m. The last sample in Borehole H3-15 was observed to comprise of gravelly sand.

The SPT 'N'-values measured within this portion of the deposit range between 7 and 26 blows per 0.3 m of penetration, indicating a loose to compact relative density. In Borehole H3-15, the gravelly sample measured an SPT 'N'-value of 66 blows per 0.3 m of penetration, indicating a very dense relative density.

The grain size distributions of two samples of the sand to sand and silt deposit are shown on Figure C21 in Appendix C.

The natural water content measured on two samples of this deposit are about 17 per cent and 25 per cent.

4.9.8 Refusal

Refusal to split-spoon and dynamic cone penetration, indicating proximity to the inferred bedrock surface was encountered in Boreholes H3-18 and H3-21 and in DCPTs H3-DC7 to H3-DC9 at depths ranging from about 12.3 m and 25.0 m below the ground surface or between Elevation 231.9 m and 219.4 m. In DCPT H3-DC12, the DCPT terminated upon recording greater than 100 blows per 0.3 m of penetration, indicative of proximity to the inferred bedrock surface, at depths up to about 26 m below the existing ground surface.

In Borehole H3-23, split-spoon refusal was encountered at 15.6 m depth (Elevation 226.3 m) within the silty clay to clay stratum. In this instance, refusal is likely indicative of the presence of an obstruction.

4.9.9 Groundwater

In general, the samples taken in the boreholes were moist to wet. The groundwater levels observed upon completion of drilling range from Elevation 243.8 m to 238.7 m, typically measured from 1.6 m to 6.0 m below ground surface. In Boreholes H3-15 and H3-19, 0.2 m of ponded water was encountered at the ground surface.

It should also be noted that the groundwater levels in the area fluctuate seasonally as well as during precipitation events and snowmelt.

5.0 CLOSURE

The field personnel supervising the drilling program were Messrs. Shane Albert, Gabriel Mathieu, Ed Savard, Indulis Dumpis, Trevor Moxam, Lubo Kosc and Adam Core, under the direction of Mr. Evan Childerhose, P.Eng. This report was prepared by Mr. Adam Core, E.I.T. and the technical aspects were reviewed by Ms. Sarah Poot, P.Eng., a senior geotechnical engineer and Associate of Golder. Mr. Jorge M.A. Costa, P.Eng., Golder's Designated MTO Contact for this project and Principal of Golder, conducted an independent quality control review of the report.

Report Signature Page

GOLDER ASSOCIATES LTD.

Adam Core, E.I.T.
Geotechnical Engineering Intern

LICENSED PROFESSIONAL ENGINEER
S. E. M. POOT
90471921
7/6/15
PROVINCE OF ONTARIO

Sarah E. M. Poot, P. Eng.
Senior Geotechnical Engineer, Associate

LICENSED PROFESSIONAL ENGINEER
J M. A. COSTA
07/06/15
PROVINCE OF ONTARIO

Jorge M. A. Costa, P. Eng.
Designated MTO Contact, Principal

AC/SEMP/JMAC/kp

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PART B

FOUNDATION DESIGN REPORT

HIGH FILL EMBANKMENTS OVER SWAMPS

HIGHWAY 17 FOUR-LANING EXTENSION FROM 20.5 KM WEST OF HIGHWAY 144, EASTERLY 6.5 KM

MINISTRY OF TRANSPORTATION, ONTARIO

GWP 156-98-00

June 6, 2015
Report No. 11-1191-0007-01

Golder Associates

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

This section of the report provides an interpretation of the geotechnical data obtained during the subsurface investigation and recommendations on the foundation aspects of the design of the proposed works. The recommendations provided are intended for the guidance of the design engineer. Where comments are made on construction, they are provided to highlight aspects of construction that could affect the design of the project. Those requiring information on aspects of construction must make their own interpretation of the subsurface information provided as it affects their proposed construction methods, costs, equipment selection, scheduling and the like.

6.1 General

Golder Associates Ltd. (Golder) has been retained by D. M. Wills Ltd. (DMW) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for high fill embankments crossing over swamp areas located within the limits of the new Highway 17 alignment. The proposed high fill embankments outlined in the project limits are part of the Highway 17 new interchange and extension of the existing four-laning at the West Junction of Sudbury Municipal Road 55, from 20.5 km west of Highway 144, easterly for 6.5 km. As part of this work, foundation recommendations are required for the high fill embankments over swamp crossings (about 1.1 km in total length). Table 1 summarizes the locations of the areas investigated within the project limits that require foundation design for the new Highway 17 alignment and maximum proposed embankment height for that section of swamp crossing.

This report presents the results of embankment stability and settlement analyses and provides recommendations for stable embankment geometry and embankment fill materials, and implementation of mitigation alternatives that may be required as a means to improve stability (if necessary) and reduce post-construction settlements. The report also addresses potential construction concerns and geotechnical problems associated with embankment construction, sub-excavation of soft/organic materials and placement of new fill materials.

6.2 High Fill Embankments and Embankments Over Swamps

Based on the vertical profiles of the proposed Highway 17 and St. Pothier road alignment provided to Golder by DMW, the new highway/road crossings over high fill/swamp areas will require fill embankments ranging in height from about 2 m to about 5.5 m.

Sections 6.2.2 and 6.2.3 of this report summarize the methods used to analyze the stability and settlement for critical sections of high fill embankment/swamp crossing construction for the new four-lane extension of Highway 17. Section 6.4 provides discussions of potential alternatives for mitigating embankment stability and settlement and related design and construction issues. The embankment height and location of the critical embankment stability sections and recommendations for mitigating stability and time-dependent settlements for each individual high fill/swamp crossing area, where applicable, are presented in Section 6.5. General aspects of subgrade preparation and embankment construction are presented in Section 6.6.

At all high fill/swamp crossing areas, the analyses assume that organic materials (i.e., peat, topsoil and soils with organics) will be removed prior to construction of the new and widened embankments (as discussed in Section 6.6.1). The thickness of organic deposits at each high fill/swamp crossing area and the soil parameters

employed in the stability and settlement analyses are presented in Table 3. The piezometric conditions required in the analyses are based on the groundwater levels noted during drilling, which were generally measured at or near the level of the natural ground surface at most borehole locations.

The analyses also assume the profile grades provided by DMW. Should the final grade be changed after issuing this report, Golder should be contacted to review the recommendations contained herein. We further understand that the median of the twinned embankments is likely to be filled with rock fill to some level and this has also been assumed in our analyses.

6.2.1 Embankment Fill Types and Berm Requirements

Different embankment fill alternatives (i.e., rock fill and granular fill) provide relative advantages and disadvantages in terms of availability, weight (i.e., driving force and applied load to the founding deposit), construction cost and time, ease of construction and post-construction performance.

We understand that rock fill is the preferred embankment fill material for this project due to its availability from rock blasting for road cuts required elsewhere on the project. In this regard, the stability and settlement analyses discussed in Section 6.5 have been carried out assuming the new highway embankments will generally be constructed of rock fill. Where the existing embankments are to be widened, granular fill has also been considered in the analyses.

Rock Fill

The advantages of constructing new embankments using rock fill include the ability to achieve steeper side slopes (1.25H:1V), which is required in areas with limited right-of-way, as well as reducing the overall quantity of fill material required for the project, and the material can be placed in sub-excavated areas under water. Rock fill will also be available locally, either from excavations in deep cuts through bedrock outcrops within this and other phases of the project alignment or from rock borrow areas close to the project limits. The disadvantage of using rock fill for the construction of embankments is that some post-construction settlement of the embankment fill itself will occur. Settlement of the rock fill is discussed further in Section 6.2.3.3.

In accordance with MTO Northern Region Pavement Practices and Guidelines (1997) as amended by MTO Memorandum "*Use of Mid-Slope Berms for Rock Fill Embankments*" dated February 8, 2005, 2 m wide berms should be incorporated into the rock fill embankment side slope profile for uninterrupted slopes greater than 10 m high. Given that none of the proposed new embankments are greater than 5.7 m high, the 2 m wide mid-slope berms will not be required within these project limits.

Granular Fill

The main advantages of using granular fill for embankment construction are the ease of construction and negligible post-construction settlement within the embankment fill itself. However, this option will require a larger volume of fill and potentially wider right-of-way because the side slopes of granular fill embankments (2H:1V) are flatter than those of rock fill embankments. For this project, acceptable granular fill is considered to be well graded, locally available and/or imported granular material. The use of granular fill may be preferred in areas of embankment widening where rock fill may be difficult to place.

Granular fill would also need to be used as backfill below the ground surface, after removal of the organic deposits and near surface cohesive soils, to allow for installation of wick drains should they be considered the preferred settlement mitigation alternative.

6.2.2 Stability

The following report sections outline the methodology used to evaluate embankment stability at the various high fill/swamp crossing areas and also present the parameters used in the analyses for each of the critical section(s). The results of the stability analyses for each high fill/swamp crossing area, the results of the settlement analyses, and recommendations regarding possible design and construction alternatives to mitigate stability issues and/or post-construction settlement are presented in Section 6.5.

6.2.2.1 Methodology

Stability analyses were carried out for the critical sections of the proposed fill embankments in each high fill/swamp crossing area. Critical sections correspond to the greatest new embankment height and/or the maximum thickness of soft, compressible cohesive soils and/or the largest amount of peat/topsoil/organic sub-excavation. Generally, one critical section was identified for each high fill/swamp crossing area. In all areas where cohesive deposits were encountered, the stability of the proposed new embankment section(s) was analyzed using limit equilibrium methods. The stability analysis assumes that the organic deposits and near surface cohesive soils have been removed and replaced in accordance with OPSD 203.010 (Embankments Over Swamps) prior to construction of the new embankment or OPSD 203.020 (Embankments over Swamp, Existing Slope Excavated to 1H:1V) for embankment widening. The thicknesses of the organic deposits are presented in Table 3.

All limit equilibrium slope stability analyses were carried out using the commercially available program GeoStudio 2007 (Version 7.19), produced by Geo-Slope International Ltd., employing the Morgenstern-Price method of analysis. For all analyses, the Factor of Safety (FoS) of numerous potential failure surfaces was computed in order to establish the minimum FoS. The FoS is defined as the ratio of the forces tending to resist failure to the driving forces tending to cause failure. A target minimum FoS of 1.3 is normally adopted for the design of embankment slopes under static total stress (undrained) conditions at the end of construction and for long-term effective stress (drained) conditions for MTO embankments. This FoS is considered adequate for the embankments at these sites considering the design requirements and the field data available and is based on deep-seated, global failure surfaces that would affect the operation of the highway. In order to obtain the critical failure surface, circular or “rotational” and/or block or “wedge” failure surfaces were modeled in the analysis. The stability analyses were carried out to assess the minimum FoS for the various embankment heights and geometries, with the results of the stability analyses compared to the target minimum FoS for each critical section.

6.2.2.2 Parameter Selection

The simplified stratigraphy together with the associated strength(s) and unit weight(s) employed for the different native soil types at the critical sections in each high fill/swamp crossing area are summarized in Table 3. Additional details of foundation engineering parameters employed for the cohesive deposits (i.e., clayey silt / silty

clay / clay) encountered are provided on Figures A21, B25 and C22 in Appendices A, B and C, respectively. The rock fill modelled in the analyses (below and above the water table) is assumed to have a unit weight of 19 kN/m^3 and an effective friction angle of 40°. The granular fill (assume Granular B Type II) modelled in the analyses is assumed to have a unit weight of 20 kN/m^3 (uncompacted below the water table) and 21 kN/m^3 (above the water table) and an effective friction angle of 35°. The stability of the Highway 17 and St. Pothier Road embankments were analyzed for a side slope geometry of 1.25H:1V assuming rock fill construction and backfill. For embankments constructed of granular fill (typically for widened embankments), side slopes of 2H:1V were analyzed. Granular fill is also required to backfill sub-excavated areas to allow for wick drain installation if this is the preferred mitigation option.

The overburden encountered in the various areas is generally composed of organic deposits and/or embankment fill underlain by interlayered deposits of either granular soils (sand, silty sand, sandy silt, silt and sand, silt) or a combination of cohesive deposits (clayey silt, silty clay and/or clay). For granular soils, effective stress parameters were employed in the analyses assuming drained conditions. The effective stress parameters (effective friction angle and effective cohesion) for the organics and granular soils were estimated from empirical correlations using the results of in situ SPTs, in conjunction with engineering judgement based on experience in similar soil conditions.

For cohesive deposits, total stress parameters were employed in the analyses assuming undrained conditions. The total stress parameters (i.e., average mobilized undrained shear strength – s_u) for the cohesive soils were assessed based on the results of in situ field vane shear tests, inferred from the laboratory consolidation tests results, and estimated from correlations with the SPT results and other laboratory test data (i.e., natural water content), where appropriate. For the consolidation tests, the following correlation proposed by Mesri (1975) was employed to estimate the undrained shear strength:

$$s_u = 0.22\sigma'_p$$

where:
s_u = average mobilized undrained shear strength (kPa)
σ'_p = preconsolidation pressure (kPa)

Where appropriate, Bjerrum's correction factor for plasticity was employed to estimate the average mobilized undrained shear strength from the results of the in situ field vane tests as follows:

$$s_{u(mob)} = \mu s_{u(FV)} \quad \text{(after Bjerrum, 1973)}$$

where:
$s_{u(mob)}$ = average mobilized undrained shear strength (kPa)
$s_{u(FV)}$ = undrained shear strength from field vane test (kPa)
μ = Bjerrum's correction factor based on Plasticity Index

Where varved clay was encountered, an additional reduction factor of 25 per cent was employed to account for the angle of minimum shearing resistance (Milligan and Lo, 1967).

6.2.3 Settlement

The following sections outline the methods used to carry out the settlement analyses at the various high fill/swamp crossing areas and also present the parameters used in the analyses for each of the embankment

critical section(s). The results of the analyses are presented in Section 6.5 for each high fill/swamp crossing area where they are discussed together with the results of the stability analyses and recommendations regarding possible design and construction alternatives to mitigate stability issues and/or post-construction settlement.

6.2.3.1 Methodology

To estimate the magnitude of the expected settlements, analyses were carried out at the critical sections of the proposed fill embankments using the commercially available program Settle^{3D} (Version 2.0) produced by Rocscience Inc. and/or hand/spreadsheet calculations. Critical sections correspond to the greatest new embankment height and/or the maximum thickness of soft, compressible cohesive soils and/or the maximum thickness of peat removal. The settlement analysis assumes that the organic deposits and near surface cohesive soils have been removed and replaced in accordance with OPSD 203.010 (Embankments Over Swamps) prior to construction of the new embankment or OPSD 203.020 (Embankments over Swamp, Existing Slope Excavated to 1H:1V) for widened embankments.

The sources of settlement are considered to include:

- immediate settlement of the native granular soils;
- primary time-dependent consolidation of the cohesive deposits (using Terzaghi's one-dimensional consolidation theory);
- secondary time-dependent (creep) consolidation of the cohesive deposits (long-term); and
- self-weight compression of the embankment fill materials (short-term and long-term).

The thickness of the compressible foundation soils and the height of the embankments vary along the proposed highway alignment within each high fill/swamp crossing area, and as such the settlement along the length of a given alignment will similarly vary. Given that the analyses were carried out at the critical sections of each high fill/swamp crossing area, the settlement estimated will generally represent the maximum value along a given section of the alignment.

6.2.3.2 Parameter Selection

The simplified stratigraphy together with the associated deformation and time-rate consolidation parameters employed for the different native soil types for the critical sections in each high fill/swamp crossing area are given in Table 3. Additional details of foundation engineering parameters employed for the cohesive deposits (i.e., clayey silt/silty clay/clay) encountered in areas H1, H2 and H3 are provided on Figures A21, B25 and C22 in Appendices A, B and C, respectively.

The immediate compression of the cohesionless deposits were modelled by estimating an elastic modulus of deformation based on the SPT 'N'-values and using correlations proposed by Bowles (1984) and Kulhawy and Mayne (1990). These estimated values were compared with the typical range of expected values for similar soil types, as outlined in Canadian Highway Bridge Design Code and its commentary (CHBDC 2006) and adjusted, if appropriate.

The consolidation settlement of the cohesive deposits was assessed using the results of the laboratory consolidation tests and, where appropriate, in situ field vane tests to estimate the deformation parameters for the cohesive deposits. In addition, the results of the laboratory index testing were also employed to further assess deformation parameters (i.e., recompression and compression indices) using empirical correlations proposed in literature by Koppula (1986), Terzaghi and Peck (1967), Kulhawy and Mayne (1990) and Azzouz et al. (1976). The correlation by Terzaghi and Peck (1967) and Koppula (1986) relating the natural water content and liquid limit to the compression index was found to be the most consistent with the results of laboratory consolidation tests for the clayey soils at this site.

The following correlation relating in situ undrained shear strength to preconsolidation pressure (Mesri, 1975) was employed:

$$\sigma'_p = \frac{s_{u(mob)}}{0.22}$$

where:

$s_{u(mob)} = \mu s_{u(FV)}$
σ'_p = preconsolidation pressure (kPa)
$s_{u(mob)}$ = average mobilized undrained shear strength (kPa)
$s_{u(FV)}$ = undrained shear strength from field vane test (kPa)
μ = Bjerrum's correction factor based on Plasticity Index

The coefficient of consolidation, c_v (cm^2/s), required in the time-rate settlement analysis, was established for the high fill/swamp crossing areas (H1, H2 and H3) using the combined results of the laboratory consolidation tests and the estimated c_v values based on the Unified Facilities Criteria (U.S. Navy, NAVFAC 1986) correlation with liquid limit assuming normally consolidated soils.

In addition to primary consolidation within the cohesive deposits (i.e., clayey silt to clay), secondary compression may also occur. Secondary compression is referred to as creep settlement and occurs over a long period of time, after full dissipation of excess pore pressure under a constant stress. The following relationship has been employed for estimating the magnitude of creep settlement over the life of the embankment following the completion of primary settlement at each location:

$$S_c = HC_{\alpha\varepsilon} log(\frac{t}{t_{EoP}})$$

where:

S_c = secondary consolidation (creep) settlement (mm)
$C_{\alpha\epsilon}$ = modified secondary compression index as estimated from laboratory consolidation tests
H = initial thickness of compressible clay deposit (mm)
t = post-construction period of interest (20 years)
t_{EoP} = time to reach end of primary consolidation (years)

In addition to estimating the modified secondary compression index from consolidation tests, the following empirical correlation by Mesri (1973) was also utilized to estimate $C_{\alpha\varepsilon}$ from water content:

$$C_{\alpha\epsilon} = \frac{w_n}{10{,}000}$$

where:

w_n = natural water content (%)

6.2.3.3 Settlement of Embankment Fill

Where rock fill is used for the construction of the proposed embankments, there will be settlement due to compression of the rock fill itself under self-weight, in addition to the settlement of the underlying foundation soils as described above. The magnitude of settlement of the rock fill depends on the following factors:

- type of rock/strength of particles;
- size and shape of rock particles;
- gradation of rock fill;
- total height/thickness of rock fill (stress level); and
- method of construction and sequence of placement (including lift thickness, compactive effort and state of packing).

The settlement of rock fill occurs as a result of re-arrangement of rock particles under load and wetting and as a result of localized crushing of rock particles at point contacts. The magnitude of both the short-term and long-term post-construction settlement of the rock fill is a function of the height of fill as well as the method of fill placement (i.e., compacted versus dumped rock fill) as outlined in MTO Foundations' Guideline for Rock Fill Settlement and Rock Fill Quantity Estimates (MTO, 2010).

Rock fill should be placed, whenever possible, in a controlled manner (i.e., not end-dumped) in accordance with OPSS.PROV 206 (Grading). Blading, dozing and 'chinking' the rock fill to form a dense, compact mass is required to minimize voids and bridging and to reduce settlements and should be used to construct rock fill embankments above the existing groundwater table. Where rock fill cannot be placed in a controlled manner (i.e., below the groundwater table), the post-construction settlement of the rock fill is expected to be greater.

Short-Term Rock Fill Settlement

The magnitude of short-term post-construction settlement associated with compacted and end-dumped rock fill may be estimated in accordance with the MTO Foundations Guideline (MTO, 2010), as follows:

Height of Rock Fill, H	Short-Term Rock Fill Settlement	
	Compacted Rock Fill	Dumped Rock Fill
Up to 5 m	0.5% H	1.0% H
>5 m to 10 m	0.75% H	1.5% H
>10 m to 15 m	1.0% H	2.0% H

Approximately 90 per cent of the short-term settlement may be expected to occur within the first six (6) months following construction of the embankment to full height. The short-term settlement is expected to be fully completed within one (1) year following the completion of embankment construction to full height.

Long-Term Rock Fill Settlement

The magnitude of long-term post-construction settlement for compacted and end-dumped rock fill may be estimated in accordance with the MTO Foundations Guideline (MTO, 2010), as follows:

Total Height of Rock Fill, H	Long-Term Rock Fill Settlement	
	Compacted Rock Fill	Dumped Rock Fill
Up to 15 m	0.1% H	0.2% H

The long-term rock fill settlement is expected to occur from one (1) year following the completion of construction over the life of the embankment.

6.2.4 Wick Drain Parameters

A detailed wick drain analysis has not been completed as part of this report. Where wick drains have been recommended to mitigate post construction settlement, total stress analysis has been used to analyze the stability of the embankments. Detailed wick drain design, which should be carried out if this mitigation option is the preferred option, typically utilizes effective stress analysis.

For purposes of the preliminary wick drain settlement analysis in this report, we have assumed that the smear ratio, (k_h/k_s), (i.e. the ratio of horizontal permeability of the undisturbed soil (k_h) to the permeability of the soil in the smear zone (k_s)),is 5. We have also assumed the ratio of the coefficient of consolidation in the horizontal direction to the coefficient of consolidation in the vertical direction, (c_h/c_v), is 1.2.

6.3 Settlement Performance Requirements

The settlement performance criteria for the design of high fill embankments and embankments over swamp crossings are in accordance with MTO Foundations' Guideline for Embankment Settlement Criteria for Design (MTO, 2010). In general, new embankments not approaching a structural element are to be designed as follows:

Type	Maximum Limits During Pavement Design Life	
	Total Settlement	Differential Settlement Rate
Freeways (i.e., Highway 17)	100 mm	200:1
Non-Freeways (i.e., St. Pothier Road)	200 mm	100:1

Widened embankments are to be designed as follows, such that drainage is not impeded:

Type	Maximum Limits During Pavement Design Life	
	Total Settlement	Differential Settlement Rate
Freeways (i.e., Highway 17)	50 mm	200:1
Non-Freeways (i.e., St. Pothier Road)	75 mm	100:1

These total and differential settlement rates are considered to be applicable over a 20-year period following completion of construction (i.e., final paving). These performance criteria form part of the overall design performance for each high fill/swamp crossing area.

Where new embankments approach structural elements, more stringent settlement criteria will apply, in accordance with the MTO Foundations' Guideline (MTO, 2010).

6.4 Stability and Settlement Mitigation Options

At each high fill embankment and embankment over swamp crossing location, stability and settlement have been assessed based on existing subsurface conditions and proposed embankment fill heights. The presence of weak/soft, compressible soils underlying a proposed embankment can lead to the potential for instability or unacceptably large settlements with the placement of fills. There are a number of options for mitigating the potential for instability and/or settlements. A brief discussion on these alternatives is given below.

Details of the mitigation options for the high fill/swamp crossing areas requiring measures to mitigate stability/settlement issues of the foundation soils are provided in Section 6.5. These measures include: preloading of the subsoil with or without surcharging the embankments; installation of wick drains into the cohesive stratum; incorporation of lightweight fill (expanded polystyrene (EPS) or cellular concrete) into the embankment; full sub-excavation of unsuitable (organic/soft/compressible) soils; and potential combinations of these measures. Other ground improvement measures such as rammed aggregate piers and deep soil mixing are also considered as discussed in Section 6.4.6. Associated monitoring programs are discussed in Section 6.4.7. The advantages, disadvantages, relative costs and risks/consequences of mitigation alternatives for the high fill/swamp crossing areas, where required, are summarized in the Evaluation of Stability/Settlement Mitigation Options Tables A1, A2, B1, B2 and C1 provided in the respective appendices. In addition, a comparison of the estimated post-construction settlement over a 20-year period between the base case (i.e., no settlement mitigation carried out) and the various mitigation alternatives considered was carried out for each of the high fill/swamp crossing areas. The results of the settlement analyses are summarized in Table 4.

Depending on the area, one alternative or a combination of alternatives to mitigate stability and/or settlement issues may be more advantageous than others. A summary of the preferred foundation mitigation option for each high fill/swamp crossing area, including the recommended embankment fill type and embankment side slope, maximum depth of organics encountered, stability/settlement mitigation, estimated settlement (during construction and post-construction), recommended width of platform widening and recommended excavation guideline is provided in Table 5.

In areas where the embankments are being widened and the overall grade raise is limited (i.e. less than about 300 mm), it is anticipated that there will not be any significant risk of instability of the embankments. In these areas there is typically no need to implement any special construction procedures or schedule to maintain stability or to mitigate differential settlement of the foundation soils.

6.4.1 Preloading (with Stability Berms and/or Staged Construction)

Preloading of the foundation soils may be considered for improving the stability and reducing post-construction settlements of the proposed embankments. Preloading refers to the placement of fill either up to the proposed profile grade of the highway/roadway or a portion thereof (i.e., partial preload), in one or more stages, in

advance of embankment completion and final pavement construction, in order to preconsolidate the underlying compressible soils. Preloading reduces the magnitude of long-term, post-construction settlements by promoting such settlements to occur under fill loads in advance of final grading of the embankment. It also may increase the strength of cohesive soils underlying the embankment footprint, thereby improving stability.

In general, preloading requires placement of embankment fill (either in whole or part), and in some cases monitoring of settlement, and possibly pore pressures, for a period of time corresponding to approximately the 'End of Primary' (EoP) consolidation of cohesive soils. EoP consolidation times will vary depending on the properties and thicknesses of the cohesive deposits, and the height of the fill. Where secondary consolidation (creep) settlements are expected to be small over the design life of the embankment, final grading for construction can proceed once the estimated EoP consolidation has occurred. Where creep settlements are considered to be large enough to affect the long-term performance of the highway, these settlements can be reduced by constructing a portion of the final embankment with lightweight fill upon the completion of the design preload period or by surcharging.

In areas where cohesive deposits are thick and/or weak/soft, and where such conditions coincide with proposed high embankment fills, it may be necessary to construct stability berms along the embankment toes and/or place the embankment fill in stages in layers of limited thickness to ensure that the stability of the embankment is maintained. Stability (toe) berms consist of rock fill buttresses placed against the toe of the proposed embankment fill, producing a stepped embankment cross-section geometry. This stepped configuration produces a similar effect (i.e., increased stability) as using flatter embankment slopes, but often requires less fill material. Depending on the subsurface conditions and the proposed embankment height, toe berms will typically be on the order of about one third to one half of the height of the final embankment. The lateral extent (width) of toe berms will vary depending on the results of the stability analyses, but could range from half to one times the highway embankment height, or greater. Where staged construction is required, the individual layers of fill would have limited thickness and each construction stage would be separated by a suitable time interval to allow pore pressures to dissipate and strength gain to occur in the underlying cohesive soils while limiting the potential for instability of the embankment.

It should also be noted that with preloading, it is still required that all existing organic deposits and near surface cohesive soils be sub-excavated prior to placement of any fill, because these soils are highly compressible and experience significant secondary consolidation (creep) settlement. The organic deposits should not be used as toe berm material.

This option is most suited for areas where removal of cohesive soils and their replacement with rock fill is not considered practical (i.e., the depth to the bottom of cohesive deposits is greater than 12 m) and where a delay in the construction schedule is acceptable or can be accommodated.

The advantages of this option are:

- reduced generation of excess excavation spoil compared with full sub-excavation;
- will not require a larger right-of-way corridor, unless large toe berms are required; and
- the quantity of rock fill is limited to that required for sub-excavation and replacement of the organic deposits and near surface cohesive soils (if toe berms are not required), and to compensate for consolidation and settlement of the foundation soil.

The disadvantages of this option are:

- construction is delayed to allow for all or a portion of primary consolidation to be completed, and possibly for staged construction (if required);
- increased quantity of rock fill if toe berms are required for stability;
- may require lightweight fill for a portion of the construction of the final embankment to reduce long-term post-construction settlements if creep settlements are expected to be large;
- requires an instrumentation and monitoring program to assess when the settlement performance criterion has been achieved; and
- requires re-grading to account for settlement prior to construction of the final pavement structure.

An operational constraint governing the embankment construction will be required for preloading. In addition, a monitoring program will be required (see Section 6.4.7).

6.4.2 Surcharging (and Stability Berms and/or Staged Construction)

Similar to preloading, surcharging refers to the placement of embankment fill in advance of final pavement construction to reduce long-term, post-construction settlements (including creep settlement). The difference between preloading and surcharging is the amount of fill placed and the time required for consolidation to be achieved. With surcharging, the fill is placed to the full embankment height, followed by an additional lift of fill (the surcharge) above that required to construct the final embankment geometry. This additional lift of fill applies greater stress to the underlying cohesive deposits and reduces the time to achieve primary consolidation over that achieved by preloading only, resulting in over consolidation of the underlying compressible foundations soils. At the EoP consolidation, the portion of the surcharge fill remaining above the required embankment height (sub-base level) is removed. The surcharge fill can also be left in place for a longer duration to reduce the magnitude of long-term, creep settlement.

As with preloading, it may be necessary to construct toe berms or stage the placement of embankment fill and surcharge to limit the potential for instability.

Surcharging is most suited to those areas considered appropriate for preloading, where the stability of the higher surcharged embankment can be practically maintained by reasonably sized excavations, toe berms or staged construction, but where sufficient time for primary consolidation settlements to occur under preload fill loads alone is not available. Surcharging can also be considered for areas where large creep settlement is expected.

The advantages of this option are:

- reduced generation of excess excavation spoil over full sub-excavation;
- reduced secondary consolidation (creep) settlement;
- will not require a larger right-of-way corridor, unless large toe berms are required;
- the quantity of rock fill is limited to that required for sub-excavation and replacement of organic deposits and near surface cohesive soils, and to compensate for consolidation and foundation soil settlement (if toe berms are not required); and

- decreased delay time for construction over preloading alone.

The disadvantages of this option are:

- construction is delayed, albeit less than for preloading, to allow for primary consolidation to occur;
- longer construction time if staged construction is required or to reduce secondary consolidation (creep) settlement;
- larger quantity of rock fill if toe berms are required for stability as compared to preloading alone;
- requires an instrumentation and monitoring program to assess when EoP consolidation is reached; and
- increased handling of the surcharge fill.

An operational constraint governing the embankment construction will be required for surcharging. In addition, a monitoring program will be required (see Section 6.4.7).

6.4.3 Wick Drains

Where the time required to reach the settlement performance criterion is considered too long (i.e., unacceptable to meet a specific construction schedule), even with surcharging, consideration may be given to installing wick drains in conjunction with surcharging to accelerate the rate of primary consolidation. Wick drains are prefabricated geotextile drains installed vertically from ground surface into or through the soft, compressible foundation soils in order to increase the rate of excess pore pressure dissipation. Typically, wick drains are installed on a 1 m to 3 m triangular grid spacing over the embankment footprint.

The use of wick drains is most suited to areas with thick (i.e., greater than about 5 m) deposits of soft, compressible foundation soils and proposed high embankment fills where primary consolidation times are large even under surcharge conditions.

It would still be necessary to sub-excavate and remove organic deposits and near surface cohesive soils and place a granular drainage blanket at ground surface prior to the installation of the wick drains.

If the thickness of sub-excavation of the organic deposits and near surface cohesive soils is greater than about 4 m, then pre-drilling to install wick drains may be required to advance the drains through the backfill material. In any case, the backfill material must consist of granular material rather than rock fill to facilitate installation of the drains with or without pre-drilling.

The advantages of this option are:

- decreased consolidation time under surcharging; and
- decreased rate of staged construction, if required to maintain stability during construction.

The disadvantages of this option are:

- additional time and expense to install wick drains prior to embankment construction;
- may require pre-drilling at wick drain locations if a substantial thickness of backfill is present above the clay, incurring additional time and expense;

- additional long-term settlements due to creep settlement of the cohesive deposit (if not compensated for by surcharging or lightweight fill);
- requires an instrumentation and monitoring program to assess when the settlement performance criterion has been achieved; and
- requires re-grading to account for settlement prior to construction of the final pavement structure.

If wick drains are utilized, an NSSP for the supply and installation of the wick drains and the drainage blanket will be required. An operational constraint governing the embankment construction will also be required. In addition, a monitoring program will be required (see Section 6.4.7).

6.4.4 Lightweight Fill

An alternative for reducing the magnitude of long-term settlement and improving stability in areas of weak/soft, compressible foundation soils is to use lightweight fill, such as EPS or cellular concrete, for embankment construction. The use of lightweight fill reduces the load applied to the foundation soils due to the low density of the fill materials. This in turn reduces the magnitude of post-construction settlement and reduces the potential for instability.

Lightweight fill is not considered a practical option for general use due to the expense and/or shipping costs for the supply of these types of fills. Rather, lightweight fill is most suited for areas underlain by deep compressible subsurface deposits, where sub-excavation is not practical or feasible, where long-term post-construction creep settlements affect the performance of the highway and where there is no available time in the construction schedule for a sufficient preload or surcharge period. In addition, lightweight fill can be used in conjunction with preloading, surcharging and wick drain designs in order to optimize the design.

Where a stability and/or settlement mitigation option requires the use of lightweight fill as part of the construction of the embankments, rock fill cannot be used as the levelling pad or protective cover for the lightweight fill due to the size of rock fill particles. As such, for these embankments, granular fill is to be used for levelling pad construction and for the side slope protective cover.

The advantages of this option are:

- improved stability;
- reduced long-term post-construction settlements; and
- shortened construction schedule.

The disadvantages of this option are:

- requires embankments to be constructed with 2H:1V side slopes given the need for granular fill for levelling pad and conventional soil cover on side slopes (i.e., cannot use rock fill);
- significant additional expense of lightweight fill (depending on the volume required); and
- not feasible to install below the groundwater table (due to buoyancy forces) and in low height embankments (due to minimum conventional soil cover requirements on top of the EPS).

It should be noted that slag fill may also be considered for use as lightweight fill for embankment construction. However, the specific environmental restrictions for this type of material should be considered by the designer prior to recommending its use.

6.4.5 Full Sub-Excavation

Sub-excavation of the weak/soft and compressible (i.e., clayey) deposits underlying the footprint of a proposed embankment in advance of the placement of rock fill is a viable option for improving the stability and controlling long-term settlement of the proposed embankments in some areas of this site. The removal of the soft, compressible cohesive soils would result in improved stability and significantly reduce settlement within the areas underlain by relatively thinner cohesive deposits and/or where high embankment fills are proposed. It should be noted that despite the reduction in settlement, the post-construction settlement of rock fill may still exceed the settlement performance criterion. As such, the embankments may need to be preloaded for a period of time to be able to attain adequate construction settlement and subsequently meet the post-construction settlement criterion associated with long-term performance of the roadway. The additional below grade rock fill embankment should be constructed with the same side slope profile as that of the above grade embankment (i.e., 1.25H:1V for rock fill) since the natural slope of the rock fill should not be affected by placement under water. This option has the advantage that construction of the above grade embankment could proceed upon completion of sub-excavation and replacement without concerns of instability. However, full sub-excavation may produce a large volume of spoil material for disposal and may require a large volume of rock fill replacement. The necessity to develop stable side slopes or back slopes within the excavation may result in cut slope geometries ranging from 1H:1V to as flat as 3H:1V. Flatter slopes would increase the lateral extent of the excavation and may require a wider right-of-way.

Based on the results of the subsurface investigation in the high fill/swamp crossing areas, there is typically a near-surface compressible organic deposit, which must be removed, and a lower compressible cohesive deposit of which the depth to the bottom of the deposit within the high fill/swamp crossing area varies across the project site. The depth to the bottom of the near-surface compressible organic deposit is up to about 4 m below existing ground surface and the depth to the bottom of the lower compressible deposit is up to about 20 m below existing ground surface. In general, groundwater was encountered at/near the existing ground surface. We understand that based on MTO field experience on similar embankment construction projects, the practical maximum depths that can be reached with conventional and long stick excavator equipment is about 6 m and 12 m, respectively. Below a depth of 12 m, specialized drag-line equipment would be required. As such, in the absence of unforeseen conditions which would prohibit its application, sub-excavation of organic and soft compressible soils up to a practical depth of about 12 m and replacement with rock fill is considered a generally feasible option for construction of the highway embankments and would result in enhanced stability and reduced settlement of the embankments.

This option is most suited for areas where there is a limited thickness of organic deposits and near surface weak/soft compressible soils underlying the proposed embankment (i.e., less than 12 m), making their removal practical where there are no requirements for setbacks, where adequate right-of-way is available, and where there are no conflicts with encroachment on existing adjacent features.

The advantages of this option are:

- improved stability;

- reduced post-construction settlements of the foundation;
- potential reduced delay in construction; and
- no requirement for stabilizing toe berms.

The disadvantages of this option are:

- generation of large volume of excavation spoil requiring disposal/management;
- increased post-construction settlement of rock fill, typically requiring a preload period, in addition to sub-excavation, to satisfy the settlement performance criterion;
- potential for requiring a larger right-of-way corridor due to backslope requirements;
- potential need for temporary excavation support where an embankment widening is constructed adjacent to existing highway embankments, and
- requires greater quantities of rock fill.

6.4.6 Ground Improvement

Ground improvement techniques (such as rammed aggregate piers or deep soil mixing) could also be considered to improve the performance of the subsoils. Rammed aggregate piers are not considered practical at this site due to the relatively great depth required to extend the columns to an appropriate bearing layer and due to the lack of lateral confinement that can be provided by the soft consistency of the cohesive deposits. Deep soil mixing, however, may be technically feasible but would require an in situ trial section to be constructed followed by completion of the soil mix design for the entire embankment.

Deep soil mixing involves the in-situ mechanical blending of soil columns with a binder material in a grid pattern under the full width and length of the affected embankment to improve the engineering properties (compressive strength, shear strength and/or permeability) of the soil layer(s). The binder material typically consists of a cement-based grout slurry (wet soil mixing) or a cement-slag powder (dry soil mixing). For wet soils (i.e., moisture contents greater than about 60 per cent), dry soil mixing is generally more cost effective than wet soil mixing due to the costs associated with supplying of grout and mixing it adequately into the soil.

The strength of the improved soil (“soilcrete”) develops differently with time depending on the type of soil and the amount and type of binder material, but generally increases with increasing binder dosage. The strength improvements are generally highest for inorganic soils with moderate water contents. Organic soils and peat soil mixtures, as encountered in the near surface cohesive deposits of the high fill/swamp areas, can be stabilized with a binder material but information on the adequacy or practicality of increasing the strength and stiffness of the soils is not readily available.

The “soilcrete” column type, size and spacing would have to be designed by a specialist ground improvement contractor. The amount of binder material required in each column to provide adequate increase in the stiffness of the soil mass is not possible to estimate without bench scale testing and may possibly require a field test program. However, in general, the higher the water content and lower the strength of the existing soils, the larger the amount of binder material that is required and the closer the required spacing of columns will result in a sufficient level of improvement.

The high cost of mobilization of equipment and materials, the use of specialized equipment and potential large volume of mixing additive required for the extent of the soil improvement area may offset the cost savings associated with reduced sub-excavation and soil disposal.

The advantages of the deep soil mixing option are:

- improved stability;
- reduced post-construction settlements of the foundation; and
- reduced sub-excavation and soil disposal quantity.

The disadvantages of the deep soil mixing option are:

- specialized testing and design required;
- specialized construction equipment and supplies required;
- additional time for soil mixing required prior to embankment construction; and
- risk that strength gains may not be cost effective and/or more conventional mitigation measures may still be required.

6.4.7 Instrumentation and Monitoring

For some areas where the preloading and surcharging options are adopted and in all areas where staged construction and/or wick drains foundation options are adopted, the magnitude and time-rate of settlement as well as dissipation of pore pressures during and after construction of the embankments should be assessed with monitoring instrumentation. Such monitoring would consist of installing settlement pins/stakes (Ss), settlement plates (SPs) and vibrating wire piezometers (VWPs) below the embankments and taking regular measurements/readings at given intervals of time during and after construction of the embankments for the duration of the preloading/surcharging period. In addition, standpipe piezometers (SPPs) may be required and are usually installed to provide background pore pressure readings for the vibrating wire piezometers. This monitoring instrumentation is particularly important where it is considered necessary to carefully monitor the stability of the foundation soils during staged placement of embankment fill.

The extent of instrumentation and the frequency of monitoring required will depend on the foundation treatment alternative chosen for a given site and the height of the proposed embankment fill. Specifications for the type, number and layout of the instrumentation, together with the supply, installation, protection and monitoring frequency and action levels should be included as a NSSP in the Contract Documents.

6.5 Results of Analysis

The results of the stability and settlement analyses for each high fill/swamp crossing area are provided in the following sections. In addition, the options and recommendations for achieving the target FoS for the required embankment geometry and for minimizing the time-dependent, post-construction settlements are also discussed. For high fill/swamp crossing areas H1, H2 and H3 that require stability and/or settlement mitigation, the advantages, disadvantages, relative costs, and risks/consequences of various alternatives for these areas

are summarized and ranked in the Evaluation of Stability/Settlement Mitigation Options Tables A1, B1, B2 and C1 in the respective Appendices.

In areas where the embankments are being widened and the overall grade raise is limited, it is anticipated that there will not be any significant risk of instability of the embankments. In these areas there is typically no need to implement any special construction procedures or schedule to maintain stability or to mitigate differential settlement of the foundation soils.

In areas where the foundation soils are comprised of cohesive deposits and the presence of weak/soft cohesive deposits constitutes zones of potential instability for the proposed embankments, time-dependent settlements of the new embankments are expected. In these areas, consideration must be given to an enhanced design and/or to follow a construction sequence that will achieve the minimum target FoS of 1.3 for the proposed new embankment height and geometry and limit the post-construction settlements and subsequent maintenance of the new highway pavement structure.

For new embankments constructed with rock fill or where sub-excavation and backfilling with rock fill is carried out, settlement of the embankment rock fill is also expected due to compression of the rock fill itself (see Section 6.2.3.3). In these areas, the post-construction settlement of rock fill may exceed the settlement performance criterion. As such, the embankment would need to be preloaded to obtain acceptable post-construction settlements associated with long-term performance.

6.5.1 Highway 17 – STA 12+220 to 12+570 High Fill H1

Along this section of the alignment, the proposed WBL will be a widening of the existing Highway 17 embankment while the proposed EBL will be constructed over the native low-lying swampy ground to the south of the existing highway and proposed widening. Therefore, the EBL and the WBL embankments in this high fill/swamp area will be considered separately in Sections 6.5.1.1 and 6.5.1.2, respectively.

6.5.1.1 Highway 17 WBL – STA 12+220 to 12+570 High Fill H1

Generally, the proposed Highway 17 WBL embankment will be constructed essentially at the same location as the existing Highway 17 embankment between STA 12+220 and 12+570. The proposed WBL centreline will be slightly shifted to the south from the existing Highway 17 centreline resulting in embankment widening up to about 9 m and a grade raise up to 0.8 m at the south edge of pavement, particularly towards the eastern portion of this section. The existing embankment is up to about 5 m high above the surrounding swamp area although greater than 5 m of fill was encountered in some boreholes, suggesting that some peat was removed and/or settlement has occurred over time since embankment construction.

The subsurface soils along the proposed WBL alignment in High Fill Area H1 consists of embankment fill or a peat/topsoil deposit underlain by a sand and silt deposit and a cohesive deposit of varved, silty clay to clay transitioning into clayey silt, which in turn is underlain by deposits of silt, sand and silt to sand and sand and gravel to gravelly sand. The cohesive deposit is up to about 8 m thick in some locations and extends to depths up to 13.4 m below ground surface. Resistance to dynamic cone penetration and borehole advancement was

encountered at depths of up to 19.4 m below ground surface. Details of the subsurface conditions for this swamp crossing area are presented in Section 4.3 and shown on Drawings A1 to A3 in Appendix A.

The simplified stratigraphy and the associated unit weight, strength, deformation and time-rate consolidation parameters employed for the different soil types encountered in this area are summarized in Table 3. Additional details of foundation engineering parameters employed for the cohesive deposits (i.e., clayey silt/silty clay/clay) encountered in H1 are provided on Figure A21 in Appendix A. The piezometric condition used in the analyses assumes the water table is at the interface between the native and fill materials (at about Elevation 241.2 m).

The critical section for this area is located at about STA 12+400 along the proposed Hwy 17 WBL alignment and corresponds to the thickest cohesive deposit up to 7.9 m. At the critical section, the embankment widening is approximately 8 m and the grade raise at the south edge of pavement is approximately 0.5 m. The widening at the critical section creates a loading equivalent to about a 4.6 m above the existing ground at the toe of slope. Sub-excavation of peat at the toe of slope of up to 1.1 m is required, resulting in a total fill thickness of 5.7 m in the widened area.

6.5.1.1.1 Stability

The stability analyses carried out at the critical section indicates that the south side of the existing embankment has a Factor of Safety (FoS) less than 1.3 for a deep-seated, global failure surface that would impact the operation of the highway. The stability analyses carried out at the critical section after completion of construction (which includes the removal and replacement of the organic deposit and the construction of the WBL widening and Hwy 17 EBL embankment), indicates that the embankment will have a Factor of Safety (FoS) greater than 1.3 for a deep-seated, global failure surface that would impact the operation of the highway. Therefore, stability mitigation is not required for the WBL embankment in the High Fill Area H1, as shown on Figure A22.

6.5.1.1.2 Settlement

To estimate the magnitude of the expected settlements due to new construction, analysis was carried out at the critical section representative of the subsurface conditions within the high fill area, at approximately STA 12+400. Based on the results of the settlement analysis for the embankment widening, the short-term settlement of the foundation soils is estimated to be about 80 mm at the south edge of pavement. This estimated settlement in the Highway 17 WBL is comprised of about 10 mm of immediate settlement due to compression of the cohesionless deposits and about 70 mm of primary consolidation of the 7.9 m thick cohesive deposit.

Based on an average coefficient of consolidation (c_v) of about 2.0 x 10^{-3} cm^2/s estimated for the cohesive deposit in the normally consolidated range, the imposed loading conditions for the approximately 5.7 m of rock fill for the widening at the toe of slope and assuming two-way drainage of the 7.9 m thick cohesive deposit, it is estimated that about 90 per cent of the primary consolidation settlement will be completed in about 3 years.

The magnitude of secondary consolidation (creep) settlement for the normally consolidated portion of the cohesive deposit is expected to be about 55 mm per log-cycle of time for this area corresponding to about 50 mm over a 20-year period following completion of construction.

Although it has been assumed that rock fill would be utilized for the embankment widening, the raise across the existing embankment would be up to about 0.5 m and would be constructed of granular fill, which properly placed and compacted would have nominal settlement.

Since the total post-construction settlement, estimated to be about 120 mm at the south edge of pavement (comprised of 70 mm primary consolidation and 50 mm of creep) exceeds the settlement criterion of 50 mm (for an embankment a widening), settlement mitigation measures are required for the Highway 17 WBL embankment in the High Fill Area H1. Further, differential settlement of 60 mm between the new centreline and new south edge of pavement (assumed to be the edge of the travelled lane for this analysis) also exceeds the criteria of 200:1. It should be noted that higher magnitudes of total and differential settlement will occur beyond the south edge of pavement along the median slope.

6.5.1.1.3 Mitigation of Time Dependent Settlements

The presence of the up to 7.9 m thick silty clay to clay deposit influences both the stability and the settlement of the widened embankment for the proposed WBL. In order to minimize post-construction settlements, the alternatives presented below can be considered. The alternatives described have been evaluated and ranked on the basis of the advantages, disadvantages, relative costs and risk/consequences and are summarised in Table A1 in Appendix A. A summary of the settlement results for each alternative is provided in Table 4.

Given the presence of the 7.9 m thick cohesive deposit and the associated magnitude of primary and secondary consolidation settlement (about 120 mm) of the foundation soils under the south edge of pavement (i.e., approximately 0.5 m additional fill above the existing ground surface) and 60 mm of differential settlement between the new centreline and new south edge of pavement, the most practical method of construction is to preload the embankment allowing settlement to occur while the traffic is using the highway, followed by maintenance of the roadway in the future. This method does not meet the MTO settlement criteria for post-construction settlement but is more practical from a cost and a construction standpoint compared to other technically feasible options.

6.5.1.1.3.1 Consolidation and Maintenance

We recommend a construction approach that involves constructing the embankment to its final height, utilizing the embankment as a travelled highway and then conducting ongoing maintenance, as may be required, as approximately 90 per cent of the primary consolidation settlement is expected to be complete in about 3 years. This construction option does not meet the MTO settlement criteria; however, this alternative is the most practical option given the magnitude of total settlement at the new outside edge of the WBL north travelled lane which is about 120 mm (70 mm primary and 50 mm creep). Provided the peat is sub-excavated under the widened portion of the embankment in accordance with OPSD 203.020 (Embankments over Swamp, Existing Slope Excavated to 1H:1V) and the EBL embankment is constructed at the same time, the widened WBL embankment will remain stable while in use, however, the expected post constructed settlements may require maintenance. This alternative relies on the fact that while the expected settlements exceed the MTO settlement criteria for a widened embankment (Figure 3, MTO 2010), the embankment can still function as a travelled lane while consolidation takes place.

This construction approach may require the installation of instrumentation to monitor for settlement, however it is not required to monitor pore pressures for embankment stability. The embankment monitoring can consist of a

series of settlement plates installed in the embankment at the crest of the widened portion of the embankment provided guide rail installation is not impacted and the monitoring points remain accessible. Settlement plates in the shoulder or on the slope (or nail pins in pavement) will be required to be installed along the full length of the high fill section on the south side of the widened embankment at offsets to be determined once the final cross sections are known. For a 350 m long section, settlement plates at approximately 50 m spacing would be appropriate. At two stations, an array of settlement plates should be installed to monitor the cross-sectional settlement across the embankment widening. Monthly readings of settlement plates are recommended for the first year of monitoring and bi-monthly readings afterwards until the decrease in the rate of settlement indicates that the remaining settlement is within the MTO criteria, likely up to 3 years.

The total post-construction settlement (i.e., after construction of the widened embankment is complete and traffic is using the lanes) for the Highway 17 WBL embankment expected during the consolidation period is estimated to be 120 mm which exceeds the settlement criteria. The differential settlement of 60 mm between the new centreline and new south edge of pavement also exceeds the settlement criterion. During an approximately two year consolidation period, approximately 65 mm of settlement will have occurred at the new south edge of pavement and approximately 10 mm at the north edge of pavement. The estimated total and differential settlement after approximately 3 years of consolidation is about 55 mm and 50 mm at the new south and north edge of pavement, respectively, and a differential settlement of 5 mm, which meet the MTO criteria. The results of this analysis are shown on Figure A23.

The main advantages of this option are that there is neither a delay in the construction schedule nor any need to divert traffic for multiple years during staged construction. The disadvantages of this option are that it does not meet the MTO settlement criteria and future highway maintenance is likely to be required.

6.5.1.1.3.2 Lightweight Fill

In order to meet the settlement criteria without preloading, lightweight (EPS) fill could be incorporated into the widened embankment mass. The Highway 17 WBL embankment can be widened to the south using a 1 m thick layer of EPS under the pavement structure of the new embankment (full width, not to interfere with guide rail installation) and an additional 1.5 m of EPS (for a total of 2.5 m) would be required within the remainder of the south half of the new embankment. This will required sub-excavation of the existing fill to accommodate the EPS. The EPS should be stepped in 0.3 m to 0.5 m increments across the embankment and in the taper zones longitudinally along the highway. Essentially, with this quantity of EPS, the induced settlement will be minimal and will not result in the induction of creep settlement. Total and differential post-construction settlement is estimated to be less than 10 mm.

The main advantages of this option are that it meets the post-construction settlement criteria as well there is a no delay in the construction schedule. The disadvantage of this option is the substantial cost of EPS fill, which is typically an order of magnitude higher than other fill materials as well as having to excavate a portion of the existing embankments in order to install the EPS.

6.5.1.1.3.3 Full Sub-Excavation

The option of full sub-excavation of the cohesive deposit up to 8 m think and up to 13.4 m below the road surface or up to 10.4 m below the ground surface at the toe of slope is not considered practical. To fully remove this deposit below the widened portion of the embankment, extensive shoring would be required along the full

350 m length of this high fill section. Further, preloading of the widened embankment would still be required due to the compression of rock fill, otherwise maintenance would need to be carried out at a later date based on the results of a monitoring program as described in Section 6.5.1.1.3.1.

6.5.1.2 Highway 17 EBL – STA 12+220 to 12+570 High Fill H1

Between STA 12+220 and 12+570, the Highway 17 EBL embankment will require a fill embankment up to 5.7 m high above the existing ground surface to achieve the vertical highway profile. The alignment extends across a low-lying swampy area. The subsurface soils along the EBL alignment consist of a surficial layer of peat/topsoil underlain by a sandy silt deposit and a cohesive deposit of clayey silt to silt transitioning into varved, silty clay to clay transitioning back into clayey silt, which in turn is underlain by deposits of silt to sandy silt, sand and silt to sand and gravelly sand. The cohesive deposit is up to 9.4 m thick in some locations and extends to depths up to 10.4 m below ground surface. Resistance to dynamic cone penetration and borehole advancement was encountered at depths of up to about 20.7 m below ground surface. Details of the subsurface conditions at this embankment are presented in Section 4.4, and are shown on Drawings A1 to A4 in Appendix A.

The simplified stratigraphy and the associated unit weight, strength, deformation and time-rate consolidation parameters employed for the different soil types encountered in this area are summarized in Table 3. Additional details of foundation engineering parameters employed for the cohesive deposits (i.e., clayey silt/silty clay/clay) encountered in H1 are provided on Figure A21 in Appendix A. The piezometric condition used in the analyses is the water table at the ground surface (about Elevation 241.2 m).

Although the existing highway embankment was not constructed with the incorporation of toe berms, it is unknown what other construction methods were used (i.e., staged construction, surcharging, etc.) to mitigate both settlement and stability. Further, the analysis of the existing embankment configuration (at the critical section at STA 12+320) indicates that for the shear strength design line considered applicable as shown on Figure A21, a Factor of Safety of about 1.1 is obtained. This implies that the existing embankment is stable, albeit with a Factor of Safety less than the current target of 1.3. It is also not known if there has been any long-term settlement that has occurred over the years and what maintenance has been carried out. It should be noted that the silty clay to clay deposit contains an approximately 1.5 m thick crust of higher shear strength, however, the design line interpreted from the undrained shear strength data does not reflect the crust due to the potential for disturbance, fissures, etc. that may be present within the crust.

The critical section (i.e., the greatest embankment height and maximum thickness of soft, compressible foundation soils) for this area is located at about STA 12+320 along the proposed Hwy 17 alignment. The proposed embankment is about 5.7 m high and the cohesive deposit is up to about 9.4 m thick.

6.5.1.2.1 Stability

The stability analyses carried out at the critical section indicates that after completion of construction (including removal and replacement of the organic deposit), the embankment will have a Factor of Safety (FoS) of less than 1.3 for a deep-seated, global failure surface that would impact the operation of the highway. Therefore, stability mitigation is required in the EBL for this High Fill Area H1.

6.5.1.2.2 Settlement

Based on the results of the settlement analysis at the critical section, for the condition where the organic deposits are removed and replaced with rock fill, the short-term settlement of the foundation soils is estimated to be about 770 mm. This estimated settlement in the Highway 17 EBL is comprised of about 110 mm of immediate settlement due to compression of the cohesionless deposits and about 585 mm of primary consolidation of the 9.4 m thick cohesive deposit.

Based on an average coefficient of consolidation (c_v) of about 2.0×10^{-3} cm^2/s estimated for the cohesive deposit, the imposed loading conditions for the approximately 5.7 m high rock fill embankment and assuming two-way drainage of the 9.4 m thick cohesive deposit, it is estimated that about 90 per cent of the primary consolidation settlement will be completed in about 3 years.

The magnitude of secondary consolidation (creep) settlement for the cohesive deposit is expected to be about 85 mm per log-cycle of time for this area corresponding to about 75 mm over a 20-year period following completion of construction.

In addition, the total settlement of the rock fill embankment itself (based on a 5.7 m high embankment at the critical section plus 0.8 m of removal of peat and replacement with rock fill) is estimated to be about 60 mm, with about 50 mm expected to occur within six months of construction of the embankment, 5 mm occurring during the next six months and about 5 mm expected to occur over the remaining design life of the embankment.

Since the total post-construction settlement (primary, creep and rock fill) exceeds the settlement criterion of 100 mm, settlement mitigation measures are required for the EBL embankment in High Fill Area H1.

6.5.1.2.3 Mitigation of Stability Issues and/or Time Dependent Settlement

The presence of the up to 9.4 m thick cohesive deposit influences both the stability and the settlement of the up to 5.7 m high embankment. In order to construct the embankments to achieve a FoS greater than or equal to 1.3, and to minimize post-construction settlements, the alternatives presented below can be considered. The alternatives described have been evaluated and ranked on the basis of the advantages, disadvantages, relative costs and risk/consequences and are summarised in Table A2 in Appendix A. A summary of the settlement results for each alternative is provided in Table 4.

Given the thick cohesive deposit (the bottom of which is up to about 10.4 m below ground surface) and the associated magnitude of primary and secondary consolidation settlement (about 660 mm) of the foundation soils under an up to 5.7 m high embankment, surcharging with wick drains and incorporating toe berms along the embankments into a staged construction schedule is considered the preferred mitigation alternative.

6.5.1.2.3.1 Surcharging, Wick Drains and Staged Construction with Toe Berms

We recommend a staged construction approach that incorporates wick drains into the cohesive stratum and a toe berm onto the south side of the embankment, as the preferred, most technically feasible mitigation measure to achieve a stable embankment and to minimize the post-construction settlements and subsequent maintenance of the new roadway surface. The staged construction approach relies on strength gain in the underlying cohesive deposit to enhance stability of the subsequent stages. The first stage could be constructed up to 5.7 m high with a 1.5 m high by 14 m wide toe berm along the south side of the Highway 17 EBL

embankment. The first stage of construction includes the installation of instrumentation to monitor for settlement and pore pressure dissipation and requires a wait period to allow for dissipation of the pore pressures and achieve a strength increase of the cohesive deposit (estimated to be about 14 kPa under the EBL embankment). The actual wait period will be dependent on the results of the monitoring.

After the first wait period is complete, the second stage of construction consisting of a 1.3 m surcharge can be completed and a second wait period will be required to allow for dissipation of the pore pressures of the cohesive deposit to satisfy the settlement criterion. The analysis assumes that the embankment will be "topped up" in the second stage to the final grade prior to placing the surcharge fill. For quantity estimation, additional fill placement of 0.5 m (i.e., second stage total 1.8 m of fill; 0.5 m top up and 1.3 m surcharge fill) for the EBL embankment should be anticipated. The results of the stability analysis for the proposed embankment geometry under the first stage and surcharge stage with the calculated strength gain of the cohesive soils is presented on Figures A24 and A25.

In this case, the up to 0.8 m thick organic deposit will be removed and replaced with granular fill to facilitate installation of the wick drains and the embankment can be constructed of rock fill.

Preliminary analysis using a wick drain spacing of 1.5 m in a triangular pattern to full depth through to the bottom of the cohesive deposit indicates that a wait period of about 10 months would be required for the first stage of embankment construction followed by a surcharge period of about 10 months for a total construction period of about 1.7 years. A detailed wick drain analysis has not been completed on this area and the preliminary analysis of the duration of the wait periods are derived from/based on undrained analyses. As such, the number of construction stages and wait period described above are approximate. The stages of construction, wait periods and estimated settlements are as follows:

Stage	Fill Thickness*	Wait Period	Settlement During Construction	Post Construction Settlement
1	5.7 m	~10 months	110 mm (immediate) 550 mm (primary) 40 mm (rock fill)	-
2 (surcharge)	1.8 m**	~10 months	185 mm (primary) 20 mm (rock fill)	0 mm (primary) 90 mm (creep) 10 mm (rock fill)

*After 0.8 m of peat has been sub-excavated and replaced with granular fill to the original ground surface.

**Includes embankment top up.

After preloading and surcharging for about 1.7 years, the total post-construction settlement at the end of the surcharge period for the Highway 17 EBL embankment is estimated to be 100 mm (comprised of 90 mm creep settlement plus 10 mm long-term rock fill settlement). The result of the settlement analysis for staged construction for the EBL embankment is presented on Figure A26.

The main advantages of this alternative are the significant reduction in the size of the required toe berm to achieve stability compared to non-staged construction as well as the reduced delay in the schedule compared to options where wick drains are not incorporated. The main disadvantage of this option is the increased cost to install and monitor the wick drains and the associated construction wait periods due to the multiple stages.

Further, the actual wait periods are dependent on the results of the monitoring program and could be shorter or longer than estimated.

If wick drains are not utilized for this option, the first stage of construction will require a wait period of about 3 years to allow for dissipation of the pore pressures and achieve the strength increase necessary. The second wait period will require another wait period of about 3 years as the pore pressures dissipate and the necessary strength gain is achieved. The total delay time for construction would be about 6 years. The actual wait periods will be dependent on the results of the monitoring program and could be shorter or longer than estimated.

6.5.1.2.3.2 Surcharging, Wick Drains with Toe Berms

As an alternative to staged construction or the use of EPS, surcharging the Highway 17 EBL embankment, while incorporating wick drains into the clay stratum and a toe berm into the embankment, will achieve stable embankments and minimize the post-construction settlements and subsequent maintenance of the new roadway surface.

Surcharging the embankment increases the load on the underlying soils thereby reducing the delay time required to meet the settlement criterion. Wick drains provide a pathway for the dissipation of excess pore pressure in the cohesive deposit thereby further reducing the time required to meet the settlement criteria. The main disadvantages of this alternative is the large toe berm required (and thus property) on the south side of the embankment, the double handling of the surcharge material and the cost of designing and installing the wick drains, including an instrumentation and monitoring program.

A 2.0 m surcharge above the final profile grade will reduce the time required for preloading and decrease the long-term post-construction settlement including creep. In this case, the up to 0.8 m thick organic deposit will be removed and replaced with granular fill to facilitate installation of the wick drains and the embankments can be constructed out of rock fill.

The maximum stable embankment height for the Highway 17 EBL is 3.4 m. However, for the final embankment plus surcharge height of 7.7 m, a toe berm will be required to enhance stability of the surcharged embankment to a FoS equal to or greater than 1.3. The toe berm required to the south of the Highway 17 EBL embankment is 25 m wide and 2 m high above ground surface.

Preliminary analysis of consolidation of the cohesive deposit under the embankment enhanced by wick drains spaced at 1.5 m in a triangular pattern to full depth through to the bottom of the cohesive deposit indicates that 90 per cent of primary consolidation would be completed in about 10 months. After surcharging for 10 months, the total post-construction settlement is estimated to be 100 mm (90 mm creep settlement plus 10 mm long-term rock fill settlement).

To facilitate the assessment for the end of the surcharge period, instrumentation and monitoring during and after construction will be required. A detailed wick drain analysis has not been completed on this area and the preliminary analysis that the wait period is derived from in this report is based on undrained analyses. As such, the above number of stages and wait times are approximate. Further, the actual wait period is dependent on the results of the monitoring program and could be shorter or longer than estimated.

6.5.1.2.3.3 Full Sub-Excavation and Preloading

Taking into consideration the depth to the bottom of the clay deposit (i.e., up to about 10.4 m below the existing ground surface), full sub-excavation of the cohesive deposit is not considered practical for High Fill Area H1 due to: the potential requirement for specialized drag-line equipment; the substantial time and costs required to complete the sub-excavation and backfilling activities; the need for extra rock fill; the increase in long-term settlement of the thicker zone of rock fill; and the requirement for preloading for 12 months to reduce the long-term (post-construction) settlement. The full sub-excavation, if adopted, eliminates the risk associated with long-term consolidation settlement associated with the silty clay to clay deposit and the long-term settlement of the rock fill after a 12 month preload period is estimated to be 30 mm. It should be noted, however, that the cost of sub-excavation and backfilling may be of the same order of magnitude as some of the other options, including wick drains and staged construction, however, the time to conduct the sub-excavation operations and subsequent preloading may be longer.

6.5.1.2.3.4 Partial Preloading and Lightweight Fill

If there is not sufficient space to accommodate a toe berm, an alternative to reduce the post-construction settlement is to partially preload the embankment and incorporate lightweight (EPS) fill into the embankment mass. The Highway 17 EBL embankment can be constructed to the maximum stable embankment height of 3.4 m without the use of toe berms. After this partial preload period, the Highway 17 EBL embankment will be constructed to the final height by incorporating a 2.5 m thick zone of EPS into the Highway 17 EBL embankment.

After partial preloading for about 3 years (without using wick drains), the total post-construction settlement at the end of the partial preloading period for the Highway 17 EBL embankment is estimated to be 100 mm (comprised of 15 mm remaining primary settlement plus 75 mm creep settlement plus 10 mm long-term rock fill settlement).

The main disadvantage of this option is the substantial cost of EPS fill, which is typically an order of magnitude higher than other fill materials.

6.5.1.2.3.5 Partial Preloading and Lightweight Fill and Wick Drains

In order to reduce the time for consolidation for the alternative of partial preloading and lightweight fill, the use of wick drains has the added advantage of reducing the preload period from about 3 years to about 10 months. In this case, preloading for about 10 months at the maximum stable embankment height of 3.4 m (without the use of toe berms) will be required prior to installation of 2.5 m of EPS.

After partial preloading for about 3 years (using wick drains), the total post-construction settlement at the end of the partial preloading period for the Highway 17 EBL embankment is estimated to be 100 mm (comprised of 90 mm creep settlement plus 10 mm long-term rock fill settlement).

The main disadvantage of this option is the substantial cost associated with both the installation of wick drains and EPS fill.

6.5.1.2.3.6 Surcharging with Toe Berms

Surcharging the Highway 17 EBL embankment and incorporating a toe berm into the south side of the embankment will achieve a stable embankment and minimize the post-construction settlements and subsequent maintenance of the new roadway surface.

If surcharging is used without the incorporation of wick drains into the foundation cohesive deposit, a surcharge period of about 2.1 years will be required to reduce the post-construction settlement to the settlement criterion. The estimated total post-construction settlement at the end of the 2.1 year surcharge period is 100 mm (90 mm creep settlement plus 10 mm long-term rock fill settlement). To facilitate the assessment for the end of the surcharge period, instrumentation and monitoring during and after construction will be required.

As discussed in Section 6.5.1.2.3.2, the maximum stable embankment height is significantly lower than the final surcharged embankment height and toe berms are required. The toe berm required to the south of the Highway 17 EBL embankment is 23 m wide and 2 m high above ground surface.

The main disadvantages of this option are the wait time required for surcharging without the use of wick drains and the requirement of large toe berms which may require the purchase of additional property. If the length of the construction schedule is not a consideration this would be the most cost effective option.

6.5.1.2.3.7 Other Mitigation Options

The option of partial sub-excavation is considered not feasible since in this case, wick drains would not be able to be installed through the rock fill backfill and thus, full preloading to reduce post-construction settlement of the remaining clay deposit would still be required. As a minimum, a 12 month preload period would be required for rock fill compression.

The option of ground improvement, consisting of either dry/wet soil mixing or rammed aggregate piers (geopiers) is also considered not feasible since the amount of cement or aggregate required would result in costs far exceeding other options. Further, additional design and bench scale testing would be required to determine the ultimate feasibility of these options and it may be that there would be insufficient strength gain of the clay deposit to make the soil mixing option feasible.

6.5.2 Highway 17 WBL – STA 13+140 to 13+390
Highway 17 EBL – STA 13+140 to 13+390
St. Pothier Road – STA 9+400 9+600
High Fill H2

Between STA 13+140 and 13+390, the WBL and EBL embankments will require a fill embankment up to 5.0 m high above the existing ground surface to achieve the vertical highway profile. The St. Pothier Road embankment will require a fill embankment up to 4.4 m high above the existing ground surface to achieve the vertical highway profile. These three alignments extend across a low lying swampy area with occasional areas of ponded water. A watercourse runs through the middle of the swamp from north to south. Considering the close proximity of these three embankments to one another, that all three of these embankments are on new alignments and the foundation benefits of building these embankments concurrently, these embankments have been combined into one high fill/swamp area (H2).

The subsurface soils along the H2 alignments generally consist of a surficial layer of peat/organics up to 3.6 m thick, underlain by a cohesive deposit of clayey silt transitioning into varved silty clay to clay transitioning to

clayey silt to silt, which in turn is underlain by deposits of silt to sand to gravelly sand. The cohesive deposit is up to about 10 m thick in some locations and extends to depths up to 13.5 m below ground surface. Resistance to dynamic cone penetration and borehole advancement was encountered at depths of up to 20.3 m below ground surface. In some boreholes, typically near the middle of the swamp, refusal was not encountered at depths of up to 25.0 m below ground surface. Details of the subsurface conditions at the Highway 17 WBL, Highway 17 EBL and St. Pothier Road embankments are presented in Sections 4.5, 4.6 and 4.7, respectively, and the stratigraphic profiles are shown on Drawings B1 to B6 in Appendix B.

The simplified stratigraphy and the associated unit weight, strength, deformation and time-rate consolidation parameters employed for the different soil types encountered in this area are summarized in Table 3. Additional details of foundation engineering parameters employed for the cohesive deposits (i.e., clayey silt/silty clay/clay) encountered in H2 are presented on Figure B25 in Appendix B. The piezometric condition used in the analyses is the water table at the existing ground surface.

The critical sections for stability and settlement are located at about STA 13+260 along the Highway 17 WBL and EBL embankments and at about STA 9+480 along the St. Pothier Road embankment, where the proposed embankment heights are 4.4 m, 4.4 m and 2.9 m high, respectively. The cohesive deposit is about 5.5 m, 9.7 m and 9.8 m thick at the WBL, EBL and St. Pothier Road embankment locations, respectively. Although the maximum embankment height was not encountered at this critical section, the thickness of the cohesive deposit governs the results of the analysis for both stability and settlement.

6.5.2.1 Stability

The stability analyses carried out at the critical section indicates that after completion of construction (including removal and replacement of the up to 3.6 m thick organic deposit with rock fill), the embankments will have a Factor of Safety (FoS) less than 1.3 for a deep-seated, global failure surface that would impact the operation of the highway. Therefore, stability mitigation is required in High Fill H2.

6.5.2.2 Settlement

The settlement analysis carried out at the critical section, estimates the short-term settlement of the foundation soils to be 690 mm. This estimated settlement of the Highway 17 EBL embankment is comprised of about 75 mm of immediate settlement due to compression of the cohesionless deposits and about 615 mm of primary consolidation of the 9.7 m thick cohesive deposit.

Based on an average coefficient of consolidation (c_v) of about 2.0×10^{-3} cm^2/s estimated for the cohesive deposit, the imposed loading conditions for the approximately 4.4 m high rock fill embankment (EBL) and assuming two-way drainage of the 9.7 m thick cohesive deposit, it is estimated that about 90 per cent of the primary consolidation settlement will be completed in about 3.2 years.

The magnitude of secondary consolidation (creep) settlement for the cohesive deposit is expected to be about 90 mm per log-cycle of time for this area corresponding to about 70 mm over a 20-year period following completion of construction.

In addition, the total settlement of the rock fill embankment itself (based on a 4.4 m high embankment at the critical section plus 3.6 m of rock fill backfill) is estimated to be about 70 mm, with about 50 mm expected to

occur within six months of construction of the embankment, 10 mm occurring during the next six months and about 10 mm expected to occur over the remaining design life of the embankment.

The estimated total settlement of the St. Pothier Road embankment is comprised of about 80 mm of immediate settlement due to compression of the cohesionless deposits and about 425 mm of primary consolidation of the 9.8 m thick cohesive deposit. These values assume that removal and replacement of the up to 3.6 m thick organic deposit with rock fill has been carried out.

Based on an average coefficient of consolidation (c_v) of about 2.0×10^{-3} cm^2/s estimated for the cohesive deposit, the imposed loading conditions for the approximately 2.9 m high rock fill embankment (St. Pothier Road) and assuming two-way drainage of the 9.8 m thick cohesive deposit, it is estimated that about 90 per cent of the primary consolidation settlement will be completed in about 3.2 years.

The magnitude of secondary consolidation (creep) settlement for the cohesive deposit is expected to be about 90 mm per log-cycle of time for this area corresponding to about 70 mm over a 20-year period following completion of construction.

In addition, the total settlement of the rock fill embankment itself (based on a 2.9 m high embankment at the critical section plus 3.6 m of rock fill backfill) is estimated to be about 60 mm, with about 45 mm expected to occur within six months of construction of the embankment, 5 mm occurring during the next six months and about 10 mm expected to occur over the remaining design life of the embankment.

Since the total post-construction settlement (primary, creep and rock fill) exceeds the settlement criterion of 100 mm for the EBL and WBL and 200 mm for the St. Pothier Road embankment, settlement mitigation measures are required for the embankments in High Fill H2.

6.5.2.3 Mitigation of Stability Issues and/or Time Dependent Settlements: Embankments Built Concurrently

The presence of the up to about 10 m thick cohesive deposit influences both the stability and the settlement of the 4.4 m high embankments at the critical section. In order to construct the embankments to achieve a FoS greater than or equal to 1.3, and to minimize post-construction settlements, the alternatives presented below can be considered.

The mitigation options discussed in this section are all based on the assumption that all three embankments are built concurrently. Constructing the three embankments concurrently greatly improves the global stability of the embankments during construction. In particular, the St. Pothier Road embankment would essentially act as a toe berm to support the Highway 17 EBL embankment - without the St. Pothier Road embankment, a temporary toe berm extending across the width of St. Pothier Road would be required to maintain the stability of the Highway 17 EBL until the St. Pothier Road embankment is constructed. For practical purposes, we recommend building the embankments concurrently, as detailed in the alternatives below.

The alternatives described have been evaluated and ranked on the basis of the advantages, disadvantages, relative costs and risk/consequences and are summarised in Table B1 in Appendix B. A summary of the settlement results for each alternative is provided in Table 4.

Section 6.5.2.4 discusses the mitigation scenarios where the St. Pothier Road embankment is constructed after the Highway 17 EBL and WBL have been constructed and the mitigation alternatives are ranked in Table B2 in Appendix B.

Given the thick cohesive deposit (the bottom of which is up to 13.5 m below ground surface) and the associated magnitude of primary consolidation settlement (about 615 mm) of the foundation soils under a 4.4 m high embankment, surcharging with wick drains and incorporating toe berms along the embankments into a staged construction schedule is considered the preferred mitigation alternative, provided all three embankments are constructed concurrently.

6.5.2.3.1 Surcharging, Wick Drains and Staged Construction with Toe Berms

We recommend a staged construction approach with surcharging that incorporates wick drains installed into the cohesive stratum and toe berms supporting the embankments, as the preferred, most technically feasible mitigation measure to achieve stable embankments and to minimize the post-construction settlements and subsequent maintenance of the new roadway surface. The staged construction approach relies on strength gain in the underlying cohesive deposit to enhance the global stability of the embankment during subsequent stages. The first stage could be constructed up to 4.4 m high with 2 m high by 10 m wide toe berms along the north side of the Highway 17 WBL embankment and a 2 m high toe berm connecting the Highway 17 EBL embankment to the St. Pothier Road embankment. During the first stage, the St. Pothier Road embankment must be constructed up to 2.9 m high with a 2 m high by 10 m wide toe berm along the south side of the embankment. The first stage of construction includes the installation of instrumentation to monitor settlement and pore pressure dissipation, and requires a wait period to allow for dissipation of the pore pressures and to achieve a strength increase of the cohesive deposit (estimated to be up to about 16 kPa under the EBL embankment). The actual wait period will be dependent on the results of the monitoring.

After the first wait period is complete, the second stage of construction consisting of a 2.0 m surcharge on the Highway 17 WBL and EBL embankments and a 1.0 m surcharge on the St. Pothier Road embankment, can be completed and a second wait period will be required to allow for dissipation of the pore pressures of the cohesive deposit to satisfy the settlement criterion. The analysis assumes that the embankment will be “topped up” in the second stage to the final grade prior to placing the surcharge fill. For quantity estimation, additional fill placement of 0.7 m (i.e., second stage total 2.7 m of fill; 0.7 m top up and 2.0 m surcharge fill) for the WBL/EBL embankments should be anticipated. For the St. Pothier Road embankment, 0.5 m of top up should be anticipated for a total second stage fill of 1.5 m. The results of the stability analysis for the proposed embankment geometry under the first stage and surcharge stage with the calculated strength gain of the cohesive soils is presented on Figures B26 and B27 for the WBL embankment and on Figures B28 and B29 for the and St. Pothier Road, respectively.

In this case, the up to 3.6 m thick organic deposit will be removed and replaced with granular fill to facilitate installation of the wick drains and the embankments can be constructed out of rock fill.

Preliminary analysis using a wick drain spacing of 1.5 m in a triangular pattern to full depth through to the bottom of the cohesive deposit indicates a wait period of about 10 months would be required for the first stage of embankment construction followed by a surcharge period of about 10 months for a total construction period of about 1.7 years. A detailed wick drain analysis has not been completed for this area and the preliminary analysis to estimate the wait periods presented in this report are based on undrained analyses. As such, the

number of stages and wait periods described above are approximate. The stages of construction, wait periods and estimated settlement are as follows:

Embank-ment	Stage	Fill Thickness*	Wait Period	Settlement During Construction	Post Construction Settlement
EBL/WBL	1	4.4 m	~10 months	75 mm (immediate) 580 mm (primary) 40 mm (rock fill)	-
	2 (surcharge)	2.7 m**	~10 months	240 mm (primary) 20 mm (rock fill)	0 mm (primary) 95 mm (creep) 5 mm (rock fill)
St. Pothier Road	1	2.9 m	~10 months	80 mm (immediate) 410 mm (primary) 40 mm (rock fill)	-
	2 (surcharge)	1.5 m**	~10 months	75 mm (primary) 20 mm (rock fill)	65 mm (primary) 130 mm (creep) 5 mm (rock fill)

*After 3.6 m of peat has been sub-excavated and replaced with granular fill to the original ground surface.

**Includes embankment top up.

After preloading and surcharging for about 1.7 years, the total post-construction settlement at the end of the surcharge period for the Highway 17 WBL and EBL embankments is estimated to be 100 mm (comprised of 95 mm creep settlement plus 5 mm long-term rock fill settlement). The result of the settlement analysis for staged construction for the EBL embankment is presented on Figure B30.

After preloading and surcharging for about 1.7 years, the total post-construction settlement at the end of the surcharge period for the St. Pothier Road embankment is estimated to be 200 mm (comprised of 65 mm remaining primary settlement plus 130 mm creep settlement plus 5 mm long-term rock fill settlement). The result of the settlement analysis for staged construction for the St. Pothier Road embankment is presented on Figure B31.

The main advantages of this alternative are the significant reduction in the size of the required toe berms to achieve stability as compared to non-staged construction, as well as the shorter schedules for the first and second stages as compared to options where wick drains are not incorporated. The main disadvantage of this option is the increased cost to install and monitor the wick drains and the associated construction wait periods due to the multiple stages. Further, the actual wait periods are dependent on the results of the monitoring program and could be shorter or longer than estimated.

If wick drains are not utilized for this option, the first stage of construction will require a wait period of about 2.5 years to allow for dissipation of the pore pressures and achieve the strength increase necessary. The second wait period will require another wait period of about 2.5 years as the pore pressures dissipate and the necessary strength gain is achieved. The total delay time for construction would be about 5 years. The actual wait periods will be dependent on the results of the monitoring program and could be shorter or longer than estimated.

6.5.2.3.2 Full Sub-Excavation and Preloading

Taking into consideration the depth to the bottom of the clay deposit (i.e., up to about 13.5 m below the existing ground surface), full sub-excavation of the cohesive deposit is not considered practical for High Fill H2 due to: the potential requirement for specialized drag-line equipment; the substantial time and costs required to complete the sub-excavation and backfilling activities; the need for extra rock fill; the increase in long-term settlement of the rock fill; and the requirement for preloading for 12 months to reduce the long-term (post-construction) settlement. The full sub-excavation alternative, if adopted, eliminates the risk associated with long-term consolidation settlement associated with the silty clay to clay deposit and the long-term settlement of the rock fill after a 12 month preload period is estimated to be 30 mm. It should be noted, however, that the cost of sub-excavation and backfilling may be of the same order of magnitude and likely greater as some of the other options, including wick drains and staged construction as no off-site rock fill would have to be supplied to site at an added cost, however, the time to conduct the sub-excavation operations and subsequent preloading would likely be longer.

6.5.2.3.3 Partial Preloading and Lightweight Fill

If there is insufficient space to accommodate toe berms, an alternative to reduce the post-construction settlement is to partially preload the embankment and incorporate lightweight (EPS) fill into the embankment mass. The Highway 17 WBL embankment can be constructed to the maximum stable embankment height of 3.1 m and the St. Pothier Road embankment can be constructed to the maximum stable height of 2.5 m without the use of toe berms. Assuming the St. Pothier Road embankment will be built at the same time as the Highway 17 WBL and EBL embankments and as such would act as a “toe berm” for the Highway 17 EBL embankment, a 4.0 m surcharge could be constructed on the Highway 17 EBL embankment. After the partial preloading of the WBL and St. Pothier Road and the surcharging of the EBL, the Highway 17 WBL and St. Pothier Road embankments would be constructed to the final height by incorporating a 1.5 m and 1.0 m thick zone of EPS into the embankments, respectively. The EBL embankment would not require the use of EPS due to the large surcharge which could be partially removed to achieve the final embankment height.

In this case, the up to 3.6 m thick organic deposit should be removed and replaced with rock fill. In areas where EPS is required (WBL and St. Pothier Road embankments), the embankments should be constructed out of granular fill to facilitate placement of the EPS. The EBL embankment should be constructed of rock fill. The appropriate side slopes should be utilized as per Section 6.2.1.

After partial preloading for about 1.8 years (without using wick drains), the total post-construction settlement at the end of the partial preloading period for the Highway 17 WBL embankment is estimated to be 100 mm (comprised of 30 mm remaining primary settlement plus 65 mm creep settlement plus 5 mm settlement of the above ground rock fill). At the end of the partial preloading period for the St. Pothier Road embankment the total post-construction settlement is estimated to be 200 mm (comprised of 120 mm remaining primary settlement plus 75 mm creep settlement plus 5 mm long-term rock fill settlement).

After surcharging the Highway 17 EBL embankment for about 1.8 years, the total post-construction settlement for the Highway 17 EBL is estimated to be 100 mm (comprised of 20 mm remaining primary and 75 mm creep settlement and 5 mm long-term rock fill settlement).

The main disadvantage of this option is the high cost of EPS fill, which is typically an order of magnitude higher than other fill materials.

6.5.2.3.4 Surcharging, Wick Drains with Toe Berms

As an alternative to staged construction or the use of EPS, surcharging the Highway 17 WBL, EBL and St. Pothier Road embankments, while incorporating wick drains into the clay stratum and constructing toe berms to support the embankments, would achieve stable embankments and minimize the post-construction settlements and subsequent maintenance of the new roadway surface.

Surcharging the embankment increases the load on the underlying soils thereby reducing the delay time required to meet the settlement criterion. Wick drains provide a pathway for the dissipation of excess pore pressure in the cohesive deposit thereby further reducing the time required to meet the settlement criteria. The main disadvantages of this alternative is that large toe berms would be required (and thus property may need to be acquired), the double handling of the surcharge material and the cost of designing and installing the wick drains, including an instrumentation and monitoring program.

A 2.0 m surcharge above the final profile grade for the WBL and EBL embankment and a 1.0 m surcharge for the St. Pothier Road embankment would reduce the time required for preloading and decrease the long-term post-construction settlement including creep. In this case, the up to 3.6 m thick organic deposit would be removed and replaced with granular fill to facilitate installation of the wick drains and the embankments can be constructed out of rock fill.

The maximum stable embankment height without toe berms is 2.9 m for the Highway 17 WBL, for the Highway 17 EBL is 4.4 m and for the St. Pothier Road embankment it is 2.5 m. The embankment plus surcharge height for each embankment is 6.4 m, 6.4 m and 3.9 m, respectively, therefore toe berms would be required to improve stability of the surcharged embankment to achieve a FoS equal to or greater than 1.3. The toe berm required on the north side of the Highway 17 WBL embankment would be14 m wide and 1.5 m high and the toe berm required on the south side of the St. Pothier Road embankment would be 22 m wide and 1.5 m above ground surface. Also a “toe berm” about 1.5 m above ground surface that connects the Highway 17 EBL and the St. Pothier Road embankments would be required.

Preliminary analysis of consolidation of the cohesive deposits under the three embankments enhanced by wick drains spaced at 1.5 m in a triangular pattern to full depth through to the bottom of the cohesive deposit indicates that 90 per cent of primary consolidation would be completed in about 10 months.

After surcharging for 10 months, the total post-construction settlement of the EBL embankment is estimated to be 100 mm (95 mm creep settlement plus 5 mm long-term rock fill settlement).

After surcharging the St. Pothier Road embankment for 10 months, the total post-construction settlement is estimated to be 200 mm (50 mm primary, 130 mm creep settlement plus 20 mm short and long-term rock fill settlement).

To facilitate the assessment for the end of the surcharge period, instrumentation and monitoring during and after construction would be required. A detailed wick drain analysis has not been completed for this area and the preliminary analysis used to estimate the wait periods presented in this report is based on undrained analyses. As such, the above number of stages and wait times are approximate. Further, the actual wait period is dependent on the results of the monitoring program and could be shorter or longer than estimated.

6.5.2.3.5 Surcharging with Toe Berms

Surcharging the Highway 17 WBL, EBL and St. Pothier Road embankments and incorporating toe berms into the embankments will achieve stable embankments and minimize the post-construction settlements and subsequent maintenance of the new roadway surface. However, without the use of toe berms, the surcharging would take longer.

The maximum stable embankment height without toe berms is 3.3 m for the Highway 17 WBL, for the Highway 17 EBL is 2.4 m and for the St. Pothier Road embankment it is 2.9 m. The embankment plus surcharge height for each embankment is 6.4 m, 6.4 m and 3.9 m, respectively, therefore toe berms would be required to improve the stability of the surcharged embankment to achieve a FoS equal to or greater than 1.3. The toe berm required on the north side of the Highway 17 WBL embankment would be 12 m wide and 1.5 m high and the toe berm required on the south side of the St. Pothier Road embankment would be 20 m wide and 1.5 m above ground surface. Also a “toe berm” about 1.5 m above ground surface that connects the Highway 17 EBL and the St. Pothier Road embankments would be required.

In this case, the up to 3.6 m thick organic deposit will be removed and replaced with granular fill to facilitate installation of the wick drains and the embankments can be constructed out of rock fill.

After surcharging the WBL and EBL embankments for 2.5 years, the total post-construction settlement of the EBL embankment is estimated to be 100 mm (10 mm primary, 80 mm creep settlement plus 10mm long-term rock fill settlement).

After surcharging the St. Pothier Road embankment for 1.5 years, the total post-construction settlement is estimated to be 200 mm (110 mm primary, 80 mm creep settlement plus 10 mm long-term rock fill settlement).

To facilitate the assessment for the end of the surcharge period, instrumentation and monitoring during and after construction would be required.

The main disadvantages of this option are the wait time required for surcharging without the use of wick drains and the requirement for large toe berms which may require the purchase of additional property. If the length of the construction schedule is not a consideration this would be the most cost effective option.

6.5.2.3.6 Other Mitigation Options

The option of partial sub-excavation is considered not feasible since in this case, wick drains would not be able to be installed through the rock fill backfill and thus full preloading to reduce post-construction settlement of the remaining clay deposit would still be required. As a minimum, a 12 month preload period would be required for rock fill compression.

The option of ground improvement, consisting of either dry/wet soil mixing or rammed aggregate piers (geopiers) is also considered not feasible since the amount of cement or aggregate required would result in costs far exceeding other options. Further, additional design and bench scale testing would be required to determine the ultimate feasibility of these options and it may be that there would be insufficient strength gain of the clay deposit to make the soil mixing option feasible.

6.5.2.4 Mitigation of Stability Issues and/or Time Dependent Settlements: Highway 17 EBL/WBL Embankments Built Independently from the St. Pothier Road Embankment

Construction of the three embankments concurrently is critical to maintaining stability of the embankments and is also a major factor in choosing the preferred mitigation alternative. Essentially, the St. Pothier Road embankment will act as a "toe berm" for the south side of the Highway 17 EBL embankment. If the St. Pothier Road embankment is not constructed concurrently with the Highway 17 embankments, then the global stability of the proposed 4.4 m high EBL embankment would be compromised. A toe berm would be required on the south side of the Highway 17 EBL embankment with approximately the same dimensions as the proposed St. Pothier Road embankment (i.e., extending over 25 m wide) to support the EBL embankment. Therefore, the number of technically feasible options is reduced when only the Highway 17 EBL and WBL embankments are considered.

As discussed in Section 6.5.2.3, we recommend surcharging in combination with wick drains and toe berms along the embankments integrated into a staged construction schedule as the preferred mitigation alternative, provided all three embankments are constructed concurrently. We do not recommend constructing the St. Pothier Road embankment at a later time as both stability and long-term settlement of the new EBL/WBL embankments would affect roadway performance and likely construction itself. Further, the costs associated with mitigation of all the embankments would be excessive.

If, however, it is not possible to construct the St. Pothier Road embankment at the same time as the Highway 17 EBL and WBL embankments, then the alternative of partial preloading with lightweight fill (EPS) is considered the only technically feasible option to mitigate both the settlement and stability concerns related to the construction of the EBL embankment. Further, if the St. Pothier Road embankment is constructed at a later date, settlement of the cohesive deposit under the new loading would induce settlement under the EBL embankment.

6.5.2.4.1 Partial Preloading and Lightweight Fill

If the construction schedule does not allow for all three embankments to be built concurrently the only technically feasible alternative to reduce the post-construction settlement while maintaining stability is to partially preload the Highway 17 WBL and EBL embankments and to incorporate lightweight (EPS) fill into the embankment mass. The Highway 17 WBL and EBL embankments can be constructed to the maximum stable embankment height of 2.2 m without the use of toe berms. Partial preloading at this embankment height for 1.8 years would be required to allow for sufficient consolidation settlement of the cohesive deposit and settlement of the rock fill prior to the construction of the pavement structure. After the partial preloading of the WBL and EBL, the embankments could be constructed to the final height by incorporating a 3.0 m thick zone of EPS into the embankments.

After partial preloading for about 1.8 years (without using wick drains) the total post-construction settlement in the Highway 17 WBL is estimated to be 100 mm (comprised of 30 mm remaining primary and 65 mm creep settlement and 5 mm long-term rock fill settlement) and the post-construction settlement in the Highway 17 EBL is estimated to be 100 mm (comprised of 20 mm remaining primary and 75 mm creep settlement and 5 mm long-term rock fill settlement).

The St. Pothier Road embankment can subsequently be constructed to the maximum stable embankment height of 2.5 m without the use of toe berms. Partial preloading at this embankment height can then be carried out for 1.8 years to allow for sufficient consolidation settlement of the cohesive deposit and settlement of the rock fill to occur prior to the construction of the pavement structure. A 1.0 m thick zone of EPS would then be required to raise the embankment to the design grade. After completion of the preload period, the total post-construction settlement is estimated to be 200 mm (comprised of 120 mm remaining primary and 75 mm creep settlement and 5 mm long-term rock fill settlement).

The main disadvantage of this option is the substantial cost of EPS fill, which is typically an order of magnitude higher than other fill materials. The construction of toe berms could reduce the amount of EPS material currently specified. Also, wait times could be reduced by incorporating more EPS material into the embankment or utilizing wick drains.

6.5.3 Highway 17 WBL – STA 13+900 to 14+200
Highway 17 EBL – STA 13+900 to 14+200
High Fill H3

Due to the close proximity and overlap of the realigned Highway 17 WBL and EBL embankments and the existing Highway 17 WBL and EBL embankments, these embankments areas have been combined into one high fill/swamp area H3.

Generally, the proposed Highway 17 WBL and EBL embankments overlap the existing Highway 17 WBL and EBL embankments throughout the high fill area with essentially a widening of the existing embankments of up to about 7 m to the north of both the WBL and EBL embankments between STA 13+950 and 14+150. Between about STA 13+900 and 13+950 and between about STA 14+150 and 14+200, there will either be a cut or minimal to no grade raise. Between about STA 13+950 and 14+150, an embankment widening up to about 7 m and a grade raise up to 3.1 m above the existing embankment will be required to achieve the horizontal and vertical highway profile.

The subsurface soils along the WBL and EBL alignments in High Fill Area H3 consist of surficial layers of peat/topsoil or asphalt and embankment fill, underlain by an upper deposit of sand to sandy silt. These upper deposits are underlain by the main cohesive deposit of clayey silt transitioning into varved silty clay to clay transitioning to clayey silt to silt underlain by a silt deposit, which is further underlain by a deposit of sand to sand and silt. The cohesive deposit is up to 16.8 m thick at some locations and extends to depths up to 19.5 m below ground surface. Resistance to dynamic cone penetration and borehole advancement was encountered at depths of up to 28.0 m ground surface. Details of the subsurface conditions for this swamp crossing area are presented in Sections 4.8 and 4.9 and shown on Drawings C1 to C4 in Appendix C.

The simplified stratigraphy and the associated unit weight, strength, deformation and time-rate consolidation parameters employed for the different soil types encountered in this area are summarized in Table 3. Additional details of foundation engineering parameters employed for the cohesive deposits (i.e., clayey silt/silty clay/clay) encountered in H3 are provided on Figure C22 in Appendix C. The piezometric condition used in the analyses is the water table just below the top of the native organic material (Elevation 241.6 m).

The critical section used in the analysis is located at approximately STA 14+100, where the existing embankments are to be widened thus requiring grade raises at the existing north crest of slope of 1.9 m and 3.1 m above the existing ground surface at the toes of the existing WBL and EBL embankments, respectively . At

STA 14+100, the grade raises will be approximately 0.8 m and 1.1 m above the existing highway grade at the new centrelines of the WBL and EBL, respectively. Boreholes drilled in the WBL and EBL embankments encountered up to 4.7 m and 5.5 m of existing fill, respectively. At this location, the cohesive deposit is up to 14.0 m thick.

6.5.3.1 Stability

At the critical section as described above, the FoS for slope stability would be greater than 1.3 for granular fill or rock fill embankments constructed on the existing fill and subsoils, provided that all organics have been removed below the widened embankment footprint, as shown on Figures C23 and C24 in Appendix C.

6.5.3.2 Settlement

To estimate the magnitude of the expected settlements due to new construction, analysis was carried out at the critical section representative of the subsurface conditions within the high fill area, at approximately STA 14+100. The critical section was chosen in the area of the largest embankment widening, which corresponds to the largest stress loading on the subsoils. At the north side of the EBL which is most critical for settlement, the widening of about 6 m creates a grade raise of 3.1 m above the existing ground surface at the crest of the slope and a grade raise of about 1.1 m above the 5.6 m of existing fill at the proposed EBL centreline.

Based on the results of the settlement analysis for the EBL embankment widening, the short-term settlement of the foundation soils under approximately the new outside edge of pavement (assumed to be the edge of the travelled lane in this analysis) is estimated to be about 115 mm. This estimated settlement in the Highway 17 WBL is comprised of about 25 mm of immediate settlement due to compression of the cohesionless deposits and about 90 mm of primary consolidation of the 14.0 m thick cohesive deposit.

Based on an average coefficient of consolidation (c_v) of about 2.0×10^{-3} cm^2/s estimated for the cohesive deposit, the imposed loading conditions for the approximately 3.1 m grade raise and assuming two-way drainage of the 14 m thick cohesive deposit, it is estimated that about 90 per cent of the primary consolidation settlement will be completed in about 6 years.

The magnitude of secondary consolidation (creep) settlement for the cohesive deposit is expected to be about 100 mm per log-cycle of time for this area corresponding to about 60 mm over a 20-year period following completion of construction (i.e., from 6 years to 20 years).

If rock fill is utilized for the embankment widening, the total settlement of the rock fill embankment itself (based on 3.1 m grade raise at the critical section) is estimated to be about 25 mm, with about 15 mm expected to occur within six months of construction of the embankment, 5 mm occurring during the next six months and about 5 mm expected to occur over the remaining design life of the embankment. If granular fill is utilized, settlement of properly placed and compacted granular fill is estimated to occur quickly during construction with no post-construction settlement.

Since the total post-construction settlement is estimated to be about 175 mm (comprised of 90 mm primary consolidation, 60 mm of creep and 25 mm rock fill settlement – if utilized), and exceeds the settlement criterion of 50 mm for an embankment widening, settlement mitigation measures are required for the Highway 17 WBL

and EBL embankments in the High Fill Area H3. Further, the estimated differential settlement of 40 mm between the new centreline and north edge of pavement also exceeds the criterion of 200:1. It should be noted that higher magnitudes of total and differential settlement are expected to occur beyond the outside edge of pavement along the slope.

6.5.3.3 Mitigation of Stability Issues and/or Time Dependent Settlements

In order to construct the embankments in the widened areas and minimize post-construction settlements, the alternatives presented below can be considered. The alternatives described have been evaluated and ranked on the basis of the advantages, disadvantages, relative costs and risk/consequences and are summarised in Table C1 in Appendix C. A summary of the results of settlement analysis for each alternative is provided in Table 4.

Outside of the critical areas, there will be a minimal grade raise and little to no embankment widening and therefore no settlement or stability mitigation will be necessary. The sections listed below do not require settlement or stability mitigation:

- Highway 17 WBL and EBL – STA 13+900 to 13+950;
- Highway 17 EBL – STA 14+150 to 14+200; and
- Highway 17 WBL, – STA 14+175 to 14+200.

The areas not listed above will require settlement mitigation. Given the thick cohesive deposit (the bottom of which is up to about 19.5 m below ground surface), the associated magnitude of primary and secondary consolidation settlement (150 mm) and 40 mm of expected differential settlement of the foundation soils under a 3.1 m grade raise in the widened area, the most practical method of construction is to preload the embankment widening, allowing settlement to occur while the traffic is using the widened highway section, followed by maintenance of the roadway in the future. This method does not meet the MTO settlement criteria for post-construction settlement but is more practical from a cost and a construction standpoint compared to other technically feasible options.

6.5.3.3.1 Consolidation and Maintenance

We recommend a construction approach that involves constructing (widening and raising) the embankments to their final geometry, utilizing the embankments as the travelled highway and then conducting ongoing maintenance, as may be required to re-grade the highway to accommodate the estimated 80 mm of settlement (approximately 90 per cent of the primary consolidation settlement) expected to occur over about 6 years. While this construction option does not meet the MTO settlement criteria in the short term, it is still considered the most practical option given that the magnitude of total settlement at the new outside north edge of the EBL pavement is about 150 mm (90 mm primary and 60 mm creep). The widened embankment will remain stable while in use as a travelled lane but the expected post constructed settlements will require maintenance. This alternative relies on the fact that while the expected settlements exceed the MTO settlement criteria for a widened embankment (Figure 3, MTO 2010), the embankment can still function as a travelled lane while consolidation takes place.

While this construction approach does not strictly require the installation of instrumentation to monitor for settlement, it would be prudent and it is recommended that settlement be monitored, however, it is not required to monitor pore pressures for embankment stability. The embankment monitoring can consist of a series of settlement plates installed within the embankment at the crest of the widened portions of the embankments provided guide rail installation is not impacted and the monitoring points remain accessible. Settlement plates in the shoulder or on the slope (or nail pins in pavement) will be required to be installed along the full length of the high fill section on the south side of the widened embankment at offsets to be determined once the final cross sections are known. For a 300 m long section, settlement plates at approximately 50 m spacing would be appropriate. Monthly readings of the settlement plates are recommended for the first year of monitoring and quarterly readings afterwards until the decrease in the rate of settlement indicates that the remaining settlement is within the MTO criteria, likely up to 6 years.

The total post-construction settlement (i.e., after construction of the widened embankments is complete and traffic is using the lanes) for the Highway 17 EBL embankment expected during the consolidation period is estimated to be 150 mm (comprised of 90 mm of primary settlement plus 60 mm creep settlement plus fill settlement) which exceeds the settlement criteria. The differential settlement of 40 mm between the new centreline and new outside edge of pavement lane also exceeds the criterion of 200:1. During the approximately 6 year consolidation period, approximately 80 mm of settlement will have occurred on the new outside edge of pavement and approximately 50 mm at the new highway centreline. The estimated total and differential settlement after approximately 6 years is about 50 mm and 5 mm at the new outside edge of pavement, respectively, which meet the MTO criteria. The results of the analysis are shown on Figure C25.

The main advantages of this option are that there is neither a delay in the construction schedule nor any need to divert traffic for multiple years during staged construction. The disadvantages of this option are that it does not meet the MTO settlement criteria and future highway maintenance is likely to be required.

6.5.3.3.2 Lightweight Fill

In order to meet the settlement criteria in the short term, lightweight (EPS) fill could be incorporated into the widened embankment mass. The Highway 17 WBL and EBL embankments can be widened to the north using a 1 m thick layer of EPS under the pavement structure of the new embankment (full width, not to interfere with guide rail installation) and an additional 1 m of EPS (for a total of 2 m) would be required within the remainder of the north half of the new embankment. This will require sub-excavation of the existing fill to accommodate the EPS. The EPS should be stepped in 0.3 m to 0.5 m increments across the embankment and in the taper zones longitudinally along the highway. Essentially, with the incorporation of this volume of EPS into the embankment mass, the induced settlement will be minimal and will not result in creep settlement. Total and differential post-construction settlement is estimated to be less than 10 mm.

The main advantages of this option are that it meets the post-construction settlement criteria in the short term and does not create delays in the construction schedule. The disadvantage of this option is the substantial cost of EPS fill, which is typically an order of magnitude higher than other fill materials, as well as the need to excavate a portion of the existing embankments in order to install the EPS. Generally, this option is not considered practical due to the added cost of material compared to the consolidation and maintenance option.

6.6 Subgrade Preparation and Embankment Construction

The following sections discuss general aspects of subgrade preparation and embankment construction for the high fill/swamp crossing areas, including: removal of organic materials; excavation and replacement of soft, cohesive deposits; groundwater control; placement of embankment fills, slope flattening and platform widening.

A summary of the recommended/preferred foundation mitigation option for each high fill/swamp crossing area is presented in Table 5. The summary contains: recommendations on embankment fill types and side slope profiles; estimated maximum depth of organic deposits encountered; the magnitude of estimated settlement (during and post-construction) for the embankment materials and the foundation soils; recommended width of platform widening as may be required to accommodate future raising of the embankment; and the recommended Ontario Provincial Standard Drawings (OPSD) excavation guideline.

6.6.1 Removal of Organic Deposits

Based on the subsurface information from the boreholes advanced during the field investigation, the thickness of organic deposits (i.e., peat and topsoil) in the proposed Highway 17 alignment generally ranges from about 0.1 m to 4.0 m, as presented in Table 3. After clearing and grubbing the high fill/swamp crossing areas and prior to the placement of any fill for the new construction, all organic deposits should be stripped from the plan limits of the proposed works, including toe berms, if applicable. The organic materials should be removed using construction procedures in accordance with OPSS 209 (Embankments Over Swamps and Compressible Soils) where the removal and backfilling operations are carried out simultaneously. An NSSP for excavation of organics should be included in the contract documents and an example is included in Appendix D.

In areas where the new embankments are being constructed away from existing embankments, the excavation limits should be consistent with OPSD 203.010 (Embankments Over Swamp, New Construction, modified to remove the restrictions on the height of the embankment and the depth of excavation (i.e., Note A). In areas where the existing embankments are to be widened, the organics should be removed below the toe of the widened embankment in accordance with OPSD 203.020 (Embankments over Swamp, Existing Slope Excavated to 1H:1V). If space is not sufficient for the proposed slopes (as be determined by the grading), then temporary roadway protection may be required as per OPSS 539 (Temporary Protection Systems) using Performance Level 2.

All excavations must be carried out in accordance with Ontario Regulation 213 of the Ontario Occupational Health and Safety Act for Construction Projects (as amended). In addition, provisions for traffic control measures should be included in the Contract Documents to maintain the safe operation of Highway 17, St. Pothier Road and any associated side roads or detours that are in close proximity to the excavation operations.

6.6.2 Groundwater and Surface Water Control

Excavation within the plan limits of the proposed works will be required to remove organic deposits prior to embankment fill placement, which will extend below the water table. Groundwater flow into the excavations will occur due to the presence of relatively permeable deposits and relatively high groundwater levels observed in the low-lying high fill/swamp crossing areas. Unwatering is not required for the excavation and backfilling in the high fill/swamp crossing areas, however, surface water should be directed away from the excavations at all times.

6.6.3 Backfilling

In general, it is recommended that rock fill be used for replacement of the sub-excavated materials. However, in areas where wick drains are required to mitigate stability and/or post-construction settlements, it is recommended that OPSS.PROV 1010 (Aggregates) Granular 'B' Type II be used for the replacement of the sub-excavated materials. Where sub-excavation of organic deposits is being carried out as a foundation mitigation option, it will not likely be possible to place rock fill or granular fill in accordance with OPSS.PROV 206 (Grading), as discussed in Section 6.6.5. For placement below the water table, rock fill and granular fill will likely have to be end dumped as the excavation advances.

6.6.4 Embankment Fill Placement

Placement of rock fill and granular fill above the water table for construction of new embankments should be should be placed and compacted in accordance with OPSS 501 (Compacting) and with the requirements as outlined in OPSS.PROV 206 (Grading). The rock fill should not be dumped in final position, but should be deposited on and pushed forward over the end of the layer being constructed. Voids and bridging should be minimized by blading, dozing and 'chinking' the rock to form a dense, compacted mass. Side slopes for rock fill embankments should be no steeper than 1.25H:1V.

Where a surcharge fill or EPS levelling pad is required, granular fill should be placed in regular lifts with loose thickness not exceeding 300 mm and compacted to at least 95 per cent of the standard Proctor maximum dry density. Side slopes for granular fill should be no steeper than 2H:1V.

Where a large thickness of EPS is required in the embankment and a partial preload is recommended, consideration should be given to constructing the preload embankment of OPSS.PROV 1010 (Aggregates) Granular 'B' Type II at side slopes of 2H:1V.

Where the existing embankments are to be widened, the new fill should be "keyed-in" or benched into the existing embankment fills, in accordance with OPSD 208.010 (Benching of Earth Slopes).

The EPS fill should be installed in accordance with the manufacturer's requirements. It is recommended that a levelling pad comprised of a minimum 300 mm thick layer of OPSS.PROV 1010 (Aggregates) Granular 'A' be placed prior to the installation of the EPS. The EPS should be encapsulated by a 10 mil thick polyethylene sheet, and a minimum 125 mm thick reinforced concrete pad (designed by others) should be constructed on top of the EPS, followed by the placement of a protective cover/pavement structure over the EPS (for a minimum thickness of 1 m including the concrete pad, compacted granular materials and asphalt). The EPS on the side slopes of the embankments should be covered with a 2 m thick layer of conventional soil. The EPS should be placed to avoid conflict with guide rail installation, if any. Specifications to supply and install the EPS should be incorporated into an NSSP in the Contract (an example is included in Appendix D.

6.7 Slope Flattening

We understand that consideration is being given to flattening the proposed embankment rock fill slopes using surplus excavated materials, which is typically considered for all embankments under 4.5 m high as per OPSD 203.010 (Embankments Over Swamp) and OPSD 203.020 (Embankments over Swamp, Existing Slope Excavated to 1H:1V). However, depending on the type of material used, and the timing of placement of the surplus material, slope flattening may adversely affect the long-term performance of the roadway by inducing

further post-construction settlement. Considerations with respect to settlement and stability are discussed below. It is assumed that the rock fill embankment side slopes will be constructed at an inclination of 1.25H:1V and that the flattened side slopes will be constructed at 3H:1V or flatter. It is also understood that the material used for the slope flattening will likely consist of the excavated organic material or other excess earth material, excavated elsewhere or locally.

6.7.1.1 Stability

In general, global stability is enhanced when side slopes are flattened, hence the FoS of the flattened embankment slopes would be greater than the FoS of the existing embankment slopes.

6.7.1.2 Settlement

Post-construction settlement of the embankments will occur as a result of placement of the excess material in the slope flattening areas of the embankments. Therefore, the timing of placement of the additional/excess material load should be considered in determining whether slope flattening should be implemented. Three scenarios are presented below for different stages of placement of the additional slope flattening material as well as the corresponding settlement implications.

1) Concurrently with construction of the embankment (in stages where required). This construction method would produce the least amount of post-construction settlement of the roadway embankment.

2) After construction of the preload embankment and prior to placement of the final surcharge and/or prior to the full preload/surcharge period. Any settlement induced prior to construction of the final roadway could be accommodated by grading operations.

3) After the preload/surcharge period is complete. This construction method imposes additional loads from the slope flattening material, which will cause immediate and long-term settlement beneath both the embankment side slopes and the roadway and is the least preferred construction method. The magnitude of the settlement could be significant, depending on the embankment geometry and subsoil conditions in the area.

6.8 Embankment Platform Widening

In accordance with the requirements of MTO Northern Region Engineering Directive NRE 98-200, Northern Region Embankment Design Guidelines, the construction of the embankments should include an allowance for platform widening (in 0.5 m increments) to accommodate settlements during construction, as well as post-construction settlements, so that the minimum standard shoulder widths are maintained if future grade raises on the embankments are required. According to NRE 98-200, the need for future raises in road grade could occur due to settlement/compression of the embankment fill, settlement of the foundation soils and to accommodate future pavement overlays up to 200 mm thick. We understand that this directive applies to all rock fill embankments, as well as for granular fill embankments, where widening restrictions are present (such as the presence of a sensitive body of water or due to space/property issues). It is further understood that the minimum required platform widening on major highways (i.e., including Highway 17) over swamp crossings is 2 m per side, unless the preferred mitigation option eliminates uncertainty regarding embankment

settlement/performance (i.e., full sub-excavation to bedrock and backfilling with granular material). For non-major highways and roadways (i.e., St. Pothier Road) over swamp crossings, the minimum required platform widening is 1 m per side.

The minimum required embankment platform widening (per embankment side) is calculated based on the estimated consolidation settlement of the foundation soils (including creep) and the settlement/compression of the embankment fill plus an additional 200 mm for the future pavement overlay, multiplied by the horizontal component of the side slope of the pavement structure (4H:1V), but cannot be less than the minimum platform widening requirements as described above.

For the proposed embankments in these swamp crossing/high fill areas, the minimum platform widening values are summarized in Table 5. The initial platform widening is required to account for settlement during and post construction. The final platform widening is required to account for post-construction settlement and future overlay.

7.0 CLOSURE

This report was prepared by Mr. Evan Childerhose, P.Eng., and the technical aspects were reviewed by Ms. Sarah E. M. Poot, P.Eng., a senior geotechnical engineer and Associate of Golder. Mr. Jorge M.A. Costa, P.Eng., Golder's Designated MTO Contact for this project and a Principal of Golder, conducted an independent quality control review of the report.

Report Signature Page

GOLDER ASSOCIATES LTD.

Sarah E. M. Poot, P. Eng.
Senior Geotechnical Engineer, Associate

Jorge M. A. Costa, P. Eng.
Designated MTO Contact, Principal

AC/SEMP/JMAC/kp

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ASTM D1587	Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
ASTM D2573	Standard Test Method for Field Vane Shear Test in Cohesive Soil

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GeoStudio (Version 7.19) by Geo-Slope International Ltd.

Settle^{3D} (Version 2.0) by Rocscience Inc.

Ministry of Transportation Ontario:

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Ontario Regulation 213/91	Construction Projects (as amended)

Ontario Provincial Standard Drawings:

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OPSD 203.020	Embankments Over Swamp – Existing Slope Excavated to 1H:1V
OPSD 208.010	Benching of Earth Slopes

Ontario Provincial Standard Specifications:

OPSS.PROV 209	Construction Specification for Embankments Over Swamps and Compressible Soils
OPSS.PROV 501	Construction Specification for Compacting
OPSS.PROV 539	Construction Specification for Temporary Protection Systems
OPSS PROV. 206	Construction Specification for Grading
OPSS PROV. 1010	Material Specification for Aggregates – Base, Subbase, Select Subgrade and Backfill Material

Ontario Water Resources Act:

Ontario Regulation 903/90 Wells (as amended)

LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

(a) Index Properties

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

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

Notes: 1 $\tau = c' + \sigma' \tan\phi'$

2 shear strength = (compressive strength)/2

LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg. (140 lb.) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) drive open sampler for a distance of 300 mm (12 in.)

Dynamic Cone Penetration Resistance; N_d:

The number of blows by a 63.5 kg (140 lb.) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60º cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

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

Piezo-Cone Penetration Test (CPT)

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

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

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

(b) Cohesive Soils

Consistency

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

IV. SOIL TESTS

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

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

V. MINOR SOIL CONSTITUENTS

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

Table 1: Summary of High Fill Areas

Foundation Investigation Area	Foundation Investigation High Fill Area Designation	Maximum Proposed Embankment Height[1]	Boreholes/DCPTs	Appendix
Highway 17 WBL STA 12+220 to 12+570 Township of Louise	H1	5.7 m	16 Boreholes (H1-1 to H1-9, H1-11 to H1-15, C1-1 and C1-2) and 6 DCPTs (H1-DC1 to H1-DC6)	A
Highway 17 EBL STA 12+220 to 12+570 Township of Louise	H1	5.7 m	17 Boreholes (H1-16 to H1-30, C1-3, C1-4) 6 DCPTs (H1-DC7 to H1-DC12)	A
Highway 17 WBL STA 13+140 to 13+390 Township of Louise	H2	5.0 m	21 Boreholes (H2-1 to H2-21) 10 DCPTs (H2-DC1 to H2-DC10)	B
Highway 17 EBL STA 13+140 to 13+390 Township of Louise	H2	5.0 m	22 Boreholes (H2-22 to H2-43) 11 DCPTs (H2-DC11 to H2-DC21)	B
St. Pothier Road STA 9+400 to 9+600 Township of Louise	H2	4.4 m	17 Boreholes (H2-44 to H2-60) 8 DCPTs (H2-DC22 to H2-DC29)	B
Highway 17 WBL STA 13+900 to 14+200 Township of Denison	H3	3.8 m	13 Boreholes (H3-1 to H3-13) 6 DCPTs (H3-DC1 to H3-DC6)	C
Highway 17 EBL STA 13+900 to 14+200 Township of Denison	H3	3.8 m	13 Boreholes (H3-14 to H3-26) 6 DCPTs (H3-DC7 to H3-DC12)	C

Note: 1. Based on centreline of highway and existing ground surface profiles, dated February 2013. Prepared by: EC Checked by: SEMP

Table 2: Summary of Consolidation Test Parameters

Foundation Investigation Area	Borehole/ Sample No.	Elevation (m)	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	e_o	C_c	C_r	c_v* (cm^2/s)	Appendix
Highway 17 EBL High Fill H1	H1-19/Sa 6	236.4	31	256	225	8.3	1.86	1.04	0.02	2.1×10^{-3}	A
Highway 17 EBL High Fill H1	H1-25/Sa 8	234.6	56	135	79	2.4	1.52	0.66	0.02	3.8×10^{-3}	
Highway 17 EBL High Fill H2	H2-26/Sa 7	233.3	39	128	89	3.2	1.67	0.48	0.01	2.0×10^{-3}	B
Highway 17 EBL High Fill H2	H2-36/Sa 8A	232.7	47	132	85	2.8	2.13	0.48	0.08	3.8×10^{-4}	
Highway 17 WBL High Fill H3	H3-12/Sa 7	231.4	97	129	32	1.3	1.13	0.41	0.02	1.3×10^{-3}	C
Highway 17 EBL High Fill H3	H3-24/Sa 9	231.3	149	149	0	1.0	1.14	0.36	0.05	1.2×10^{-3}	

Note: For the normally consolidated stress range. Prepared by: EC Checked by: SEMP

where: σ_{vo}' is the in situ vertical effective overburden stress in kPa
σ_p' is the preconsolidation stress in kPa
OCR is the over consolidation ratio
e_o is the initial void ratio
C_c is the compression index
C_r is the recompression index
c_v is the coefficient of consolidation in cm^2/s

Table 3: Summary of Foundation Engineering Parameters

Foundation Investigation Area	Stratigraphic Unit	Top Elevation (m)	Thickness (m)	γ' (kN/m^3)	ϕ' (^{o})	c' (kPa)	S_u (kPa)	σ_p' (kPa)	e_o	C_c	C_r	m_v (kPa^{-1})	E' (MPa)	c_v (N/C) (cm^2/s)
High Fill Area 1 Highway 17 WBL STA 12+220 to 12+570 Highway 17 EBL STA 12+220 to 12+570	Existing Embankment Fill - Granular	246.5 to 241.6	0.2 to 6.1	21	33	-	-	-	-	-	-	-	12	-
	Peat/Topsoil	244.6 to 241.0	0.1 to 1.4	12	27	1	-	-	-	-	-	-	-	-
	Sand and Silt to Sandy Silt	242.1 to 237.2	0.2 to 2.3	19	28	-	-	-	-	-	-	-	12	-
	Clayey Silt to Silt	240.6 to 240.0	0.9 to 2.4	16.6	25	-	18 - 40	82 – 182	1.0 – 1.8	0.5 – 0.9	0.05 – 0.09	1.3 x 10^{-4}	-	2.0 x 10^{-3}
	Silty Clay to Clay	244.4 to 238.2	2.1 to 8.2											
	Clayey Silt	241.2 to 231.9	0.8 to 2.4											
	Silt to Sandy Silt	241.0 to 231.0	0.8 to 7.6	18	28	-	-	-	-	-	-	-	8	-
	Sand and Silt to Sand	240.3 to 227.9	0.4 to 8.8	18	28	-	-	-	-	-	-	-	10	-
	Sand and Gravel to Gravelly Sand	239.0 to 225.6	1.0 to 5.4	19	35	-	-	-	-	-	-	-	15	-
High Fill Area 2 Highway 17 WBL STA 13+140 to 13+390 Highway 17 EBL STA 13+140 to 13+390 St. Pothier Road 9+400 to 9+600	Peat / Organics	242.1 to 239.5	0.1 to 4.0	12	27	1	-	-	-	-	-	-	-	-
	Silty Sand	239.3	0.6	19	28	-	-	-	-	-	-	-	12	-
	Clayey Silt to Silt	242.0 to 235.9	0.5 to 5.7	16.2	25	-	16 – 22	73 – 100	1.0 – 1.8	0.5	0.05	1.3 x 10^{-4}	-	2.0 x 10^{-3}
	Silty Clay to Clay	241.7 to 233.6	1.7 to 9.8											
	Clayey Silt to Silt	237.2 to 229.5	1.3 to 4.9											
	Silt to Sandy Silt	240.6 to 226.0	0.5 to 10.4	18	28	-	-	-	-	-	-	-	8	-
	Sand and Silt to Sand	239.8 to 217.3	0.6 to 7.5	18	28	-	-	-	-	-	-	-	10	-
	Sand and Gravel to Gravelly Sand	238.0 to 217.7	0.1 to 4.2	19	35	-	-	-	-	-	-	-	15	-
High Fill Area 3 Highway 17 WBL STA 13+900 to 14+200 Highway 17 EBL STA 13+900 to 14+200	Existing Embankment Fill - Granular	247.8 to 240.9	0.9 to 7.2	21	33	-	-	-	-	-	-	-	12	-
	Existing Embankment Fill – Cohesive			20	30	-	-	-	-	-	-	-	-	-
	Peat / Topsoil	243.5 to 239.2	0.1 to 2.0	12	27	1	-	-	-	-	-	-	-	-
	Sand to Sandy Silt	244.0 to 239.1	0.6 to 3.1	18	28	-	-	-	-	-	-	-	10	-
	Clayey Silt	240.3 to 238.8	0.8 to 3.4	18.2	27	-	23 – 33	105 – 150	1.0 – 1.8	0.2 – 0.4	0.02 – 0.04	1.3 x 10^{-4}	-	2.0 x 10^{-3}
	Silty Clay to Clay	241.0 to 236.6	3.0 to 15.2											
	Clayey Silt to Silt	237.9 to 224.4	0.9 to 2.2											
	Silt to Sandy Silt	236.3 to 222.8	1.4 to 7.2	18	28	-	-	-	-	-	-	-	10	-
	Sand (Interlayer)	231.4 to 228.0	1.5 to 1.7	18	28	-	-	-	-	-	-	-	10	-
	Sand to Sand and Silt	236.3 to 219.2	1.1 to >4.3	18	28	-	-	-	-	-	-	-	15	-

Prepared by: EC
Reviewed by: SEMP

Table 4: Summary of Settlement Analyses

Foundation Investigation Area	Settlement (mm) / Delay Time	No Mitigation	Estimated Post-Construction Settlement Over 20-Year Period at the Critical Section (mm)								Preferred Foundation Mitigation Option
			Staged Construction with Toe Berms, Surcharge and Wick Drains	Surcharge and Toe Berms (Large)	Surcharge, Toe Berms (Large) and Wick Drains	Consolidation and Maintenance	Partial Preloading and Lightweight Fill	Partial Preloading, Lightweight Fill and Wick Drains	Partial Embankment Sub-Excavation and Lightweight Fill	Full Sub-Excavation and Preloading	
High Fill Area 1 Highway 17 WBL STA 12+220 to 12+570	$\delta_{primary}$ $\delta_{secondary}$ $\delta_{rock\ fill\ -\ short}$ $\delta_{rock\ fill\ -\ long}$ **δ_{total}** t_{delay} Criterion = 50 mm (Widening)	70 50 0 0 **120** 3 years	n/a	n/a	n/a	70 50 0 0 **120** 3 years	50 0 0 0 **50** 2 months	n/f	n/f	n/f	Consolidation and Maintenance
High Fill Area 1 Highway 17 EBL STA 12+220 to 12+570	$\delta_{primary}$ $\delta_{secondary}$ $\delta_{rock\ fill\ -\ short}$ $\delta_{rock\ fill\ -\ long}$ **δ_{total}** t_{delay} Criterion = 100 mm	585 75 50 10 **720** No delay	0 90 0 10 **100** 1.7 yrs	0 90 0 10 **100** 2.1 yrs	0 90 5 10 **100** 10 months	n/f	15 75 0 10 **100** 3.2 yrs (2.5 m EPS)	0 90 5 5 **100** 10 months (2.5 m EPS)	n/f	n/f	Staged Construction with Toe Berms, Surcharge and Wick Drains
High Fill Area 2 (Constructed Concurrent with St. Pothier Road Embankment) Highway 17 WBL STA 13+140 to 13+390 Highway 17 EBL STA 13+140 to 13+390	$\delta_{primary}$ $\delta_{secondary}$ $\delta_{rock\ fill\ -\ short}$ $\delta_{rock\ fill\ -\ long}$ **δ_{total}** t_{delay} Criterion = 100 mm	615 70 60 10 **755** 3.2 years	0 95 0 5 100 1.7 years	10 80 0 10 **100** 2.5 years	0 95 0 5 **100** 9 months	n/a	20 75 0 5 100 1.8 years (EBL)	30 65 0 5 100 1.8 years (WBL)	n/f	n/f	n/f	Staged Construction with Toe Berms, Surcharge and Wick Drains
High Fill Area 2 (Constructed Prior to St. Pothier Road Embankment) Highway 17 WBL STA 13+140 to 13+390 Highway 17 EBL STA 13+140 to 13+390	$\delta_{primary}$ $\delta_{secondary}$ $\delta_{rock\ fill\ -\ short}$ $\delta_{rock\ fill\ -\ long}$ **δ_{total}** t_{delay} Criterion = 100 mm	615 70 60 10 **755** 3.2 years	n/a	10 80 0 10 **100** 2.5 years	0 95 0 5 **100** 10 months	n/a	20 75 0 5 **100** 1.8 yr. 3 m EPS (EBL)	30 65 0 5 **100** 1.8 yr. 3 m EPS (WBL)	n/f	n/f	n/f	Not Recommended

Foundation Investigation Area	Settlement (mm) / Delay Time	No Mitigation	Estimated Post-Construction Settlement Over 20-Year Period at the Critical Section (mm)								Preferred Foundation Mitigation Option
			Staged Construction with Toe Berms, Surcharge and Wick Drains	Surcharge and Toe Berms (Large)	Surcharge, Toe Berms (Large) and Wick Drains	Consolidation and Maintenance	Partial Preloading and Lightweight Fill	Partial Preloading, Lightweight Fill and Wick Drains	Partial Embankment Sub-Excavation and Lightweight Fill	Full Sub-Excavation and Preloading	
High Fill Area 2 St. Pothier Road 9+400 to 9+600	$\delta_{primary}$ $\delta_{secondary}$ $\delta_{rock\ fill\ -\ short}$ $\delta_{rock\ fill\ -\ long}$ **δ_{total}** t_{delay} Criterion = 200 mm	425 70 60 10 **565**	65 130 0 5 **200** 1.7 years	110 80 0 10 **200** 1.5 years	50 130 10 510 **200** 10 months	n/a	120 75 0 5 **200** 1.8 years	n/f	n/f	n/f	Staged Construction with Toe Berms, Surcharge and Wick Drains
High Fill Area 3 Highway 17 WBL STA 13+900 to 14+200 Highway 17 EBL STA 13+900 to 14+200	$\delta_{primary}$ $\delta_{secondary}$ $\delta_{rock\ fill\ –\ short}$ $\delta_{rock\ fill\ –\ long}$ **δ_{total}** t_{delay} Criterion = 50 mm (Widening)	90 60 20 5 **175** 6 years	n/f	n/f	n/f	90 60 20 5 **175** 6 years	n/f	n/f	10 0 0 0 **10** 0 years (1 m EPS)	n/f	Consolidation and Maintenance

n/f = not feasible

Prepared by: EC
Reviewed by: SEMP

Table 5: Summary of Preferred Foundation Mitigation Options

Foundation Investigation Area	Foundation Design Issue (Maximum Height of Fill)	Topography and Surface Conditions	Recommended Embankment Side Slope and Platform Widening	Maximum Thickness of Organics Encountered Along Alignment[1]	Preferred Stability/ Settlement Mitigation Option[2,3]	Estimated Settlement (δ) During Construction at the Critical Section	Estimated Post-Construction Settlement (δ) Over 20-Year Period at the Critical Section	Swamp Excavation/ Organic Removal Specification
High Fill Area 1 Highway 17 WBL STA 12+220 to 12+570 Highway 17 EBL STA 12+220 to 12+570	High Fill (5.6 m) High Fill (5.7 m)	Low-lying swamp area with moderate forest to the east and an existing highway embankment running along the same alignment as the proposed WBL.	1.25H:1V (Rock Fill) 2 m initial platform 1.5 m final platform	Topsoil and near surface cohesive soils up to about 10.2 m below ground surface.	Consolidation and Maintenance	$\delta_{Immediate}$ = 50 mm $\delta_{Primary}$ = 70 mm $\delta_{Rock\ Fill}$ = 25 mm	$\delta_{Primary}$ = 70 mm $\delta_{Secondary}$ = 50 mm $\delta_{Rock\ Fill}$ = ~0 mm (maintenance required)	OPSD 203.020
					Staged Construction with Toe Berms, Surcharge and Wick Drains (total surcharge 1.7 years)	$\delta_{Immediate}$ = 110 mm $\delta_{Primary}$ = 735 mm $\delta_{Rock\ Fill}$ = 60 mm	$\delta_{Primary}$ = 0 mm $\delta_{Secondary}$ = 90 mm $\delta_{Rock\ Fill}$ = 10 mm	OPSD 203.010
High Fill Area 2 (Constructed Concurrent with St. Pothier Road Embankment) Highway 17 WBL STA 13+140 to 13+390 Highway 17 EBL STA 13+140 to 13+390	Swamp Crossing (about 5.0 m)	Low-lying swamp covered by tall grasses.	1.25H:1V (Rock Fill) 2 m initial platform 1.5 m final platform	Peat and near surface cohesive soils up to about 13.5 m below ground surface.	Staged Construction with Toe Berms, Surcharge and Wick Drains (total surcharge 1.7 years)	$\delta_{Immediate}$ = 75 mm $\delta_{Primary}$ = 820 mm $\delta_{Rock\ Fill}$ = 65 mm	$\delta_{Primary}$ = 0 mm $\delta_{Secondary}$ = 95 mm $\delta_{Rock\ Fill}$ = 5 mm	OPSD 203.010
High Fill Area 2 St. Pothier Road 9+400 to 9+600	Swamp Crossing (about 4.4 m)	Low-lying swamp covered by tall grasses.	1.25H:1V (Rock Fill) 1 m initial platform 1 m final platform	Peat and near surface cohesive soils up to about 13.5 m below ground surface.	Staged Construction with Toe Berms, Surcharge and Wick Drains (total surcharge 1.7 years)	$\delta_{Immediate}$ = 80 mm $\delta_{Primary}$ = 485 mm $\delta_{Rock\ Fill}$ = 65 mm	$\delta_{Primary}$ = 65 mm $\delta_{Secondary}$ = 130 mm $\delta_{Rock\ Fill}$ = 5 mm	OPSD 203.010

Table 5: Summary of Preferred Foundation Mitigation Options

Foundation Investigation Area	Foundation Design Issue (Maximum Height of Fill)	Topography and Surface Conditions	Recommended Embankment Side Slope and Platform Widening	Maximum Thickness of Organics Encountered Along Alignment[1]	Preferred Stability/ Settlement Mitigation Option[2,3]	Estimated Settlement (δ) During Construction at the Critical Section	Estimated Post-Construction Settlement (δ) Over 20-Year Period at the Critical Section	Swamp Excavation/ Organic Removal Specification
High Fill Area 3 Highway 17 WBL STA 13+900 to 14+200 Highway 17 EBL STA 13+900 to 14+200	High Fill (3.8 m) High Fill (3.8 m)	A low-lying swampy area with the existing four-lane highway transitioning into a two-lane undivided highway from east to west.	1.25H:1V (Rock Fill)	Peat and near surface cohesive soils up to about 19.5 m below ground surface.	Consolidation and Maintenance	$\delta_{Immediate}$ = 25 mm $\delta_{Primary}$ = 90 mm $\delta_{Rock\ Fill}$ = 25 mm	$\delta_{Primary}$ = 90 mm $\delta_{Secondary}$ = 60 mm $\delta_{Rock\ Fill}$ = 25 mm (maintenance required)	OPSD 203.020

Prepared By: EC Reviewed By: SEMP

MINISTRY OF TRANSPORTATION, ONTARIO

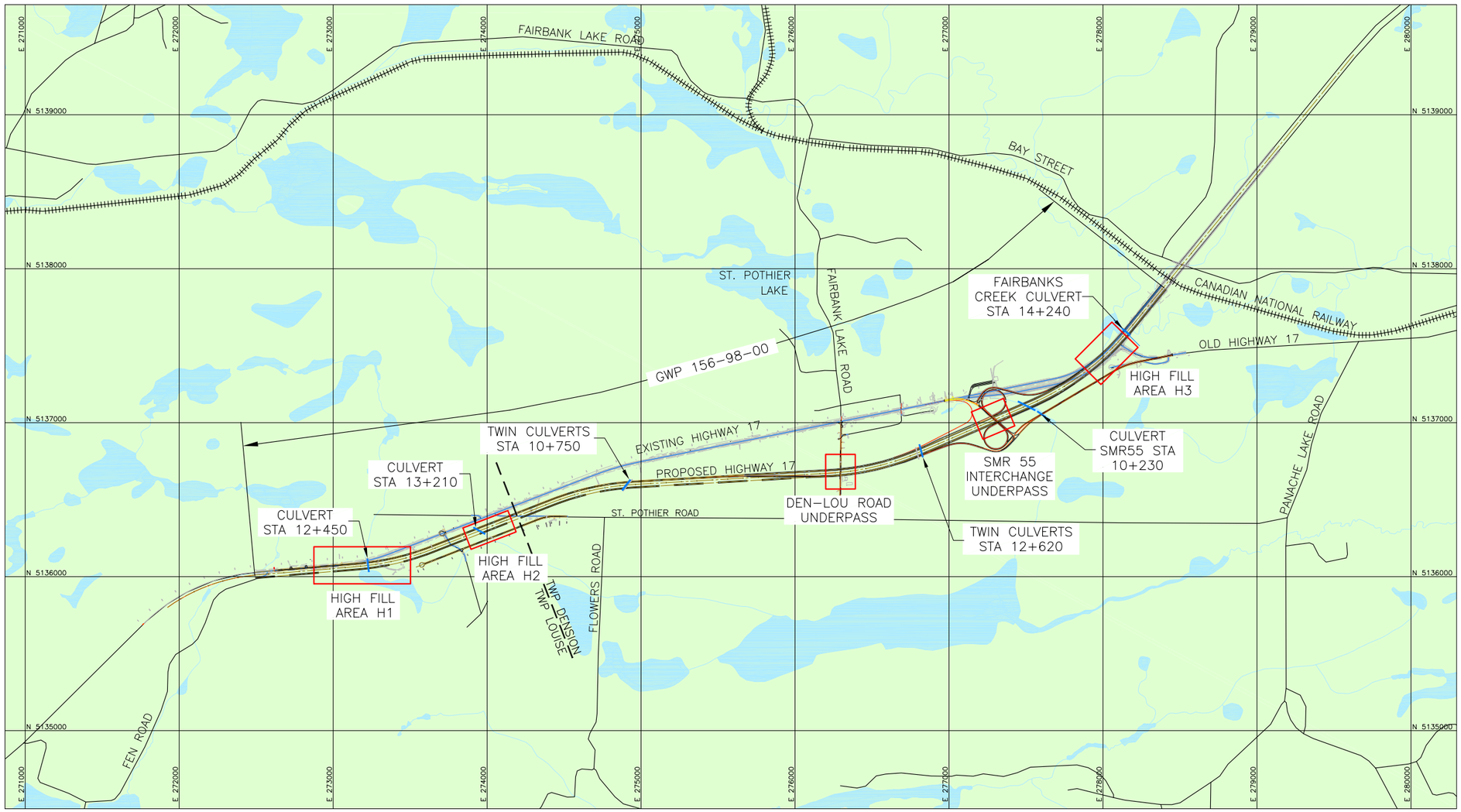
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 156-98-00

SHEET

HIGHWAY 17
SITE LOCATION PLAN

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



PLAN

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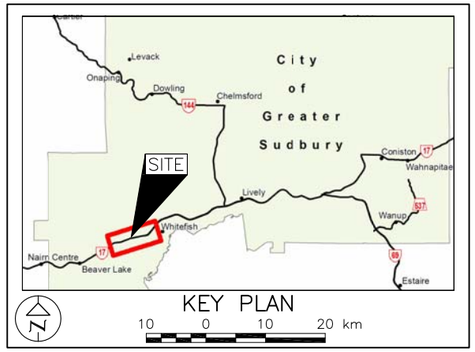


REFERENCE

Base plans provided by Golder GIS and highway alignment provided in digital format by DM Wills, drawing file EBL & WBL PROFILES.dwg received Feb 28, 2013.

NO.	DATE	BY	REVISION

HWY. 17	PROJECT NO. 11-1191-0007		DIST.
SUBM'D. MT	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. 1

PLOT DATE: April 16, 2015
FILENAME: \\golder.gds\gal\Sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0007 HWY 17 4 Laning\Culverts\11119100007 Ind.Culv.dwg

APPENDIX A

HIGHWAY 17 WBL – STA 12+220 TO STA 12+570 AND HIGHWAY 17 EBL – STA 12+220 TO 12+570 (HIGH FILL H1)

Table A1: Evaluation of Settlement Mitigation Options
Highway 17 WBL – STA 12+220 to 12+570 (High Fill Area H1)

Stability/Settlement Mitigation Option	Option No.	Rank	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Consolidation and Maintenance ■ 3 year preload period	A	1	■ Standard embankment construction operation – no need for specialized material or equipment.	■ **Does not meet MTO's Settlement Criteria** ■ Contractor will have to remobilize to site for maintenance. ■ Significant wait period is required before settlement is mitigated. ■ Instrumentation and monitoring program required to assess end of preload period.	■ Remobilization costs required for maintenance.	■ There will be no impact on the construction schedule ■ Very low risk of not achieving stability of preload embankments on weak/soft foundation soils. ■ Low risk of experiencing unexpected post-construction settlements (i.e. creep). ■ Low risk that unexpected post-construction settlements create an unsafe travelled laneway.
Partial Embankment Sub-Excavation and Lightweight Fill (EPS) ■ A 2.5 m zone of EPS	B	2	■ Meets MTO's Settlement Criteria ■ Creates a negligible load on subsoils thereby inducing negligible settlement of foundations soils. ■ Re-grading is not required	■ Expensive material compared to conventional embankment fill. ■ Will need to sub-excavate some of the existing embankment material.	■ Relative cost of EPS fill is about an order of magnitude higher than fill required for the other options. ■ 5,000 m^3 x \$200/m^3 = \$1,000,000.	■ There will be a minimal impact on the construction schedule ■ Very low risk of not achieving stability of preload embankments and final EPS embankments on weak/soft foundation soils. ■ Low risk of experiencing unexpected post-construction settlements (i.e. creep).
Full Sub-Excavation of Cohesive Deposit (up to approximately 13.4 m below existing highway grade) ■ 6 to 12 month preload period required to reduce post-construction settlement of rock fill.	C	NP	■ Reduces total settlement of foundations soils as most of the soft compressible material has been removed.	■ Extensive roadway protection system required at huge additional cost ■ Generation of large volume of excess excavation spoil – may not have suitable disposal area depending on environmental and property concerns. ■ Large quantity of rock fill backfill required. ■ Longer construction period required to install shoring, sub-excavate and replace with rock fill. ■ Additional post-construction settlement of rock fill itself and 6 to 12 month preload period required (or allow traffic and conduct future maintenance). ■ Conventional/long-stick backhoe equipment not capable of removing material to its full depth - specialized equipment (i.e., dragline) and additional effort required for deep sub-excavation and replacement below the groundwater level.	■ Shoring, sub-excavation, disposal and replacement of weak/soft, compressible deposits. ■ Cost of shoring (250 m long, average 15 m deep) @ 500/m^2(salvage material)= \$1,875,000. ■ 82,100 m^3 x \$14/m^3 (sub-excavation and replacement with rock fill) = \$1,149,400. ■ Cost for disposal not quantified.	■ Higher risk of not achieving/maintaining stability of excavation slopes unless shoring utilized. ■ Very low risk of not achieving/maintaining stability of proposed embankments if using shoring. ■ High risk of experiencing unexpected post-construction settlements (i.e. long term rock fill settlement). ■ High risk that not all compressible soils are removed during the sub-aqueous operations which could lead to additional settlement.

NP: Not Practical

Prepared By: SEMC **Reviewed By:** JMAC

Table A2: Evaluation of Settlement Mitigation Options
Highway 17 EBL – STA 12+220 to 12+570 (High Fill Area H1)

Stability/Settlement Mitigation Option[1]	Option No.	Rank	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Staged Construction and 1.3 m Surcharge with Wick Drains and Toe Berms ■ 1st stage 5.7 m high for 10 months ■ 2nd stage 1.8 m fill for 10 months ■ 1.7 years total surcharge period ■ 1.5 m high by 14 m wide toe berm on south side of embankment	A	1	■ Improves engineering parameters of soft cohesive soils thereby improving stability and reducing post-construction settlement. ■ Reduced time for primary consolidation when compared to not using wick drains	■ Toe berms are required to maintain embankment stability but are smaller than for non-staged construction options. ■ Delay in construction for each stage to allow for strength gain in soft soils for stability of subsequent stage. ■ More expensive Granular B required to backfill peat sub-excavation to facilitate wick drain installation. ■ Detail wick drain investigation and design will be required. ■ Additional time required for installation of wick drains. ■ Wick drains increase magnitude of secondary consolidation (creep) settlement as a result of the accelerated completion of primary consolidation settlement. ■ Instrumentation and monitoring program required to assess end of each stage. ■ Increased handling of surcharge fills upon completion of surcharge period.	■ Rock fill toe berm material and associated sub-excavation and replacement of organic deposits below toe berm ($137,000) ■ Granular backfill for peat sub-excavation required to facilitate wick drain installation. ($23,000 more than rock fill) ■ Surcharge material (Granular B). ($90,000) ■ Detail wick drain investigation and design. ($50,000) ■ Installation of wick drains including pre-drilling, instrumentation and associated monitoring program. ($342,500)	■ Surcharging time for each stage will be determined by assessment of the monitoring data. ■ There will be a high impact on the schedule. ■ There is a risk that unexpected post-construction settlements (i.e. creep) will be experienced depending on the efficiency of improving/strengthening the soft/weak soil deposit.
2 m Surcharge with Wick Drains and Toe Berms ■ 10 month surcharge period ■ 2 m high by 25 m wide toe berms on south side of embankment	B	2	■ Reduced time for primary consolidation when compared to not using wick drains ■ One stage construction.	■ Very large toe berms (twice as large as Option A) required for embankment stability including additional peat sub-excavation and backfilling. ■ Delay in construction to reduce magnitude of post-construction settlement. ■ More expensive Granular B required to backfill peat sub-excavation to facilitate wick drain installation. ■ Detail wick drain investigation and design will be required. ■ Additional time required for installation of wick drains. ■ Wick drains increase magnitude of secondary consolidation (creep) settlement as a result of the accelerated completion of primary consolidation settlement. ■ Instrumentation and monitoring program required to assess end of surcharge period. ■ Increased handling of surcharge fills upon completion of surcharge period.	■ Rock fill toe berm material and associated sub-excavation and replacement of organic deposits below toe berm ($247,500) ■ Granular backfill for peat sub-excavation required to facilitate wick drain installation. ($23,000 more than if rock fill is used) ■ Surcharge material (Granular B). ($117,000) ■ Detail wick drain investigation and design. ($50,000) ■ Installation of wick drains including pre-drilling, instrumentation and associated monitoring program. ($382,900)	■ Surcharging time will be determined by assessment of the monitoring data. ■ There will be a moderate impact on the construction schedule. ■ Property issues may arise due to the size of the toe berms. ■ There is a risk that unexpected post-construction settlements (i.e. creep) will occur.

Table A2: Evaluation of Settlement Mitigation Options
Highway 17 EBL – STA 12+220 to 12+570 (High Fill Area H1)

Stability/Settlement Mitigation Option[1]	Option No.	Rank	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Full Sub-Excavation (up to approximately 10 m below ground surface) ■ 6 to 12 month preload period required to reduce post-construction settlement of rock fill.	C	3	■ Reduces total settlement of foundations soils as soft compressible material has been removed.	■ Generation of very large volume of excess excavation spoil – may not have suitable disposal area depending on environmental and property concerns. ■ Very large quantity of rock fill backfill required. ■ Longer construction period required to sub-excavate and replace with rock fill. ■ Additional post-construction settlement of rock fill itself and 6 to 12 month preload period required. ■ Specialized equipment (i.e. dragline) and additional effort required for deep sub-excavation and replacement below the groundwater level. ■ May require additional right-of-way to accommodate deep sub-excavation.	■ Sub-excavation, disposal and replacement of weak/soft, compressible deposits. ■ 210,000 – 50,000 m^3 x \$14/m^3 (sub-excavation and replacement with rock "supply" fill) = \$2,240,000. ■ Cost for disposal not quantified.	■ Higher risk of not achieving/maintaining stability of excavation slopes. ■ Very low risk of not achieving/maintaining stability of proposed embankments. ■ High risk of experiencing unexpected post-construction settlements (i.e. long term rock fill settlement). ■ High risk that not all compressible soils are removed during the sub-aqueous operations which could lead to unexpected settlement.
Partial Preload with Lightweight Fill (EPS) ■ 3.2 year preload period ■ 2.5 m of EPS	D	4	■ Reduces total load on subsoils thereby reducing total settlement of foundations soils. ■ Rock fill can be used to backfill peat sub-excavation. ■ Toe berms are not required.	■ Expensive material compared to conventional embankment fill. ■ Significant wait period is required (since wick drains not being utilized). ■ Instrumentation and monitoring program required to assess end of preload period. ■ Removal of preload material required prior to EPS installation.	■ Relative cost of EPS fill is about an order of magnitude higher than fill required for the other options. ■ 10,125 m^3 x \$200/m^3 = \$2,025,000. (which assumes 40.5 m^2 for a 250 m length)	■ There will be a very high impact on the construction schedule, longer than all other options. ■ Very low risk of not achieving stability of preload embankments and final EPS embankments on weak/soft foundation soils. ■ Low risk of experiencing unexpected post-construction settlements (i.e. creep).
Partial Preload with Lightweight Fill (EPS) and Wick Drains ■ 3.2 year preload period ■ 2.5 m of EPS	E	5	■ Reduces total load on subsoils thereby reducing total settlement of foundations soils. ■ Toe berms are not required. ■ Reduced time for primary consolidation when compared to not using wick drains.	■ Expensive material compared to conventional embankment fill. ■ More expensive Granular B required to backfill peat sub-excavation to facilitate wick drain installation. Rock fill cannot be used to backfill peat sub-excavation unless pre-drilling through rock fill is carried out to allow for installation of wick drains. ■ ■ Detail wick drain investigation and design will be required. ■ Additional time required for installation of wick drains. ■ Wick drains increase magnitude of secondary consolidation (creep) settlement as a result of the accelerated completion of primary consolidation settlement. ■ Instrumentation and monitoring program required to assess end of each stage ■ Removal of preload material required prior to EPS installation.	■ Relative cost of EPS fill is about an order of magnitude higher than fill required for the other options. ■ Granular backfill for peat sub-excavation required to facilitate wick drain installation. (\$23,000 more than rock fill) ■ Cost of EPS 10,125 m^3 x \$200/m^3 = \$2,025,000. (which assumes 40.5 m^2 for a 250 m length). ■ Detail wick drain investigation and design. (\$50,000) ■ Installation of wick drains including pre-drilling, instrumentation and associated monitoring program. (\$342,500)	■ Low impact on the construction schedule. ■ Very low risk of not achieving stability of preload embankments and final EPS embankments on weak/soft foundation soils. ■ Low risk of experiencing unexpected post-construction settlements (i.e. creep).

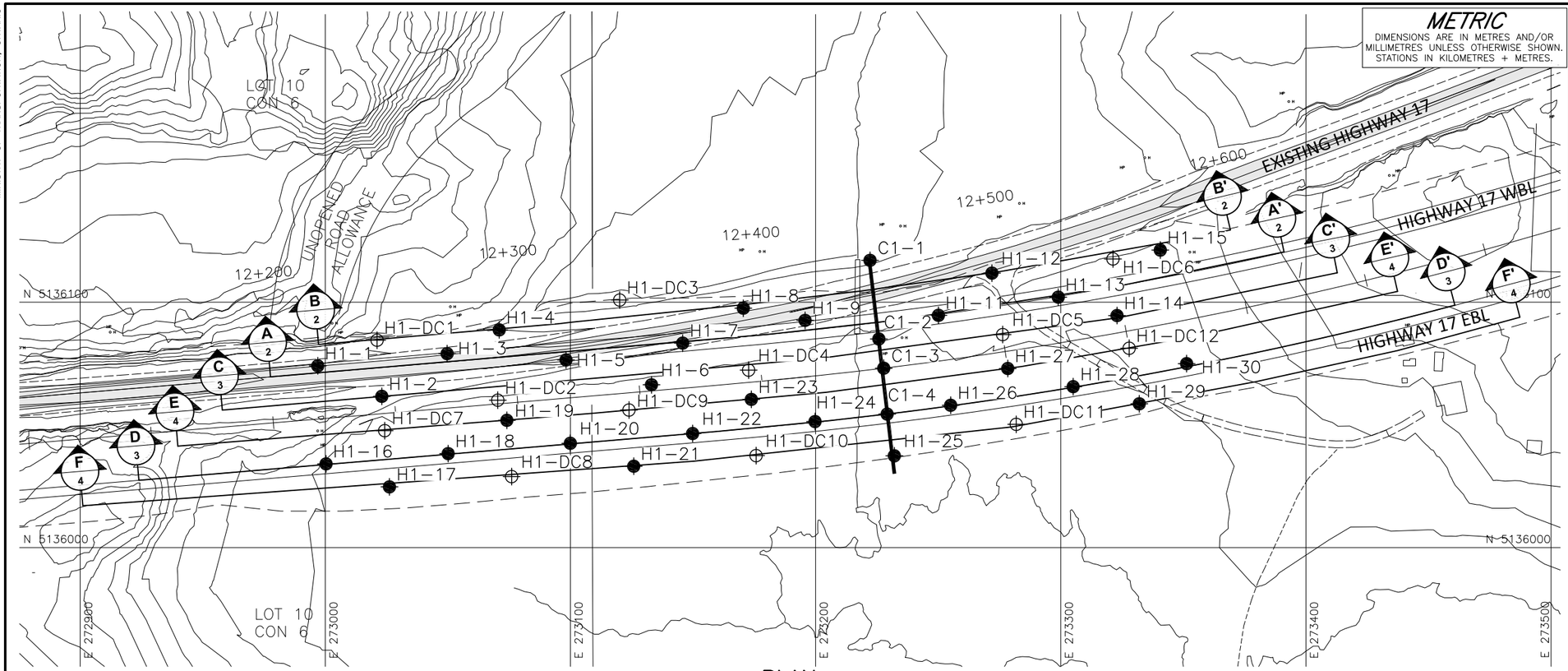
Table A2: Evaluation of Settlement Mitigation Options
Highway 17 EBL – STA 12+220 to 12+570 (High Fill Area H1)

Stability/Settlement Mitigation Option[1]	Option No.	Rank	Advantages	Disadvantages	Relative Costs	Risks/Consequences
2 m Surcharge with Toe Berms (no Wick Drains) ■ 2.1 year surcharge period ■ 2 m high by 23 m wide toe berms on south side of embankment	F	6	■ Standard construction operation. ■ Rock fill can be used to backfill peat sub-excavation.	■ Very large toe berms (twice as large as Option A) required for embankment stability including additional peat sub-excavation and backfilling. ■ Significant wait period is required (since wick drains not being utilized). ■ Instrumentation and monitoring program required to assess end of surcharge period. ■ Increased handling of surcharge fills upon completion of surcharge period.	■ Rock fill toe berm material and associated sub-excavation and replacement of organic deposits below toe berm. ($205,000) ■ Use of rock fill as backfill instead of granular fill as in Options A and B creates a savings of $23,000 ■ Surcharge material (Granular B). ($117,000)	■ Surcharging time will be determined by assessment of the monitoring data ■ There will be a very high impact on the construction schedule (only option C is longer). ■ Property issues may arise due to the size of the toe berms.
Partial Sub-Excavation and Preloading	G	NF	■ Reduces total settlement of foundations soils as some of the soft compressible material has been removed. ■ Specialized equipment (i.e. dragline) may not be required compared to sub-excavation to the full depth. ■ Reduced construction schedule compared to full sub-excavation and possibly wick drain installation ■ Less volume of material to be diposed.	■ Generation of large volume of excess excavation spoil – may not have suitable disposal area depending on environmental and property concerns. ■ Large quantity of rock fill backfill required. ■ Longer construction period required to sub-excavate and replace with rock fill although not as long as full sub-excavation. ■ Additional post-construction settlement of rock fill itself and preloading of clay deposit for extended period of time (as wick drains not utilized). ■ Toe berms may still be required depending on depth of sub-excavation.	■ Sub-excavation, disposal and replacement of weak/soft, compressible deposits. ■ Cost for disposal not quantified.	■ High risk of not achieving/maintaining stability of excavation slopes. ■ High risk of not achieving/maintaining stability of proposed embankments. ■ High risk of experiencing additional post-construction settlements (i.e. long term rock fill settlement) as well as settlement of the cohesive deposit.
Ground Improvement ■ Dry/wet soil mixing ■ Geopiers (rammed aggregate)	H	NF	■ Reduces future creep settlement of clay (and potentially peat) by improving strength and stiffness of the material. ■ No spoil material for off-site disposal	■ Need bulk samples of clay for mix design to allow for design of soil mixing columns or piers. ■ Specialized design and equipment required. ■ High cost of specialized equipment and mobilization to the site. ■ Geogrid reinforced embankment required to distribute the load over the columns/piers and to mitigate potential differential settlement. ■ Bench scale tests and field program may be required. ■ No readily available information on mixes of peat/clay and additives and potential strength gain – may require large amount of cement or aggregate to realize improvement.	■ Cost of DSM columns or rammed aggregate piers and geogrid. ■ Cost would be higher than other options including potentially full sub-excavation with preloading and EPS options	■ Future creep settlement may still occur in the subsoils between the columns/piers. ■ May not mix properly with organic and fine grained clayey soil – likely no guarantee from contractor. ■ Potential increase in cost for additional cement or aggregate if required to enhance soil/peat or soil/clay cement mix.

NF: Not Feasible
Note: 1. All of these mtitgation options assume that the peat/organics is sub-excavated and replaced with backfill.

Prepared By: SEMC **Reviewed By:** JMAC

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

SCALE
20 0 20 40 m

METRIC

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

CONT No.
GWP No. 156-98-00

SHEET

HIGHWAY 17 4 LANING
HWY 17 EBL – STA 12+220 TO 12+570
HWY 17 WBL – STA 12+220 TO 12+570
BOREHOLE LOCATIONS

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA

KEY PLAN
10 0 10 20 km

LEGEND

- Borehole – Current Investigation
- Dynamic Cone Penetration Test

NOTES

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The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans provided in digital format by DM Wills, drawing files 581_base.dwg, GWP156-98-00_B & C Plans.dwg and 581_contours.dwg received Jan 17, 2012.

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
H1-1	246.6	5136074.1	272996.9
H1-2	242.2	5136061.6	273023.1
H1-3	246.6	5136079.0	273049.7
H1-4	241.6	5136088.7	273071.0
H1-5	246.3	5136076.5	273098.2
H1-6	241.3	5136066.4	273133.1
H1-7	246.0	5136083.3	273145.8
H1-8	245.8	5136097.6	273170.5
H1-9	245.8	5136092.6	273195.7
H1-11	243.2	5136094.7	273250.1
H1-12	246.3	5136111.9	273271.9
H1-13	243.0	5136102.1	273299.0
H1-14	244.5	5136094.6	273323.0
H1-15	244.6	5136121.3	273340.6
H1-16	241.3	5136034.1	273000.3
H1-17	241.3	5136024.7	273026.2
H1-18	241.3	5136038.3	273050.1
H1-19	241.3	5136051.9	273074.1
H1-20	241.2	5136042.5	273099.9
H1-21	241.0	5136033.1	273125.8
H1-22	241.0	5136046.5	273149.8
H1-23	241.3	5136060.4	273173.8
H1-24	241.2	5136051.4	273199.8
H1-25	241.2	5136037.4	273232.1

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
C1-1	241.7	5136117.1	273222.2
C1-2	241.4	5136085.0	273225.8
C1-3	241.5	5136073.1	273227.8
C1-4	241.2	5136054.4	273229.2
H1-26	241.3	5136058.0	273255.1
H1-27	241.6	5136073.0	273278.4
H1-28	241.3	5136065.6	273305.1
H1-29	241.3	5136058.6	273332.0
H1-30	241.2	5136075.0	273351.3
H1-DC1	245.1	5136084.5	273021.1
H1-DC2	241.3	5136060.1	273070.4
H1-DC3	242.0	5136100.9	273120.1
H1-DC4	241.3	5136072.3	273172.7
H1-DC5	242.6	5136086.8	273276.3
H1-DC6	243.2	5136117.6	273321.3
H1-DC7	241.2	5136047.6	273024.2
H1-DC8	241.2	5136028.9	273076.0
H1-DC9	241.3	5136056.1	273123.9
H1-DC10	241.2	5136037.5	273175.7
H1-DC11	241.0	5136050.2	273281.8
H1-DC12	241.2	5136081.2	273327.9

LICENCED PROFESSIONAL ENGINEER
S.E.M. POOT
90471921
APR 15, 2015
PROVINCE OF ONTARIO

LICENCED PROFESSIONAL ENGINEER
J.M.A.COSTA
APR 15, 2015
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17	PROJECT NO. 11-1191-0007		DIST.
SUBM'D. EC	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. A1

PLOT DATE: April 15, 2015
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MINISTRY OF TRANSPORTATION, ONTARIO

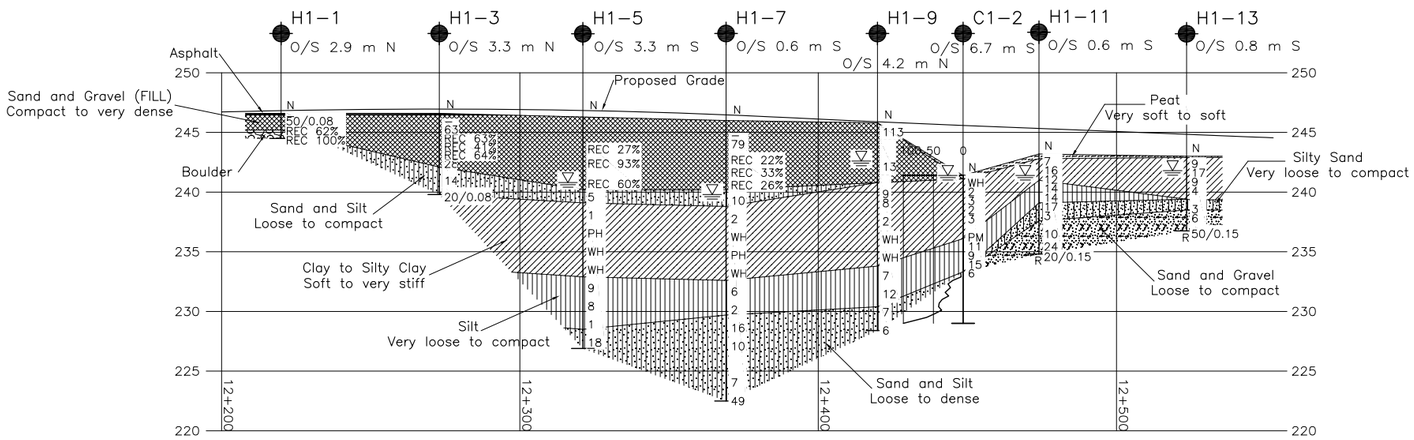
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 156-98-00

HIGHWAY 17 4 LANING
HWY 17 EBL – STA 12+220 TO 12+570
HWY 17 WBL – STA 12+220 TO 12+570
BOREHOLE LOCATIONS

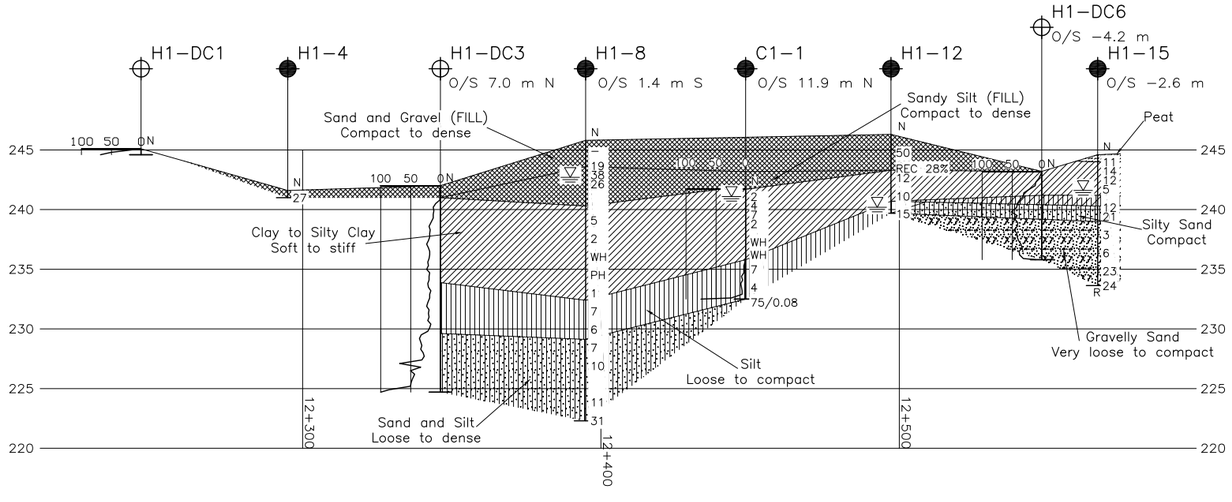
SHEET

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



A-A' / 1 — CENTRELINE PROFILE
HIGHWAY 17 (WBL)

HORIZONTAL SCALE
20 0 20 40 m
5 0 5 10 m
VERTICAL SCALE



B-B' / 1 — NORTH TOE PROFILE
HIGHWAY 17 (WBL)

HORIZONTAL SCALE
20 0 20 40 m
5 0 5 10 m
VERTICAL SCALE

LEGEND

⊕	Borehole
⊕	Dynamic Cone Penetration Test
N	Standard Penetration Test Value
16	Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
REC	Recovery (%)
R	Refusal
▽	WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
C1-1	241.7	5136117.1	273222.2
C1-2	241.4	5136085.0	273225.8
H1-1	246.6	5136074.1	272996.9
H1-3	246.6	5136079.0	273049.7
H1-4	241.6	5136088.7	273071.0
H1-5	246.3	5136076.5	273098.2
H1-7	246.0	5136083.3	273145.8
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H1-13	243.0	5136102.1	273299.0
H1-15	244.6	5136121.3	273340.6
H1-DC1	245.1	5136084.5	273021.1
H1-DC3	242.0	5136100.9	273120.1
H1-DC6	243.2	5136117.6	273321.3

NOTES

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LICENCE PROFESSIONAL ENGINEER S.E.M. POOT 90471921 APR 15, 2015 PROVINCE OF ONTARIO

LICENCED PROFESSIONAL ENGINEER J.M.A.COSTA APR 15, 2015 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17		PROJECT NO. 11-1191-0007	DIST.
SUBM'D. EC	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. A2

PLOT DATE: June 30, 2015
FILENAME: \\golder.gds\gal\sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0007 HWY 17 4 Laning\11119100074001_H1.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

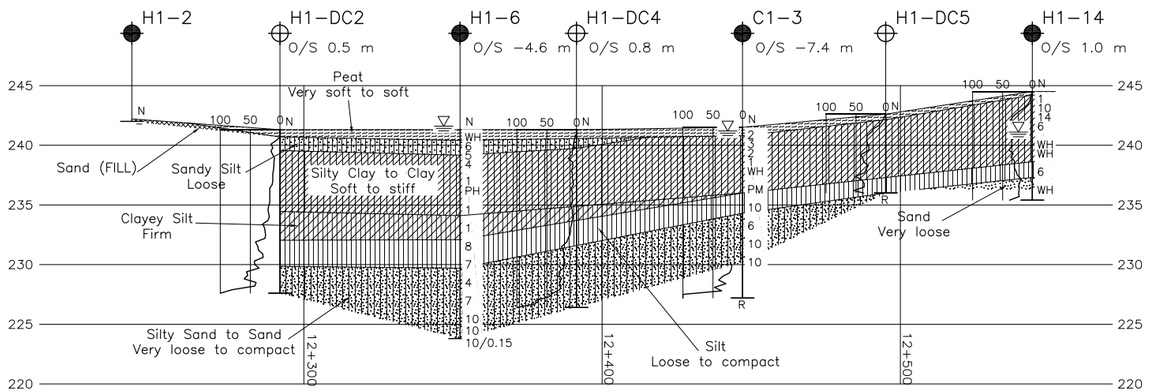
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 156-98-00

HIGHWAY 17 4 LANING
HWY 17 EBL – STA 12+220 TO 12+570
HWY 17 WBL – STA 12+220 TO 12+570
BOREHOLE LOCATIONS

SHEET

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



C-C' / 1 — SOUTH TOE PROFILE
HIGHWAY 17 (WBL)

HORIZONTAL SCALE
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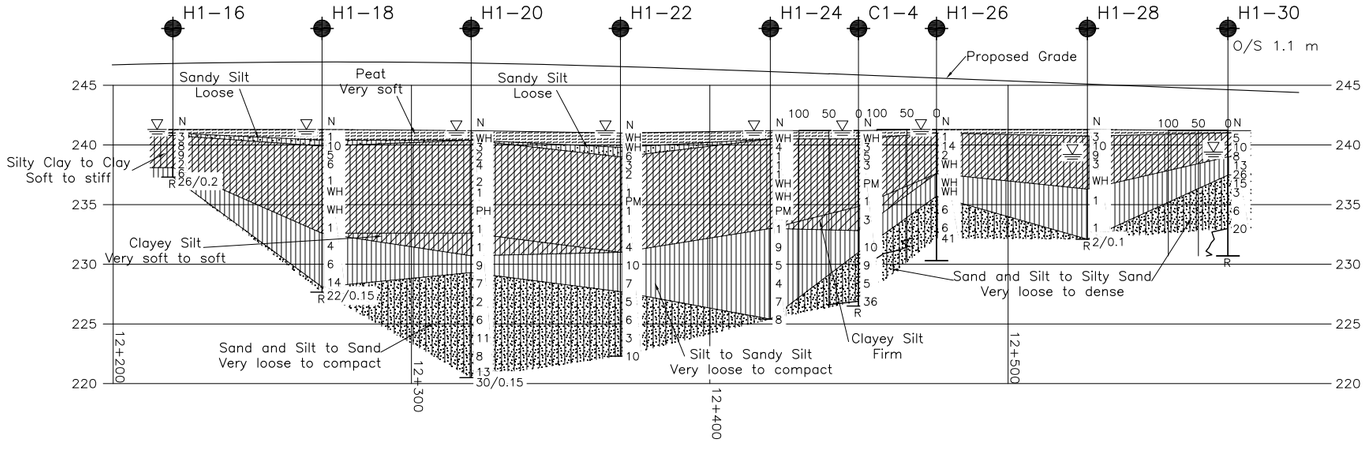
5 0 5 10 m
VERTICAL SCALE



D-D' / 1 — CENTRELINE PROFILE
HIGHWAY 17 (EBL)

HORIZONTAL SCALE
20 0 20 40 m
5 0 5 10 m
VERTICAL SCALE

LEGEND

- Borehole
- Dynamic Cone Penetration Test
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- REC — Recovery (%)
- R — Refusal
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H1-2	242.2	5136061.6	273023.1
H1-6	241.3	5136066.4	273133.1
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H1-DC4	241.3	5136072.3	273172.7
H1-DC5	242.6	5136086.8	273276.3
C1-3	241.5	5136073.1	273227.8
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LICENCE PROFESSIONAL ENGINEER S.E.M. POOT 90471921 APR 15, 2015 PROVINCE OF ONTARIO

LICENCED PROFESSIONAL ENGINEER J.M.A.COSTA APR 15, 2015 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17	PROJECT NO. 11-1191-0007		DIST.
SUBM'D. EC	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. A3

PLOT DATE: June 30, 2015
FILENAME: \\golder.gds\gal\Sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0007 HWY 17 4 Laning\11191000704001_H1.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

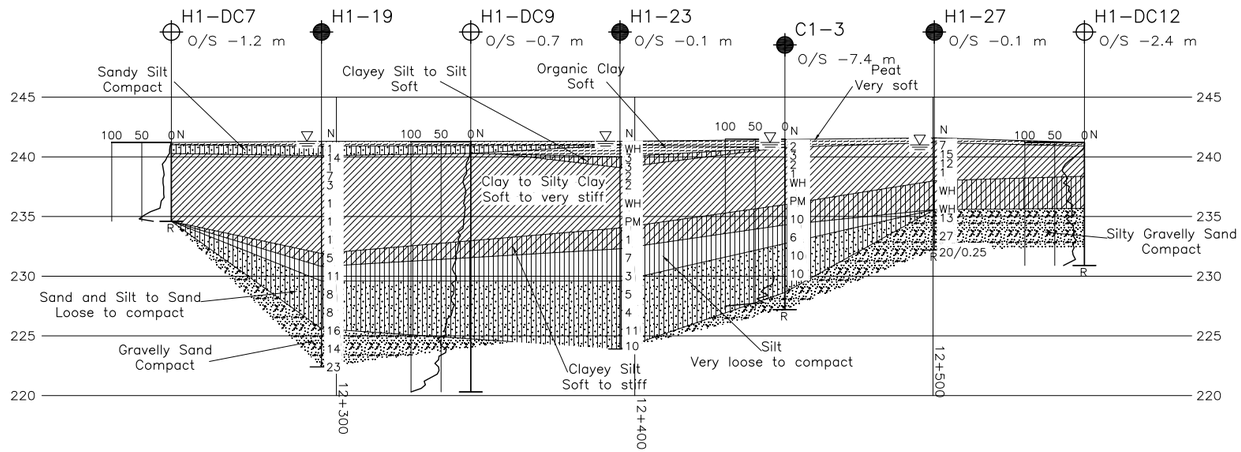
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 156-98-00

HIGHWAY 17 4 LANING
HWY 17 EBL – STA 12+220 TO 12+570
HWY 17 WBL – STA 12+220 TO 12+570
BOREHOLE LOCATIONS

SHEET

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



E-E' / 1 — NORTH TOE PROFILE
HIGHWAY 17 (EBL)

HORIZONTAL SCALE
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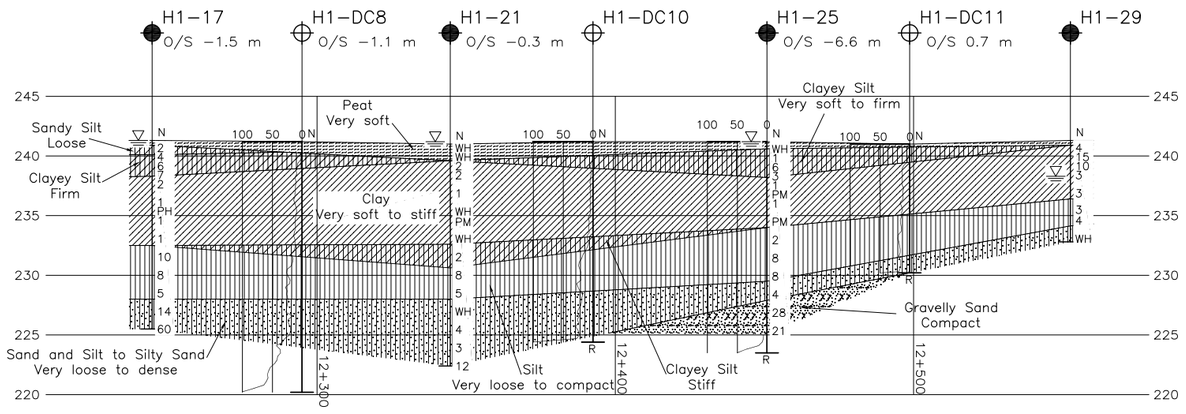
5 0 5 10 m
VERTICAL SCALE



F-F' / 1 — SOUTH TOE PROFILE
HIGHWAY 17 (EBL)

HORIZONTAL SCALE
20 0 20 40 m
5 0 5 10 m
VERTICAL SCALE

LEGEND

- Borehole
- Dynamic Cone Penetration Test
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R — Refusal
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H1-17	241.3	5136024.7	273026.2
H1-19	241.3	5136051.9	273074.1
H1-21	241.0	5136033.1	273125.8
H1-23	241.3	5136060.4	273173.8
H1-25	241.2	5136037.4	273232.1
H1-27	241.6	5136073.0	273278.4
H1-29	241.3	5136058.6	273332.0
H1-DC7	241.2	5136047.6	273024.2
H1-DC8	241.2	5136028.9	273076.0
H1-DC9	241.3	5136056.1	273123.9
H1-DC10	241.2	5136037.5	273175.7
H1-DC11	241.0	5136050.2	273281.8
H1-DC12	241.2	5136081.2	273327.9
C1-3	241.5	5136073.1	273227.8

NOTES

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

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

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans provided in digital format by DM Wills, drawing files 581_base.dwg, GWP156-98-00_B & C Plans.dwg and 581_contours.dwg received Jan 17, 2012.

LICENCED PROFESSIONAL ENGINEER — S.E.M. POOT — 90471921 — APR 15, 2015 — PROVINCE OF ONTARIO

LICENCED PROFESSIONAL ENGINEER — J.M.A.COSTA — APR 15, 2015 — PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17	PROJECT NO. 11-1191-0007		DIST.
SUBM'D. EC	CHK'D.	DATE: APR 2015	SITE:
DRAWN: TB	CHK'D. SEMP	APP'D. JMAC	DWG. A4

PLOT DATE: June 30, 2015
FILENAME: \\golder.gds\gal\Sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0007 HWY 17 4 Laning\11191000704001_H1.dwg

Golder Associates

RECORD OF BOREHOLE No H1-1

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136074.1; E 272996.9 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing and Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE July 4, 2011 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
246.6	GROUND SURFACE										
0.0	ASPHALT (130 mm)										
0.1	Sand and gravel, containing blast rock (FILL) Dense Brown Moist		1	AS	-		246				
			2	SS	50/0.08						
245.2			3	RC	REC 62%						
1.4	Boulder/rock Fill Possible bedrock or boulder cored from 1.4 m depth to 2.1 m depth.		4	RC	REC 100%		245				
244.5											
2.1	END OF BOREHOLE Note: 1. Borehole dry upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-2

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136061.6; E 273023.1 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Hand Equipment | COMPILED BY EC

DATUM Geodetic | DATE June 11, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
242.2	GROUND SURFACE										
0.0	Sand, some gravel, trace organics (FILL) Brown Moist	▨	1	CS	-		242				
0.2	END OF BOREHOLE SHOVEL REFUSAL										

Note:

1. Hand digging carried out at borehole location to expose boulders/rock fill.

2. Borehole dry upon completion of drilling.

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-3

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136079.0; E 273049.7 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing and Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE July 6, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
246.6	GROUND SURFACE										
0.0	ASPHALT (130 mm)										
0.1	Sand and gravel, trace to some silt containing blast rock (FILL) Compact to very dense Brown to grey Moist to wet		1	AS	-		246				
			2	SS	63				○		38 51 (11)
			3	REC	REC 63%		245				
			4	REC	REC 41%		244				
			5	REC	REC 64%						
			6	SS	28		243				
242.1											
4.5	SAND and SILT, trace gravel, trace clay Compact Brown Wet		7	SS	14		242		○		3 63 33 1
239.8			8	SS	20/0.08		241				
							240				
6.8	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Borehole dry upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-4

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136088.7; E 273071.0
ORIGINATED BY GM
DIST HWY 17
BOREHOLE TYPE Portable Equipment
COMPILED BY EC
DATUM Geodetic
DATE June 11, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.6	GROUND SURFACE										
0.0 241.0	Sand and gravel, some silt, trace organics (FILL) Compact Brown Wet		1	SS	27		241				
0.6	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING)										

Note:

1. Borehole dry upon completion of drilling.

2. Split-spoon sample obtained by driving with a 1/2 weight hammer. SPT 'N' values have been adjusted to the inferred values that would be obtained using a standard weight hammer.

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

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

Golder Associates

RECORD OF BOREHOLE No H1-5

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136076.5; E 273098.2 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing and Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE July 9 and 10, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
246.3	GROUND SURFACE										
0.0	Sand and gravel containing blast rock (FILL) Grey Moist to wet						246				
							245				
			1	RC	REC 27%		244				
			2	RC	REC 93%		243				
							242				
			3	RC	REC 60%	▽	241				
240.2											
6.1	SAND and SILT, trace gravel, trace clay Loose Grey Wet		4	SS	5		240				
239.1											
7.2	CLAY, varved Soft to stiff Grey Wet		5	SS	1		239				
							238	2			
			6	TO	PH		237				
								4			
			7	SS	WH		236				
							235	3			
			8	SS	WH		234				
								2			
232.9							233				
13.4	SILT, some clay, trace sand Very loose to loose Grey Wet		9	SS	9		232		H ○		0 1 86 13

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H1-5

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136076.5; E 273098.2 ORIGINATED BY LK

DIST HWY 17 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing and Wash Boring COMPILED BY EC

DATUM Geodetic DATE July 9 and 10, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
	SILT, some clay, trace sand Very loose to loose Grey Wet		10	SS	8		231				
							230				
			11	SS	1		229				
228.5											
17.8	SAND and SILT Compact Grey Wet		12	SS	18		228		○		0 69 31 0
226.9							227				
19.4	END OF BOREHOLE REFUSAL TO FURTHER CASING ADVANCEMENT Note: 1. Water level at a depth of 5.5 m below ground surface (Elev. 240.8 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-6

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136066.4; E 273133.1 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 6 and 7, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
241.3	GROUND SURFACE					
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	WH	
240.4						
0.9	SAND and SILT Loose Brown to grey Wet		2	SS	6	
			3	SS	5	
239.2						
2.1	SILTY CLAY, varved Soft to stiff Grey Wet		4	SS	4	
			5A	SS	1	
			5B	TO	PH	
			6	SS	1	
234.1						
7.2	CLAYEY SILT Firm Grey Wet		7	SS	1	
232.5						
8.8	SILT, trace to some clay Loose Grey Wet		8	SS	8	
			9	SS	7	
229.7						
11.6	Silty SAND, trace clay, trace gravel Loose Grey Wet		10	SS	4	
			11	SS	7	

ELEVATION SCALE: 241, 240, 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m^3

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

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H1-6

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136066.4; E 273133.1 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 6 and 7, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Silty SAND, trace clay, trace gravel Loose Grey Wet						226				
			12	SS	10				○		1 68 28 3
							225				
	Approximated 0.2 of heave encountered at 17.4 m depth.		13	SS	10						
223.8			14	SS	10/0.15		224				
17.5	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING)										

Note:

1. Water level at 0.3 above ground surface (Elev. 241.6 m) upon completion of drilling.

2. Moved 1.0 m east of Borehole H1-6 and advanced a shelby tube at 4.6 m depth (Sample 5B).

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

Golder Associates

RECORD OF BOREHOLE No H1-7

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136083.3; E 273145.8 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing and Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE July 10 and 11, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
246.0	GROUND SURFACE										
0.0	Sand and gravel, containing blast rock (FILL) Very dense Grey Moist		1	AS	-		245				
			2	SS	79		244				
			3	RC	REC 22%		243				
			4	RC	REC 33%		242				
			5	RC	REC 26%		241				
240.2											
5.8	SAND and SILT, some clay Loose Grey Moist		6	SS	10	▽	240		○		0 40 37 23
238.8							239				
7.2	CLAY to SILTY CLAY, varved Firm to stiff Grey Wet		7	SS	2		238	+ 3			
			8	SS	WH		237				
			9	TO	PH		236	+ 4			
			10	SS	WH		235	+ 4			0 0 61 39
232.6							234				
13.4	SILT, trace sand, trace clay Very loose to loose Grey Wet		11	SS	6		233	+ 3			
							232				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H1-7

 METRIC

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136083.3; E 273145.8
ORIGINATED BY LK
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing and Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE July 10 and 11, 2012
CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
229.7	SILT, trace sand, trace clay Very loose to loose Grey Wet		12	SS	2		230		○		0 5 90 5
16.3	SAND and SILT, trace clay Loose to dense Grey Wet		13	SS	16		229				
							228				
			14	SS	10				○		0 45 54 1
							227				
							226				
							225				
			15	SS	7						
							224				
222.5			16	SS	49		223				
23.5	END OF BOREHOLE Note: 1. Water level at a depth of 6.2 m below ground surface (Elev. 239.8 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H1-8

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136097.6; E 273170.5 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing and Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE July 5, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
245.8	GROUND SURFACE										
0.0	Sand and gravel, containing blast rock (FILL) Compact Brown Moist		1	AS	-		245				
			2	SS	19		244				
243.6											
2.2	Sandy silt, some gravel, trace to some clay, containing blast rock (FILL) Compact to dense Brown Moist to wet		3	SS	38		243				
			4	SS	26	▽			○		17 25 52 6
	Spoon refusal at 4.6 m depth.						242				
240.3							241				
5.5	CLAY, trace sand Soft to firm Grey Wet		5	SS	5		240				
			6	SS	2		239				
			7	SS	WH		238	2			0 1 31 68
			8	TO	PH		237	2			
			9	SS	1		236	3			
232.4							235				
13.4	SILT, trace to some clay, trace sand Loose Grey Wet		10	SS	7		234			NP	0 1 91 8
							233				
							232				
							231				

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-8

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136097.6; E 273170.5 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing and Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE July 5, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
	SILT, trace to some clay, trace sand Loose Grey Wet		11	SS	6		230				
229.5											
16.3	SAND and SILT, trace clay Loose to dense Grey Wet		12	SS	7		229				
							228				
			13	SS	10				○		0 53 44 3
							227				
							226				
							225				
			14	SS	11		224				
							223				
222.3			15	SS	31						
23.5	END OF BOREHOLE Note: 1. Water level at a depth of 3.1 m below ground surface (Elev. 242.7 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-9

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136092.6; E 273195.7 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE NW Casing and Wash Boring | COMPILED BY MT

DATUM Geodetic | DATE January 8 and 9, 2014 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
245.8	GROUND SURFACE								
0.0	Sandy gravel to sand and gravel, containing blast rock (FILL) Very dense to compact Grey Frozen to wet		1	SS	113		245		
			2	SS	13	▽	244		
							243		
240.8							242		
5.0	SILTY CLAY, trace sand Firm to stiff Grey Wet		3	SS	9		241		
			4	SS	8		240		
							239		
	Trace organics in Sample 5.		5	SS	2		238		
							237		
			6	SS	WH		236		
	Varved below 10.7 m depth. Approximately 5 mm thick varves encountered from 10.7 m to 12.0 m depth.		7	SS	WH		235		
233.8							234		
12.0	SILT, trace to some clay Loose to compact Grey Wet		8	SS	7		233	NP	0 0 82 18
			9	SS	12		232		
							231		

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

>100

3

6

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 27/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-9

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136092.6; E 273195.7 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE NW Casing and Wash Boring | COMPILED BY MT

DATUM Geodetic | DATE January 8 and 9, 2014 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
230.4											
15.4	SAND and SILT Loose Grey Wet		10	SS	7		230		○		0 48 49 3
							229				
228.4			11	SS	6						
17.4	END OF BOREHOLE Note: 1. Water level at a depth of 3.2 m below ground surface (Elev. 242.6 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H1-11

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136094.7; E 273250.1
ORIGINATED BY GM
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
COMPILED BY EC
DATUM Geodetic
DATE April 25, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
243.2	GROUND SURFACE						243				
0.0 / 242.8	PEAT (Fibrous) Firm Black Wet		1	SS	7						
0.4	SILTY CLAY, trace sand, mottled Firm to very stiff Brown Moist		2	SS	16		242		○		0 1 57 42
241.0			3	SS	12	▽					
2.2	SILT, some gravel, trace to some clay, trace to some sand Compact Brown to grey Wet		4	SS	14		241		○	NP	
239.5			5	SS	14		240		○		20 6 67 7
3.7	Silty SAND, some gravel Very loose to compact Grey Wet		6	SS	17		239				
237.6			7	SS	3		238				
5.6	SAND and GRAVEL, trace to some silt, trace clay Compact Grey Wet Between 0.3 and 1.5 m of heave encountered below 6.1 m depth.		8	SS	10		237		○		36 50 12 2
234.8			9	SS	24		236				
8.4	END OF BOREHOLE AUGER REFUSAL Note: 1. Water level at a depth of 1.8 m below ground surface (Elev. 241.4 m) upon completion of drilling.		10	SS	20/0.15		235				

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

Golder Associates

RECORD OF BOREHOLE No H1-12

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136111.9; E 273271.9 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing and Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE July 11 and 12, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
246.3	GROUND SURFACE										
0.0	Sand and gravel, some silt, containing blast rock (FILL) Dense Grey Moist		1	SS	50		246				
			2	RC	REC 28%		245				
243.3							244				
3.0	SILTY CLAY Stiff Brown Moist		3	SS	12		243				
			4	SS	10		242		○		
240.7							241				
5.6	SILT, some clay, trace sand Compact Grey Wet		5	SS	15	▽	240		○	NP	0 1 80 19
239.7											
6.6	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) AND REFUSAL TO FURTHER CASING ADVANCEMENT Note: 1. Water level at a depth of 6.1 m below ground surface (Elev. 240.2m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-13

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136102.1; E 273299.0
ORIGINATED BY GM
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
COMPILED BY EC
DATUM Geodetic
DATE April 25, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
243.0	GROUND SURFACE										
0.0 242.6	PEAT (Fibrous) Stiff Black		1	SS	9				○		
0.4	Dry SILTY CLAY, varved Soft to very stiff Brown to grey Moist to wet		2	SS	17	▽	242				
			3	SS	9		241		⊢○⊣		
			4	SS	4		240	2 +			
239.4											
3.6	Silty SAND, trace to some gravel Very loose Grey Wet		5	SS	3		239		○	NP	
238.5											
4.5	SAND and GRAVEL, some silt, trace clay Loose to compact Grey Wet Approximately 0.9 m of heave encountered below a depth of 5.2 m.		6	SS	6		238				
236.8			7	SS	50/0.15		237		○		43 41 14 2
6.2	END OF BOREHOLE AUGER REFUSAL Note: 1. Water level at a depth of 1.2 m below ground surface (Elev. 241.8 m) upon completion of drilling.										

+ ³, × ³: Numbers refer to Sensitivity

○ ³% STRAIN AT FAILURE

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-14

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
DIST _____ HWY 17
DATUM Geodetic
LOCATION N 5136094.6; E 273323.0
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
DATE April 25, 2012
ORIGINATED BY GM
COMPILED BY EC
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
244.5	GROUND SURFACE										
0.0 / 244.2	PEAT (Fibrous) Very soft Black Moist		1	SS	1		244		○		
0.3	CLAY, varved Soft to stiff Brown to grey Wet		2	SS	10						
			3	SS	14		243				
			4	SS	6		242				
						▽		+3			
			5	SS	WH		241		○		0 1 73 26
			6	SS	WH		240				
238.6							239	+3			
5.9	SILT, trace to some clay Loose Grey Wet		7	SS	6		238		○		
237.3											
7.2	SAND, trace to some silt Very loose Grey Wet		8	SS	WH		237				
236.3											
8.2	Approximately 3.0 m of heave encountered below 8.2 m depth. END OF BOREHOLE						236				
235.4											
9.1	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

Note:

1. Water level at a depth of 3.4 m below ground surface (Elev. 241.1 m) upon completion of drilling.

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-15

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136121.3; E 273340.6 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE April 26, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
244.6	GROUND SURFACE										
0.0 / 244.0	PEAT Stiff Black Wet		1	SS	11		244				
0.6	CLAY, varved Firm to stiff Brown Moist to wet		2	SS	14						
			3	SS	12		243				
			4	SS	5	▽	242				
241.2								+ 6			
3.4 / 240.3	CLAYEY SILT Stiff Grey Wet		5	SS	12		241				
4.3	Silty SAND, trace to some gravel Compact Grey Wet		6	SS	21		240				
239.0	Approximately 0.6 m of heave encountered below 5.2 m depth.										
5.6	Gravelly SAND, trace to some silt, trace clay Very loose to compact Grey Wet		7	SS	3		239				
			8	SS	6		238		○		28 61 9 2
			9	SS	23		237				
			10	SS	24		236				
233.6							235				
11.0	END OF BOREHOLE AUGER REFUSAL Note: 1. Water level at a depth of 3.0 m below ground surface (Elev. 241.6 m) upon completion of drilling.						234				

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-16

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136034.1; E 273000.3 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 22, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.3	GROUND SURFACE										
0.0 / 241.0	PEAT (Fibrous) Soft Black Wet		1	SS	3		241				
0.5	Sandy SILT										
	SILTY CLAY, varved Soft Brown to grey Wet		2	SS	8						
			3	SS	9		240				
			4	SS	2		239	+ 5			
238.1											
3.2	SILT, trace to some clay, trace sand, trace gravel Loose to compact Brown to grey		5A 5B	SS	6		238		○		2 2 90 6
237.3	Wet		6	SS	26/0.2						
4.0	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING)										

Note:

1. Water level at ground surface (Elev. 241.3 m) upon completion of drilling.

2. Moved 1 m north of Borehole H1-16 and turned an N-vane at 2.7 m depth.

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-17

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136024.7; E 273026.2 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 24 and 25, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.3	GROUND SURFACE						241				
0.0 / 240.9	PEAT (Fibrous) Very soft Black Wet		1A, 1B	SS	2						
0.4	Sandy SILT, trace to some clay Loose Brown Wet		2A, 2B	SS	4		240				
240.1 / 1.2	CLAYEY SILT Firm Brown to grey Wet		3	SS	6						
238.3			4	SS	7		239				
3.0	CLAY, varved Soft to stiff Grey Wet		5	SS	2		238	4			
			6A	SS	1		237				
			6B	TO	PH		236	4			
			7	SS	1		235	3			
			8	SS	1		234	5			
232.5							233	2			
8.8	SILT, trace clay, trace sand Loose to compact Grey Wet		9	SS	10		232				
			10	SS	8		231				0 3 92 5
			11	SS	5		230				
228.0							229				
13.3	SAND and SILT, trace to some gravel, trace clay Compact to dense Grey Wet Approximately 0.3 m of heave encoutered at 14.3 m depth.		12	SS	14		228				10 36 52 2
							227				

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-17

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136024.7; E 273026.2 | ORIGINATED BY GM

DIST _____ HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 24 and 25, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
225.5			13	SS	60		226				
15.8	END OF BOREHOLE Note: 1. Moved 1 m east of Borehole H1-17 and obtained a Shelby tube at 5.2 m depth. 2. Water level at ground surface (Elev. 241.3 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H1-18

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136038.3; E 273050.1 | ORIGINATED BY GM

DIST _____ HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 23 and 24, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.3	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	1		241				
240.4			2A								
0.9	Sandy SILT, trace to some clay, some organics		2B	SS	10				○		0 23 65 12
239.9	Loose						240				
1.4	Brown to grey Wet		3	SS	5						
	CLAY, varved Soft to stiff Brown to grey Wet		4	SS	6		239	>100			
								6 +			
			5	SS	1		238				
								4 +			
			6	SS	WH		237		○		
								5 +			
			7	SS	WH		236				
								4 +			
			8	SS	1		235				
232.6											
8.7	SILT, trace to some clay, trace sand, trace gravel Loose to compact Grey Wet		9	SS	4		234		○	NP	1 2 89 8
			10	SS	6		233				
			11	SS	14		232				
228.1	Approximately 0.2 m of heave encountered at 12.8 m depth.						231				
13.2	SAND, trace silt Compact Grey Wet		12	SS	22/0.15		230				
227.7							229				
13.6							228				

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H1-18

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136038.3; E 273050.1 ORIGINATED BY GM

DIST HWY 17 BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE May 23 and 24, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Moved 1 m southeast of Borehole H1-18 and obtained a Shelby tube at 4.6 m depth. 2. Water level at ground surface (Elev. 241.3 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H1-19

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136051.9; E 273074.1 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 28 and 29, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.3	GROUND SURFACE						241				
0.0 / 240.9	PEAT (Fibrous) Very soft Black Wet		1	SS	1						
0.4	Sandy SILT, some clay, trace organics Compact Grey Wet		2	SS	14		240				
240.1 / 1.2	CLAY, varved Soft to stiff Brown to grey Wet		3	SS	1						
			4	SS	7		239				
			5	SS	3		238	7			
			6	SS	1		237			16.3	
			7	SS	1		236	5			
			8	SS	1		235	4			
			9A 9B	SS	5		234	5			
231.9 / 9.4	CLAYEY SILT Firm Grey Wet						233				
230.9 / 10.4	SILT Compact Grey Wet		10	SS	11		232				
229.6 / 11.7	SAND and SILT, trace clay Loose Grey Wet		11	SS	8		231				0 43 55 2
			12	SS	8		230				
							229				
							228				
							227				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H1-19

 METRIC

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136051.9; E 273074.1 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 28 and 29, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
225.6			13	SS	16		226				
15.7	Gravelly SAND, some silt, trace clay Compact Grey Wet Approximately 0.6 m of heave encountered at 15.8 m depth.		14	SS	14		225				
							224				
222.4			15	SS	23		223		○		23 55 20 2
18.9	END OF BOREHOLE Note: 1. Moved 1 m north of Borehole H1-19 and obtained a Shelby tube at 4.6 m depth. 2. Water level at ground surface (Elev. 241.3 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H1-20

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136042.5; E 273099.9 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 30, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.2	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	WH		241				
240.4											
0.8	SILTY CLAY, varved Firm to stiff Brown to grey Wet		2	SS	3		240				
			3	SS	2						
	Varved below 2.6 m depth.		4A 4B	SS	4		239				
							238	10			
			5	SS	2						0 4 46 50
							237	7			
			6A	SS	1						
							236	6			
			6B	TO	PH		235				
								6			
							234				
			7	SS	1						
232.4							233				
8.8	CLAYEY SILT Very soft to soft Grey Wet		8	SS	1		232				
231.0											
10.2	SILT Loose Grey Wet		9	SS	9		231				
229.3							230				
11.9	SAND and SILT, trace clay Very loose to loose Grey Wet		10	SS	7		229				
							228				
			11	SS	2		227				0 30 66 4

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H1-20

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136042.5; E 273099.9 ORIGINATED BY GM

DIST HWY 17 BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE May 30, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND and SILT, trace clay Very loose to loose Grey Wet Approximately 0.3 m of heave encountered at 15.8 m depth.		12	SS	6		226				
224.9							225				
16.3	SAND, some silt Loose to compact Grey Wet		13	SS	11		224				
			14	SS	8		223				
			15	SS	13		222				
220.5			16	SS	30/0.15		221				
20.7	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at ground surface (Elev. 241.2 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H1-21

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136033.1; E 273125.8
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE June 4, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
241.0	GROUND SURFACE					
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	WH	
			2	SS	WH	
239.6						
1.4	CLAY, varved Firm to stiff Brown to grey Wet		3	SS	2	
			4	SS	2	
			5	SS	1	
			6	SS	WH	
			7	TO	PM	
			8	SS	WH	
232.6						
8.4	CLAYEY SILT, trace sand Stiff Grey Wet		9	SS	2	
231.1						
9.9	SILT, trace to some clay, trace sand Loose Grey Wet		10	SS	8	
			11	SS	5	
228.0						
13.0	SAND and SILT, trace clay Very loose to compact Grey Wet		12	SS	WH	

ELEVATION SCALE: 240, 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%) (20 40 60)

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
0	2	92	6

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H1-21

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136033.1; E 273125.8 | ORIGINATED BY AC

DIST _____ HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 4, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND and SILT, trace clay Very loose to compact Grey Wet		13	SS	4				○		0 52 46 2
							225				
			14	SS	3						
							224				
222.4			15	SS	12		223				
18.6	END OF BOREHOLE Note: 1. Water level at ground surface (Elev. 241.0 m) upon completion of drilling. 2. Ponded water at 0.2 m above ground surface (Elev. 241.2 m).										

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

Golder Associates

RECORD OF BOREHOLE No H1-22

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136046.5; E 273149.8
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE June 5, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.0	GROUND SURFACE								
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	WH				
			2	SS	WH		240		
239.8									
1.2	Sandy SILT, trace clay Loose Grey Wet		3	SS	6		239		
239.0									
2.0	SILTY CLAY, varved Firm to stiff Grey Wet		4	SS	3				
			5	SS	2		238		
							237		
			6	SS	1		236		
			7	TO	PM				
			8	SS	1		235		
							234		
			9	SS	1		233		
			10	SS	4		232		
231.0									
10.0	SILT, trace clay, trace to some sand Loose Grey Wet		11	SS	10		231		
			12	SS	7		230		0 7 90 3
227.7							229		
13.3	Silty SAND Very loose to loose Grey Wet		13	SS	5		228		
							227		

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-22

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136046.5; E 273149.8 | ORIGINATED BY AC

DIST _____ HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 5, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Silty SAND Very loose to loose Grey Wet		14	SS	6		225				
			15	SS	3		224				
			16	SS	10		223				
222.3 / 18.7	END OF BOREHOLE Note: 1. Water level at ground surface (Elev. 241.0 m) upon completion of drilling. 2. Ponded water at 0.2 m above ground surface (Elev. 241.2 m).										

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

Golder Associates

RECORD OF BOREHOLE No H1-23

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
DIST _____ HWY 17
DATUM Geodetic
LOCATION N 5136060.4; E 273173.8
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
DATE September 18 and 19, 2012
ORIGINATED BY AC
COMPILED BY EC
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.3	GROUND SURFACE										
0.0 / 241.0	PEAT (Fibrous) Very soft Black Wet		1A 1B	SS	WH		241				
0.3	ORGANIC CLAY Soft Brown to black Wet		2	SS	3						
240.0							240				
1.3	CLAYEY SILT to SILT Soft Grey Wet		3	SS	3						0 38 39 23
239.1							239				
2.2	CLAY, varved Soft to firm Grey Wet		4	SS	2						
			5	SS	2		238				
								9			
			6	SS	WH		237				
							236	12			
			7	TO	PM		235				
								9			
234.0							234				
7.3	CLAYEY SILT, trace sand Firm Grey Wet		8	SS	1						
232.6							233	4			
8.7	SILT, trace sand, trace to some clay Very loose to loose Grey Wet		9	SS	7		232				0 2 86 12
			10	SS	3		231				
229.6							230				
11.7	SAND and SILT to SAND, trace clay Loose to compact Grey Wet		11	SS	5		229				
							228				
			12	SS	4						0 53 46 1
							227				

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H1-23

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136060.4; E 273173.8 ORIGINATED BY AC

DIST HWY 17 BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE September 18 and 19, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND and SILT to SAND, trace clay Loose to compact Grey Wet		13	SS	11		226				
							225				
223.9			14	SS	10		224				
17.4	END OF BOREHOLE Note: 1. Water level at ground surface (Elev. 241.3 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H1-24

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136051.4; E 273199.8 | ORIGINATED BY ID

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE September 25 and 26, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.2	GROUND SURFACE									
0.0	PEAT (Fibrous) Very soft Brown to black		1	SS	WH		241			
240.5	Wet									
0.7	CLAY to SILTY CLAY Very soft to firm Brown to grey Wet		2	SS	4		240			
			3	SS	1					OC=2.9%
	Trace organics above 2.3 m depth.		4	SS	1		239			
			5	SS	1		238			11 13 46 30
	Varved below 3.7 m depth.		6	SS	WH		237	11		
			7	SS	WH		236			
			8	TO	PM		235	8		
			9	SS	1		234	9		
233.0										
8.2	Sandy SILT, trace to some gravel Loose Grey Wet		10	SS	9		233			
			11	SS	5		232			0 21 79 0
			12	SS	4		231			
			13	SS	7		230			9 26 65 0
							229			
							228			
							227			

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H1-24

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136051.4; E 273199.8 ORIGINATED BY ID

DIST HWY 17 BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE September 25 and 26, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
225.4	Sandy SILT, trace to some gravel Loose Grey Wet		14	SS	8		226				
15.8	END OF BOREHOLE										
	Note: 1. Water level at ground surface (Elev. 241.2 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H1-25

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136037.4; E 273232.1 | ORIGINATED BY ID

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE September 26, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.2	GROUND SURFACE						241				
0.0 / 240.6	PEAT (Fibrous) Very soft Brown Wet		1	SS	WH						
0.6	CLAYEY SILT, trace organics Very soft to firm Grey Wet		2	SS	1		240				
			3	SS	6						
238.2			4	SS	3		239				
3.0	CLAY, varved Soft Grey Wet		5	SS	1		238				
			6	TO	PM						
			7	SS	1		237				0 0 40 60
							236	+ 11, + 13			
234.0			8	TO	PM		235			16.9	
7.2	SILT, some clay Very loose to loose Grey Wet		9	SS	2		234			NP	0 0 82 18
			10	SS	8		233				
			11	SS	8		232				
229.5							231				
11.7	Silty SAND, trace clay Very loose Grey Wet		12	SS	4		230				0 69 29 2
227.9							229				
13.3	Gravelly SAND Compact Grey Wet		13	SS	28		228				
							227				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H1-25

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136037.4; E 273232.1
ORIGINATED BY ID
DIST HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE September 26, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
225.1	Gravelly SAND Compact Grey Wet		14	SS	21		226				
16.1	END OF BOREHOLE						225				
223.5							224				
17.7	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING) Note: 1. Water level at ground surface upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-26

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136058.0; E 273255.1 | ORIGINATED BY ID

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE October 22 and 23, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.3	GROUND SURFACE					▽					
0.0 / 241.0	PEAT (Fibrous) Very soft Brown Wet		1	SS	1		241				
0.3	CLAY Firm to stiff Brown to grey Wet		2	SS	14						
			3	SS	2		240				
			4	SS	WH		239				
237.6							238	11, 11			
3.7	SILT, some clay Very loose Grey Wet		5	SS	WH					NP	
235.7			6	SS	WH		237				
5.6	SAND and SILT, trace to some gravel, trace clay Loose to dense Grey Wet		7	SS	6		236				7 36 54 3
			8	SS	6		235				
232.2			9	SS	41		234				
9.1	END OF BOREHOLE						233				
230.3							232				
11.0	END OF DCPT REFUSAL TO FURTHER PENETRATION (107 Blows / 0.30 m)						231				

Notes:

1. Water level at ground surface (Elev. 241.3 m) upon completion of drilling.

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-27

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136073.0; E 273278.4 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE April 24, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.6	GROUND SURFACE										
0.0 / 241.2	PEAT (Fibrous) Black Frozen		1	SS	7	▽	241				
0.4	CLAY, varved Soft to very stiff Brown to grey Wet		2	SS	15						
			3	SS	12		240				
			4	SS	1		239				
238.0								5			
3.6	CLAYEY SILT Soft Grey Wet		5	SS	WH		238				
							237	2			
235.6			6	SS	WH		236				
6.0	Silty Gravelly SAND, trace clay Compact Grey Wet Between 0.9 m and 2.4 m of heave encountered below 6.7 m depth.		7	SS	13		235				
			8	SS	27		234		○		27 49 22 2
232.2			9	SS	20/0.25		233				
9.4	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) AND AUGER REFUSAL Note: 1. Water level at a depth of 0.6 m below ground surface (Elev. 241.0 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-28

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136065.6; E 273305.1 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE April 24, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.3	GROUND SURFACE										
0.0 / 240.7	PEAT (Fibrous), some silt Very soft Brown to black Frozen to wet		1	SS	3		241				
0.6	CLAY, varved Soft to stiff Brown to grey Moist to wet		2	SS	10						
			3	SS	9	▽	240				
			4	SS	3		239				
							238	8			
			5	SS	WH		237				
236.3								4			
5.0	SILT, trace clay Very loose Grey to brown Wet		6	SS	1		236			NP	
	Between 0.2 m and 1.2 m of heave encountered below 6.1 m depth.						235	4			
	Some gravel below 7.6 m depth.		7	SS	1		234				
232.1			8	SS	2/0.1m		233				
9.2	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) AND AUGER REFUSAL Note: 1. Water level at a depth of 2.1 m below ground surface (Elev. 239.2 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-29

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136058.6; E 273332.0 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE April 23, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.3	GROUND SURFACE									
0.0 / 240.9	TOPSOIL		1	SS	4		241			
0.4	CLAY, varved Soft to stiff Brown to grey Wet		2	SS	15					
			3	SS	10		240			
			4	SS	3	▽	239			
							238	+ 5		
			5	SS	3		237			
236.4								+ 6		
4.9	SILT, some sand, trace clay Very loose Grey Wet		6	SS	3		236			0 14 81 5
	Approximately 0.3 and 1.2 m of heave encountered below 5.8 m depth.		7	SS	4		235			
234.1										
7.2	Silty SAND, trace gravel Very loose Grey Wet		8	SS	WH		234			
232.8							233			
8.5	END OF BOREHOLE AUGER REFUSAL Note: 1. Water level at a depth of 3.0 m below ground surface (Elev. 238.3 m) upon completion of drilling.									

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H1-30

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
DIST _____ HWY 17
DATUM Geodetic
LOCATION N 5136075.0; E 273351.3
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
DATE April 26, 2012
ORIGINATED BY GM
COMPILED BY EC
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.2	GROUND SURFACE										
0.0	PEAT (Fibrous)										
0.2	Black Wet		1	SS	5		241		○		
	SILTY CLAY Firm to stiff Brown to grey Wet		2	SS	10		240		⊢○⊣		
239.0			3	SS	8	▽	239				
2.2	SILT, trace to some clay, trace sand Compact Grey Wet		4	SS	13				○		0 2 89 9
237.5			5	SS	26		238				
3.7	Silty SAND, trace to some gravel, trace clay Very loose to compact Grey Brown		6	SS	15		237				
			7	SS	3		236				
	Between 0.9 m and 4.6 m of heave encountered below 5.2 m depth.										
			8	SS	6		235		○		15 63 21 1
233.0			9	SS	20		234				
8.2	END OF BOREHOLE						233				
230.7							232				
10.5	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)						231				
	Note: 1. Water level at a depth of 1.8 m below ground surface (Elev. 239.4 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No C1-1

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136117.1; E 273222.2
ORIGINATED BY ID
DIST HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE September 28 and October 1, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.7	GROUND SURFACE										
0.0	TOPSOIL										
0.1	CLAY to SILTY CLAY, varved Soft to firm Brown to grey Moist to wet		1	SS	2	▽	241				
			2	SS	4						
			3	SS	7		240				
	Trace organics above 2.1 m depth.		4	SS	2		239				
								15			
			5	SS	WH		238				
								24			
			6	SS	WH		237				
235.8								25			
5.9	SILT, trace sand, trace clay Loose to compact Grey Wet		7	SS	7		236				
							235				
			8	SS	4		234				0 4 92 4
							233				
232.5			9	SS	75/0.08						
9.2	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING)										

Note:

1. Water level at a depth of 0.6 m below ground surface (Elev. 241.1 m) upon completion of drilling.

2. Moved 1.0 m east of Borehole C1-1 and obtained a Shelby tube at 3.7 m depth. Advanced Dynamic Cone Penetration Test below 5.9 m depth.

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

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No C1-2

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136091.7; E 273224.8
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE September 20, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.4	GROUND SURFACE										
0.0 / 241.1	PEAT (Fibrous) Very soft Black Wet		1A 1B	SS	WH						
0.3	CLAY to SILTY CLAY Soft Brown to grey Wet		2	SS	2						
			3	SS	3						
	Trace organics above 2.1 m depth.		4	SS	2						
			5	SS	3						
								+ 10			
236.1			6	TO	PM						
5.3	SILT, trace to some sand, trace clay Loose to compact Grey Wet		7	SS	11						0 8 90 2
			8	SS	9						
			9	SS	15						
233.3			10	SS	6						
8.1	END OF BOREHOLE										
229.0											
12.4	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.25 m) Note: 1. Water level at ground surface (Elev. 241.4 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No C1-3

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136073.1; E 273227.8
ORIGINATED BY ID
DIST HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE September 27, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.5	GROUND SURFACE										
0.0	PEAT (Fibrous) Soft Black		1A 1B	SS	2	▽	241				
240.8	Moist to wet										
0.7	SILTY CLAY, trace sand Soft Grey Wet		2	SS	3						0 1 56 43
			3	SS	2		240				
	Trace organics above 2.3 m depth.		4	SS	1		239				
			5	SS	WH		238				
								+ 17 + 18			
			6	TO	PM		237				
236.0											
5.5	SILT, some clay Compact Grey Wet		7	SS	10		236				
234.3							235				
7.2	SAND, trace silt Loose to compact Grey Wet		8	SS	6		234				
							233				
			9	SS	10		232				0 98 (2)
	Between 0.9 m and 1.8 m of heave encountered below 9.7 m depth.						231				
230.2			10	SS	10						
11.3	END OF BOREHOLE						230				
							229				
227.2							228				
14.3											

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No C1-3

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136073.1; E 273227.8 ORIGINATED BY ID

DIST HWY 17 BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE September 27, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING) Note: 1. Water level at a depth of 0.3 m below ground surface (Elev. 241.2 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No C1-4

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136054.4; E 273229.2
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE September 20 and 21, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.2	GROUND SURFACE						
0.0	PEAT (Fibrous) Very soft Brown to black	1	SS	WH			
240.5	Wet						
0.7	SILTY CLAY Soft to firm Grey Wet	2	SS	3			
		3	SS	5			
	Trace organics above 2.2 m depth.	4	SS	3			
		5	TO	PM			
		6	SS	1			
234.6							
6.6	CLAYEY SILT Firm Grey Wet	7	SS	3			
233.3							
7.9	SILT, trace to some sand, trace clay Compact Grey Wet	8	SS	10		NP	0 7 88 5
231.0							
10.2	Silty SAND, trace to some gravel, trace clay Loose to dense Grey Wet	9	SS	9			
		10	SS	5			
		11	SS	36			
226.9							
	END OF BOREHOLE						
226.5							
14.7							

ELEVATION SCALE: 241, 240, 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

Continued Next Page

+3, ×3: Numbers refer to Sensitivity

○3% STRAIN AT FAILURE

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No C1-4

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136054.4; E 273229.2 ORIGINATED BY AC

DIST HWY 17 BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE September 20 and 21, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING) Note: 1. Water level at ground surface (Elev. 241.2 m) upon completion of drilling.										

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

Golder Associates

RECORD OF DCPT No H1-DC1

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136084.5; E 273021.1 ORIGINATED BY GM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 11, 2012 CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
245.1 GROUND SURFACE											
0.0							245				
244.6											
0.5	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

Golder Associates

RECORD OF DCPT No H1-DC2

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136060.1; E 273070.4 ORIGINATED BY GM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 8, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.3	GROUND SURFACE										
0.0							241				
							240				
							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
227.6											
13.7	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.28 m)										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF DCPT No H1-DC3

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136100.9; E 273120.1 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE September 17, 2012 CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
242.0 / 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60		

241 240 239 238 237 236 235 234 233 232 231 230 229 228

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H1-DC3

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136100.9; E 273120.1 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE September 17, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---						226 225				
224.7 17.3	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.25 m)										

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

Golder Associates

RECORD OF DCPT No H1-DC4

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136072.3; E 273172.7 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE September 18, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.3	GROUND SURFACE										
0.0							241				
							240				
							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
							227				
226.4											

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF DCPT No H1-DC4

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136072.3; E 273172.7 ORIGINATED BY AC

DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC

DATUM Geodetic DATE September 18, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa (20 40 60 80 100) ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
14.9	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.30 m)										

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

Golder Associates

RECORD OF DCPT No H1-DC5

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136086.8; E 273276.3 ORIGINATED BY GM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE April 21, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
242.6	GROUND SURFACE										
0.0							242				
							241				
							240				
							239				
							238				
							237				
236.0							236				
6.6	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF DCPT No H1-DC6

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136117.6; E 273321.3 ORIGINATED BY GM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE April 21, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
243.2	GROUND SURFACE										
0.0							243				
							242				
							241				
							240				
							239				
							238				
							237				
235.8							236				
7.4	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: 20 40 60 80 100
WATER CONTENT (%): 20 40 60

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

Golder Associates

RECORD OF DCPT No H1-DC7

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136047.6; E 273024.2 ORIGINATED BY GM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE May 23, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.2	GROUND SURFACE										
0.0							241				
							240				
							239				
							238				
							237				
							236				
							235				
234.6											
6.6	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

Golder Associates

RECORD OF DCPT No H1-DC8

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136028.9; E 273076.0
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE May 31, 2012
CHECKED BY SEMP

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			SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
241.2	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0							241				
							240				
							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
							227				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF DCPT No H1-DC8

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136028.9; E 273076.0 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE May 31, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
							226				
							225				
							224				
							223				
							222				
							221				
220.2											
21.0	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.30 m)										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED
20 40 60 80 100
PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L
WATER CONTENT (%) 20 40 60
UNIT WEIGHT γ kN/m^3
REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

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

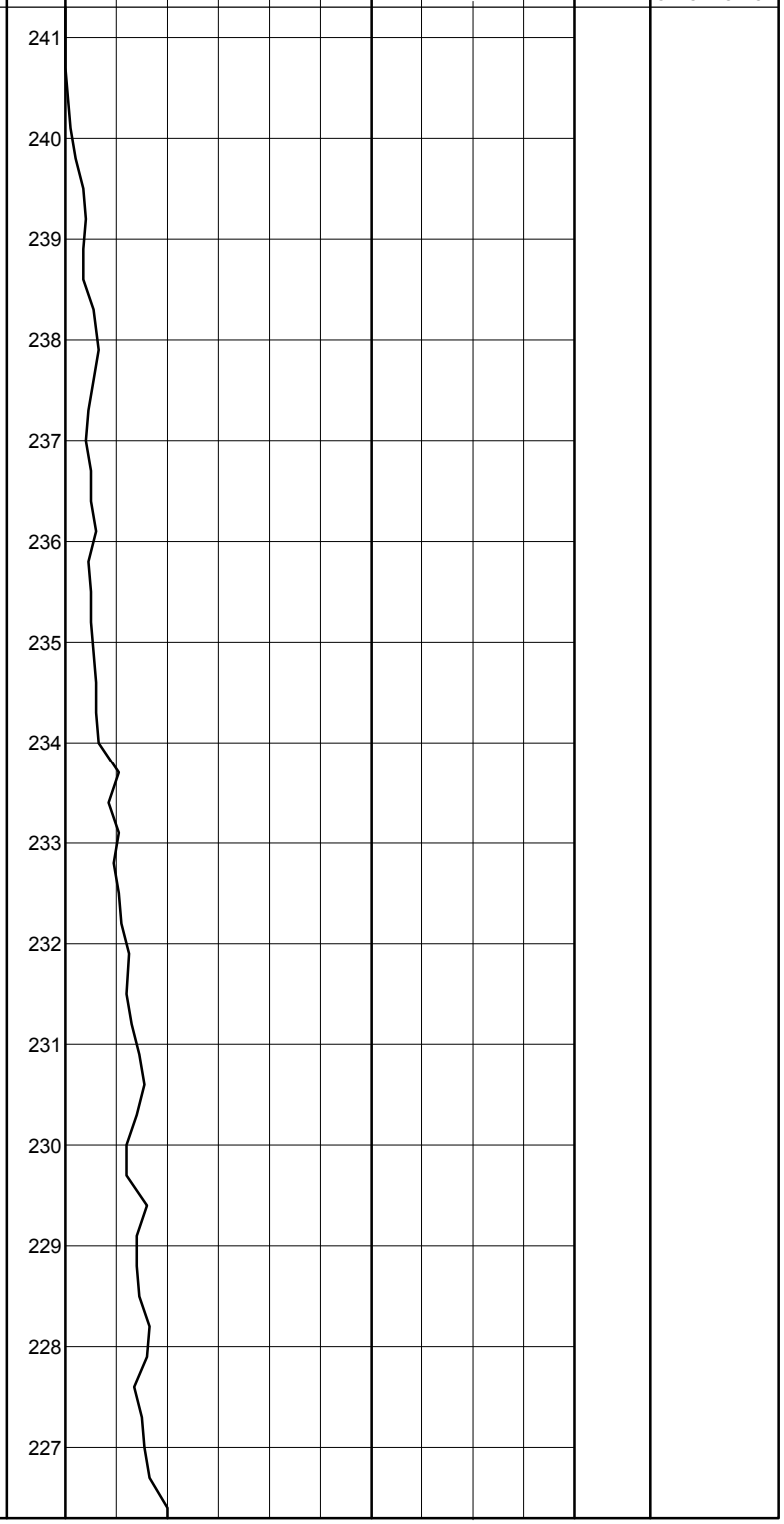
Golder Associates

RECORD OF DCPT No H1-DC9

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136056.1; E 273123.9
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE May 31, 2012
CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
241.3 / 0.0	GROUND SURFACE										



Continued Next Page

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

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

Golder Associates

RECORD OF DCPT No H1-DC9

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136056.1; E 273123.9 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE May 31, 2012 CHECKED BY SEMP

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			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
							226				
							225				
							224				
							223				
							222				
							221				
220.3											
21.0	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.30)										

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

Golder Associates

RECORD OF DCPT No H1-DC10

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136037.5; E 273175.7 ORIGINATED BY ID
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE October 23, 2012 CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m^3	GR SA SI CL
241.2	GROUND SURFACE										
0.0							241				
							240				
							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
							227				

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF DCPT No H1-DC10

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136037.5; E 273175.7 ORIGINATED BY ID
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE October 23, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100 ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L 20 40 60	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---						226				
							225				
224.4											
16.8	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF DCPT No H1-DC11

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136050.2; E 273281.8 ORIGINATED BY ID
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE October 22, 2012 CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
241.0	GROUND SURFACE										
0.0							240				
							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
230.2											
10.8	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF DCPT No H1-DC12

1 OF 1 **METRIC**

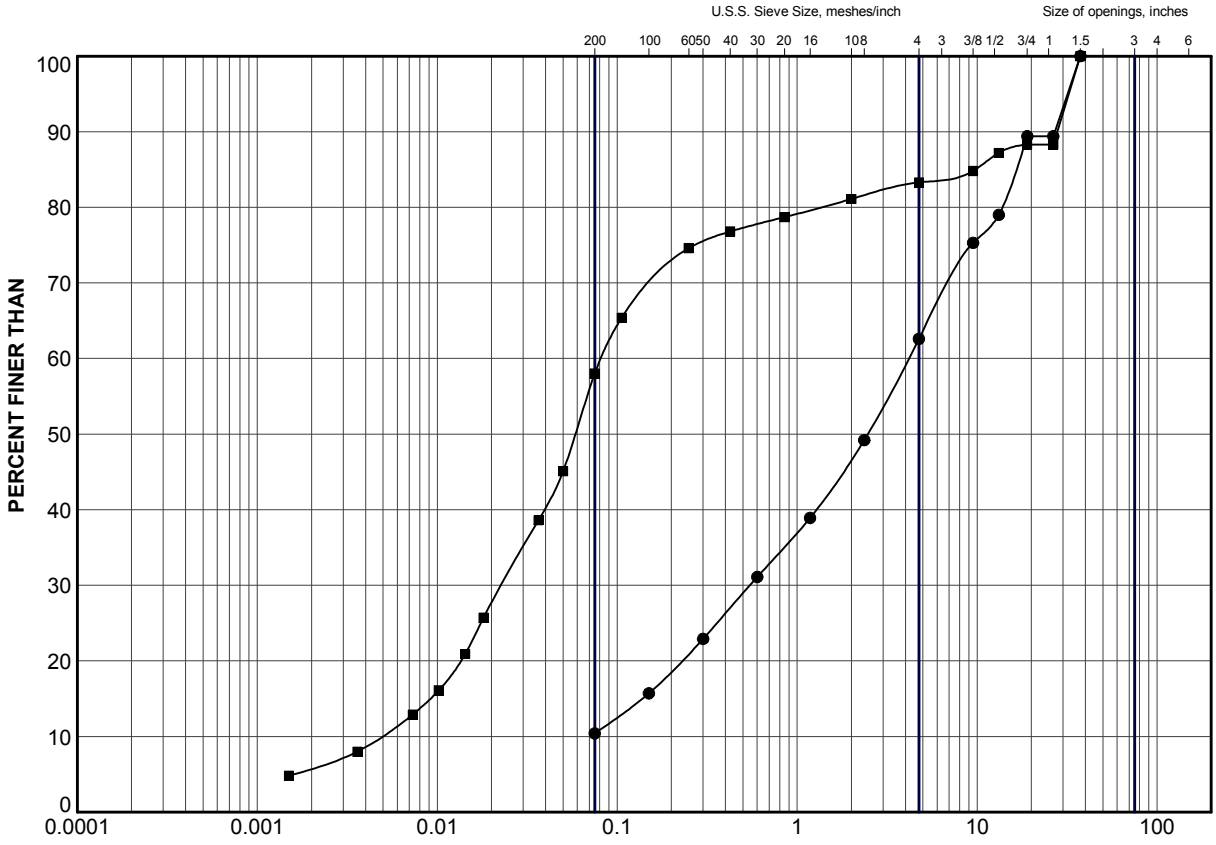
PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136081.2; E 273327.9 ORIGINATED BY GM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE April 26, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.2	GROUND SURFACE										
0.0							241				
							240				
							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
230.9							231				
10.3	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: 20 40 60 80 100
WATER CONTENT (%): 20 40 60

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H1-3	2	245.5
■	H1-8	4	242.4

PROJECT

HIGHWAY 17

TITLE

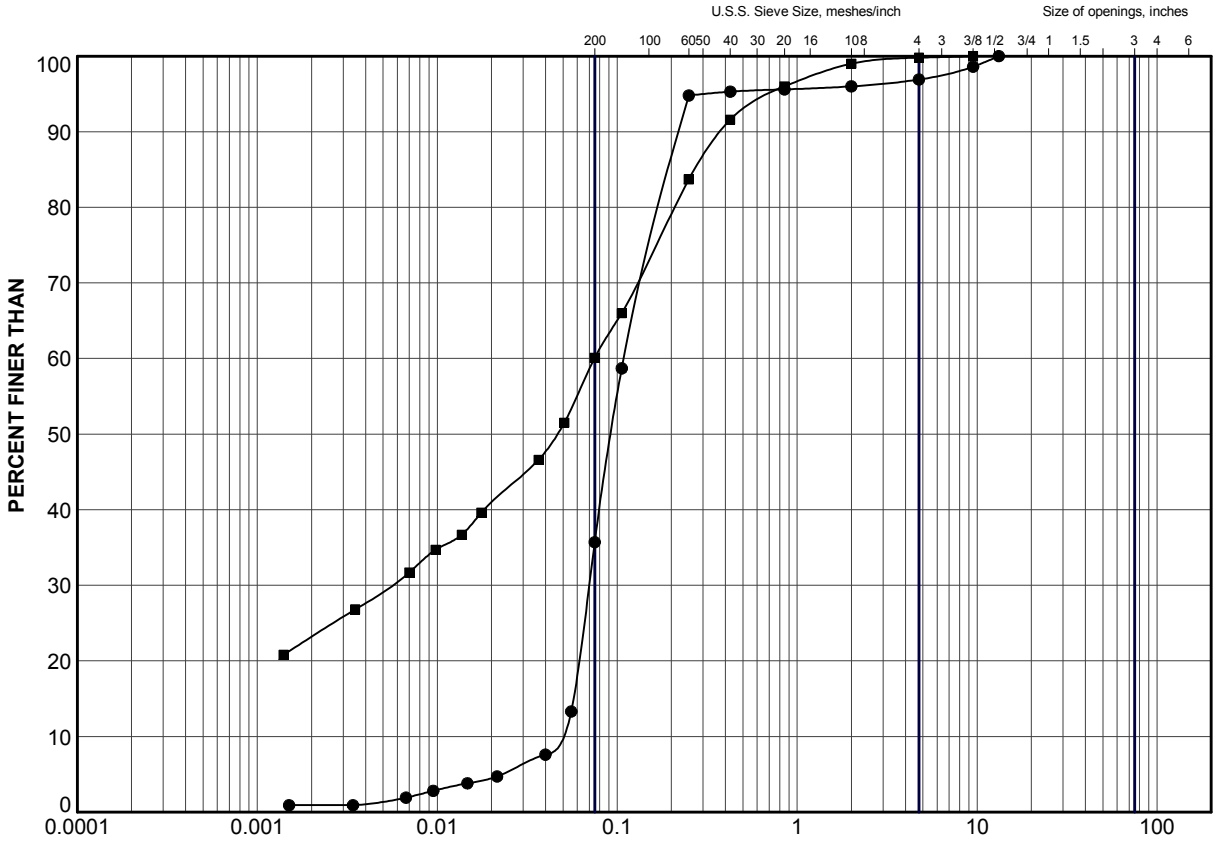
GRAIN SIZE DISTRIBUTION

SAND and GRAVEL to SANDY SILT (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	JJL	Jun 2015	SCALE N/A	REV.
CHECK	SEMP	Jun 2015		
APPR		Jun 2015	**FIGURE A1**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H1-3	7	241.3
■	H1-7	6	239.6

PROJECT

HIGHWAY 17

TITLE

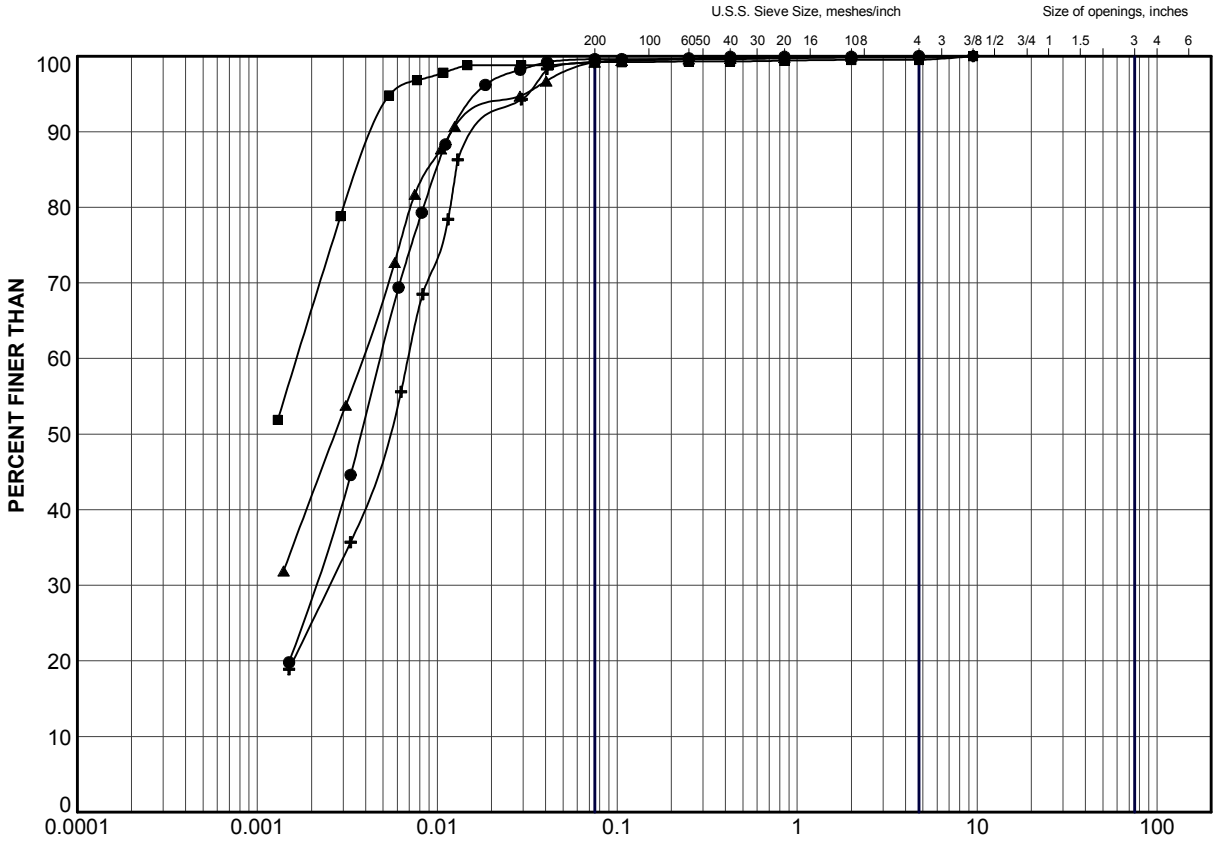
GRAIN SIZE DISTRIBUTION

SAND and SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	JJL	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE A2**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H1-7	10	233.5
■	H1-8	7	236.4
▲	H1-11	2	242.1
✚	H1-14	5	240.4

PROJECT

HIGHWAY 17

TITLE

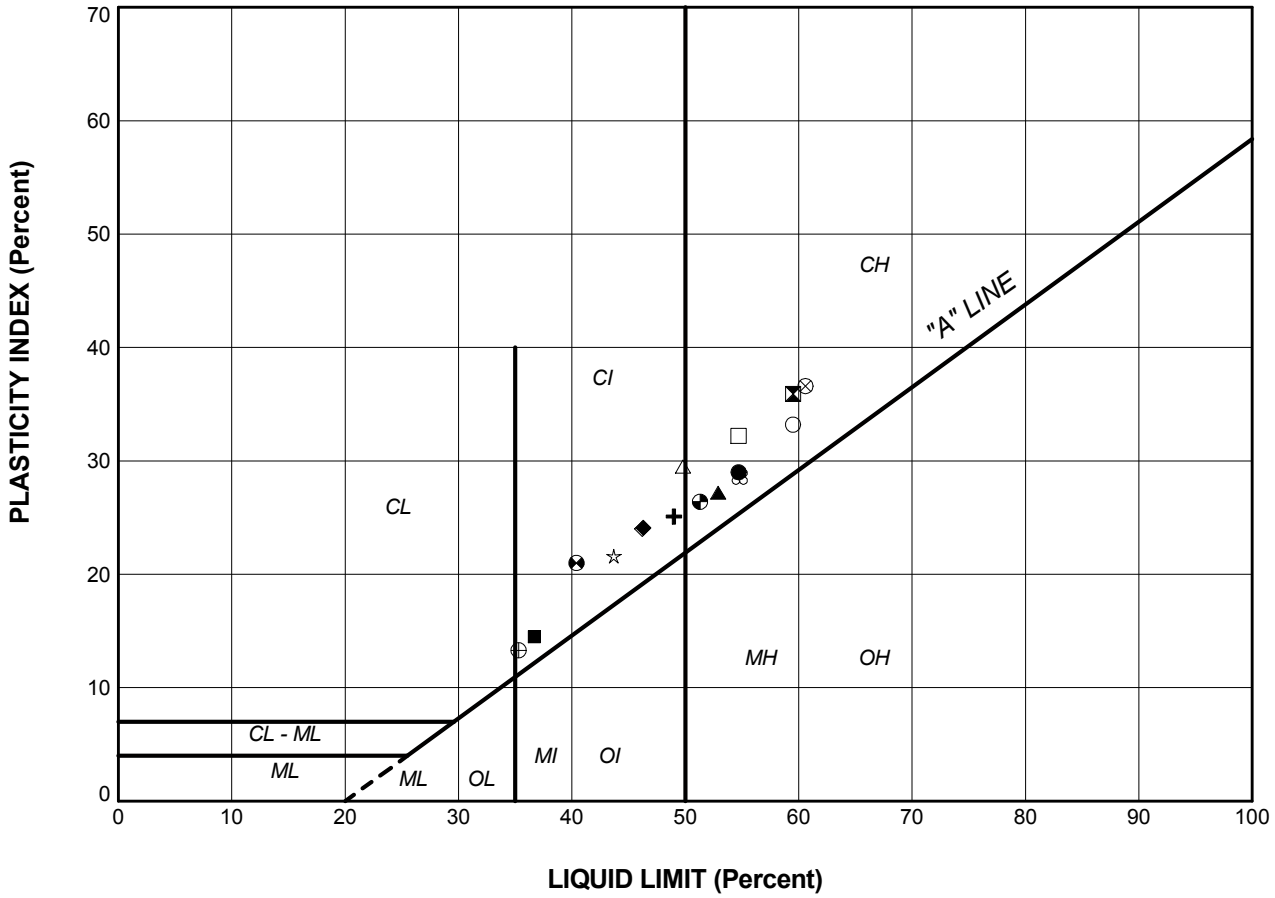
GRAIN SIZE DISTRIBUTION

SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	JJL	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE A3**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	C1-1	1	54.7	25.7	29.0
■	C1-1	5	36.7	22.2	14.5
▲	C1-2	2	52.9	25.7	27.2
✚	C1-2	5	49.0	23.9	25.1
◆	C1-3	2	46.3	22.2	24.1
◇	C1-3	5	46.2	22.2	24.0
○	H1-5	7	59.5	26.3	33.2
△	H1-6	4	49.8	20.3	29.5
⊗	H1-7	7	60.6	24.0	36.6
⊕	H1-7	10	35.3	22.0	13.3
□	H1-8	7	54.7	22.5	32.2
⊖	H1-9	4	40.4	19.4	21.0
◒	H1-9	6	51.3	24.9	26.4
☆	H1-13	3	43.7	22.1	21.6
⊠	H1-14	2	54.8	26.2	28.6
⧓	H1-15	3	59.5	23.6	35.9

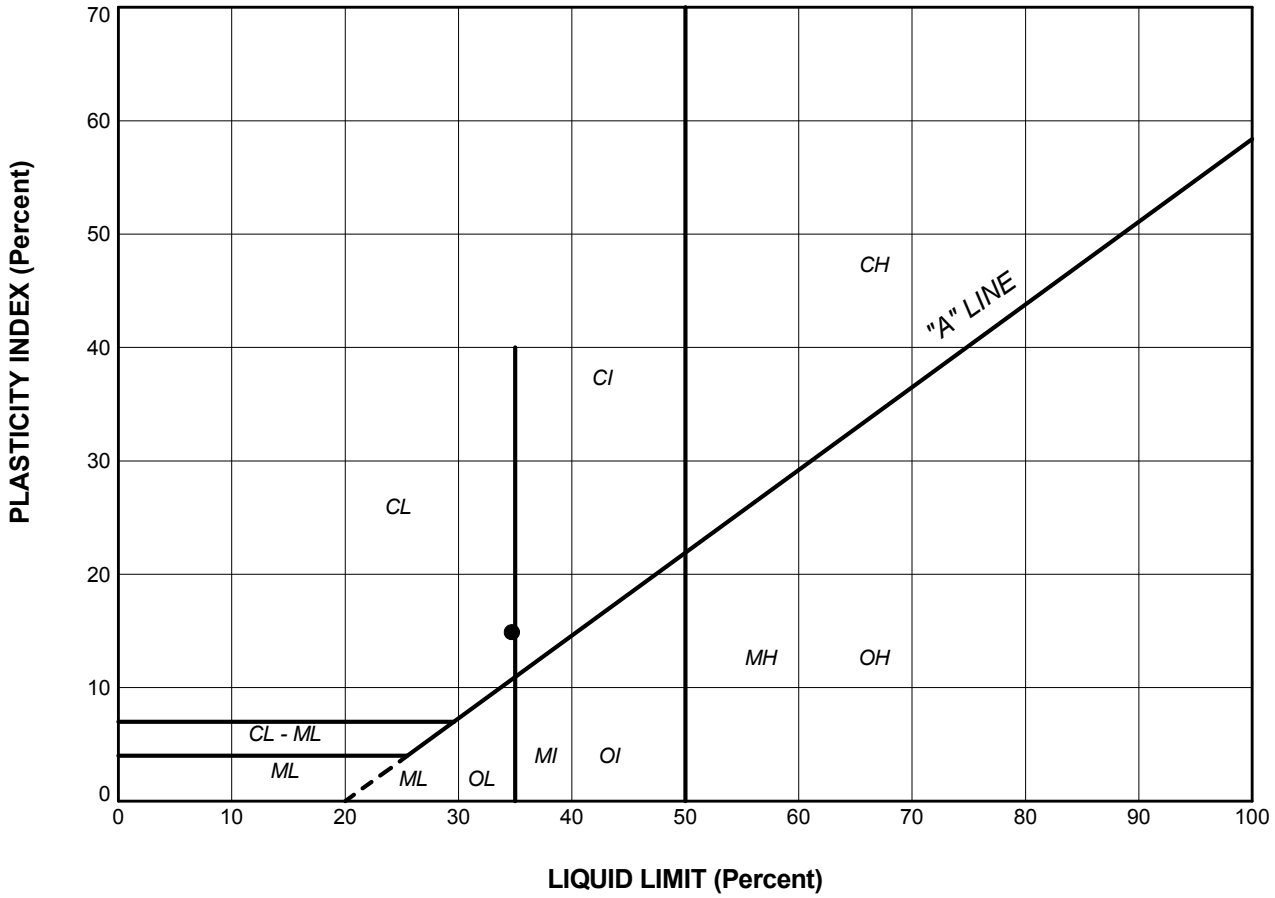
PROJECT
HIGHWAY 17

TITLE
PLASTICITY CHART
SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	JJL	Mar 2014	SCALE	N/A	REV.
CHECK	SEMP	Mar 2014			
APPR		Mar 2014	**FIGURE**	**A4**	

SUD-MTO PL (NEW) 25 GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H1-6	7	34.7	19.8	14.9

PROJECT

HIGHWAY 17

TITLE

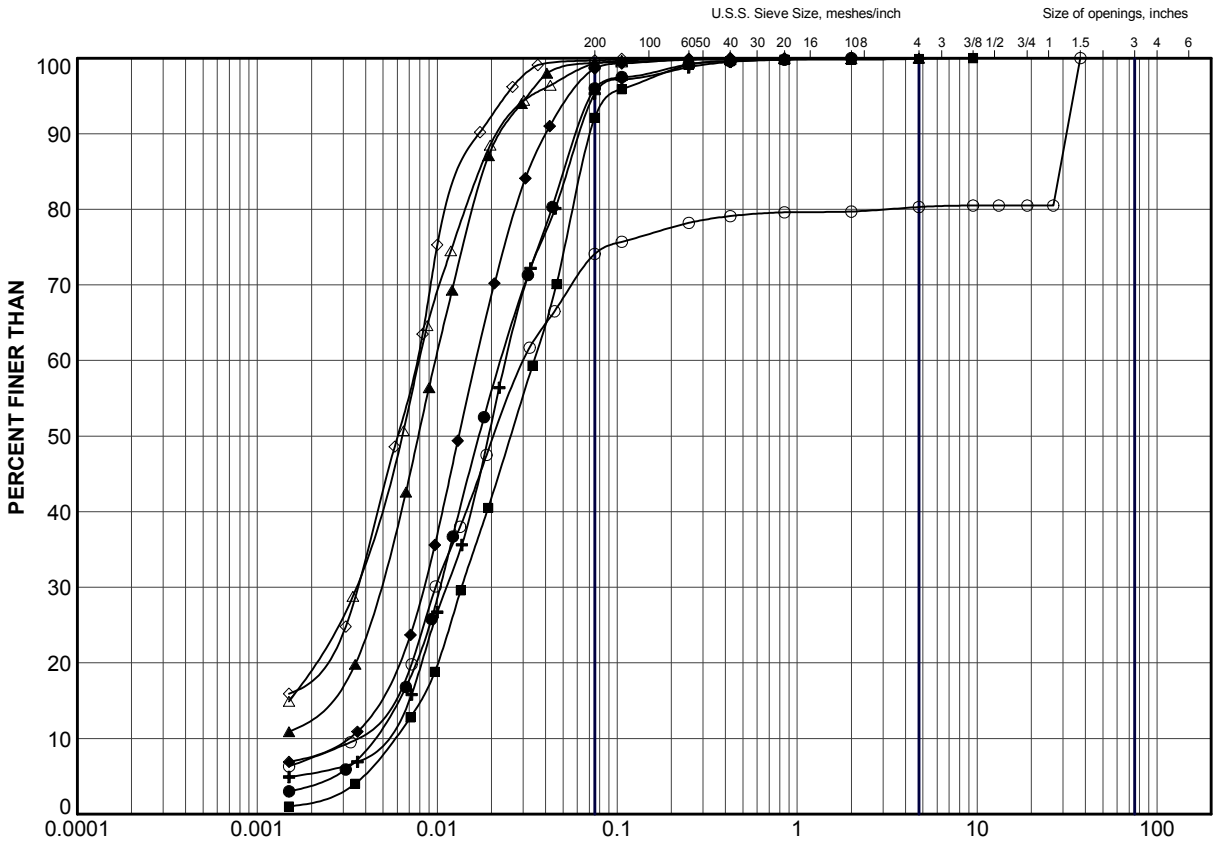
PLASTICITY CHART

CLAYEY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	JJL	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE A5**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C1-1	8	233.8
■	C1-2	7	235.8
▲	H1-5	9	232.3
✚	H1-7	12	230.5
◆	H1-8	10	231.8
◇	H1-9	8	233.3
○	H1-11	5	239.8
△	H1-12	5	240.0

PROJECT

HIGHWAY 17

TITLE

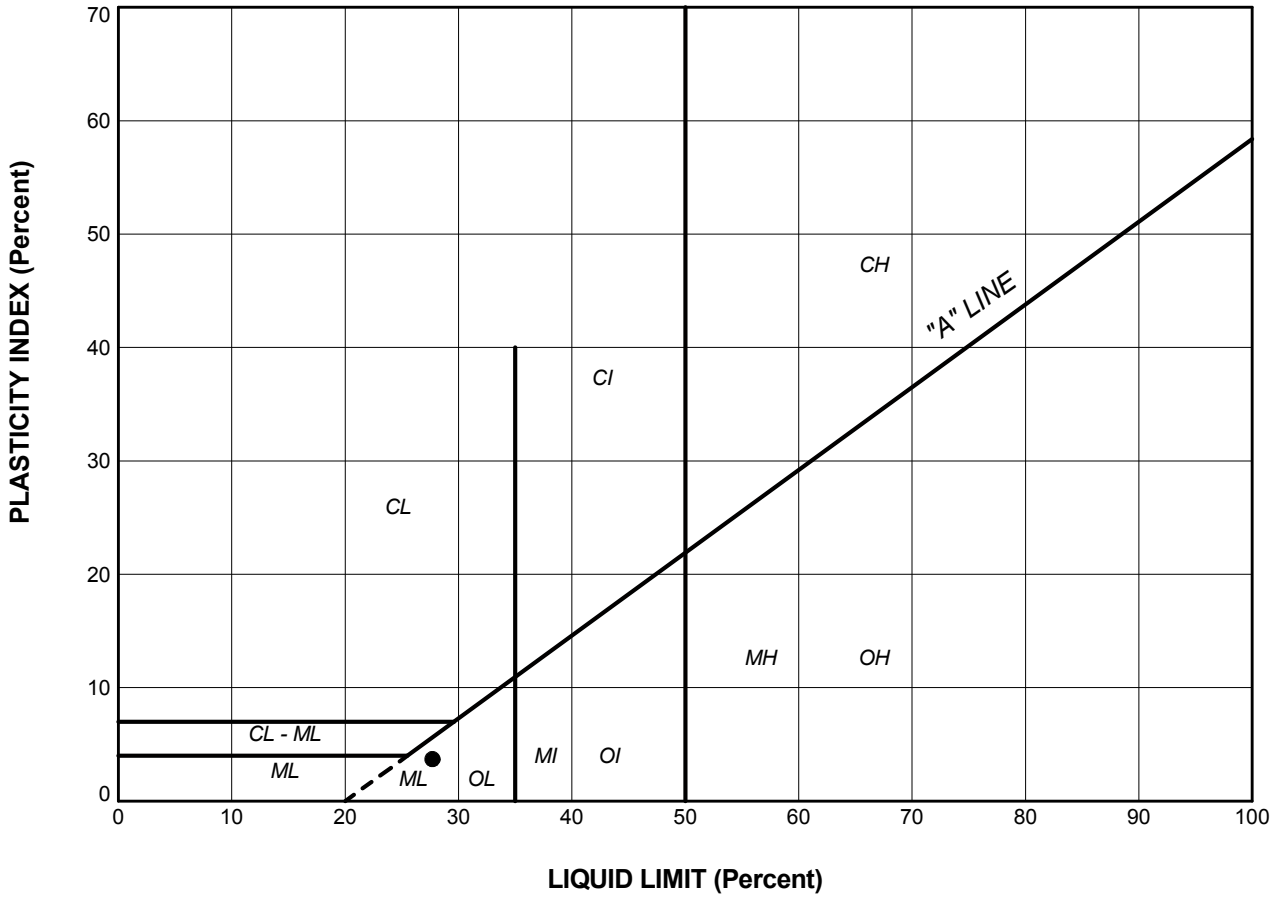
GRAIN SIZE DISTRIBUTION

SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	JJL	Mar 2014	SCALE	N/A	REV.
CHECK	SEMP	Mar 2014			
APPR		Mar 2014	**FIGURE A6**		

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H1-5	9	27.7	24.0	3.7

PROJECT

HIGHWAY 17

TITLE

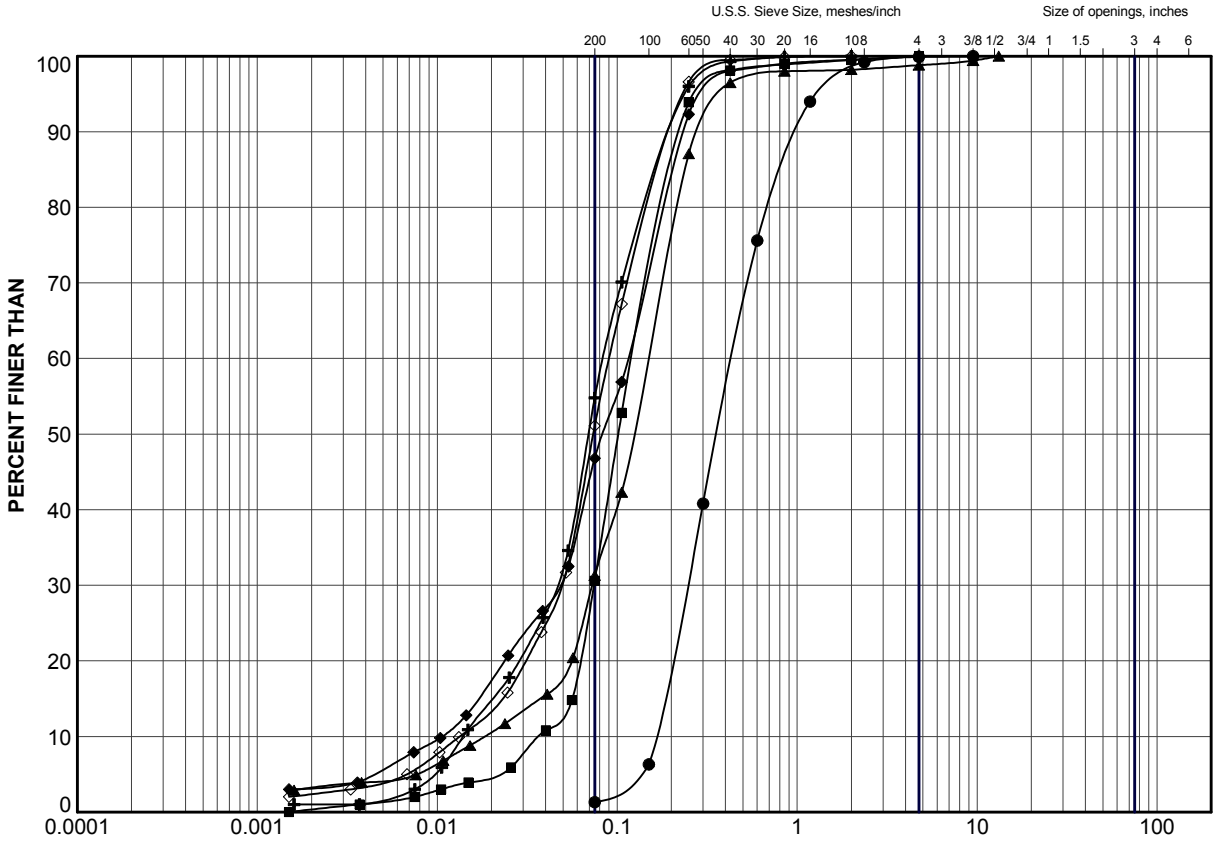
PLASTICITY CHART

SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	JJL	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE A7**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C1-3	9	232.1
■	H1-5	12	227.7
▲	H1-6	12	225.8
✚	H1-7	14	227.4
◆	H1-8	13	227.2
◇	H1-9	10	230.3

PROJECT

HIGHWAY 17

TITLE

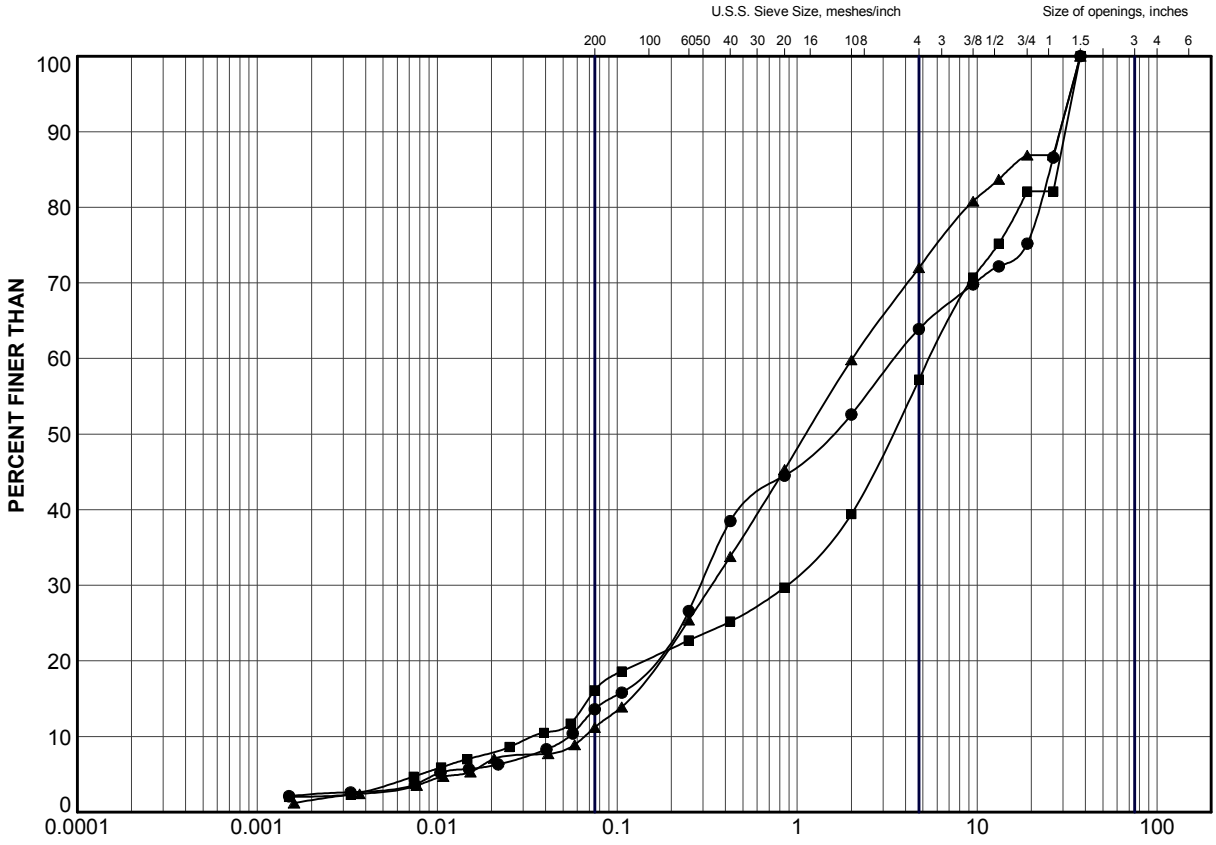
GRAIN SIZE DISTRIBUTION

SAND and SILT to SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	JJL	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE A8**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H1-11	8	236.8
■	H1-13	7	236.8
▲	H1-15	8	236.7

PROJECT

HIGHWAY 17

TITLE

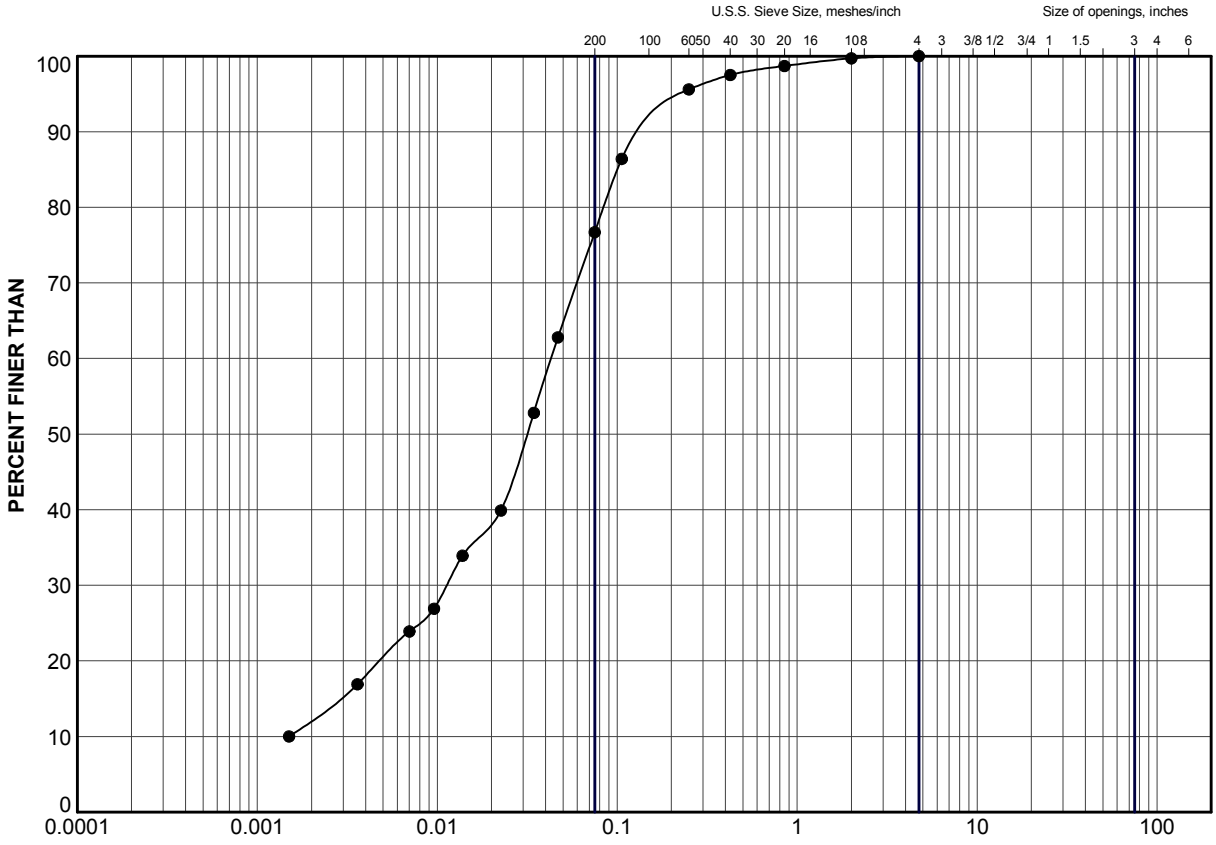
GRAIN SIZE DISTRIBUTION

SAND to SAND and GRAVEL

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	JJL	Mar 2014	SCALE	N/A	REV.
CHECK	SEMP	Mar 2014			
APPR		Mar 2014	**FIGURE A9**		

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H1-18	2b	240.2

PROJECT

HIGHWAY 17

TITLE

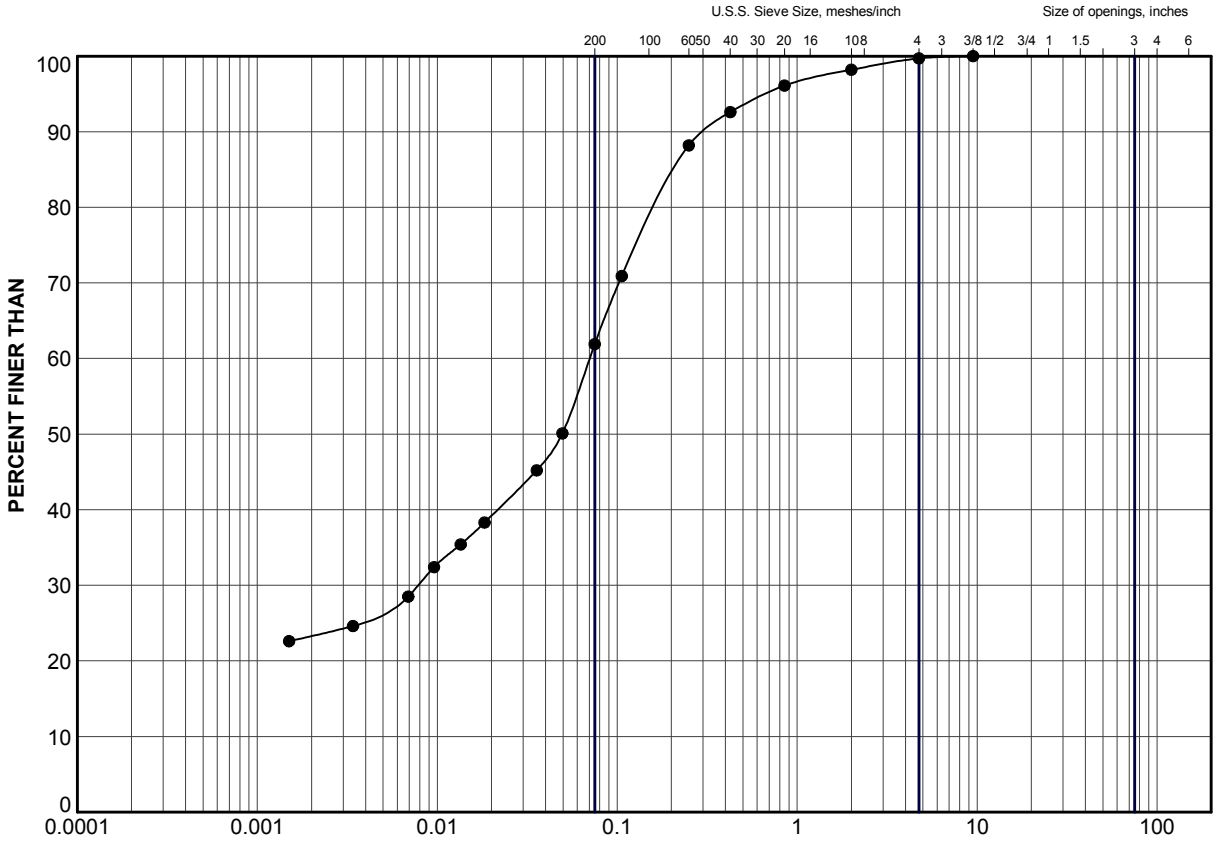
GRAIN SIZE DISTRIBUTION

SANDY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	JJL	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE A10**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H1-23	3	239.5

PROJECT

HIGHWAY 17

TITLE

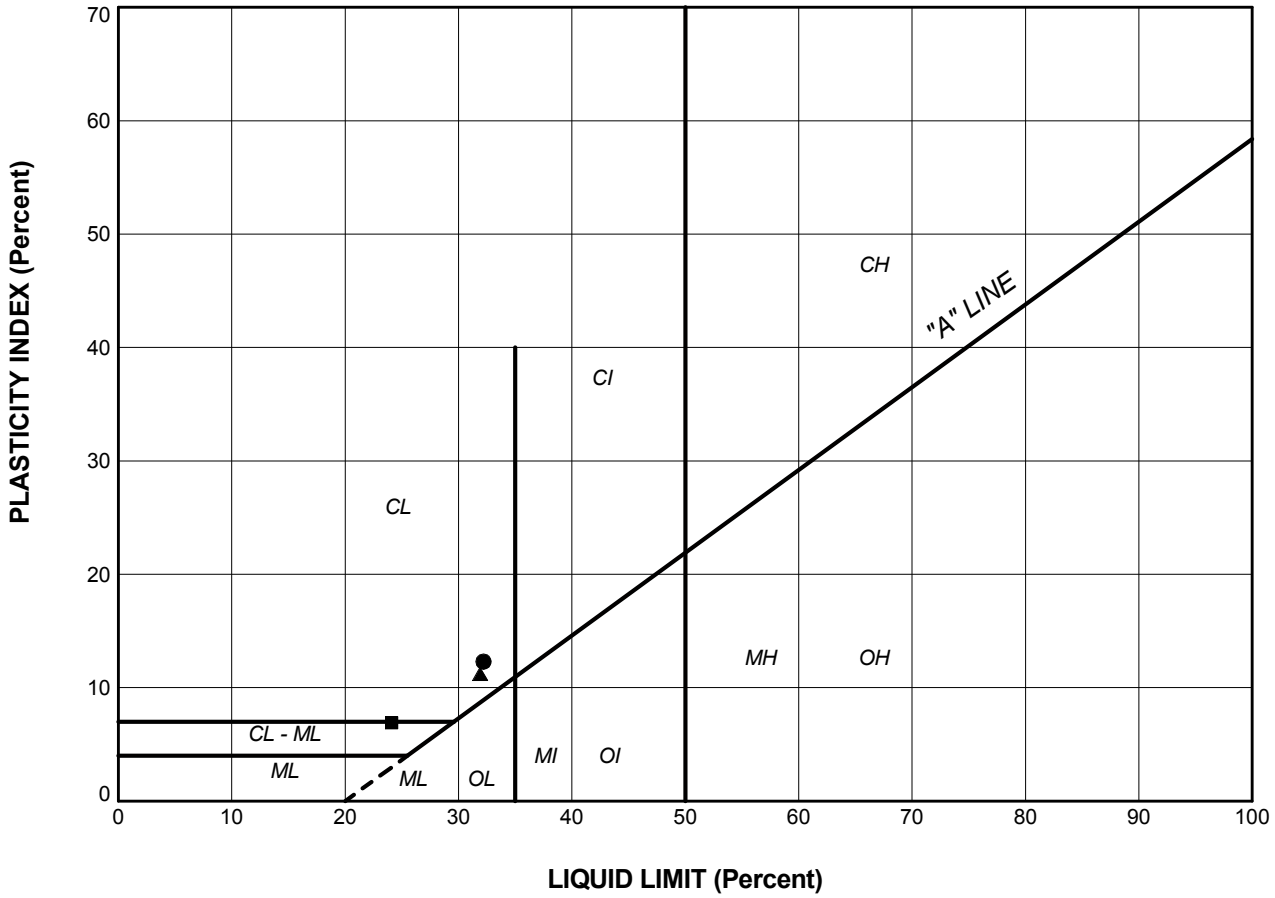
GRAIN SIZE DISTRIBUTION

CLAYEY SILT to SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	JJL	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE A11**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H1-17	2B	32.2	19.9	12.3
■	H1-23	3	24.1	17.2	6.9
▲	H1-25	3	31.9	20.7	11.2

PROJECT

HIGHWAY 17

TITLE

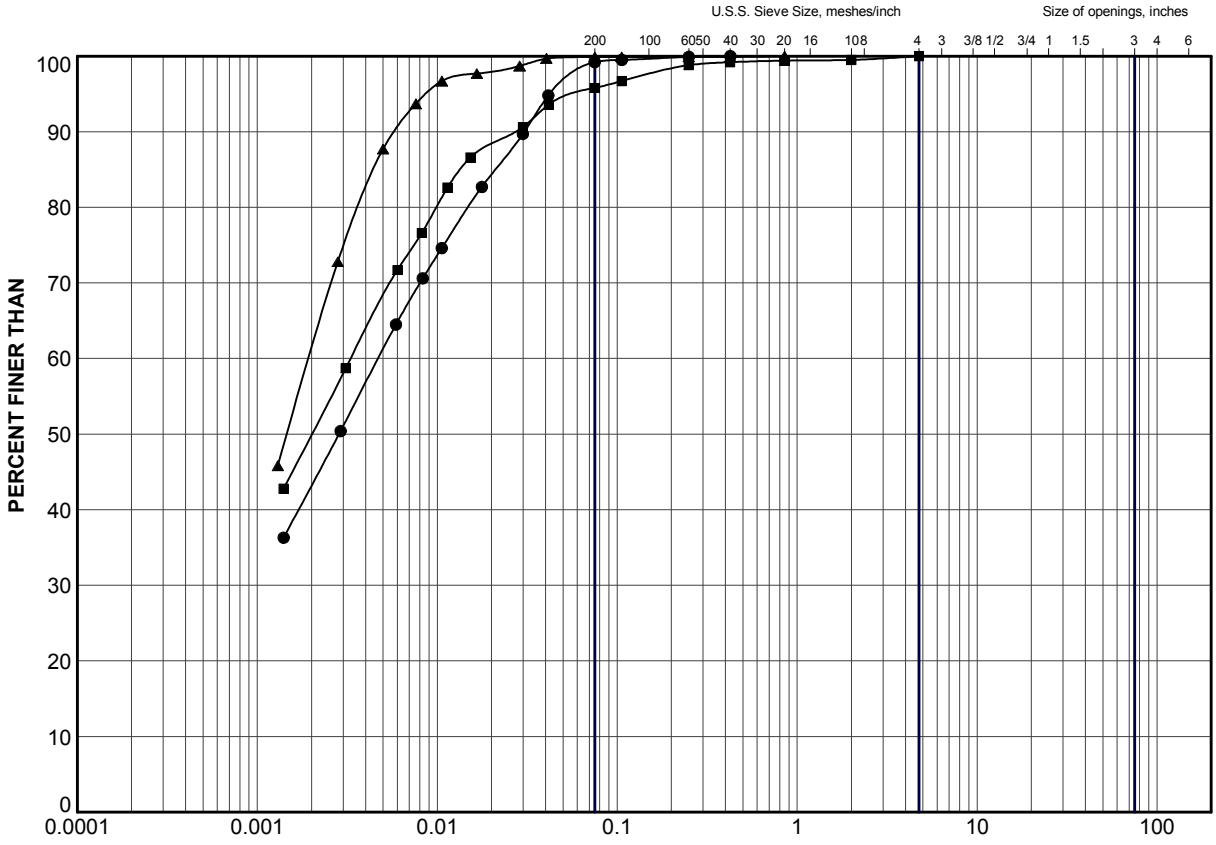
PLASTICITY CHART

CLAYEY SILT to SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	JJL	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE A12**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C1-3	2	240.4
■	H1-20	5	237.2
▲	H1-25	7	236.4

PROJECT

HIGHWAY 17

TITLE

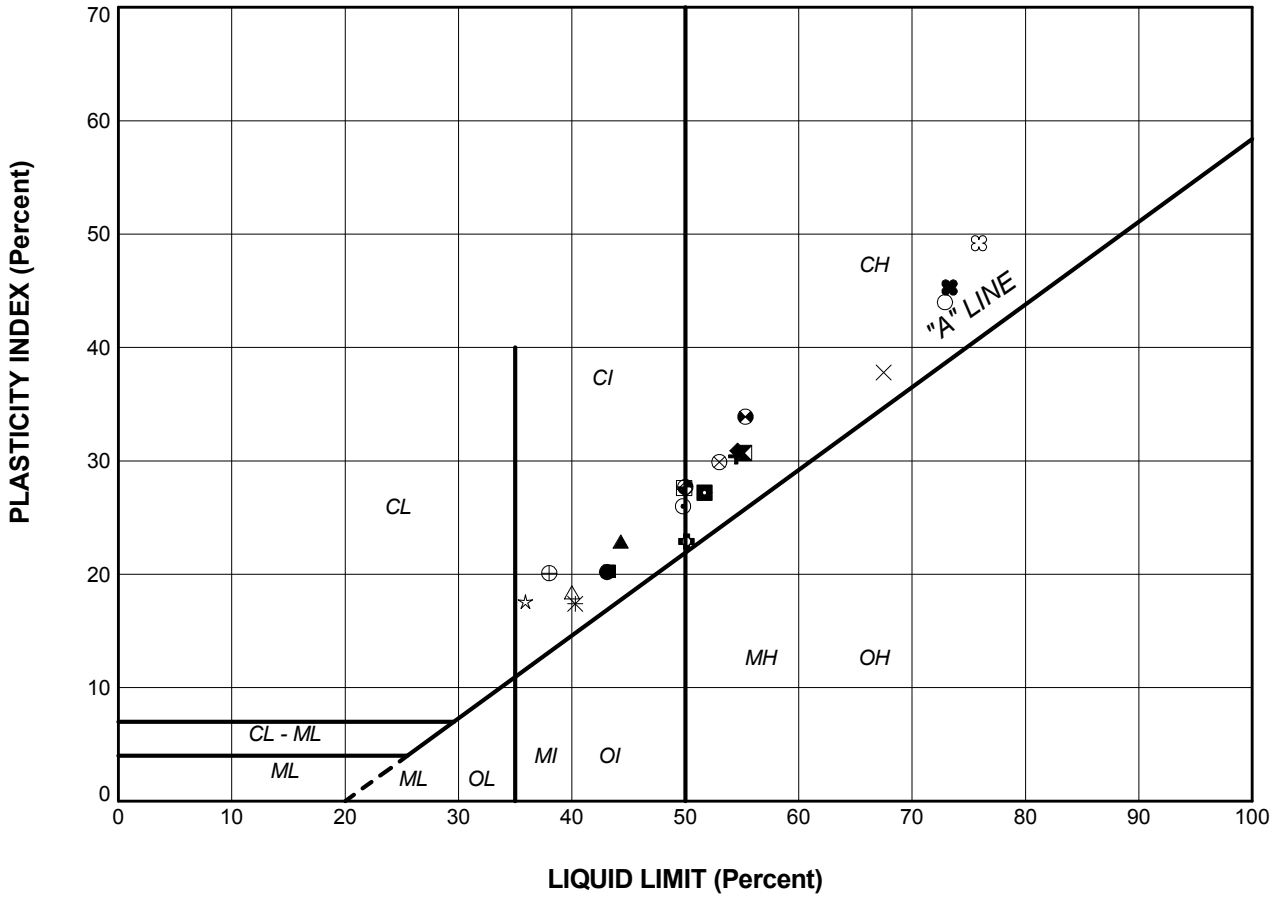
GRAIN SIZE DISTRIBUTION

SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	JJL	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE A13**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	C1-4	2	43.1	22.9	20.2
■	C1-4	6	43.3	23.0	20.3
▲	H1-16	2	44.3	21.4	22.9
✚	H1-17	6A	54.5	24.1	30.4
◆	H1-18	6	54.6	23.7	30.9
◇	H1-19	5	50.0	22.5	27.5
○	H1-19	6	72.9	28.9	44.0
△	H1-20	4B	40.0	21.6	18.4
⊗	H1-21	5	53.0	23.1	29.9
⊕	H1-22	5	38.0	17.9	20.1
□	H1-22	8	49.9	22.3	27.6
⊖	H1-23	5	55.3	21.4	33.9
◒	H1-24	3	50.0	22.3	27.7
☆	H1-24	5	35.9	18.3	17.6
⊠	H1-24	7	75.9	26.7	49.2
⊠	H1-25	7	55.2	24.5	30.7
⊙	H1-25	8	49.8	23.8	26.0
✿	H1-26	2	50.1	27.2	22.9
×	H1-27	2	67.5	29.7	37.8
✱	H1-28	3	73.3	28.0	45.3
⊡	H1-29	3	51.7	24.5	27.2
✳	H1-30	2	40.3	22.9	17.4

PROJECT
HIGHWAY 17

TITLE
PLASTICITY CHART
SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	JJL	Mar 2014	SCALE	N/A	REV.
CHECK	SEMP	Mar 2014			
APPR		Mar 2014	**FIGURE A14**		

SUD-MTO PL (NEW) 25 GLDR_LDN.GDT

CONSOLIDATION TEST SUMMARY

FIGURE A15

SAMPLE IDENTIFICATION

Project Number:	11-1191-0007	Sample Number:	6
Borehole Number:	H1-19	Sample Depth, m:	4.9

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	2		
Date Started	8/16/12		
Date Completed	8/31/12		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.526	Unit Weight, kN/m^3	16.27
Sample Diameter, cm	6.351	Dry Unit Weight, kN/m^3	9.49
Area, cm^2	31.68	Specific Gravity, Measured	2.77
Volume, cm^3	80.02	Solids Height, cm	0.884
Water Content, %	71.33	Volume of Solids, cm^3	28.02
Wet Mass, g	132.73	Volume of Voids, cm^3	52.00
Dry Mass, g	77.47	Degree of Saturation, %	106.3

TEST COMPUTATIONS

Pressure	Primary	Corr. Height	Void	Average Height	t_{90}	cv.	mv	k	Total Work
kPa	Consolidation	cm	Ratio	cm	sec	cm^2/s	m^2/kN	cm/s	kJ/m3
0	0	2.526	1.856	2.526					
4	0.04	2.522	1.852	2.524	86	0.0156	3.59E-04	5.51E-07	0.003
13	0.03	2.519	1.848	2.521	60	0.0224	1.33E-04	2.93E-07	0.013
31	0.06	2.513	1.842	2.516	101	0.0132	1.31E-04	1.70E-07	0.065
66	0.09	2.504	1.831	2.509	135	0.0099	1.06E-04	1.03E-07	0.248
137	0.19	2.485	1.810	2.494	240	0.0055	1.05E-04	5.67E-08	1.005
277	0.58	2.427	1.744	2.456	577	0.0022	1.64E-04	3.57E-08	5.859
558	2.81	2.146	1.427	2.287	3840	0.0003	3.96E-04	1.12E-08	54.116
1117	1.60	1.987	1.246	2.067	2774	0.0003	1.13E-04	3.61E-09	116.364
558	-0.12	1.999	1.260	1.993					
137	-0.50	2.049	1.316	2.024					
31	-0.61	2.109	1.385	2.079					
4	-0.50	2.159	1.442	2.134					

Note:
k calculated using c_v based on t_{90} values.

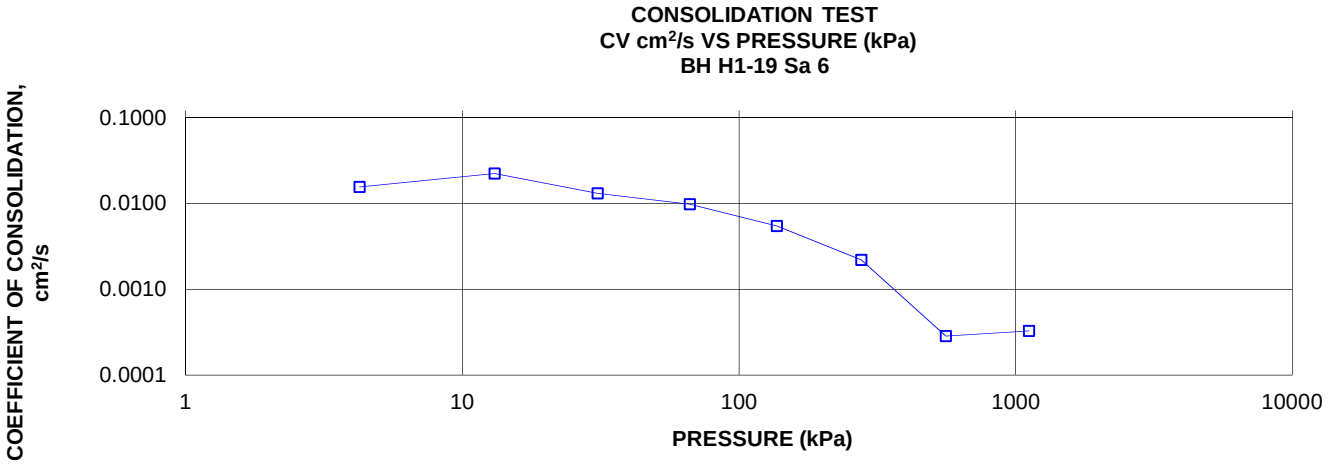
SAMPLE DIMENSIONS AND PROPERTIES - FINAL

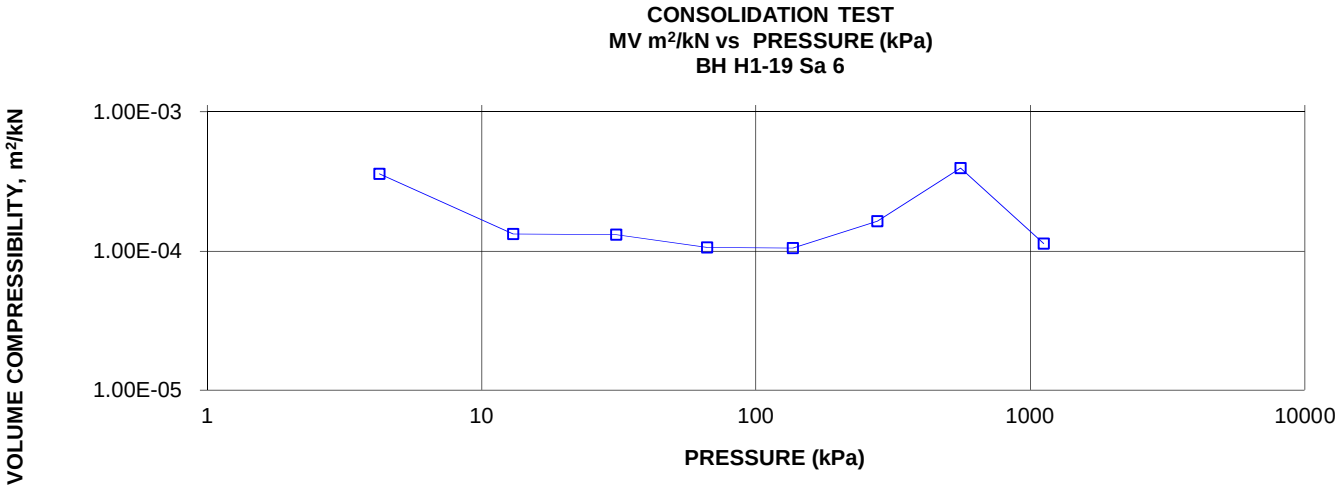
Sample Height, cm	2.159	Unit Weight, kN/m^3	16.19
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	11.11
Area, cm^2	31.68	Specific Gravity, Measured	2.77
Volume, cm^3	68.41	Solids Height, cm	0.884
Water Content, %	45.79	Volume of Solids, cm^3	28.02
Wet Mass, g	112.94	Volume of Voids, cm^3	40.39
Dry Mass, g	77.47		

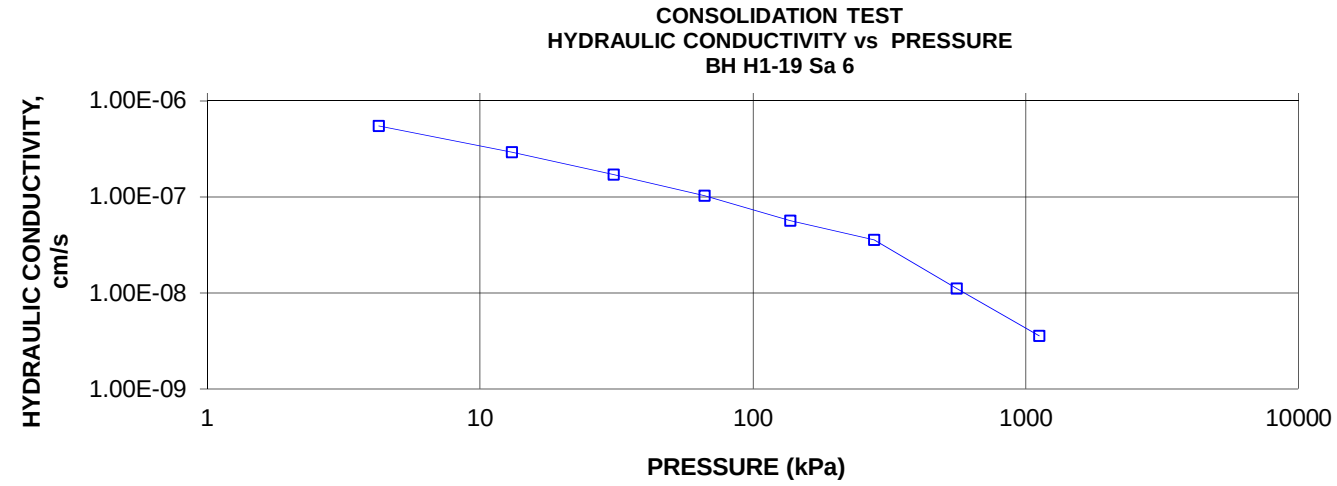
Prepared By: TG

Golder Associates

Checked By:

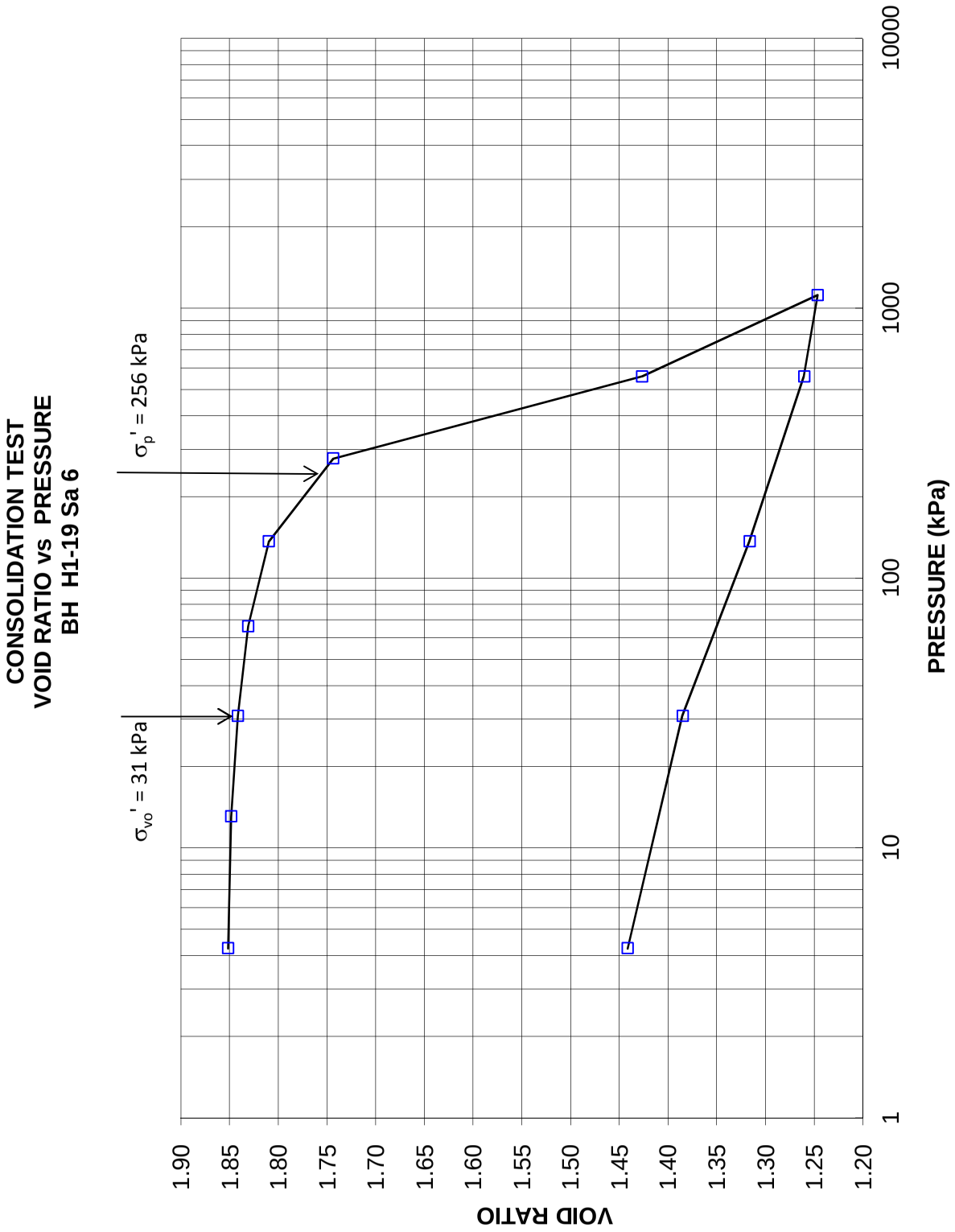

CONSOLIDATION TEST
CV cm²/s VS PRESSURE (kPa)
BH H1-19 Sa 6
COEFFICIENT OF CONSOLIDATION, cm²/s
0.1000
0.0100
0.0010
0.0001
1
10
100
1000
10000
PRESSURE (kPa)


CONSOLIDATION TEST
MV m²/kN vs PRESSURE (kPa)
BH H1-19 Sa 6
VOLUME COMPRESSIBILITY, m²/kN
1.00E-03
1.00E-04
1.00E-05
1
10
100
1000
10000
PRESSURE (kPa)


CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH H1-19 Sa 6
HYDRAULIC CONDUCTIVITY, cm/s
1.00E-06
1.00E-07
1.00E-08
1.00E-09
1
10
100
1000
10000
PRESSURE (kPa)

CONSOLIDATION TEST
VOID RATIO VS LOG PRESSURE

FIGURE A15
Pg. 3 of 4



Project No. 11-1191-0007

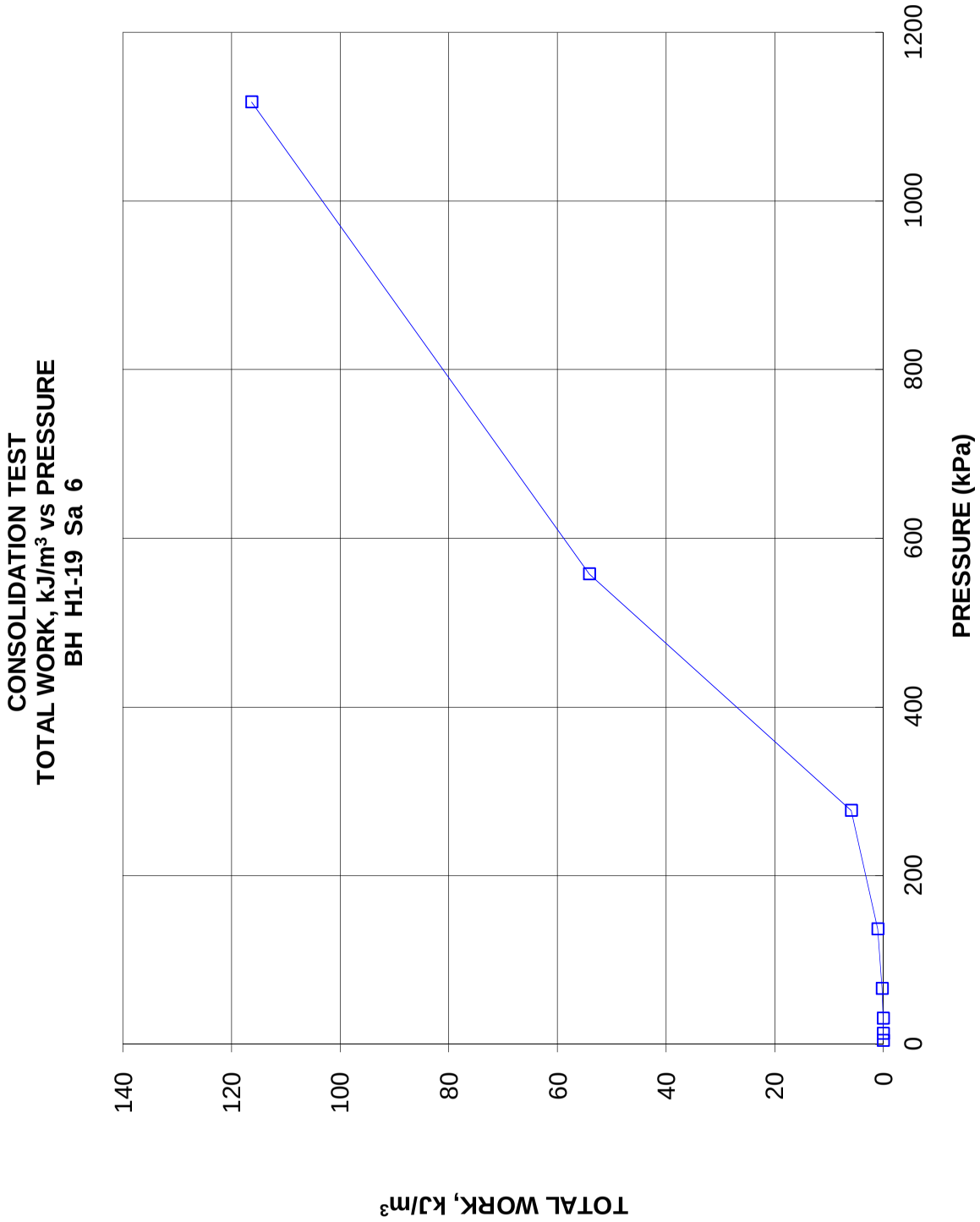
Prepared By TG

Golder Associates

Checked By:

CONSOLIDATION TEST
TOTAL WORK VS PRESSURE

FIGURE A15
Pg. 4 of 4



Project No: 11-1191-0007

Prepared By: TG

Golder Associates

Checked By:

CONSOLIDATION TEST SUMMARY

FIGURE A16

SAMPLE IDENTIFICATION

Project Number	11-1191-0007	Sample Number	8
Borehole Number	H1-25	Sample Depth, m	6.55

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	1		
Date Started	January 10, 2013		
Date Completed	January 24, 2013		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.544	Unit Weight, kN/m^3	16.85
Sample Diameter, cm	6.353	Dry Unit Weight, kN/m^3	10.83
Area, cm^2	31.70	Specific Gravity, measured	2.78
Volume, cm^3	80.64	Solids Height, cm	1.011
Water Content, %	55.54	Volume of Solids, cm^3	32.06
Wet Mass, g	138.52	Volume of Voids, cm^3	48.58
Dry Mass, g	89.06		

TEST COMPUTATIONS

Pressure	Primary	Corr. Height	Void	Average Height	t_{90}	cv.	mv	k	Total Work
kPa	Consolidation	cm	Ratio	cm	sec	cm^2/s	m^2/kN	cm/s	kJ/m3
0	0.00	2.544	1.515	2.544					
9	0.04	2.540	1.512	2.542	135	0.0101	1.65E-04	1.64E-07	0.007
18	0.03	2.537	1.508	2.538	118	0.0116	1.45E-04	1.65E-07	0.024
35	0.06	2.531	1.503	2.534	101	0.0134	1.36E-04	1.78E-07	0.086
69	0.12	2.519	1.490	2.525	135	0.0100	1.41E-04	1.38E-07	0.337
143	0.25	2.493	1.465	2.506	217	0.0061	1.35E-04	8.16E-08	1.401
285	2.01	2.292	1.266	2.393	866	0.0014	5.56E-04	7.63E-08	18.660
570	1.10	2.182	1.158	2.237	505	0.0021	1.51E-04	3.12E-08	39.187
1140	0.83	2.099	1.076	2.141	173	0.0056	5.70E-05	3.13E-08	71.517
570	-0.01	2.100	1.077	2.100					
143	-0.22	2.122	1.099	2.111					
35	-0.29	2.151	1.127	2.137					
9	-0.27	2.178	1.154	2.165					

Note:
k calculated using c_v based on t_{90} values.

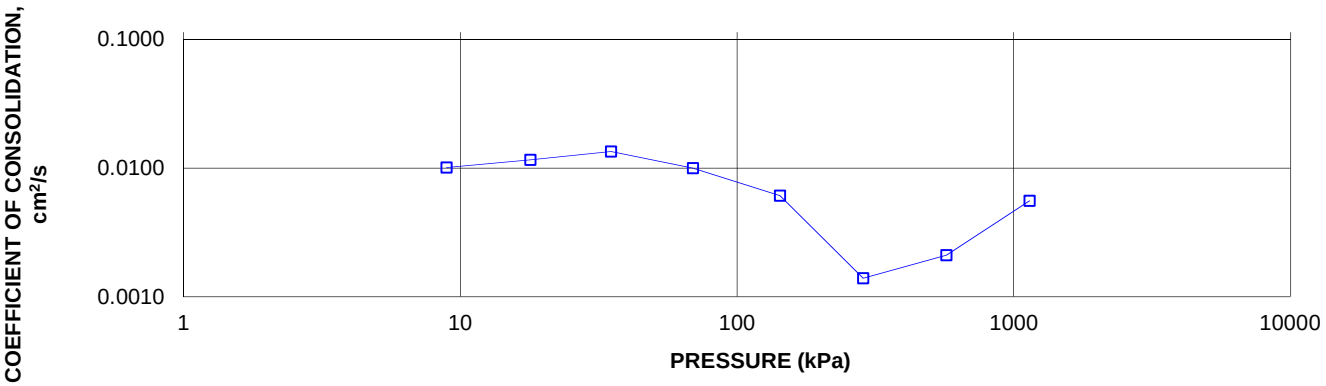
SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	2.178	Unit Weight, kN/m^3	17.14
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	12.65
Area, cm^2	31.70	Specific Gravity, measured	2.78
Volume, cm^3	69.06	Solids Height, cm	1.011
Water Content, %	35.52	Volume of Solids, cm^3	32.06
Wet Mass, g	120.69	Volume of Voids, cm^3	37.00
Dry Mass, g	89.06		

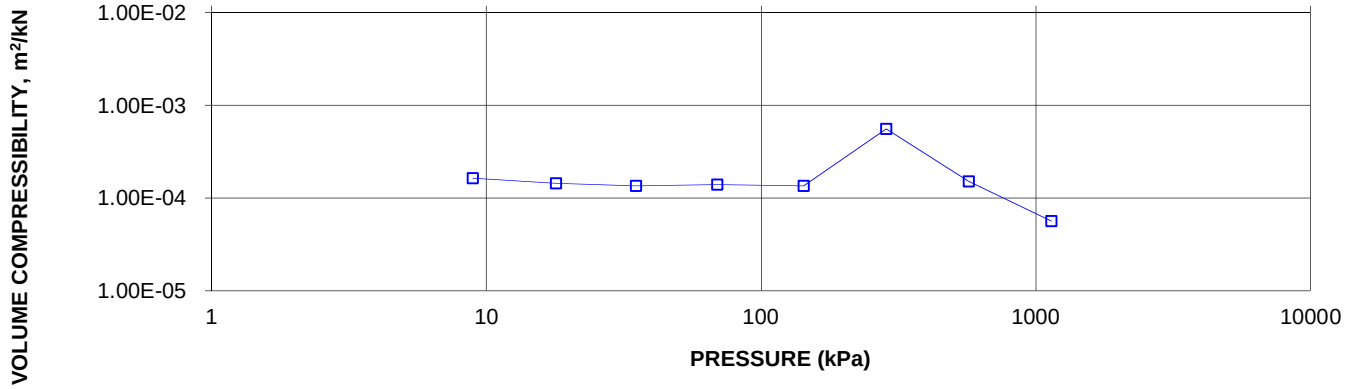
CONSOLIDATION TEST SUMMARY

FIGURE A16
Pg. 2 of 4

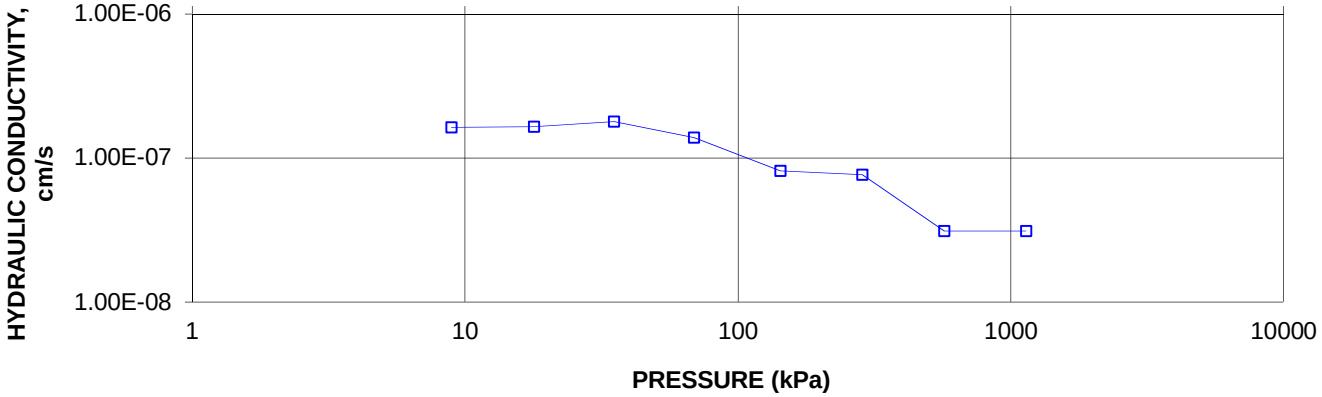
CONSOLIDATION TEST
CV cm²/s VS PRESSURE (kPa)
BH H1-25 Sa 8



CONSOLIDATION TEST
MV m²/kN vs PRESSURE (kPa)
BH H1-25 Sa 8



CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH H1-25 Sa 8



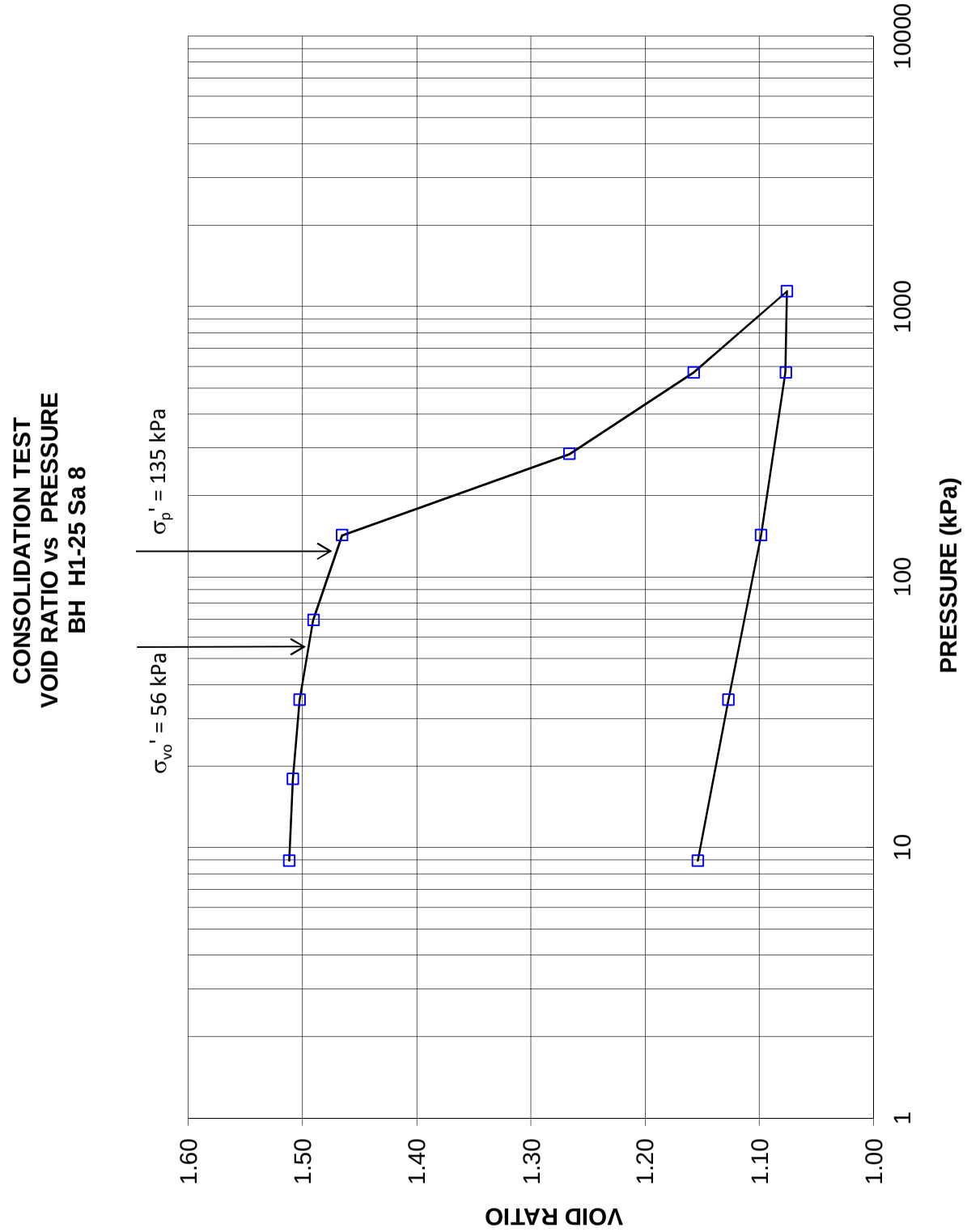
Project No. 11-1191-0007
Prepared By: TG

Golder Associates

Checked By:

CONSOLIDATION TEST
VOID RATIO VS LOG PRESSURE

FIGURE A16
Pg. 3 of 4



Project No. 11-1191-0007

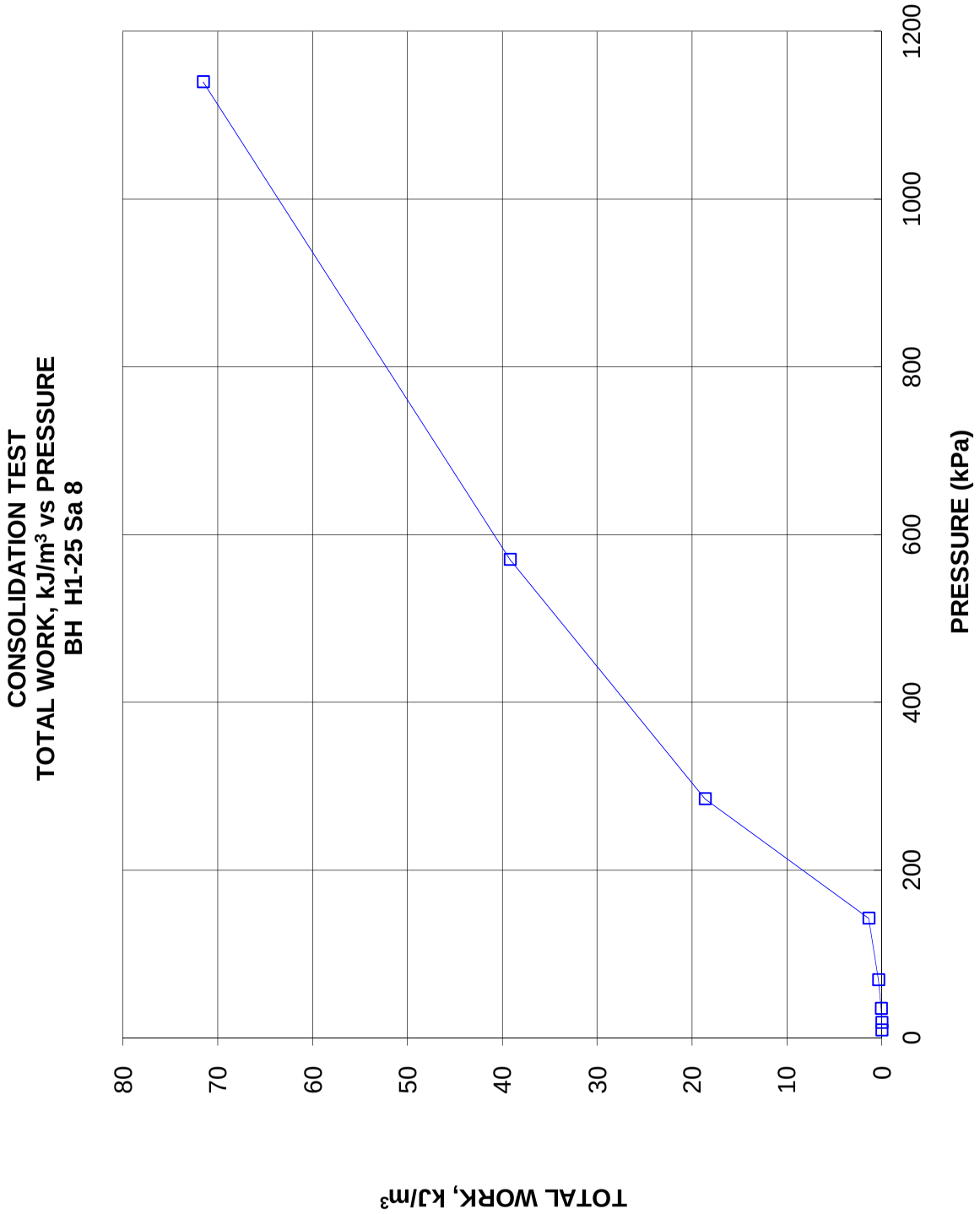
Prepared By: TG

Golder Associates

Checked

CONSOLIDATION TEST
TOTAL WORK VS PRESSURE

FIGURE A 16
Pg. 4 of 4

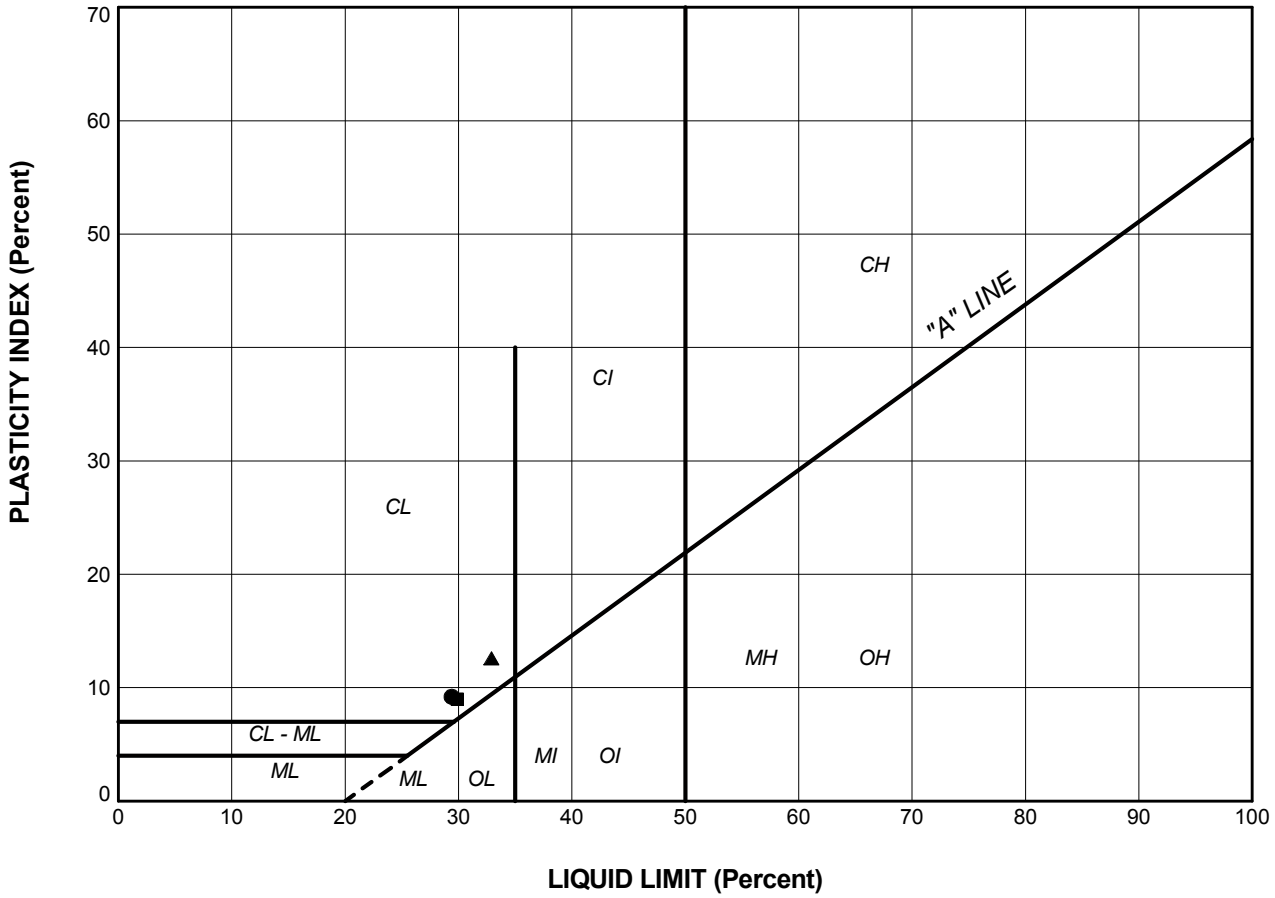


Project No: 11-1191-0007

Prepared By: TG

Golder Associates

Checked By:



LIQUID LIMIT (Percent)

SOIL TYPE	**PLASTICITY**
C = Clay	L = Low
M = Silt	I = Intermediate
O = Organic	H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H1-19	9B	29.4	20.2	9.2
■	H1-20	8	29.9	20.9	9.0
▲	H1-23	8	32.9	20.3	12.6

PROJECT

HIGHWAY 17

TITLE

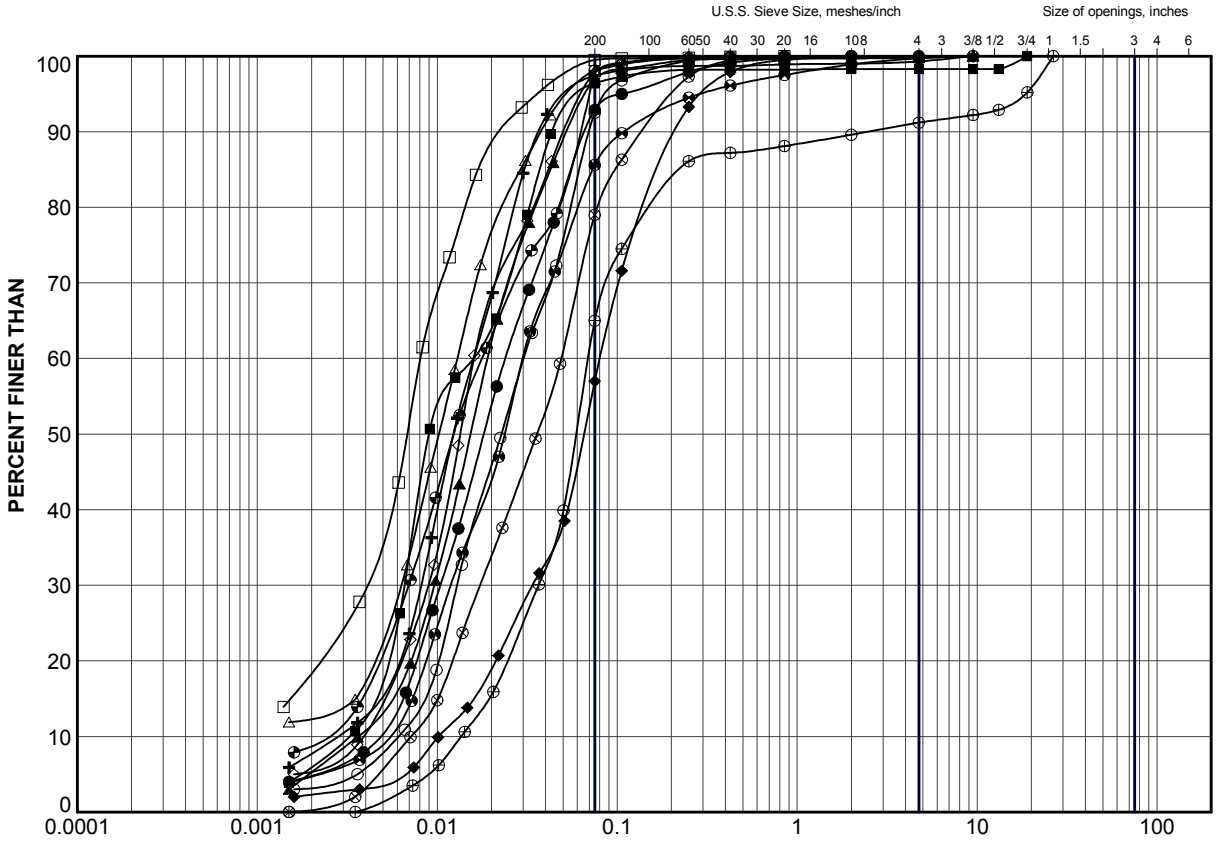
PLASTICITY CHART

CLAYEY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	JJL	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE A17**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	C1-4	8	231.8
■	H1-16	5B	237.9
▲	H1-17	10	230.3
✚	H1-18	9	231.9
◆	H1-19	11	228.8
◇	H1-21	10	230.3
○	H1-22	12	228.7
△	H1-23	9	231.9
⊗	H1-24	11	230.2
⊕	H1-24	13	227.2
□	H1-25	9	233.3
◓	H1-29	6	235.8
◔	H1-30	4	238.6

PROJECT

HIGHWAY 17

TITLE

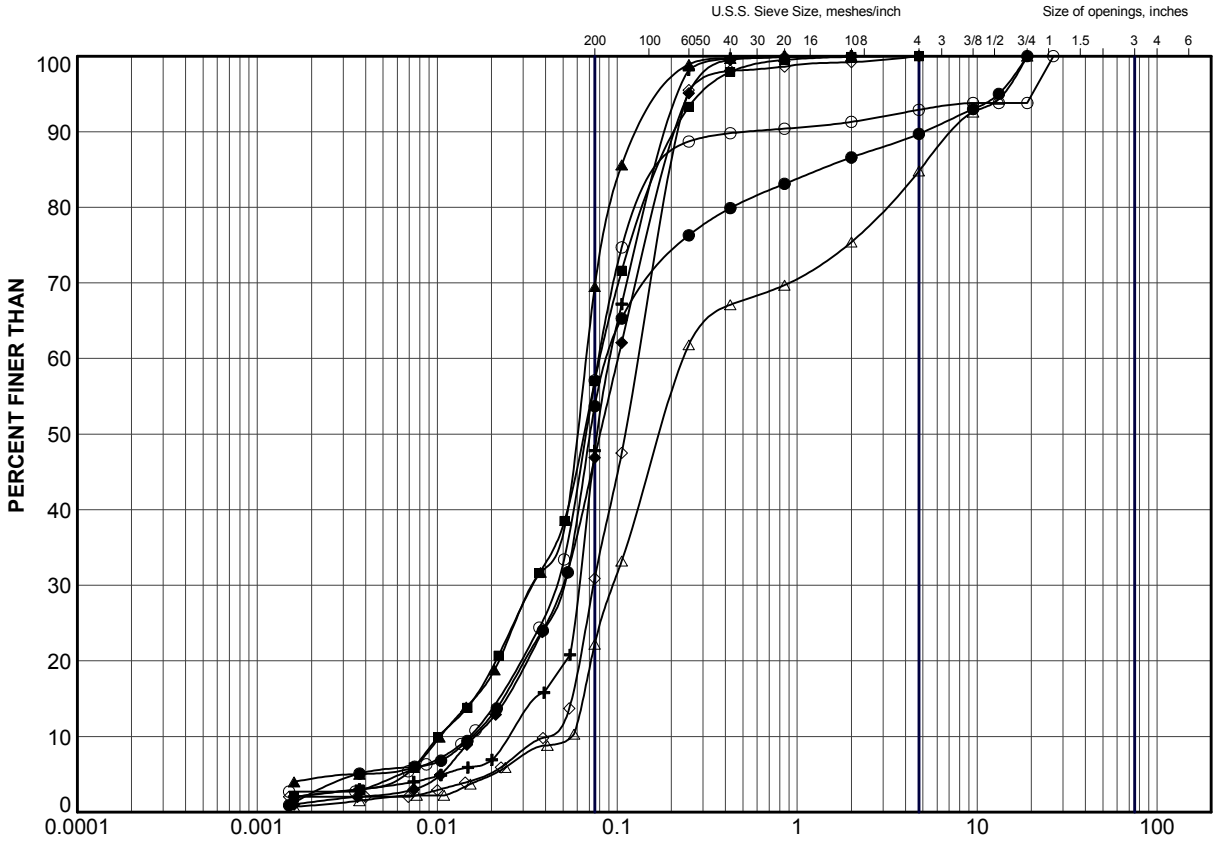
GRAIN SIZE DISTRIBUTION

SILT to SAND and SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	JJL	Mar 2014	SCALE	N/A	REV.
CHECK	SEMP	Mar 2014			
APPR		Mar 2014	**FIGURE A18**		

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H1-17	12	227.3
■	H1-19	12	227.3
▲	H1-20	11	227.2
✚	H1-21	13	225.8
◆	H1-23	12	227.3
◇	H1-25	12	228.7
○	H1-26	7	234.9
△	H1-30	8	234.8

PROJECT

HIGHWAY 17

TITLE

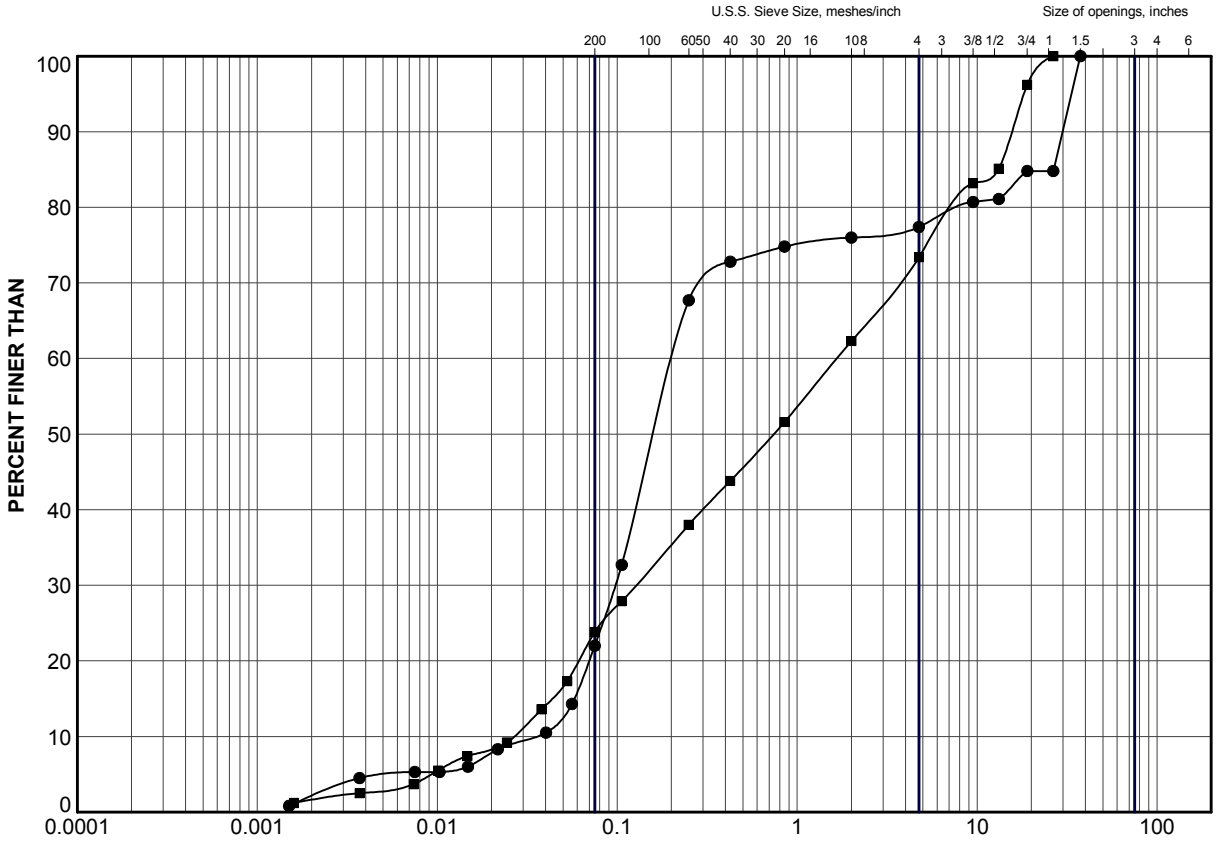
GRAIN SIZE DISTRIBUTION

SAND and SILT to SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	JJL	Mar 2014	SCALE	N/A	REV.
CHECK	SEMP	Mar 2014			
APPR		Mar 2014	**FIGURE A19**		

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H1-19	15	222.7
■	H1-27	8	233.7

PROJECT

HIGHWAY 17

TITLE

GRAIN SIZE DISTRIBUTION

GRAVELLY SAND

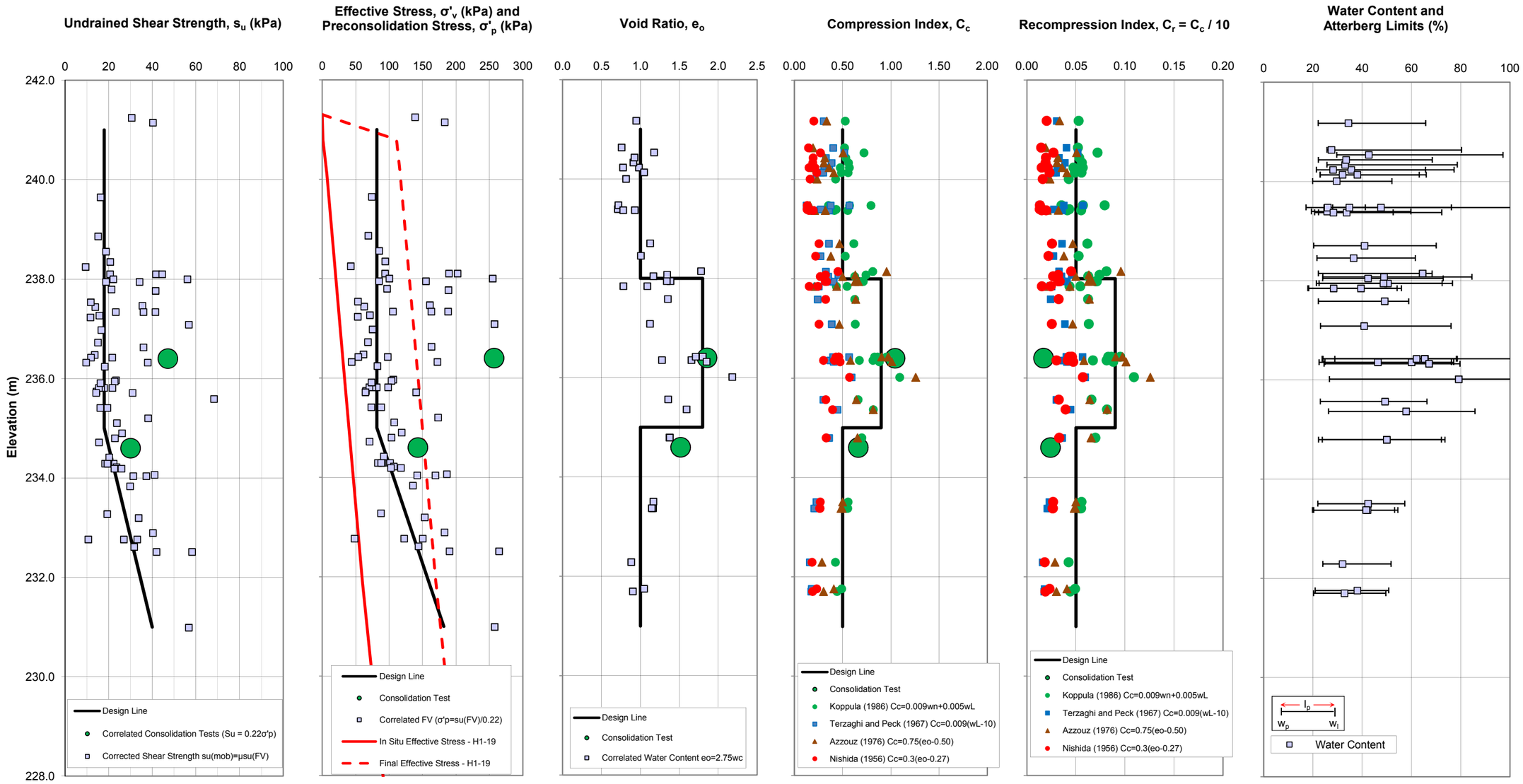
Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	JJL	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE A20**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT

SUMMARY PLOT OF ENGINEERING PARAMETERS FOR COHESIVE DEPOSITS
Highway 17 - STA 12+220 to 12+570 Township of Louise (H1)

FIGURE A21



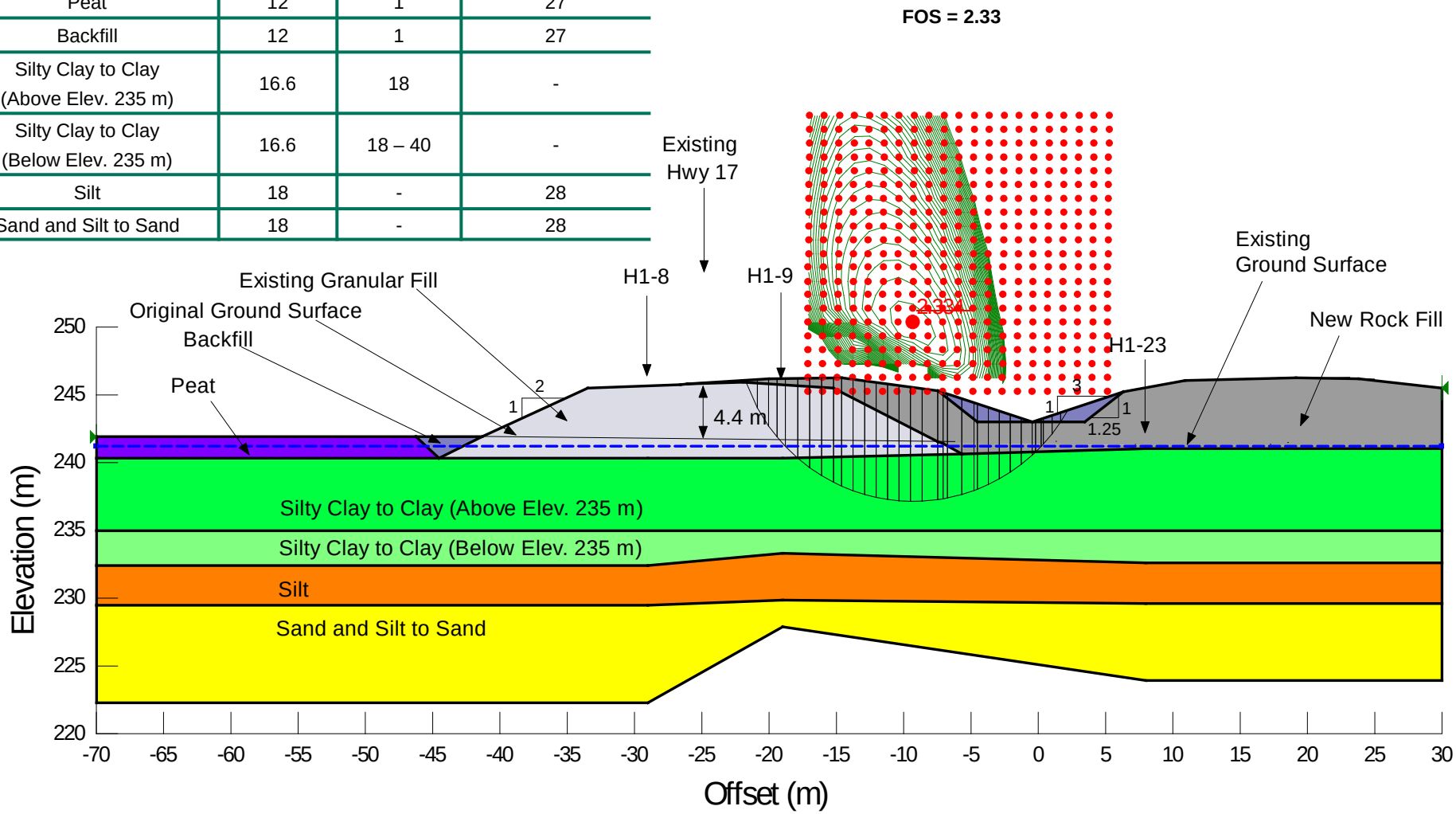
Date: May 2014
Project No: 11-1191-0007

Prepared By: EC
Checked By: SEMP

Golder Associates

https://capws.golder.com/sites/capws2/P111910007mtoHwy17FourLaningSudbury/Phases and Tasks/Analysis/[11-1191-0007-Parameters and Design Lines.xlsx]Swamp H3 Plots - Final

Material Name	Unit Weight (kN/m³)	Cohesion (kPa)	Friction Angle (°)
New Rock Fill	19	-	40
Existing Granular Fill	20	-	35
Peat	12	1	27
Backfill	12	1	27
Silty Clay to Clay (Above Elev. 235 m)	16.6	18	-
Silty Clay to Clay (Below Elev. 235 m)	16.6	18 – 40	-
Silt	18	-	28
Sand and Silt to Sand	18	-	28



Date July 6, 2015

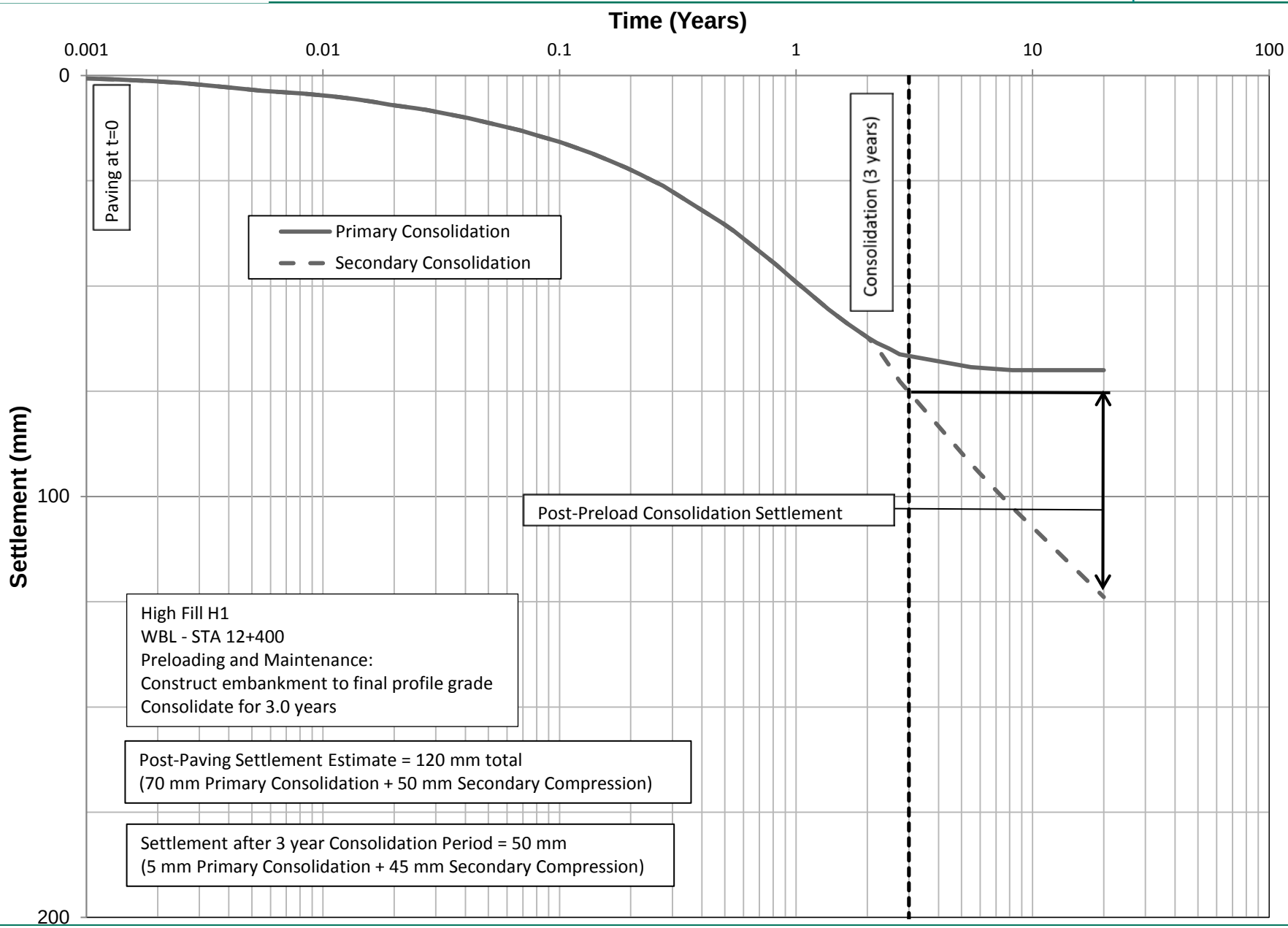
Project No: 11-1191-0007-01

Analysis By: DAM **Reviewed By:** SEMP

Golder Associates

Settlement Analysis
STA 12+400 – WBL
Consolidation and Maintenance

Figure A23



Date: July 6, 2015

Project No: 11-1191-0007

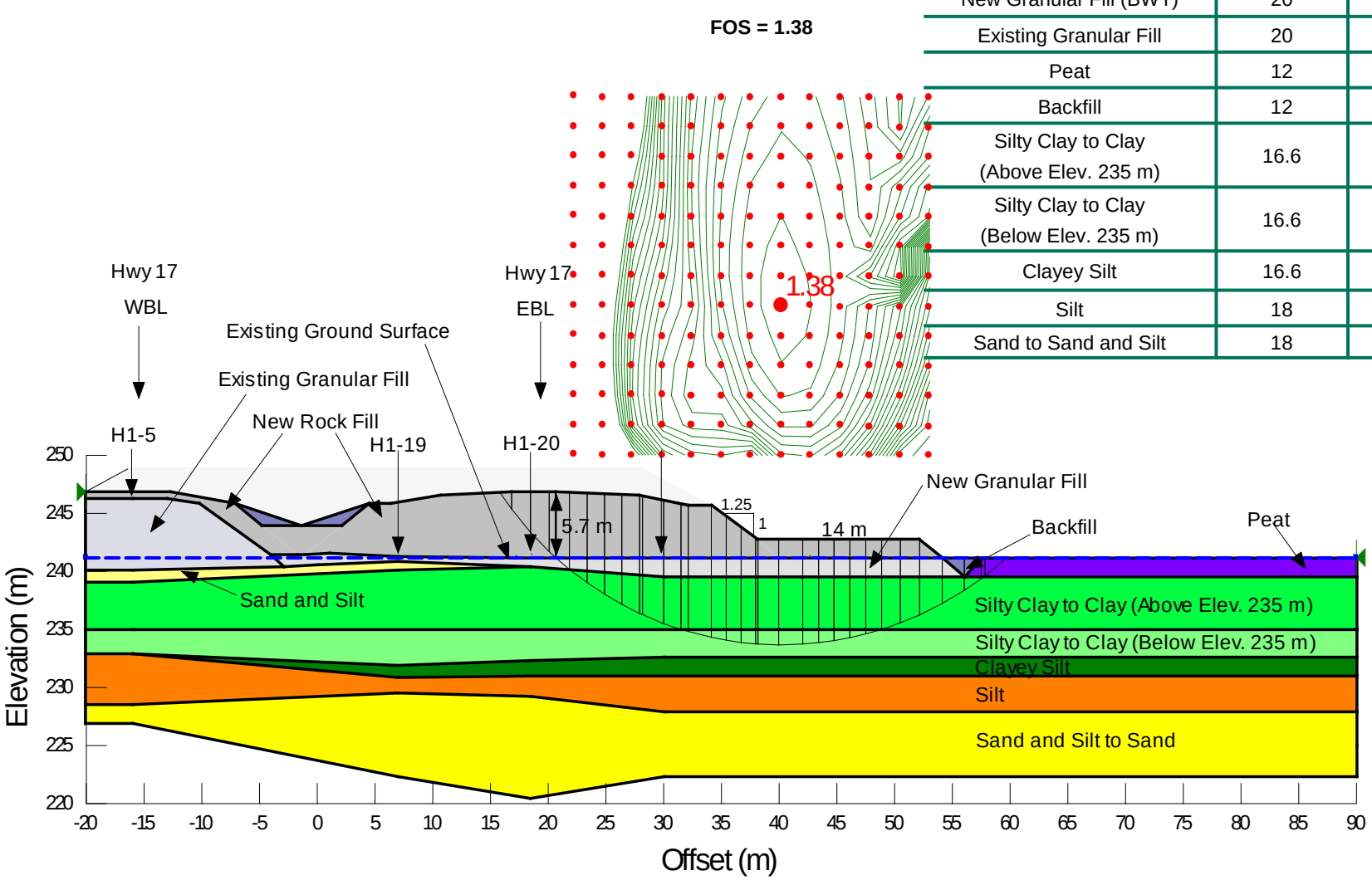
Analysis By: DAM **Reviewed By:** SEMP

Golder Associates

Stability Analysis
STA 12+320 – EBL South Side
Stage 1 - Embankment Height (14 m Toe Berms)

Figure A24

Material Name	Unit Weight (kN/m³)	Cohesion (kPa)	Friction Angle (°)
New Rock Fill	19	-	40
New Granular Fill (BWT)	20	-	35
Existing Granular Fill	20	-	35
Peat	12	1	27
Backfill	12	1	27
Silty Clay to Clay (Above Elev. 235 m)	16.6	18	-
Silty Clay to Clay (Below Elev. 235 m)	16.6	18 – 40	-
Clayey Silt	16.6	32 – 40	-
Silt	18	-	28
Sand to Sand and Silt	18	-	28



Date July 6, 2015

Project No: 11-1191-0007-01

Analysis By: DAM **Reviewed By:** SEMP

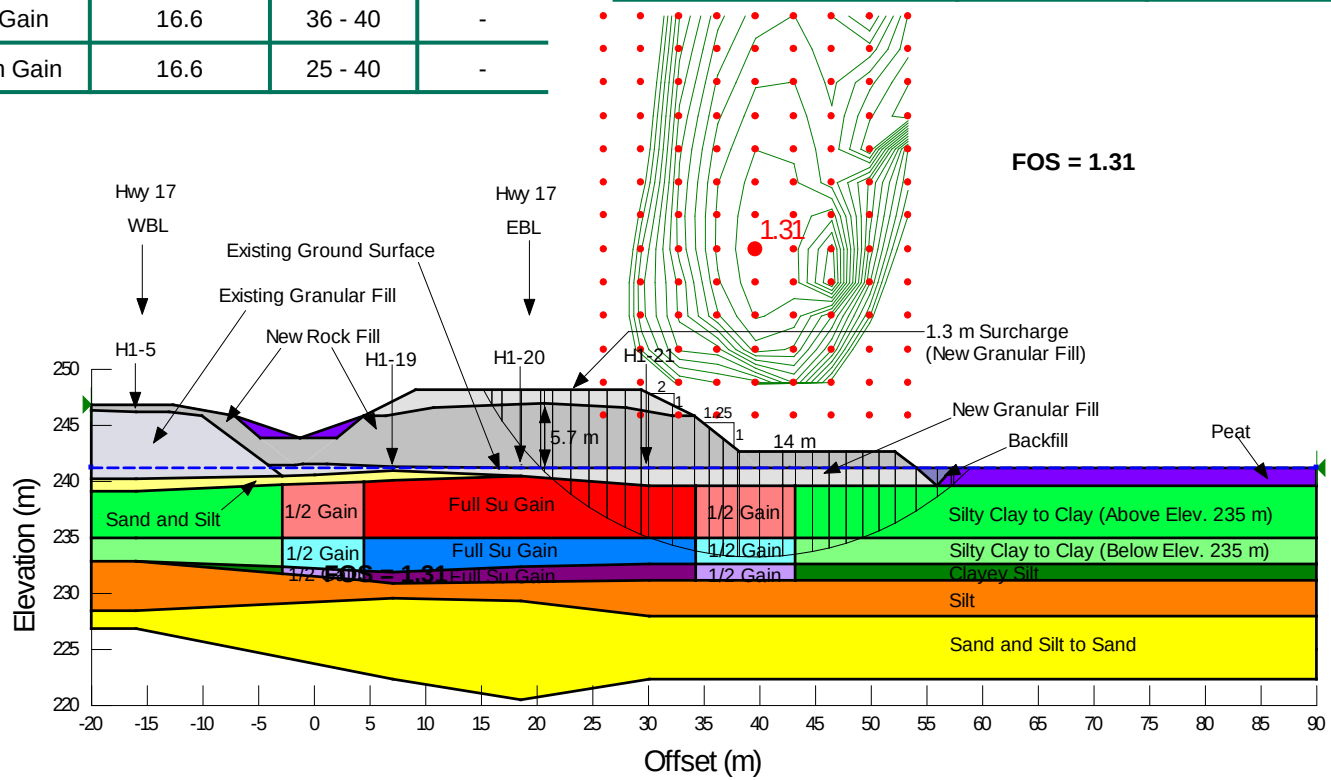
Golder Associates

Stability Analysis
STA 12+320 – EBL South Side
Stage 2 – 1.3 m Surcharge with Strength Gain

Figure A25

Material Name		Unit Weight (kN/m³)	Cohesion (kPa)	Friction Angle (º)
Silty Clay to Clay (Above Elev. 235 m)	No Strength Gain	16.6	18	-
	Strength Gain	16.6	25 - 32	-
	½ Strength Gain	16.6	21 - 25	-
Silty Clay to Clay (Below Elev. 235 m)	No Strength Gain	16.6	18 – 32	-
	Strength Gain	16.6	32 - 36	-
	½ Strength Gain	16.6	25 - 34	-
Clayey Silt	No Strength Gain	16.6	32 - 40	-
	Strength Gain	16.6	36 - 40	-
	½ Strength Gain	16.6	25 - 40	-

Material Name	Unit Weight (kN/m³)	Cohesion (kPa)	Friction Angle (º)
New Rock Fill	19	-	40
New Granular Fill	21	-	35
New Granular Fill (BWT)	20	-	35
Existing Granular Fill	20	-	35
Peat	12	1	27
Backfill	12	1	27
Silt	18	-	28
Sand to Sand and Silt	18	-	28



Date: July 6, 2015

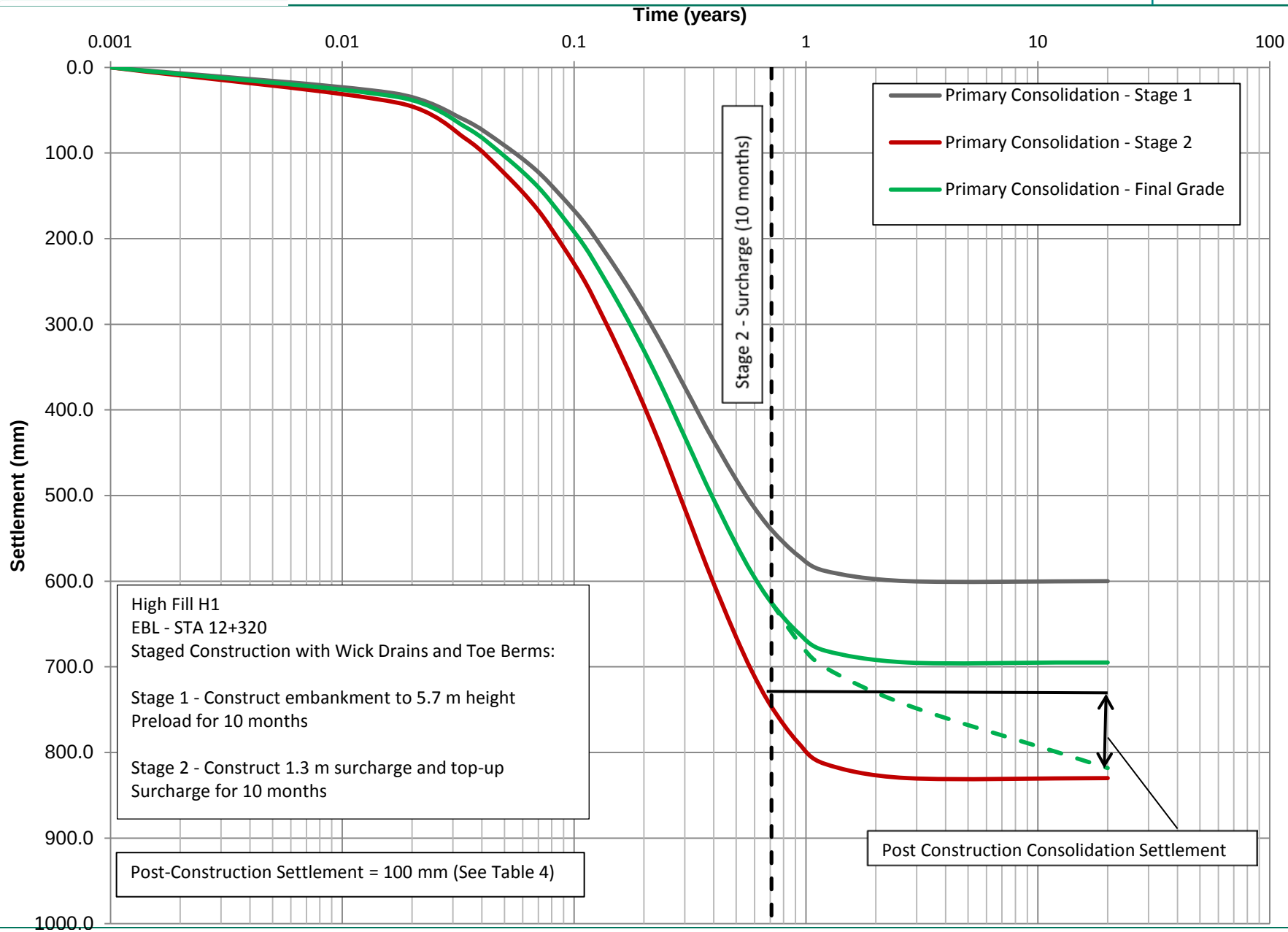
Project No: 11-1191-0007-01

Analysis By: DAM **Reviewed By:** SEMP

Golder Associates

Settlement Analysis
STA – 12+320 – EBL
Settlement vs. log Time – Staged Construction

Figure A26



Date July 6, 2015

Project No: 11-1191-0007

Analysis By: DAM **Reviewed By:** SEMP

Golder Associates

APPENDIX B

HIGHWAY 17 WBL – STA 13+140 TO 13+390;
HIGHWAY 17 EBL – STA 13+140 TO 13+390; AND
ST. POTHIER ROAD – STA 9+400 TO 9+600 (HIGH FILL H2)

Table B1: Evaluation of Settlement Mitigation Options
Highway 17 – STA 13+140 to 13+390 (High Fill Area H2)
[EBL/WBL and St. Pothier Road Embankments Constructed Concurrently]

Stability/Settlement Mitigation Option[1]	Option No.	Rank	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Staged Construction and 2 m Surcharge with Wick Drains and Toe Berms ■ 1st stage 4.4 m high for EBL/WBL and 2.9 m high for SPR for 10 months ■ 2nd stage 2.7 m fill for EBL/WBL and 1.5 m fill for SPR for 10 months ■ 1.7 years total surcharge period ■ 10 m wide toe berms (WBL and SPR), "toe berm" connection between EBL and SPR	A	1	■ Improves engineering parameters of soft cohesive soils thereby improving stability and reducing post-construction settlement. ■ Reduced time for primary consolidation when compared to not using wick drains	■ Toe berms are required to maintain embankment stability but are smaller than for non-staged construction options. ■ Delay in construction for each stage to allow for strength gain in soft soils for stability of subsequent stage. ■ More expensive Granular B required to backfill peat sub-excavation to facilitate wick drain installation. ■ Detail wick drain investigation and design will be required. ■ Additional time required for installation of wick drains. ■ Wick drains increase magnitude of secondary consolidation (creep) settlement as a result of the accelerated completion of primary consolidation settlement. ■ Instrumentation and monitoring program required to assess end of each stage. ■ Increased handling of surcharge fills upon completion of surcharge period. ■ Re-grading is required prior to final pavement structure construction.	■ Rock fill toe berm material and associated sub-excavation and replacement of organic deposits below toe berm ($320,000) ■ Granular backfill for peat sub-excavation required to facilitate wick drain installation. ($232,000 more than rock fill) ■ Surcharge material (Granular B). ($236,250) ■ Detail wick drain investigation and design. ($50,000) ■ Installation of wick drains including pre-drilling, instrumentation and associated monitoring program. ($805,000)	■ Surcharging time for each stage will be determined by assessment of the monitoring data. ■ There will be a high impact on the schedule. ■ There is a risk that unexpected post-construction settlements (i.e. creep) will be experienced depending on the efficiency of improving/strengthening the soft/weak soil deposit.
Full Sub-Excavation (up to approximately 15 m below ground surface) ■ 6 to 12 month preload period required to reduce post-construction settlement of rock fill.	B	2	■ Reduces total settlement of foundations soils as soft compressible material has been removed.	■ Generation of very large volume of excess excavation spoil - may not have suitable disposal area depending on environmental and property concerns. ■ Very large quantity of rock fill backfill required. ■ Longer construction period required to sub-excavate and replace with rock fill. ■ Additional post-construction settlement of rock fill itself and 6 to 12 month preload period required. ■ Specialized equipment (i.e. dragline) and additional effort required for deep sub-excavation and replacement below the groundwater level. ■ May require additional right-of-way to accommodate deep sub-excavation.	■ Sub-excavation, disposal and replacement of weak/soft, compressible deposits. ■ 256,500 – 50,000 m^3 x $14/$m^3$ (sub-excavation and replacement with rock "supply" fill) = $2,891,000. ■ Cost for disposal not quantified.	■ Higher risk of not achieving/maintaining stability of excavation slopes. ■ Very low risk of not achieving/maintaining stability of proposed embankments. ■ High risk of experiencing unexpected post-construction settlements (i.e. long term rock fill settlement). ■ High risk that not all compressible soils are removed during the sub-aqueous operations which could lead to unexpected settlement.

Table B1: Evaluation of Settlement Mitigation Options
Highway 17 – STA 13+140 to 13+390 (High Fill Area H2)
[EBL/WBL and St. Pothier Road Embankments Constructed Concurrently]

Stability/Settlement Mitigation Option[1]	Option No.	Rank	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Partial Preload with Lightweight Fill (EPS) (no Wick Drains, no Toe Berms) ■ 1.8 year preload period ■ 1.5 m of EPS on WBL and 1 m on St. Pothier Road (no EPS on EBL) ■ Surcharge required for EBL	C	3	■ Reduces total load on subsoils thereby reducing total settlement of foundations soils. ■ Toe berms are not required ■ Rock fill can be used to backfill peat sub-excavation.	■ Expensive material compared to conventional embankment fill. ■ Significant wait period is required (since wick drains not being utilized). ■ Instrumentation and monitoring program required to assess end of preload period. ■ Restricted thickness that can be used dependent on overall thickness of embankment and groundwater/water level. ■ Removal of preload material required prior to EPS installation.	■ Relative cost of EPS fill is about an order of magnitude higher than fill required for the other options. ■ 13,400 m^3 x \$200/m^3 = \$2,680,000. (which assumes 44 m^2 for a 250 m length for WBL & 12 m^2 for 200 m length for SPR EPS) ■ Surcharge material for EBL (Granular B). (\$225,000)	■ There will be a very high impact on the construction schedule. ■ Very low risk of not achieving stability of preload embankments and final EPS embankments on weak/soft foundation soils. ■ Low risk of experiencing unexpected post-construction settlements (i.e. creep).
2 m Surcharge with Wick Drains and Toe Berms ■ 9 month surcharge period ■ 14 m wide toe berm WBL, 22 m wide toe berm St. Pothier Rd., “toe berm” connection between EBL and SPR	D	\$	■ Reduced time for primary consolidation when compared to not using wick drains ■ One stage construction.	■ Very large toe berms required for embankment stability including additional peat sub-excavation and backfilling. ■ Increased handling of surcharge fills upon completion of surcharge period. ■ Delay in construction to reduce magnitude of post-construction settlement. ■ More expensive Granular B required to backfill peat sub-excavation to facilitate wick drain installation. ■ Detail wick drain investigation and design will be required. ■ Additional time required for installation of wick drains. ■ Wick drains increase magnitude of secondary consolidation (creep) settlement as a result of the accelerated completion of primary consolidation settlement. ■ Instrumentation and monitoring program required to assess end of surcharge period. ■ Increased handling of surcharge fills upon completion of surcharge period. ■ Re-grading is required prior to final pavement structure construction.	■ Rock fill toe berm material excluding granular backfill for wick drains. (\$84,000) ■ Granular backfill for peat sub-excavation required to facilitate wick drain installation. (\$250,000 more than if rock fill is used) ■ Surcharge material (Granular B). (\$216,000) ■ Detail wick drain investigation and design. (\$50,000) ■ Installation of wick drains including pre-drilling, instrumentation and associated monitoring program. (\$865,000)	■ Surcharging time will be determined by assessment of the monitoring data. ■ There will be a moderate impact on the construction schedule. ■ Property issues may arise due to the size of the toe berms. ■ There is a risk that unexpected post-construction settlements (i.e. creep) will occur.

Table B1: Evaluation of Settlement Mitigation Options
Highway 17 – STA 13+140 to 13+390 (High Fill Area H2)
[EBL/WBL and St. Pothier Road Embankments Constructed Concurrently]

Stability/Settlement Mitigation Option[1]	Option No.	Rank	Advantages	Disadvantages	Relative Costs	Risks/Consequences
2 m Surcharge with Toe Berms (no Wick Drains) ■ 2.5 year surcharge period ■ 12 m wide toe berm WBL, 20 m wide toe berm St. Pothier Rd. and a "toe berm" connection between EBL and SPR	E	5	■ Standard construction operation. ■ Rock fill can be used to backfill peat sub-excavation.	■ Very large toe berms required for embankment stability including additional peat sub-excavation and backfilling. ■ Significant wait period is required (since wick drains not being utilized). ■	■ Rock fill toe berm material and associated sub-excavation and replacement of organic deposits below toe berm. ($84,000) ■ Use of rock fill as backfill instead of granular fill as in Option C creates a savings of $250,000 ■ Surcharge material (Granular B). ($216,000)	■ There will be a very high impact on the construction schedule. ■ Property issues may arise due to the size of the toe berms.
Partial Sub-Excavation and Preloading	F	NF	■ Reduces total settlement of foundations soils as soft compressible material has been removed. ■ Specialized equipment (i.e. dragline) may not be required compared to sub-excavation to the full depth.	■ Generation of large volume of excess excavation spoil – may not have suitable disposal area depending on environmental and property concerns. ■ Large quantity of rock fill backfill required. ■ Longer construction period required to sub-excavate and replace with rock fill although not as long as full sub-excavation. ■ Additional post-construction settlement of rock fill itself and preloading of clay deposit for extended period of time (as wick drains not utilized). ■ Toe berms may still be required depending on depth of sub-excavation.	■ Sub-excavation, disposal and replacement of weak/soft, compressible deposits. ■ Cost for disposal not quantified.	■ High risk of not achieving/maintaining stability of excavation slopes. ■ High risk of not achieving/maintaining stability of proposed embankments. ■ High risk of experiencing unexpected post-construction settlements (i.e. long term rock fill settlement).
Ground Improvement ■ Dry/wet soil mixing ■ Geopiers (rammed aggregate)	G	NF	■ Reduces future creep settlement of clay (and potentially peat) by improving strength and stiffness of the material.	■ Need bulk samples of clay for mix design to allow for design of soil mixing columns or piers. ■ Specialized design and equipment required. ■ High cost of specialized equipment and mobilization to the site. ■ Geogrid reinforced embankment required to distribute the load over the columns/piers and to mitigate potential differential settlement. ■ Bench scale tests and field program may be required. ■ No readily available information on mixes of peat/clay and additives and potential strength gain – may require large amount of cement or aggregate to realize improvement.	■ Cost of DSM columns or rammed aggregate piers and geogrid. ■ Cost would be higher than other options including potentially full sub-excavation with preloading and EPS options	■ Future creep settlement may still occur in the subsoils between the columns/piers. ■ May not mix properly with organic and fine grained clayey soil – likely no guarantee from contractor. ■ Potential increase in cost for additional cement or aggregate if required to enhance soil/peat or soil/clay cement mix.

NF: Not Feasible
Note: 1. All of these mtitgation options assume that the peat/organics is sub-excavated and replaced with backfill.

Prepared By: SEMC **Reviewed By:**JMAC

Table B2: Evaluation of Settlement Mitigation Options
Highway 17 – STA 13+140 to 13+390 (High Fill Area H2)
EBL/WBL and St. Pothier Road Embankments Constructed at Different Times

Stability/Settlement Mitigation Option	Option No.	Rank	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Partial Preload with Lightweight Fill (EPS) (no Wick Drains, no Toe Berms) ■ 1.8 year preload period ■ 3 m of EPS on EBL/WBL, 1 m of EPS on St. Pothier Road	A	1	■ Reduces total load on subsoils thereby reducing total settlement of foundations soils. ■ Toe berms are not required ■ Rock fill can be used to backfill peat sub-excavation	■ Expensive material compared to conventional embankment fill. ■ Significant wait period is required (since wick drains not being utilized). ■ Instrumentation and monitoring program required to assess end of preload period. ■ Restricted thickness that can be used dependent on overall thickness of embankment and groundwater/water level. ■ Removal of preload material required prior to EPS installation ■ The option of surcharging the EBL instead of using EPS is not available without building the St. Pothier Road embankment.	■ Relative cost of EPS fill is about an order of magnitude higher than fill required for the other options. ■ 21,000 m^3 x \$200/m^3 = \$4,200,000.	■ There will be a very high impact on the construction schedule ■ Very low risk of not achieving stability of preload embankments and final EPS embankments on weak/soft foundation soils. ■ Low risk of experiencing unexpected post-construction settlements (i.e. creep). ■ High risk that construction of SPR at a later time will induce settlement under EBL/WBL embankment.
2 m Surcharge with Wick Drains and Toe Berms ■ 10 month surcharge period ■ 14 m wide toe berm WBL, 35 m wide toe berm EBL	B	NP	■ Reduced time for primary consolidation when compared to not using wick drains ■ One stage construction.	■ Very large toe berms required for embankment stability including additional peat sub-excavation and backfilling. ■ Increased handling of surcharge fills upon completion of surcharge period. ■ Delay in construction to reduce magnitude of post-construction settlement. ■ More expensive Granular B required to backfill peat sub-excavation to facilitate wick drain installation. ■ Detail wick drain investigation and design will be required. ■ Additional time required for installation of wick drains ■ Wick drains increase magnitude of secondary consolidation (creep) settlement as a result of the accelerated completion of primary consolidation settlement. ■ Instrumentation and monitoring period required to assess end of surcharge period. ■ Increased handling of surcharge fills upon completion of surcharge period. ■ Re-grading is required prior to final pavement structure construction.	■ Rock fill toe berm material and associated sub-excavation and replacement of organic deposits below toe berm. ■ Granular backfill for peat sub-excavation required to facilitate wick drain installation. ■ Surcharge material (Granular B). ■ Detail wick drain investigation and design. ■ Installation of wick drains including pre-drilling, instrumentation and associated monitoring program.	■ Surcharging time will be determined by assessment of the monitoring data ■ There will be a moderate impact on the construction schedule ■ Property issues may arise due to the size of the toe berms. ■ There is a risk that unexpected post-construction settlements (i.e. creep) will occur. ■ The sizes of toe berms necessary are roughly equivalent to the St. Pothier Road embankment (and connecting toe berm). ■ **Not practical to build a toe berm of an equivalent size to St. Pothier Road and not build that embankment at the same time.**

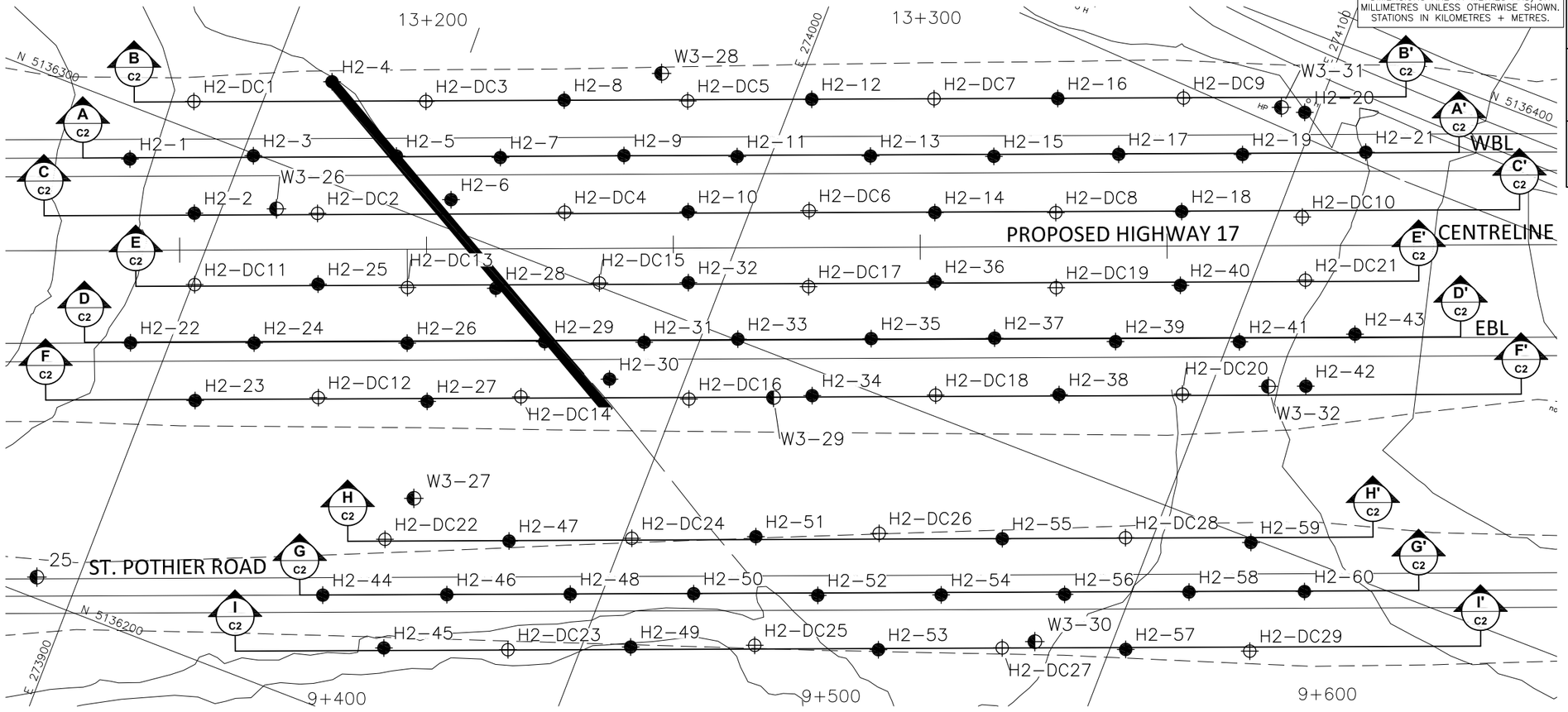
Table B2: Evaluation of Settlement Mitigation Options
Highway 17 – STA 13+140 to 13+390 (High Fill Area H2)
EBL/WBL and St. Pothier Road Embankments Constructed at Different Times

Stability/Settlement Mitigation Option	Option No.	Rank	Advantages	Disadvantages	Relative Costs	Risks/Consequences
2 m Surcharge with Toe Berms ■ 2.5 year surcharge period ■ 12 m wide toe berm WBL, 35 m wide toe berm EBL	C	NP	■ Standard construction operation. ■ Rock fill can be used to backfill peat sub-excavation.	■ Very large toe berms required for embankment stability including additional peat sub-excavation and backfilling. ■ Significant wait period is required (since wick drains not being utilized).	■ Rock fill toe berm material and associated sub-excavation and replacement of organic deposits below the toe berm. ■ Surcharge material (Granular B).	■ There will be a very high impact on the construction schedule ■ Property issues may arise due to the size of the toe berms ■ The sizes of toe berms necessary are roughly equivalent to the St. Pothier Road embankment (and connecting toe berm). ■ **Not practical to build a toe berm of an equivalent size to St. Pothier Road and not build that embankment at the same time.**

NP: Not Practical
Note: 1. All of these mtitgation options assume that the peat/organics is sub-excavated and replaced with backfill.

Prepared By: SEMC **Reviewed By:** JMAC

MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

SCALE
10 0 10 20 m

METRIC

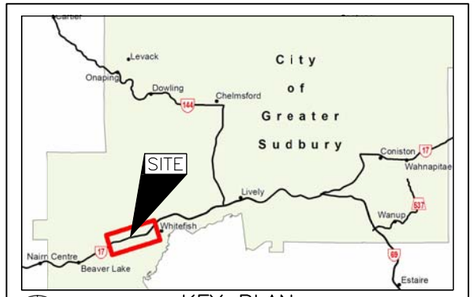
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 156-98-00

HIGHWAY 17 4 LANING
HWY 17 WBL – STA 13+140 TO 13+390
HWY 17 EBL – STA 13+140 TO 13+390
ST. POITHIER RD. – STA 9+400 TO 9+600
BOREHOLE LOCATIONS

SHEET

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



LEGEND

- Borehole – Current Investigation
- Dynamic Cone Penetration Test – Current Investigation
- Previous Investigation (by others)

NOTES

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

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

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans provided in digital format by DM Wills, drawing files 581_base.dwg, GWP156-98-00_B & C Plans.dwg and 581_contours.dwg received Jan 17, 2012.

LICENCED PROFESSIONAL ENGINEER S.E.M. POOT 90471921 APR 15, 2015 PROVINCE OF ONTARIO

LICENCED PROFESSIONAL ENGINEER J.M.A.COSTA APR 15, 2015 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17	PROJECT NO. 11-1191-0007		DIST.
SUBM'D. EC	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. B1

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H2-1	240.7	5136289.9	273879.1
H2-2	239.7	5136284.4	273895.2
H2-3	239.8	5136299.6	273902.2
H2-4	239.7	5136319.3	273911.6
H2-5	239.8	5136309.9	273929.2
H2-6	239.8	5136305.7	273942.7
H2-7	239.9	5136317.2	273949.0
H2-8	239.9	5136332.8	273956.8
H2-9	239.8	5136326.6	273972.2
H2-10	239.8	5136320.7	273988.4
H2-11	239.8	5136334.7	273993.6
H2-12	239.9	5136351.0	274003.6
H2-13	239.9	5136344.5	274018.8
H2-14	239.8	5136338.5	274035.1
H2-15	239.9	5136353.5	274042.1
H2-16	240.0	5136369.1	274050.0
H2-17	239.9	5136363.0	274065.6
H2-18	240.1	5136356.7	274081.7
H2-19	240.2	5136372.0	274089.0
H2-20	240.4	5136384.5	274097.7
H2-21	240.3	5136381.4	274112.1
H2-22	240.3	5136255.2	273892.6

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H2-23	239.6	5136249.0	273909.0
H2-24	239.6	5136264.2	273916.0
H2-25	239.7	5136280.0	273923.8
H2-26	239.7	5136275.4	273944.9
H2-27	239.7	5136265.8	273952.9
H2-28	239.8	5136292.2	273957.6
H2-29	239.8	5136285.6	273970.8
H2-30	239.7	5136283.3	273985.8
H2-31	239.7	5136292.8	273989.6
H2-32	239.8	5136307.3	273993.6
H2-33	239.8	5136300.2	274007.1
H2-34	239.7	5136295.0	274025.3
H2-35	239.7	5136310.1	274032.3
H2-36	239.8	5136325.5	274040.2
H2-37	239.9	5136319.2	274055.5
H2-38	239.8	5136313.2	274071.8
H2-39	239.8	5136327.3	274078.6
H2-40	240.0	5136342.7	274086.8
H2-41	239.8	5136336.3	274102.1
H2-42	241.8	5136332.8	274117.9
H2-43	242.1	5136346.2	274123.4
H2-44	239.6	5136221.5	273947.3

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H2-45	239.5	5136216.0	273962.7
H2-46	239.5	5136230.7	273970.8
H2-47	239.5	5136245.4	273978.6
H2-48	239.5	5136239.8	273994.0
H2-49	239.6	5136234.2	274009.3
H2-50	239.5	5136248.9	274017.3
H2-51	239.5	5136264.2	274024.9
H2-52	239.5	5136257.6	274040.9
H2-53	239.5	5136251.8	274056.3
H2-54	239.6	5136266.7	274064.2
H2-55	239.7	5136281.8	274071.6
H2-56	239.7	5136275.8	274087.5
H2-57	239.6	5136269.9	274103.0
H2-58	239.6	5136285.3	274110.8
H2-59	239.7	5136299.2	274118.9
H2-60	239.8	5136293.8	274132.6
H2-DC1	239.6	5136305.5	273887.0
H2-DC2	239.7	5136293.3	273918.5
H2-DC3	239.8	5136322.4	273930.8
H2-DC4	239.7	5136311.6	273965.1
H2-DC5	239.8	5136341.6	273980.2
H2-DC6	239.8	5136329.7	274011.2

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H2-DC7	239.9	5136360.0	274026.6
H2-DC8	239.8	5136347.4	274058.0
H2-DC9	240.0	5136378.3	274073.7
H2-DC10	240.0	5136364.5	274104.8
H2-DC11	239.6	5136270.9	273900.5
H2-DC12	239.7	5136258.6	273932.1
H2-DC13	239.7	5136285.9	273940.9
H2-DC14	239.6	5136273.5	273970.3
H2-DC15	239.7	5136300.8	273976.8
H2-DC16	239.7	5136285.3	274002.2
H2-DC17	239.8	5136315.3	274016.6
H2-DC18	239.7	5136304.1	274048.6
H2-DC19	240.0	5136333.2	274063.5
H2-DC20	239.7	5136322.3	274095.1
H2-DC21	240.3	5136352.8	274110.0
H2-DC22	239.5	5136236.6	273955.0
H2-DC23	238.9	5136224.7	273986.3
H2-DC24	239.5	5136254.8	274001.6
H2-DC25	239.8	5136243.6	274032.6
H2-DC26	239.6	5136273.8	274048.0
H2-DC27	239.6	5136261.1	274079.6
H2-DC28	239.6	5136291.0	274094.8
H2-DC29	239.6	5136278.6	274126.6

PLOT DATE: June 30, 2015
FILENAME: \\golder.gds\gal\Sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0007 HWY 17 4 Laning\11191000700A002_H2.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

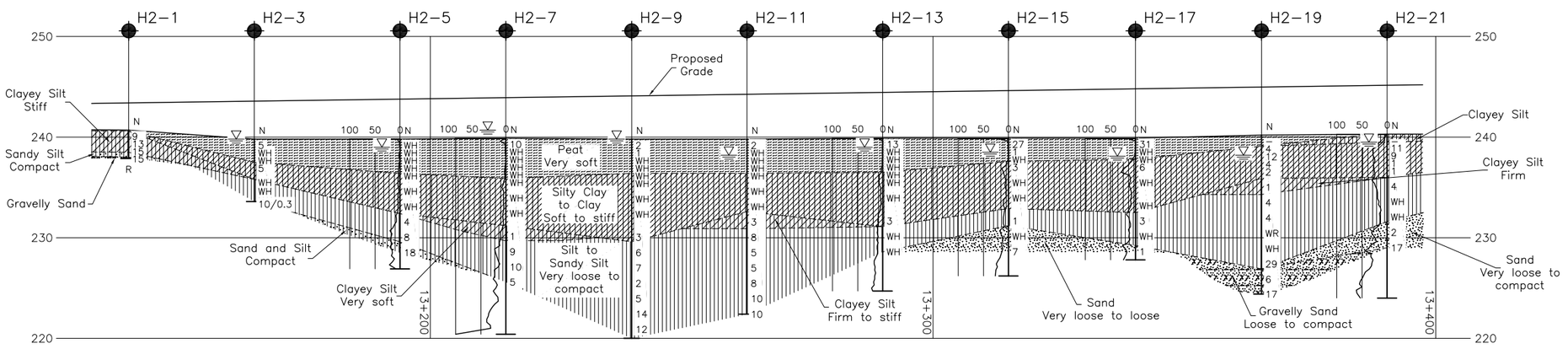
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 156-98-00

HIGHWAY 17 4 LANING
HWY 17 WBL – STA 13+140 TO 13+390
SOIL STRATA

SHEET

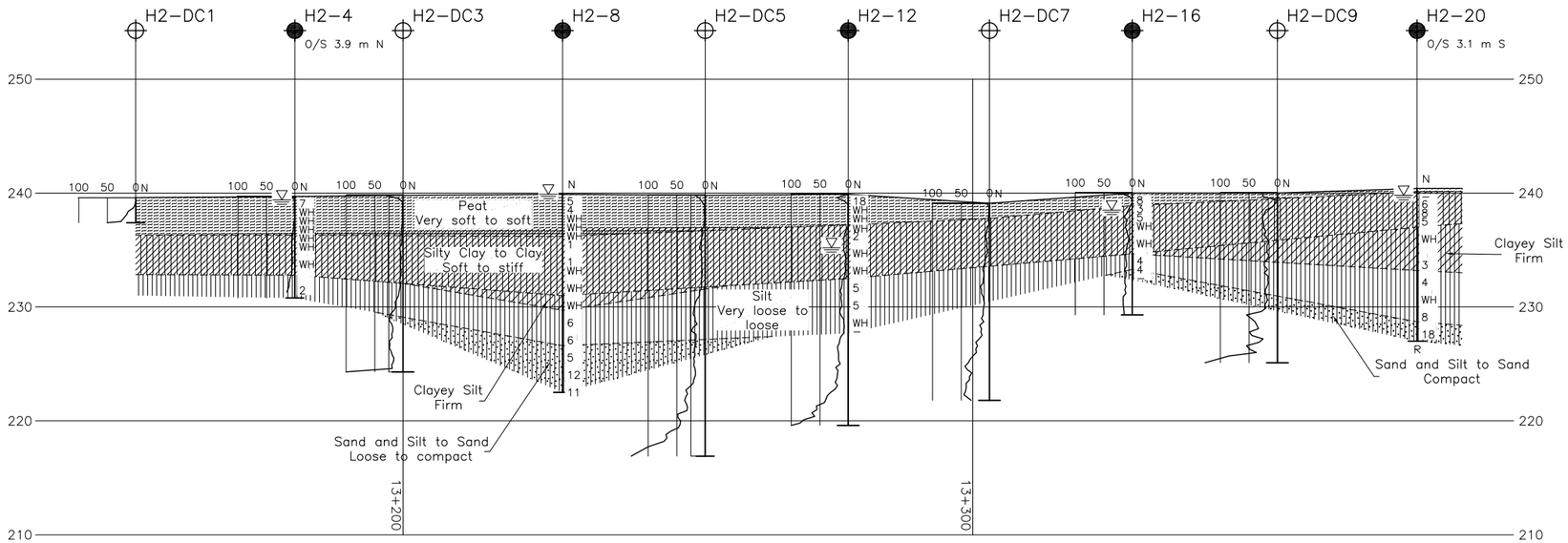
Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



A-A'
1

CENTRELINE PROFILE
HIGHWAY 17 (WBL)

HORIZONTAL SCALE
10 0 10 20 m
5 0 5 10 m
VERTICAL SCALE



B-B'
1

NORTH TOE PROFILE
HIGHWAY 17 (WBL)

HORIZONTAL SCALE
10 0 10 20 m
5 0 5 10 m
VERTICAL SCALE

LEGEND

- Borehole
- Dynamic Cone Penetration Test
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R — Refusal
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H2-1	240.7	5136289.9	273879.1
H2-3	239.8	5136299.6	273902.2
H2-4	239.7	5136319.3	273911.6
H2-5	239.8	5136309.9	273929.2
H2-7	239.9	5136317.2	273949.0
H2-8	239.9	5136332.8	273956.8
H2-9	239.8	5136326.6	273972.2
H2-11	239.8	5136334.7	273993.6
H2-12	239.9	5136351.0	274003.6
H2-13	239.9	5136344.5	274018.8
H2-15	239.9	5136353.5	274042.1
H2-16	240.0	5136369.1	274050.0
H2-17	239.9	5136363.0	274065.6
H2-19	240.2	5136372.0	274089.0
H2-20	240.4	5136384.5	274097.7
H2-21	240.3	5136381.4	274112.1
H2-DC1	239.6	5136305.5	273887.0
H2-DC3	239.8	5136322.4	273930.8
H2-DC5	239.8	5136341.6	273980.2
H2-DC7	239.9	5136360.0	274026.6
H2-DC9	240.0	5136378.3	274073.7

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REFERENCE

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LICENSED PROFESSIONAL ENGINEER S.E.M. POOT 90471921 APR 15, 2015 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.M.A.COSTA APR 15, 2015 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17	PROJECT NO. 11-1191-0007		DIST.
SUBM'D. EC	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. B2

PLOT DATE: June 30, 2015
FILENAME: \\golder.gds\gal\Sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0007 HWY 17 4 Laning\11119100074A002_H2.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

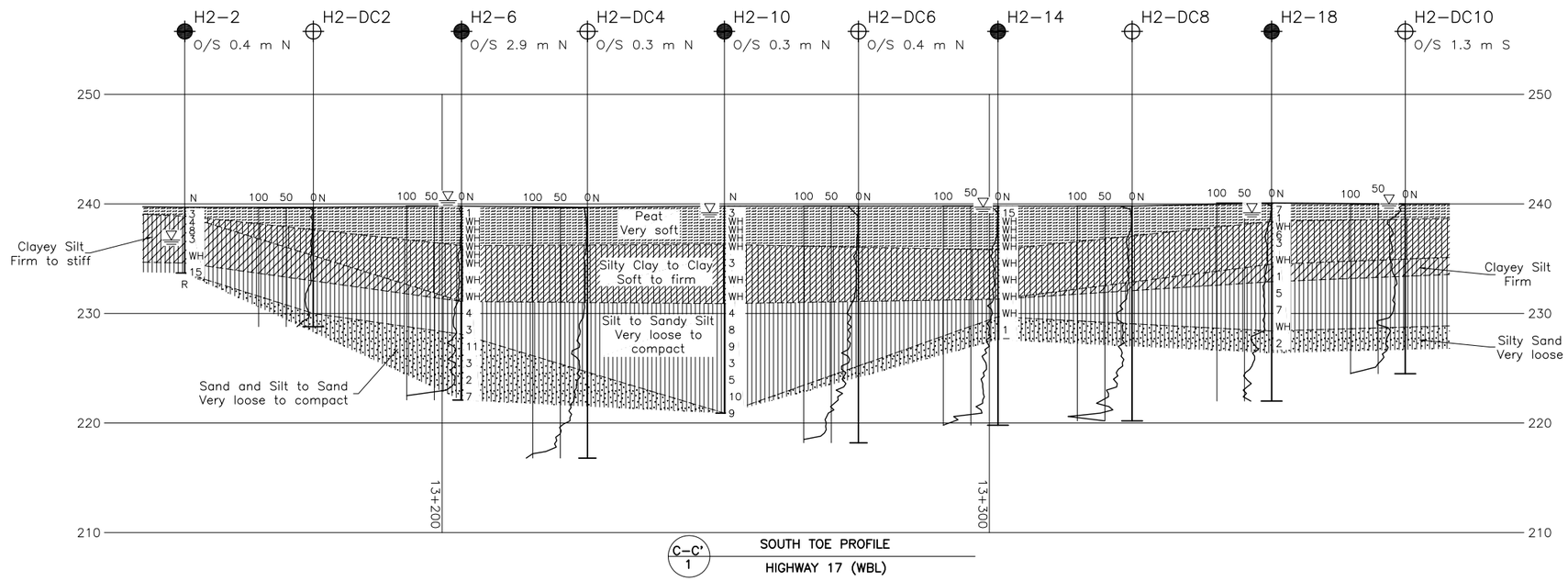
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 156-98-00

HIGHWAY 17 4 LANING
HWY 17 WBL – STA 13+140 TO 13+390
HWY 17 EBL – STA 13+140 TO 13+390
SOIL STRATA

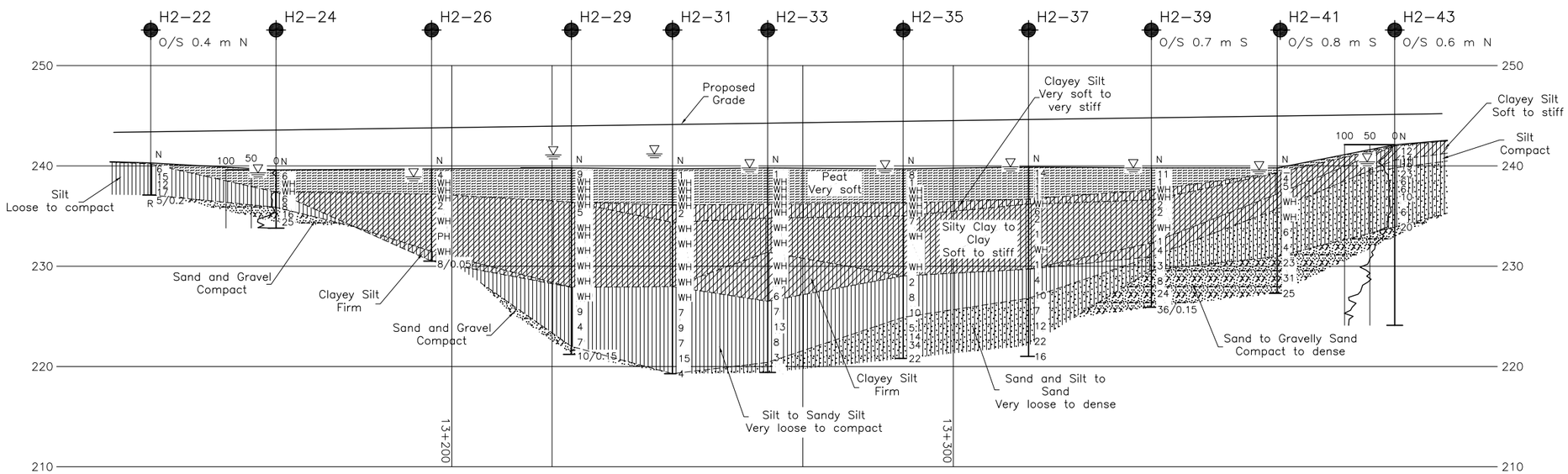
SHEET

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



C-C'
1
SOUTH TOE PROFILE
HIGHWAY 17 (WBL)

HORIZONTAL SCALE
10 0 10 20 m
5 0 5 10 m
VERTICAL SCALE



D-D'
1
CENTRELINE
HIGHWAY 17 (EBL)

HORIZONTAL SCALE
10 0 10 20 m
5 0 5 10 m
VERTICAL SCALE

LEGEND

- Borehole
- Dynamic Cone Penetration Test
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R — Refusal
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H2-2	239.7	5136284.4	273895.2
H2-6	239.8	5136305.7	273942.7
H2-10	239.8	5136320.7	273988.4
H2-14	239.8	5136338.5	274035.1
H2-18	240.1	5136356.7	274081.7
H2-22	240.3	5136255.2	273892.6
H2-24	239.6	5136264.2	273916.0
H2-26	239.7	5136275.4	273944.9
H2-29	239.8	5136285.6	273970.8
H2-31	239.7	5136292.8	273989.6
H2-33	239.8	5136300.2	274007.1
H2-35	239.7	5136310.1	274032.3
H2-37	239.9	5136319.2	274055.5
H2-39	239.8	5136327.3	274078.6
H2-41	239.8	5136336.3	274102.1
H2-43	242.1	5136346.2	274123.4
H2-DC2	239.7	5136293.3	273918.5
H2-DC4	239.7	5136311.6	273965.1
H2-DC6	239.8	5136329.7	274011.2
H2-DC8	239.8	5136347.4	274058.0
H2-DC10	240.0	5136364.5	274104.8

NOTES

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LICENCED PROFESSIONAL ENGINEER S.E.M. POOT 90471921 APR 15, 2015 PROVINCE OF ONTARIO

LICENCED PROFESSIONAL ENGINEER J.M.A.COSTA APR 15, 2015 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17	PROJECT NO. 11-1191-0007		DIST.
SUBM'D. EC	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. B3

PLOT DATE: June 30, 2015
FILENAME: \\golder.gds\gal\Sudbury\CAD-GIS\CAD\Projects\2011\1191-0007 HWY 17 4 Laning\11119100070A002_H2.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

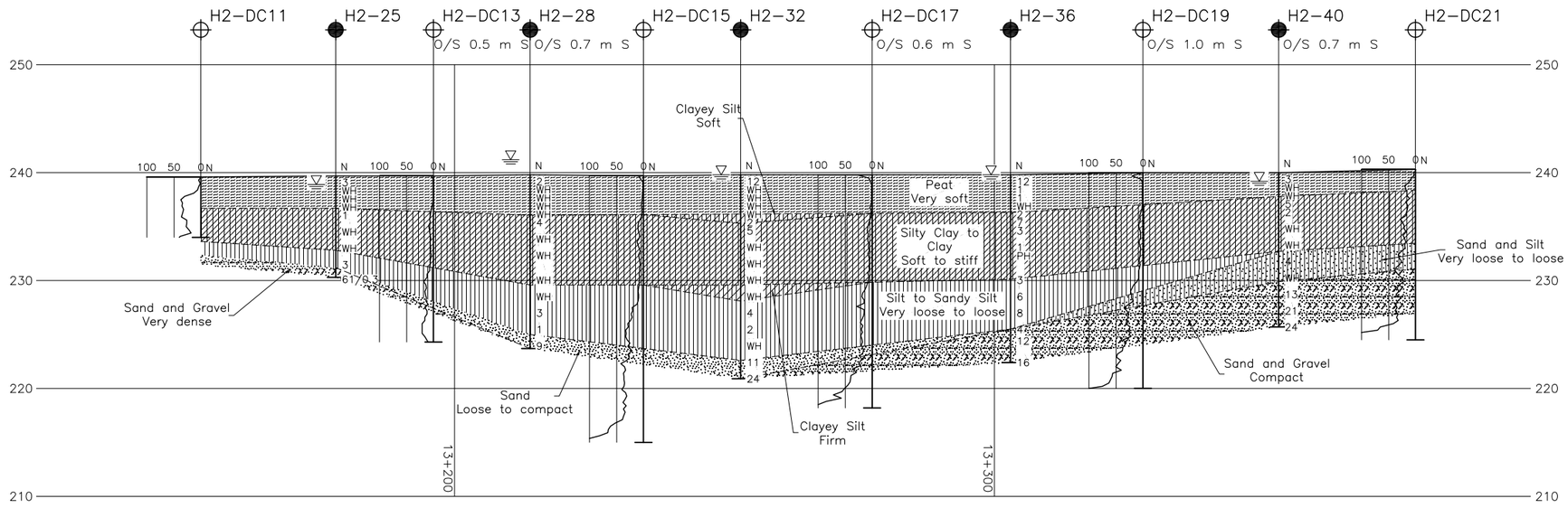
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 156-98-00

HIGHWAY 17 4 LANING
HWY 17 EBL – STA 13+140 TO 13+390
SOIL STRATA

SHEET

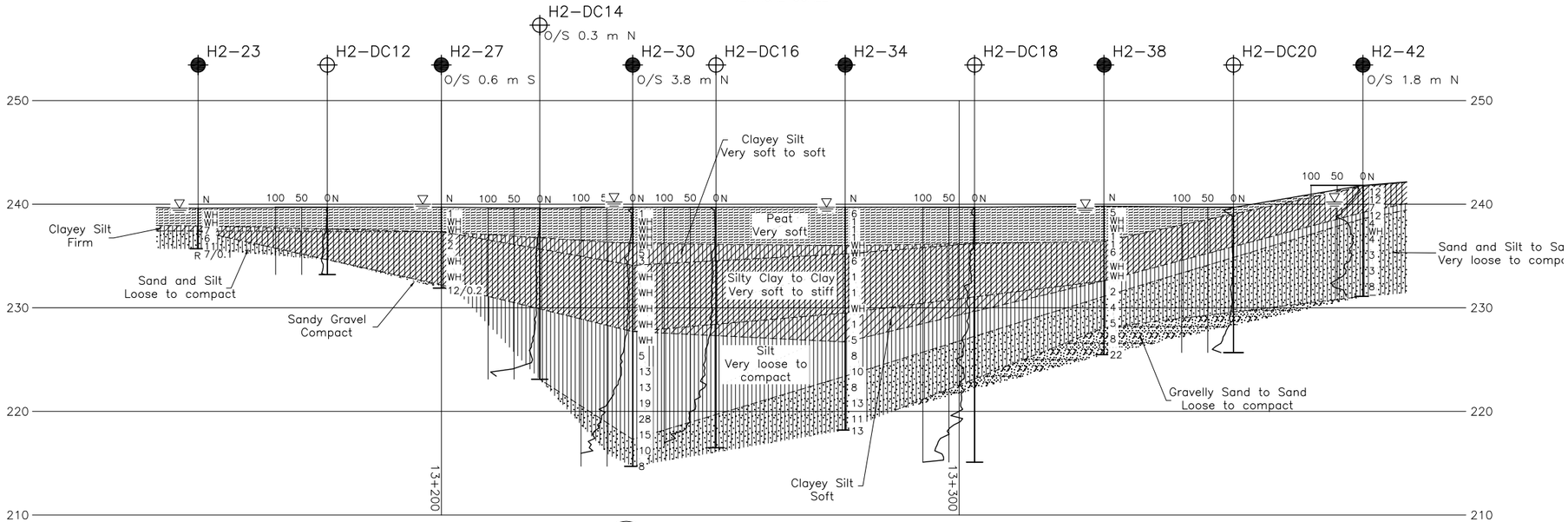
Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



E-E'
1

NORTH TOE PROFILE
HIGHWAY 17 (EBL)

HORIZONTAL SCALE
10 0 10 20 m
5 0 5 10 m
VERTICAL SCALE



F-F'
1

SOUTH TOE PROFILE
HIGHWAY 17 (EBL)

HORIZONTAL SCALE
10 0 10 20 m
5 0 5 10 m
VERTICAL SCALE

LEGEND

- Borehole
- Dynamic Cone Penetration Test
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R — Refusal
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H2-23	239.6	5136249.0	273909.0
H2-25	239.7	5136280.0	273923.8
H2-27	239.7	5136265.8	273952.9
H2-28	239.8	5136292.2	273957.6
H2-30	239.7	5136283.3	273985.8
H2-32	239.8	5136307.3	273993.6
H2-34	239.7	5136295.0	274025.3
H2-36	239.8	5136325.5	274040.2
H2-38	239.8	5136313.2	274071.8
H2-40	240.0	5136342.7	274086.8
H2-42	241.8	5136332.8	274117.9
H2-DC11	239.6	5136270.9	273900.5
H2-DC12	239.7	5136258.6	273932.1
H2-DC13	239.7	5136285.9	273940.9
H2-DC14	239.6	5136273.5	273970.3
H2-DC15	239.7	5136300.8	273976.8
H2-DC16	239.7	5136285.3	274002.2
H2-DC17	239.8	5136315.3	274016.6
H2-DC18	239.7	5136304.1	274048.6
H2-DC19	240.0	5136333.2	274063.5
H2-DC20	239.7	5136322.3	274095.1
H2-DC21	240.3	5136352.8	274110.0

NOTES

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REFERENCE

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LICENCED PROFESSIONAL ENGINEER
S.E.M. POOT
90471921
APR 15, 2015
PROVINCE OF ONTARIO

LICENCED PROFESSIONAL ENGINEER
J.M.A.COSTA
APR 15, 2015
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17		PROJECT NO. 11-1191-0007	DIST.
SUBM'D. EC	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. B4

PLOT DATE: June 30, 2015
FILENAME: \\golder.gds\gal\sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0007 HWY 17 4 Laning\11119100078A002_H2.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

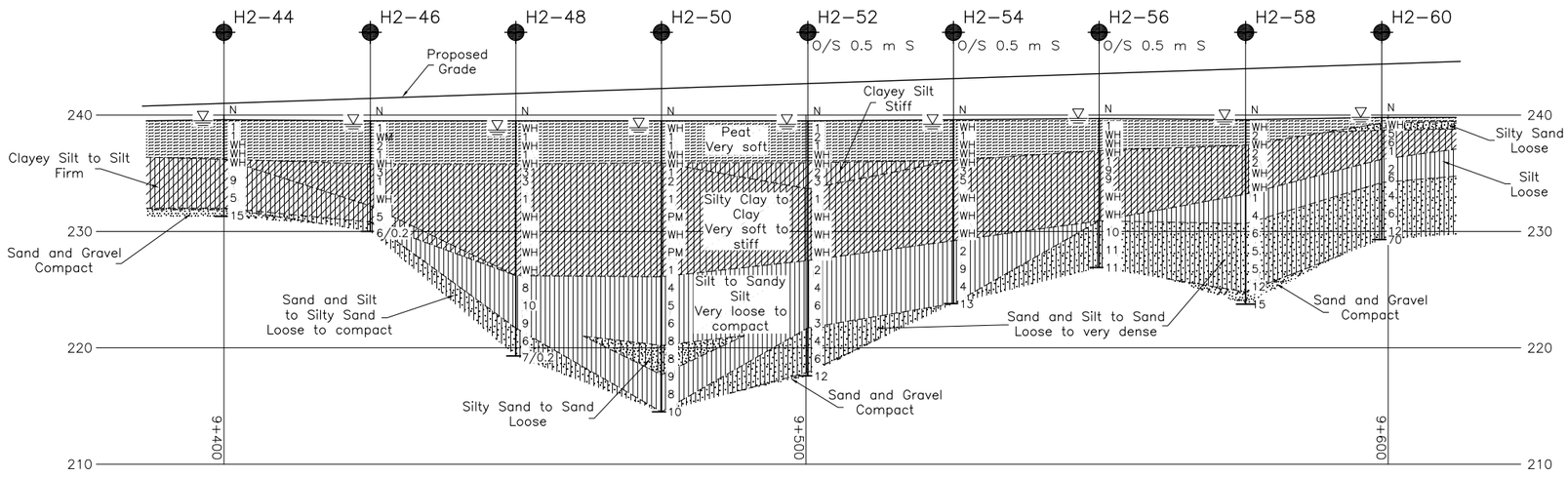
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 156-98-00

HIGHWAY 17 4 LANING
ST. POITHIER RD. – STA 9+400 TO 9+600
SOIL STRATA

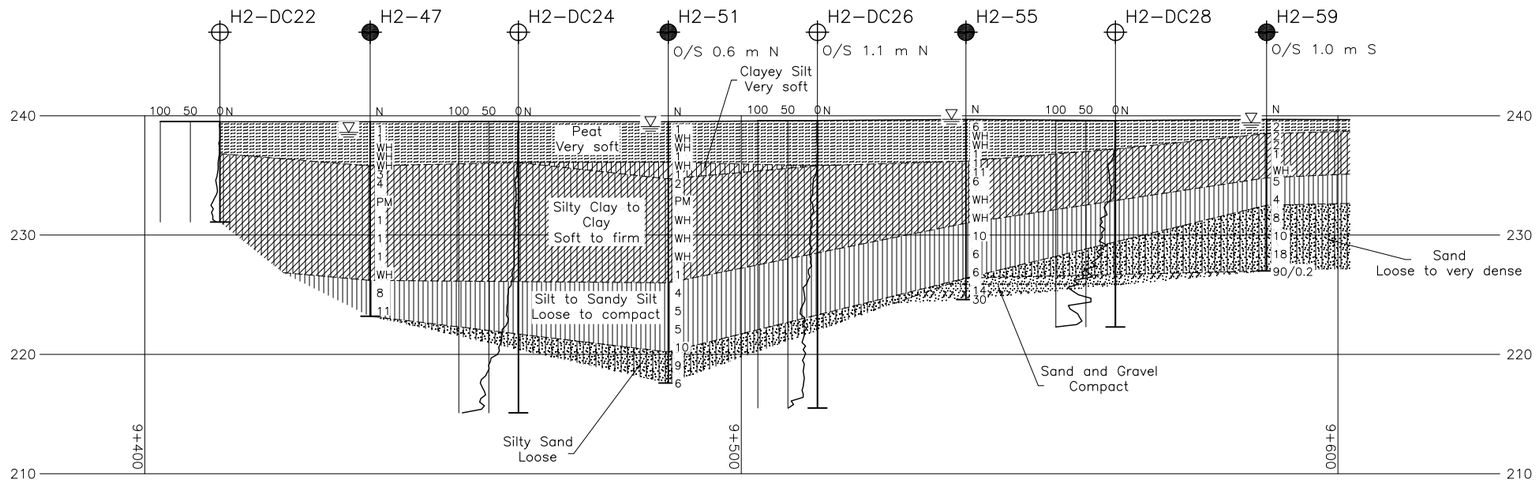
SHEET

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



G-G' / 1 **CENTRELINE PROFILE**
ST. POTHIER ROAD

HORIZONTAL SCALE
10 0 10 20 m
5 0 5 10 m
VERTICAL SCALE



H-H' / 1 **NORTH TOE PROFILE**
ST. POTHIER ROAD

HORIZONTAL SCALE
10 0 10 20 m
5 0 5 10 m
VERTICAL SCALE

LEGEND

- Borehole
- Dynamic Cone Penetration Test
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H2-44	239.6	5136221.5	273947.3
H2-46	239.5	5136230.7	273970.8
H2-47	239.5	5136245.4	273978.6
H2-48	239.5	5136239.8	273994.0
H2-50	239.5	5136248.9	274017.3
H2-51	239.5	5136264.2	274024.9
H2-52	239.5	5136257.6	274040.9
H2-54	239.6	5136266.7	274064.2
H2-55	239.7	5136281.8	274071.6
H2-56	239.7	5136275.8	274087.5
H2-58	239.6	5136285.3	274110.8
H2-59	239.7	5136299.2	274118.9
H2-60	239.8	5136293.8	274132.6
H2-DC22	239.5	5136236.6	273955.0
H2-DC24	239.5	5136254.8	274001.6
H2-DC26	239.6	5136273.8	274048.0
H2-DC28	239.6	5136291.0	274094.8

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LICENSED PROFESSIONAL ENGINEER S.E.M. POOT 90471921 APR 15, 2015 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.M.A.COSTA APR 15, 2015 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17		PROJECT NO. 11-1191-0007	DIST.
SUBM'D. EC	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. B5

PLOT DATE: April 15, 2015
FILENAME: \\golder.gds\gal\Sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0007 HWY 17 4 Laning\11119100074002_H2.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

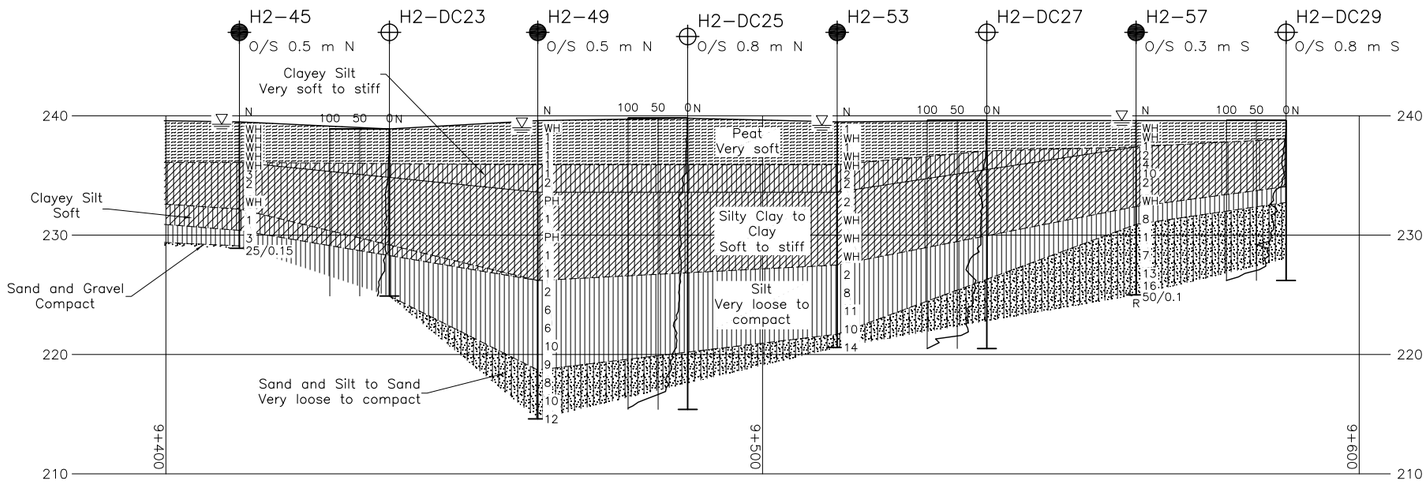
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 156-98-00

HIGHWAY 17 4 LANING
ST. POITHIER RD. – STA 9+400 TO 9+600
SOIL STRATA

SHEET

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



I–I'
1

SOUTH TOE PROFILE
ST. POTHIER ROAD

HORIZONTAL SCALE
10 0 10 20 m
5 0 5 10 m
VERTICAL SCALE

LEGEND

- Borehole
- Dynamic Cone Penetration Test
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R — Refusal
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H2-45	239.5	5136216.0	273962.7
H2-49	239.6	5136234.2	274009.3
H2-53	239.5	5136251.8	274056.3
H2-57	239.6	5136269.9	274103.0
H2-DC23	238.9	5136224.7	273986.3
H2-DC25	239.8	5136243.6	274032.6
H2-DC27	239.6	5136261.1	274079.6
H2-DC29	239.6	5136278.6	274126.6

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S.E.M. POOT
90471921
APR 15, 2015
PROVINCE OF ONTARIO

LICENCED PROFESSIONAL ENGINEER
J.M.A.COSTA
APR 15, 2015
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NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17	PROJECT NO. 11-1191-0007		DIST.
SUBM'D. EC	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. B6

PLOT DATE: June 30, 2015
FILENAME: \\golder.gds\gal\Sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0007 HWY 17 4 Laning\11119100070A002_H2.dwg

Golder Associates

RECORD OF BOREHOLE No H2-1

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136289.9; E 273879.1
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
COMPILED BY EC
DATUM Geodetic
DATE April 10, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
240.7	GROUND SURFACE										
0.0	ORGANICS										
0.1	CLAYEY SILT, trace sand, trace organics Stiff Brown Moist		1	SS	9						
			2	SS	13		240				
			3	SS	15		239				
238.5											
2.2	Sandy SILT, trace clay Compact Grey Wet		4A 4B	SS	15						
238.0							238				
2.8	Gravelly SAND, trace to some silt Brown Wet										
	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) AND AUGER REFUSAL										

Note:

1. Borehole dry upon completion of drilling.

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

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-2

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136284.4; E 273895.2
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
COMPILED BY EC
DATUM Geodetic
DATE April 10, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.7	GROUND SURFACE										
0.0 / 238.9	PEAT (Fibrous) Black Frozen to wet		1	SS	3		239				
0.8	CLAYEY SILT Firm to stiff Grey to brown Wet		2	SS	4						
			3	SS	8		238				
			4	SS	3	▽	237	6			
			5	SS	WH		236				
234.6							235	5			
5.1	Sandy SILT, some gravel, trace clay Compact Grey Wet		6	SS	15		234				13 29 55 3
233.7											
6.0	Spoon bouncing at 5.9 m depth. END OF BOREHOLE AUGER REFUSAL										

Note:

1. Water level at a depth of 3.0 m below ground surface (Elev. 236.7 m) upon completion of drilling.

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-3

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136299.6; E 273902.2 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 11, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.8	GROUND SURFACE										
0.0	PEAT (Fibrous to amorphous) Very soft Black Frozen to wet		1	SS	5		239				
			2	SS	WH				67		
			3	SS	WH		238				
237.5											
2.3	SILTY CLAY to CLAY Stiff Grey Wet		4	SS	5		237	8			
235.8			5A 5B	SS	WH		236				
4.0	SILT, some clay Very loose Grey Wet		6	SS	WH		235			NP	0 0 84 16
233.6			7	SS	10/0.28		234				
6.2	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) AND REFUSAL TO FURTHER CASING ADVANCEMENT Note: 1. Water level at ground surface (Elev. 239.8 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-4

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136319.3; E 273911.6 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 11, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.7	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	7	▽	239				
			2	SS	WH				66		
			3	SS	WH		238				
			4	SS	WH		237				
236.3			5	SS	WH						
3.4	SILTY CLAY Soft Grey Wet		6	SS	WH		236				
							235	+ 16			
			7	SS	WH		234				
232.8								+ 3			
6.9	SILT, trace to some clay Very loose Grey to brown Wet						233				
			8	SS	2		232				0 0 92 8
230.8	Spoon attempted at 8.9 m depth, spoon bouncing.						231				
8.9	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING)										

Notes:

1. Water level at a depth of 0.3 m below ground surface (Elev. 239.4 m) upon completion of drilling.

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-5

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136309.9; E 273929.2
ORIGINATED BY EHS
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE April 11 and 12, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.8	GROUND SURFACE										
0.0	PEAT (Fibrous to amorphous) Very soft Black Frozen to wet		1	SS	WH	▽	239				
			2	SS	WH						
			3	SS	WH		238				
			4	SS	WH		237				
236.4			5	SS	WH						
3.4	CLAY Soft to firm Black Wet						236	7			
	Varved below 4.9 m depth.		6	SS	WH		235	8			
			7	SS	WH		234				
232.4							233	10			
7.4	SILT, some clay Loose Grey Wet		8	SS	4		232				0 0 87 13
			9	SS	8		231				
229.6							230				
10.2	SAND and SILT, trace gravel Compact Grey Wet		10	SS	18		229				
228.5											
11.3	END OF BOREHOLE						228				
226.9							227				
12.9	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

Notes:

1. Water level at a depth of 0.8 m below ground surface (Elev. 239.0 m) upon completion of drilling.

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

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-6

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136305.7; E 273942.7 | ORIGINATED BY AC

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 3 and 4, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
239.8	GROUND SURFACE					
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	1	
			2	SS	WH	
			3	SS	WH	
			4	SS	WH	
			5	SS	WH	
236.2						
3.6	CLAY, varved Soft Grey to brown Wet		6	SS	WH	
			7	SS	WH	
			8	SS	WH	
			9	SS	WH	
231.1						
8.7	SILT, trace sand, trace clay Very loose Grey Wet		10	SS	4	
			11	SS	3	
228.1						
11.7	SAND and SILT, trace clay Very loose to compact Grey Wet		12	SS	11	
			13	SS	3	
	Casing grinding was noted at 14.9 m depth.					

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

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

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

WATER CONTENT (%) (20 40 60)

ELEVATION SCALE: 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225

UNIT WEIGHT γ kN/m³

NP

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

0 34 64 2

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-6

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136305.7; E 273942.7 | ORIGINATED BY AC

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 3 and 4, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
	SAND and SILT, trace clay Very loose to compact Grey Wet		14	SS	2		224				
223.5											
16.3	SAND, some silt Loose Grey Wet Spoon attempted at 17.7 m depth, spoon bouncing.		15	SS	7		223				
222.1											
17.7	END OF BOREHOLE REFUSAL TO FURTHER CASING ADVANCEMENT Notes: 1. Water level 0.5 m above ground surface (Elev. 240.3 m) upon completion of drilling. 2. On April 5, 2012, the water level was measured in the casing at 0.5 m above ground surface (Elev. 240.3 m); approximately 3.7 m of sand and silt heave was measured in casing.										

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

Golder Associates

RECORD OF BOREHOLE No H2-7

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136317.2; E 273949.0 | ORIGINATED BY AC

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE March 30, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.9	GROUND SURFACE						
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	10		
			2	AS	WH		
			3	SS	WH		
			4	SS	WH		
			5	SS	WH		
235.9							
4.0	SILTY CLAY to CLAY Soft to stiff Grey Wet		6	SS	WH		
			7	SS	WH		0 0 35 65
			8	SS	WH		
231.2							
8.7	CLAYEY SILT Very soft Grey Wet		9	SS	1		
229.7							
10.2	SILT, trace clay, trace sand Loose Grey Wet		10	SS	9		
			11	SS	10		0 3 93 4
	Casing grinding was noted at 13.1 m depth.		12	SS	5		
225.6							
14.3	END OF BOREHOLE						

ELEVATION SCALE: 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

+12 +6 +4 +4 +4 ○40

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-7

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136317.2; E 273949.0
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE March 30, 2012
CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
	END OF BOREHOLE						224 223 222 221				
220.4											
19.5	END OF DCPT REFUSAL TO FURTHER PENETRATION HAMMER BOUNCING (100 Blows / 0.15 m)										

Notes:

1. Water level at ground surface (Elev. 239.9 m) upon completion of drilling. Water level measured in casing at a height of 0.8 m above ground surface (Elev. 240.7 m) prior to removing casing.

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

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

Golder Associates

RECORD OF BOREHOLE No H2-8

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136332.8; E 273956.8 | ORIGINATED BY AC

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 2 and 3, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
239.9	GROUND SURFACE					
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	5	
			2	SS	4	
			3	SS	WH	
			4	SS	WH	
			5	SS	WH	
236.2						
3.7	CLAY Soft to stiff Grey Wet		6	SS	1	
	Varved below 5.3 m depth.		7	SS	1	
			8	SS	WH	
			9	SS	WH	
231.0						
8.9	CLAYEY SILT to SILT Firm Grey Wet		10	SS	WH	
229.7						
10.2	SILT, trace to some sand, trace clay Loose Grey Wet		11	SS	6	
			12	SS	6	
	Casing grinding was noted at 13.1 m depth.					
226.6						
13.3	SAND and SILT, trace gravel, trace clay Loose to compact Grey Wet		13	SS	5	

ELEVATION SCALE: 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

0 8 88 4

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Continued Next Page

Golder Associates

RECORD OF BOREHOLE No H2-8

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136332.8; E 273956.8 | ORIGINATED BY AC

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 2 and 3, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND and SILT, trace gravel, trace clay Loose to compact Grey Wet		14	SS	12		224		○		3 40 54 3
223.6											
16.3	SAND, trace gravel, trace silt Compact Grey Wet		15	SS	11		223				
222.5											
17.4	END OF BOREHOLE Note: 1. Water level at ground surface (Elev. 239.9 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-9

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136326.6; E 273972.2 | ORIGINATED BY AC

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 2, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.8	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	2						
			2	SS	1		239		574.6		
			3	SS	WH		238				
			4	SS	WH		237				
236.4			5	SS	WH						
3.4	SILTY CLAY Soft to stiff Grey Wet		6	SS	WH		236				2 18 39 41
							235	8			
	Varved below 5.6 m depth.		7	SS	WH		234	5			
			8	SS	WH		233				
							232	4, 7			
			9	SS	3		231				
229.6							230	3			
10.2	SILT, trace to some sand, trace clay Very loose to compact Grey Wet		10	SS	6		229				
			11	SS	7		228				0 8 89 3
			12	SS	2		227				
							226				
							225				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-9

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136326.6; E 273972.2 | ORIGINATED BY AC

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 2, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---									
	SILT, trace to some sand, trace clay Very loose to compact Grey Wet		13	SS	5		224			
			14	SS	14		223		○	
			15	SS	12		222			
	1.5 m of heave encountered at 18.9 m depth.						221			
220.0 19.8	END OF BOREHOLE						220			

Note:

1. Water level at ground surface (Elev. 239.8 m) upon completion of drilling.

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-10

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136320.7; E 273988.4 | ORIGINATED BY AC

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing and Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE March 23, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.8	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	3	▽	239				
			2	SS	WH						
			3	SS	WH		238		52%		
			4	SS	WH		237				
236.3			5	SS	WH						
3.5	CLAY Soft to firm Grey Wet						236	7			
			6	SS	3		235				
								8			
			7	SS	WH		234				
							233	5			
			8	SS	WH		232				
230.9								5			
8.9	SILT, trace sand, trace clay Loose Grey Wet		9	SS	4		231			NP	
			10	SS	8		230				
			11	SS	9		229				0 2 93 5
226.6							228				
13.3	Sandy SILT, trace clay Very loose to loose Grey Wet		12	SS	3		227				
							226				
							225				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-10

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136320.7; E 273988.4 | ORIGINATED BY AC

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing and Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE March 23, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Sandy SILT, trace clay Very loose to loose Grey Wet		13	SS	5		224				
			14	SS	10		223		○		0 28 69 3
			15	SS	9		222				
220.9							221				
18.9	END OF BOREHOLE Note: 1. Water level at a depth of 0.6 m below ground surface (Elev. 239.2 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-11

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136334.7; E 273993.6 | ORIGINATED BY AC

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 26, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.8	GROUND SURFACE										
0.0	PEAT (Fibrous to amorphous) Very soft Black Frozen to wet		1	SS	2						
			2	SS	WH		239				
			3	SS	WH	▽	238		28		
			4	SS	WH		237				
236.4			5	SS	WH						
3.4	CLAY, varved Soft to stiff Grey to brown Wet						236	4			
			6	SS	WH		235	5			
			7	SS	WH		234				
232.6							233	11			
7.2	CLAYEY SILT Firm to stiff Grey Wet		8	SS	3		232				
230.9							231	3			
8.9	SILT, some clay, trace sand Loose Grey Wet		9	SS	8		230				0 1 86 13
			10	SS	5		229				
	Between 0.6 m and 1.5 m of heave encountered below 12.2 m depth.		11	SS	5		228				
226.5							227				
13.3	Sandy SILT, trace clay Loose to compact Gery Wet		12	SS	8		226				
	Auger grinding was noted at 14.6 m depth.						225				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-11

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136334.7; E 273993.6 | ORIGINATED BY AC

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 26, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Sandy SILT, trace clay Loose to compact Gery Wet		13	SS	10		224		○		0 24 74 2
222.4			14	SS	10		223				
17.4	END OF BOREHOLE Note: 1. Water level at a depth of 1.6 m below ground surface (Elev. 238.2 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-12

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136351.0; E 274003.6 | ORIGINATED BY EHS

DIST — HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 21, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.9	GROUND SURFACE							
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	18			
			2	SS	WH			
	No recovery in sample from 1.5 m to 2.1 m depth.		-	SS	WH			
237.2			3A 3B	SS	WH			
2.7	SILTY CLAY, trace sand, varved Soft to firm Grey to brown Wet		4	SS	2			
			5	SS	WH	▽		
			6	SS	WH			
232.5								
7.4	SILT, trace to some clay, trace sand Very loose to loose Grey Wet		7	SS	5			0 1 88 11
			8	SS	5			
	Between 0.6 m and 4.0 m of heave encountered below 9.8 m depth.							
			9	SS	WH			
227.7			10	AS	-			
12.2	END OF BOREHOLE							

ELEVATION SCALE: 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

182.1

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

Continued Next Page

Golder Associates

RECORD OF BOREHOLE No H2-12

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136351.0; E 274003.6 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 21, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF BOREHOLE						224 / 223 / 222 / 221 / 220				
219.6 / 20.3	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.15 m) Notes: 1. Water level at a depth of 4.7 m below ground surface (Elev. 235.2 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-13

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136344.5; E 274018.8 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 21, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.9	GROUND SURFACE								
0.0	PEAT (Fibrous to amorphous) Very soft Black Frozen to wet		1	SS	13	▽	239		
			2	SS	WH				
			3	SS	WH		238		
			4	SS	WH		237		
236.5			5	SS	WH				
3.4	SILTY CLAY, trace sand, varved Soft to firm Grey to brown Wet		6	SS	WH		236		
			7	SS	WH		235		
			8	SS	3		234		
231.1							233		
8.8	SILT, trace to some sand, trace clay Very loose Grey Wet		9	SS	WH		232		0 8 87 5
	Between 1.5 and 4.6 m of heave encountered below 9.1 m.						231		
228.6			10	SS	WH		230		
11.3	END OF BOREHOLE						229		
							228		
							227		
							226		
							225		

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

+10 (235); +4 (234); +14 (231); ○38 (239); ○ (236); ○ (234); ○ (231)

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-13

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136344.5; E 274018.8 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 21, 2012 | CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
224.7											
15.2	END OF DCPT										

Notes:

1. Water level at a depth of 0.9 m below ground surface (Elev. 239.0 m) upon completion of drilling.

2. Borehole H2-13 was terminated due to heaving in the augers that jammed the rods.

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

Golder Associates

RECORD OF BOREHOLE No H2-14

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136338.5; E 274035.1 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 20 and 21, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.8	GROUND SURFACE							
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	15			
			2	SS	WH			
			3	SS	WH			
			4	SS	WH			
			5	SS	WH			
235.8								
4.0	SILTY CLAY, trace sand, varved Soft to firm Grey to brown Wet		6	SS	WH			
			7	SS	WH			
			8	SS	WH			
231.3								
8.5	SILT, some sand, trace clay Very loose Grey Wet		9	SS	WH		NP	
229.7	Between 0.5 m and 2.1 m of heave encountered below 9.7 m.							
10.1	Silty SAND, trace gravel Very loose Grey Wet		10	SS	1			
			11	AS	-			1 74 (25)
227.6								
12.2	END OF BOREHOLE							

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

ELEVATION SCALE: 239 238 237 236 235 234 233 232 231 230 229 228 227 226 225

+ 11 + 10 + 2 + 13

○ 43 ○ 82

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-14

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136338.5; E 274035.1 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 20 and 21, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF BOREHOLE						224				
							223				
							222				
							221				
219.8							220				
20.0	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.20 m) Notes: 1. Water level at a depth of 0.1 m below ground surface (Elev. 239.7 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-15

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136353.5; E 274042.1 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 20, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.9	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	27						
			2	SS	1	▽			467		
			3	SS	WH						
237.6											
2.3	SILTY CLAY Soft to firm Grey Wet		4	SS	3						
			5	SS	WH			9			
	Varved below 5.3 m depth.		6	SS	WH			16			0 1 63 36
232.9											
7.0	SILT, trace sand Very Loose Grey Wet		7	SS	1						
231.2	Between 0.9 m and 2.4 m of heave encountered below 8.2 m.										
8.7	SAND, some silt, trace gravel Very loose to loose Grey Wet		8	SS	WH						
			9	SS	7						4 81 (15)
228.6											
11.3	END OF BOREHOLE										
226.2											
13.7	END OF DCPT Notes: 1. Water level at a depth of 1.4 m below ground surface (Elev. 238.5 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-16

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136369.1; E 274050.0 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 19, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
240.0	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	8						
238.9			2	SS	3		239				
1.1	SILTY CLAY Soft to firm Grey to brown Wet		3	SS	5	▽					
	Varved below 2.4 m depth.		4	SS	WH		238				
							237	13			
			5	SS	WH		236				0 1 68 31
234.7								9			
5.3	SILT, trace to some sand, trace clay Loose Grey Wet		6	SS	4		235				
233.3			7	SS	4		234				0 9 89 2
6.7	SAND, trace to some gravel Grey Wet		8	AS	-		233				
232.4	4.9 m of heave encountered at 7.6 m.										
7.6	END OF BOREHOLE						232				
							231				
							230				
229.3											
10.7	END OF DCPT Notes: 1. Water level at a depth of 1.5 m below ground surface (Elev. 238.5 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-17

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136363.0; E 274065.6 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 19, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.9	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	31						
			2	SS	WH						
237.8			3	SS	WH	▽					
2.1	SILTY CLAY Soft to stiff Grey to brown Wet		4	SS	6						
	Varved below 3.8 m depth.		5	SS	WH						
232.5			6	SS	WH						
7.4	SILT, trace sand, trace clay Very loose Grey Wet Between 0.3 m and 2.4 m of heave encountered below a depth of 8.2 m.		7	SS	3						0 2 93 5
229.2			8	SS	WH						
10.7	SAND, some silt, some gravel Very loose Grey Wet		9	SS	1						18 66 (16)
228.6											
11.3	END OF BOREHOLE										
227.8											
12.1	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING) Notes: 1. Water level at a depth of 1.8 m below ground surface (Elev. 238.1 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-18

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136356.7; E 274081.7 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 9, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
240.1	GROUND SURFACE							
0.0	PEAT (Fibrous) Very soft Brown to black Frozen to wet		1	SS	7	▽		
			2	SS	1			
238.4								
1.7	CLAY Firm Grey to brown Wet		3	SS	WH			
			4	SS	6			
	Varved below 3.0 m depth.		5	SS	3			
			6	SS	WH			
234.5								
5.6	CLAYEY SILT, trace sand, varved Firm Grey Wet		7	SS	1			
232.9								
7.2	SILT, trace to some clay, trace sand Very loose to loose Grey Wet		8	SS	5		NP	0 3 89 8
			9	SS	7			
	Between 0.3 m and 1.5 m of heave encountered below 9.8 m depth.		10	SS	WH			
228.4								
11.7	Silty SAND, trace to some gravel Very loose Grey Wet		11	SS	2			
226.4								
13.7	END OF BOREHOLE							

ELEVATION SCALE: 240, 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

+ 4 (236), + 9 (235), + 6 (233), ○ 42% (239), ○ (238), ○ (234), ○ (232), ○ (229)

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-18

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136356.7; E 274081.7 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 9, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF BOREHOLE						225				
							224				
							223				
222.0											
18.1	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING) Notes: 1. Water level at a depth of 0.9 m below ground surface (Elev. 239.2 m) upon completion of drilling.						222				

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

Golder Associates

RECORD OF BOREHOLE No H2-19

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136372.0; E 274089.0 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 8 and 9, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
240.2	GROUND SURFACE						240				
0.0	PEAT (Fibrous to amorphous) Very soft Brown to black Frozen to wet		1	AS	-						
239.1			2	SS	4		239				
1.1	CLAY, trace sand Firm to stiff Grey to brown Moist to wet		3	SS	12	▽					
			4	SS	4		238				
			5	SS	2		237				
235.9							236	4 +			
4.3	CLAYEY SILT, varved Firm Grey Wet		6	SS	1				○		0 0 75 25
234.3							235	3 +			
5.9	SILT, trace to some clay, trace sand Very loose to compact Grey Wet		7	SS	4		234				
	Between 0.3 m and 0.9 m of heave encountered below 7.6 m depth.		8	SS	4		233		○		0 5 88 7
			9	SS	WR		232				
			10	SS	WH		231				
			11	SS	29		230				
226.9							229				
13.3	Gravelly SAND, some silt, trace clay Loose to compact Grey Wet		12	SS	6		228				
							227				
							226		○		23 62 14 1

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-19

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136372.0; E 274089.0 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 8 and 9, 2012 | CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	WATER CONTENT (%) 20 40 60		
224.4	Gravelly SAND, some silt, trace clay Loose to compact Grey Wet		13	SS	17		225				
15.8	END OF BOREHOLE Note: 1. Water level at a depth of 2.0 m below ground surface (Elev. 238.2 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-20

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136384.5; E 274097.7 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 8, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
240.4	GROUND SURFACE										
0.0 / 240.1	PEAT (Fibrous) Black Wet		1	AS	-	▽	240				
0.3	SILTY CLAY, some sand, trace organics Firm to stiff Brown Wet		2	SS	6						
			3	SS	8		239				
	Varved below 2.3 m depth.		4	SS	5		238				
237.0							237	11			
3.4	CLAYEY SILT, trace sand Firm Grey Wet		5	SS	WH						
							236	13			
			6	SS	3		235				
233.2							234				
7.2	SILT, some sand , trace clay Very loose to loose Grey Wet		7	SS	4		233				
	Between 0.6 m and 1.8 m of heave encountered below a depth of 8.2 m.						232				
			8	SS	WH		231				0 17 79 4
			9	SS	8		230				
228.7							229				
11.7	SAND and SILT, some gravel, trace clay Compact Grey Wet		10	SS	18		228				13 42 42 3
227.0	Auger grinding was noted at 12.9 m depth.										
13.4	END OF BOREHOLE AUGER REFUSAL						227				

Notes:

1. Water level at a depth of 0.6 m below ground surface (Elev. 239.8 m) upon completion of drilling.

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-21

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136381.4; E 274112.1 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 7, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
240.3	GROUND SURFACE							
0.0	CLAYEY SILT, some sand Brown Wet		1	AS	-	▽		
239.5								
0.8	SILTY CLAY Firm to stiff Grey to brown Wet		2	SS	11			
			3	SS	9			
	Varved below 2.3 m depth.		4	SS	1			
			5	SS	1			
236.0								
4.3	SILT, trace to some clay Very loose Grey Wet		6	SS	4		NP	
234.7								
5.6	Sandy SILT, trace clay Very loose Grey Wet		7	SS	WH		NP	0 22 76 2
	Between 0.9 m and 1.2 m of heave encountered below depth of 6.7 m		8	SS	WH			
231.6								
8.7	SAND, trace to some silt, trace gravel Very loose to compact Grey Wet		9	SS	2			
			10	SS	17			
229.0								
11.3	END OF BOREHOLE							

ELEVATION SCALE: 240, 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

+3, ×3: Numbers refer to Sensitivity

○3% STRAIN AT FAILURE

Continued Next Page

Golder Associates

RECORD OF BOREHOLE No H2-21

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136381.4; E 274112.1 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 7, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF BOREHOLE						225				
224.0											
16.3	END OF DCPT REFUSAL TO FURTHER PENETRATION (53 Blows / 0.15 m)						224				

Notes:

1. Water level at a depth of 0.8 m below ground surface (Elev. 239.5 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No H2-22

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136255.2; E 273892.6
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
COMPILED BY EC
DATUM Geodetic
DATE April 10, 2012
CHECKED BY SEMP

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
240.3	GROUND SURFACE										
0.0	ORGANICS										
0.1	SILT, trace to some sand, trace clay Loose to compact Brown Moist to wet		1	SS	6		240				
			2	SS	15				○	NP	
							239				
			3	SS	12						
							238				
			4	SS	17				○		0 8 88 4
237.1			5	SS	5/0.2						
3.2	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) AND AUGER REFUSAL										

Note:

1. Borehole dry upon completion of drilling.

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-23

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136249.0; E 273909.0 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE April 11, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.6	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	WH		239				
			2	SS	WH				297		
237.9							238				
1.7	CLAYEY SILT, trace organics Firm Grey Wet		3	SS	7						
237.4											
2.2	SAND and SILT, trace gravel, trace clay Loose to compact Grey Wet		4	SS	6		237				
			5	SS	11						1 35 62 2
235.7							236				
3.9	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) AND AUGER REFUSAL		6	AS	7/0.1						

Notes:

1. Water level at ground surface (Elev. 239.6 m) upon completion of drilling.

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-24

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136264.2; E 273916.0
ORIGINATED BY EHS
DIST _____ HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
COMPILED BY EC
DATUM Geodetic
DATE April 19, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.6	GROUND SURFACE								
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	6	▽	239		
			2	SS	WH				
237.4			3	SS	WH		238		
2.2	SILT, trace to some sand, trace clay Loose Grey Wet		4	SS	6		237		0 9 87 4
235.9			5	SS	8		236		
3.7	SAND and GRAVEL, some silt Compact Grey Wet		6	SS	16		235		
234.4			7	SS	25				
5.2	END OF BOREHOLE						234		
233.8									
5.8	END OF DCPT REFUSAL TO FUTHER PENETRATION (HAMMER BOUNCING) Notes: 1. Water level at a depth of 0.3 m below ground surface (Elev. 239.3 m) upon completion of drilling. 2. Augers sliding north at a depth of 4.3 m below existing ground surface.								

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-25

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
DIST _____ HWY 17
DATUM Geodetic
LOCATION N 5136280.0; E 273923.8
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring
DATE April 19, 2012
ORIGINATED BY EHS
COMPILED BY EC
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.7	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	3	▽	239				
			2	SS	WH						
			3	SS	WH		238		○ 63		
			4	SS	WH		237				
236.7											
3.0	SILTY CLAY Soft Grey to brown Wet		5	SS	1		236	+ 35			
								+ 8			
	Varved below 4.9 m depth.		6	SS	WH		235		○		
								+ 10			
			7	SS	WH		234				
232.8							233	+ 9			
6.9	SILT, trace to some sand Very loose Grey Wet		8	SS	3		232				
231.2											
8.5	SAND and GRAVEL, some silt, trace clay Compact Grey						231				
230.3	Wet		9	SS	61/0.28				○		33 47 18 2
9.4	Possible boulder at 9.2 m depth.										
	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING)										

Notes:

1. Advanced Borehole 1.0 m west of Borehole H2-25. obtained a Shelby tube sample at a depth of 3.8 m and vane at a depth of 4.6 m below existing ground surface.

2. Water level at a depth of 0.8 m below ground surface (Elev. 238.9 m) upon completion of drilling.

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-26

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136275.4; E 273944.9 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 18, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.7	GROUND SURFACE										
0.0	PEAT (Fibrous to amorphous) Very soft Black Frozen to wet		1	SS	4	▽	239				
			2	SS	WH				64		
			3	SS	WH		238				
237.2											
2.5	CLAY, varved Soft to firm Grey to brown Wet Trace organics above 3.0 m depth.		4	SS	WH		237				
			5	SS	2						
							236	9			
			6	SS	WH		235		81		
								5			
			7	TO	PH		234			16.6	
232.6							233	7			
7.1	CLAYEY SILT, trace sand Firm Grey Wet		8	SS	WH		232				
								19			
230.5							231				
9.2	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 0.8 m below ground surface (Elev. 238.9 m) upon completion of drilling.		9	SS	8/0.05						

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-27

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136265.8; E 273952.9
ORIGINATED BY EHS
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE April 20 and 23, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.7	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	1		239				
			2	SS	WH						
			3	SS	WH		238		33		
237.3											
2.4	CLAY, varved Soft to firm Grey to brown Wet Silt layer between 2.6 m and 3.2 m depth.		4	SS	2		237				
			5	SS	2						
							236	15			
			6	SS	WH		235				
								6			
			7	SS	WH		234				
							233	9			
232.2											
231.9	Sandy GRAVEL, some silt Compact Grey Wet		8	SS	12/0.2		232				
7.8	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING)										
	Note: 1. Water level 0.3 m above ground surface (Elev. 240.0 m) upon completion of drilling.										

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No H2-28

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136292.2; E 273957.6 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 12 and 13, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.8	GROUND SURFACE								
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	2				
			2	SS	WH		239		
			3	SS	WH		238		
			4	SS	WH		237		
			5	SS	WH				
236.1							236		
3.7	CLAY to SILTY CLAY Soft to stiff Grey to brown Wet Varved between 3.7 m depth and 5.9 m depth.		6	SS	4				
			7	SS	WH		235		
			8	SS	WH		234		
			9	SS	WH		233		0 1 64 35
229.6							232		
10.2	SILT, trace to some clay, trace sand Very loose Grey Wet		10	SS	WH		231		
			11	SS	3		230	NP	0 5 89 6
			12	SS	1		229		
225.0							228		
14.8							227		
							226		
							225		

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

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

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

WATER CONTENT (%) (20 40 60)

+3, ×3: Numbers refer to Sensitivity

○3% STRAIN AT FAILURE

Continued Next Page

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H2-28

 METRIC

G.W.P. 156-98-00 LOCATION N 5136292.2; E 273957.6 ORIGINATED BY EHS

DIST HWY 17 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE April 12 and 13, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
223.7	SAND, some gravel, trace to some silt Loose Grey Wet		13	SS	9		224				
16.1	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) AND REFUSAL TO FURTHER CASING ADVANCEMENT Notes: 1. Moved over 1.5 m west of Borehole H2-28 and advanced augers to a depth of 5.5 m below existing ground surface. Obtained a Shelby tube at 5.5 m depth below existing ground surface. 2. Water level measured in casing at 1.4 m above ground surface (Elev. 241.2 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-29

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136285.6; E 273970.8 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 13 and 16, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
239.8	GROUND SURFACE					
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	9	
			2	SS	WH	
			3	SS	WH	
			4	SS	WH	
236.4			5	SS	WH	
3.4	SILTY CLAY Soft to stiff Grey to brown Wet		6	SS	5	
	Varved below 5.6 m depth.		7	SS	WH	
			8	TO	WH	
			9	SS	WH	
			10	SS	WH	
			11	SS	WH	
227.9						
11.9	SILT, trace to some clay, trace sand Very loose to loose Grey Wet		12	SS	WH	
			13	SS	9	

ELEVATION SCALE: 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

NP

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR SA SI CL

0 2 90 8

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-29

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136285.6; E 273970.8 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 13 and 16, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
	SILT, trace to some clay, trace sand Very loose to loose Grey Wet		14	SS	4		224				
			15	SS	7		223				
222.0							222				
17.8	SAND and GRAVEL Compact Grey										
221.2	Wet		16	SS	10/0.15				○		31 48 19 2
18.6	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING)										

Notes:

1. Water level measured in casing at 1.3 m above ground surface (Elev. 241.4 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No H2-30

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136283.3; E 273985.8 | ORIGINATED BY AC

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 4 and 5, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
239.7	GROUND SURFACE					
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	1	
			2	SS	WH	
			3	SS	WH	
			4	SS	WH	
236.2			5	SS	WH	
3.5	CLAYEY SILT Soft Grey Wet		6	SS	5	
			7	SS	3	
234.1						
5.6	SILTY CLAY to CLAY, varved Firm Grey to brown Wet		8	SS	WH	
			9	SS	WH	
			10	SS	WH	
			11	SS	WH	
227.7						
12.0	SILT, trace to some sand, trace clay Very loose to compact Grey Wet		12	SS	WH	
			13	SS	5	

ELEVATION SCALE: 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
0	0	57	43

NP

+ 13

+ 5

+ 5

+ 7

+ 16

○ 56%

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No H2-30

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
DIST HWY 17
DATUM Geodetic
LOCATION N 5136283.3; E 273985.8
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring
DATE April 4 and 5, 2012
ORIGINATED BY AC
COMPILED BY EC
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace to some sand, trace clay Very loose to compact Grey Wet										
			14	SS	13		224				
			15	SS	13		223				
							222				
			16	SS	19		221		○		0 6 91 3
			17	SS	28		220				
							219				
			18	SS	15		218				
217.3											
22.4	SAND and SILT, trace clay Loose Grey Wet		19	SS	10		217		○		0 31 65 4
							216				
			20	SS	8		215				
214.7											
25.0	END OF BOREHOLE Notes: 1. Water level at 0.5 m above ground surface (Elev. 239.7 m) upon completion of drilling. 2. Prior to resuming drilling on April 5, 2012, water level was measured in casing at 0.5 m above existing ground surface (Elev. 240.2 m).										

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

Golder Associates

RECORD OF BOREHOLE No H2-31

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136292.8; E 273989.6 | ORIGINATED BY AC

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE March 28 and 29, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
239.7	GROUND SURFACE					
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	1	
			2	AS	WH	
			3	AS	WH	
			4	SS	WH	
			5	SS	WH	
236.1						
3.6	CLAYEY SILT Very stiff Grey Wet		6	SS	2	
234.4						
5.3	CLAY Soft to firm Grey to brown Wet		7	SS	WH	
	Varved above 6.7 m depth.		8	SS	WH	
			9	SS	WH	
			10	SS	WH	
228.0						
11.7	SILT, trace to some clay Very loose to loose Grey Wet		11	SS	WH	
			12	SS	7	

ELEVATION SCALE: 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
0	0	90	10

>100

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

Continued Next Page

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H2-31

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136292.8; E 273989.6 ORIGINATED BY AC

DIST HWY 17 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE March 28 and 29, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace to some clay Very loose to loose Grey Wet		13	SS	9		224				
223.4											
16.3	Sandy SILT, trace to some clay Very loose to compact Grey Wet		14	SS	7		223				
							222				
			15	SS	15		221		○		
							220				
219.3			16	SS	4						
20.4	END OF BOREHOLE Note: 1. Water level measured in casing at 1.5 m above existing ground surface (Elev. 241.2 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-32

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136307.3; E 273993.6 | ORIGINATED BY AC

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE March 27 and 28, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
239.8	GROUND SURFACE					
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	12	
			2	SS	WH	
			3	SS	WH	
			4	SS	WH	
236.2			5	SS	WH	
3.6	CLAYEY SILT, some gravel, some sand Soft Grey		6	SS	2	
235.3	Wet					
4.5	SILTY CLAY Soft to firm Grey to brown Wet		7	SS	5	
			8	SS	WH	
			9	SS	WH	
			10	SS	WH	
229.6						
10.2	CLAYEY SILT Firm Grey Wet		11	SS	WH	
228.1						
11.7	SILT, trace to some clay Very loose Grey Wet		12	SS	4	
			13	SS	2	
225.0						
14.8						

ELEVATION SCALE: 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

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

NP

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H2-32

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136307.3; E 273993.6 ORIGINATED BY AC

DIST HWY 17 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE March 27 and 28, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	Sandy SILT, trace to some clay Very loose Grey Wet		14	SS	WH		224		○		0 23 74 3
222.6			15	SS	11		223				
17.2	SAND, some gravel, trace silt Compact Grey Wet						222				
220.9			16	SS	24		221		○		19 79 (2)
18.9	END OF BOREHOLE Note: 1. Water level at ground surface (Elev. 239.8 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-33

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136300.2; E 274007.1 | ORIGINATED BY AC

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE March 27, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
239.8	GROUND SURFACE					
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	1	
			2	AS	WH	
			3	SS	WH	
			4	SS	WH	
236.2			5	SS	WH	
3.6	CLAYEY SILT, some sand, some gravel Very stiff Grey Wet		6	SS	WH	
234.8						
5.0	SILTY CLAY, varved Soft to firm Grey to brown Wet		7	SS	WH	
			8	SS	WH	
231.4						
8.4	CLAYEY SILT Firm Grey Wet		9	SS	WH	
			10	SS	WH	
			11	SS	6	
226.5						
13.3	SILT, trace to some sand, trace clay Very loose to compact Grey Wet		12	SS	7	

ELEVATION SCALE: 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227, 226, 225

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

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

650

5

8 5

5 4

5

5

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-33

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136300.2; E 274007.1 | ORIGINATED BY AC

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE March 27, 2012 | CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace to some sand, trace clay Very loose to compact Grey Wet		13	SS	13		224				
			14	SS	8		223		○		0 10 87 3
			15	SS	3		222				
220.4							221				
19.4	SAND, trace gravel Compact Grey Wet		16	SS	11		220		○		
219.4											
20.4	END OF BOREHOLE Note: 1. Water level at ground surface (Elev. 239.8 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-34

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136295.0; E 274025.3 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE April 30, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.7	GROUND SURFACE										
0.0	PEAT (Fibrous to Amorphous) Very soft Black Frozen to wet		1	SS	6		239				
			2	SS	1				624		
			3	SS	1		238				
			4	SS	1		237				
			5	SS	WH						
236.0							236				
3.7	CLAYEY SILT, some sand Very soft Grey Wet		6	SS	WH						
235.2							235				0 0 41 59
4.5	SILTY CLAY, varved Soft Grey Wet		7	SS	6						
			8	SS	1		234				
							233	8			
			9	SS	1		232				
								8			
							231				
			10	SS	WH		230	4			
229.5											
10.2	CLAYEY SILT Soft Grey Wet		11	SS	1		229				
							228	5			
			12	SS	5		227				
226.7											
13.0	SILT, trace to some clay, trace sand Loose Grey Wet		13	SS	8		226			NP	0 1 89 10
							225				

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H2-34

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136295.0; E 274025.3 ORIGINATED BY GM

DIST HWY 17 BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE April 30, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace to some clay, trace sand Loose Grey Wet		14	SS	10		224				
223.4											
16.3	SAND and SILT, trace to some gravel, trace clay Loose to compact Grey Wet Between 0.2 m and 0.3 m of heave encountered below 17.4 m depth.		15	SS	8		223				
			16	SS	13		222				
			17	SS	11		221				9 46 41 4
			18	SS	13		220				
218.2							219				
21.5	END OF BOREHOLE Note: 1. Water level at ground surface (Elev. 239.7 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-35

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136310.1; E 274032.3
ORIGINATED BY GM
DIST HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE May 1 and 2, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.7	GROUND SURFACE										
0.0	PEAT (Fibrous to Amporphous) Very soft Black Frozen to wet		1	SS	8		239				
			2	SS	1						
			3	SS	WH		238		352		
			4	SS	WH		237				
236.3			5	SS	WH						
3.4	CLAYEY SILT, some sand, trace to some gravel Very soft Grey Wet		6	SS	WH		236				
235.0			7A								
4.7	CLAY, varved Soft Grey Wet		7B	SS	7		235				10 13 33 44
			8	SS	WH		234				
			9	SS	WH		233	5			
							232	7			
							231	8			
229.0							230	2			
10.7	SILT, trace to some clay, trace sand Very loose to loose Grey Wet		10	SS	2		229	3		NP	
			11	SS	8		228				
			12	SS	10		227				
224.9							226				0 3 91 6
14.8							225				

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H2-35

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136310.1; E 274032.3 ORIGINATED BY GM

DIST HWY 17 BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE May 1 and 2, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND and SILT, some gravel, trace clay Loose to dense Grey Wet		13	SS	5		224				
	Difficult casing advancement below 16.3 m depth.		14	SS	14		223				
			15	SS	34				○		20 41 37 2
							222				
220.8			16	SS	22		221				
18.9	END OF BOREHOLE Note: 1. Water level at ground surface (Elev. 239.7 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-36

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136325.5; E 274040.2 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 2, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.8	GROUND SURFACE										
0.0	PEAT (Fibrous to Amorphous) Very soft Black Frozen to wet		1	SS	12		239		774		
			2	SS	1						
			3	SS	1		238				
			4	SS	WH		237				
236.3			5A	SS	2						
3.5	SILTY CLAY to CLAY, varved Soft to firm Grey Wet		5B				236				
			6	SS	7						
			7	SS	3		235				
								10			
							234	4			
			8	SS	1						
							233				
			8A	TO	PH					15.6	
								5			
230.1							232				
			9	SS	3		231				
9.7	SILT, trace to some clay, trace gravel Loose Grey Wet						230				
			10	SS	6		229			NP	0 1 86 13
228.1											
11.7	Sandy SILT, trace to some clay, trace gravel Loose Grey Wet						228				
			11	SS	8		227				
	Between 0.2 m and 0.6 m of heave encountered below 14.3 m depth.		12	SS	4		226				1 29 65 5
225.5											
14.3	SAND and GRAVEL Compact Grey Wet						225				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-36

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136325.5; E 274040.2 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 2, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND and GRAVEL Compact Grey Wet		13	SS	12		224				
							223				
222.4			14	SS	16						
17.4	END OF BOREHOLE Note: 1. Water level at ground surface (Elev. 239.8 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 20/10/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-37

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136319.2; E 274055.5 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 3 and 4, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.9	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	14						
			2	SS	1		239		447		
			3	SS	1		238				
			4	SS	1		237				
236.7											
3.2	CLAYEY SILT, trace organics Very soft Grey Wet		5	SS	WH						
236.2											
3.7	SILTY CLAY, varved Soft to firm Grey Wet		6	SS	6		236				
			7	SS	2		235				
								9			
			8	SS	1		234				
							233	3			
								4			
			9	SS	WH		232				
								4			
			10	SS	1		231				
229.7							230				
10.2	SILT, trace to some clay Loose Grey Wet		11	SS	4		229			NP	0 0 91 9
			12	SS	10		228				
226.8							227				
13.1	SAND and SILT, trace gravel Loose to compact Grey Wet		13	SS	7		226				
	Between 0.2 m and 0.3 m of heave encountered below 14.3 m depth.						225				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-37

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136319.2; E 274055.5 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 3 and 4, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND and SILT, trace gravel Loose to compact Grey Wet		14	SS	12		224		○		3 42 55 0
			15	SS	22		223				
222.1											
17.8	Gravelly SAND Compact Grey Wet		16	SS	16		222				
221.0							221				
18.9	END OF BOREHOLE Note: 1. Water level at ground surface (Elev. 239.9 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-38

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136313.2; E 274071.8 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 7 and 8, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.8	GROUND SURFACE										
0.0	PEAT (Fibrous to Amorphous) Very soft Black Frozen to wet		1	SS	5	▽					
			2	SS	WH		239				
			3	SS	WH		238		31 39		
			4	SS	1		237				
236.4			5	SS	1						
3.4	CLAY, varved Very soft to stiff Grey Wet		6	SS	6		236				
							235	8			
			7	SS	WH						
			8	SS	WH		234	5			
232.6							233	5			
7.2	SILT, some clay Very loose Grey Wet		9	SS	2		232				0 0 84 16
231.1											
8.7	SAND and SILT, trace to some gravel, trace clay Loose Grey Wet Between 0.2 m and 1.5 m of heave encountered below depth of 9.9 m.		10	SS	4		231				
			11	SS	5		230				
							229				
			12	SS	8		228				6 43 49 2
226.5							227				
13.3	Gravelly SAND Compact Grey to brown Wet		13	SS	22		226				
225.5											
14.3											

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-38

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136313.2; E 274071.8
ORIGINATED BY GM
DIST HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE May 7 and 8, 2012
CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF BOREHOLE REFUSAL TO FURTHER CASING ADVANCEMENT (HAMMER BOUNCING) Note: 1. Water level at a depth of 0.2 m below ground surface (Elev. 239.6 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-39

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136327.3; E 274078.6 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 4 and 7, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.8	GROUND SURFACE										
0.0	PEAT (Fibrous to Amorphous) Very soft Black Frozen to wet		1	SS	11						
			2	SS	1		239		586		
			3	SS	WH		238				
237.6											
2.2	CLAYEY SILT, trace organics Soft Grey to black Wet		4	SS	WH		237				
236.6											
3.2	SILTY CLAY, varved Soft to firm Grey Wet		5	SS	2		236				
			6	SS	2			5			
			7	SS	WH		235				
							234	4			
			8	SS	1		233				
232.3								7			
7.5	CLAYEY SILT, varved Firm Grey Wet		9	SS	4		232				
230.9								3			
8.9	SAND and SILT, trace clay Very loose Grey to brown Wet Between 0.2 m and 0.9 m of heave encountered below depth of 9.7 m.		10	SS	3		231			NP	0 65 32 3
229.6							230				
10.2	Gravelly SAND Compact to dense Brown Wet		11	SS	8		229				
			12	SS	24		228				
							227				
225.9			13	SS	36/0.15		226				
13.9											

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-39

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136327.3; E 274078.6
ORIGINATED BY GM
DIST HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE May 4 and 7, 2012
CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at ground surface (Elev. 239.8 m) upon completion of drilling.										

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

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

Golder Associates

RECORD OF BOREHOLE No H2-40

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136342.7; E 274086.8 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 16, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
240.0	GROUND SURFACE										
0.0	PEAT (Fibrous to amorphous) Very soft Black Frozen to wet		1	SS	3	▽					
			2	SS	WH		239		367		
			3	SS	WH		238				
237.8											
2.2	CLAY, trace sand Soft to firm Grey to brown Wet		4	SS	5						
			5	SS	2		237				
							236	9			
	Varved below 4.6 m depth.		6	SS	WH		235				
								4			
			7	SS	WH		234				
							233	4			
232.7	Augers grinding at 7.2 m depth.										
7.3	SAND and SILT, trace clay Very loose to loose Grey Wet		8	SS	4		232				0 63 35 2
			9	SS	WH		231				
229.9											
10.1	Silty SAND and GRAVEL, trace clay Compact Grey Wet		10	SS	13		229				36 42 21 1
	Approximately 0.3 m of heave encountered at 12.2 m depth.		11	SS	21		228				
							227				
225.7			12	SS	24		226				
14.3											

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H2-40

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136342.7; E 274086.8 ORIGINATED BY EHS

DIST HWY 17 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers COMPILED BY EC

DATUM Geodetic DATE March 16, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF BOREHOLE Note: 1. Water level at a depth of 0.8 m below ground surface (Elev. 239.2 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-41

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
DIST _____ HWY 17
DATUM Geodetic
LOCATION N 5136336.3; E 274102.1
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
DATE March 16, 2012
ORIGINATED BY EHS
COMPILED BY EC
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.8	GROUND SURFACE										
0.0 / 239.3	PEAT (Fibrous) Black Frozen		1	SS	-	▽					
0.5	CLAY, trace sand Soft Grey to brown Wet		2	SS	4		239		○		
			3	SS	5		238	+ 2 2			
237.2											
2.6	CLAYEY SILT, varved Soft Grey to brown Wet		4	SS	WH		237		⊢○		
235.7							236	+ 2			
4.1	Silty SAND, trace clay Very loose to loose Grey Wet		5	SS	WH			+ 5			
	Between 0.2 m and 1.0 m of heave encountered below depth of 5.8 m.		6	SS	6		234		○		0 71 27 2
			7	SS	4		233				
	Augers grinding at 8.8 m depth.						232				
231.0											
8.8	SAND to Gravelly SAND, trace to some silt Compact to dense Grey Wet		8	SS	23		231				
			9	SS	31		230				
							229		○		1 89 (10)
227.3			10	SS	25		228				
12.5	END OF BOREHOLE										

Note:

1. Water level at a depth of 0.2 m below ground surface (Elev. 239.6 m) upon completion of drilling.

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-42

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136332.8; E 274117.9 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 14 and 15, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.8	GROUND SURFACE										
0.0	ORGANICS										
0.1	SILTY CLAY, trace sand Firm to stiff Brown Moist to wet Varved below 1.5 m depth.		1	SS	12		241				
			2	SS	12						
			3	SS	7	▽	240				
239.2			4	SS	12		239			NP	0 2 95 3
2.6	SILT, trace sand, trace clay Compact Brown Wet										
238.6			5	SS	4		238				
3.2	SAND to SAND and SILT, trace to some gravel, trace clay Very loose to loose Grey to brown Wet Between 0.6 m and 0.9 m of heave encountered below 3.8 m depth.		6	SS	WH						
			7	SS	4		237				0 92 (8)
			8	SS	3		236				
			9	SS	3		235				
			10	SS	8		234				
			11	AS	-		233				0 58 41 1
231.1							232				
10.7	END OF BOREHOLE Notes: 1. Water level at a depth of 1.6 m below ground surface (Elev. 240.2 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-43

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136346.2; E 274123.4
ORIGINATED BY EHS
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
COMPILED BY EC
DATUM Geodetic
DATE March 14, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR	SA	SI	CL
242.1	GROUND SURFACE										
0.0	ORGANICS										
0.1	CLAYEY SILT, trace sand Stiff Brown Frozen to moist		1	SS	12						
			2	SS	14						
240.6											
1.5	SILT, trace to some clay, trace sand Compact Brown Wet		3	SS	19	▽		0	1	91	8
239.8											
2.3	SAND and SILT to SAND, trace to some gravel, trace to some clay Loose to compact Brown to grey Wet		4	SS	23		NP	9	42	41	8
			5	SS	6						
			6	SS	6						
			7	SS	10						
	Augers grinding at 7.0 m depth.										
			8	SS	6						
	0.6 m of heave encountered at 7.6 m.		9	SS	20						
233.9											
8.2	END OF BOREHOLE										

ELEVATION SCALE: 242, 241, 240, 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

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

PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-43

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136346.2; E 274123.4 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE March 14, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
	END OF BOREHOLE						227				
							226				
							225				
224.1											
18.0	END OF DCPT										

Notes:

1. Water level at a depth of 1.7 m below ground surface (Elev. 240.4 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No H2-44

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136221.5; E 273947.3
ORIGINATED BY SA
DIST HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE August 27, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.6	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	1		239				
			2	SS	1				399		
			3	SS	WH		238				
			4	SS	WH		237				
236.2			5	SS	WH						
3.4	CLAYEY SILT to SILT, trace sand Firm Grey Wet						236				
			6	SS	9		235		H		0 2 84 14
			7	SS	5		234				
232.4							233				
7.2	SAND and GRAVEL Compact Grey Wet		8	SS	15		232				
231.3											
8.3	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 0.1 m below ground surface (Elev. 239.5 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-45

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136216.0; E 273962.8 | ORIGINATED BY SA

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE August 28, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.5	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	WH	▽	239				
			2	SS	WH						
			3	SS	WH		238		902		
			4	SS	WH		237				
236.1			5A 5B	SS	WH				274		
3.4	SILTY CLAY, varved, trace to some sand Soft to stiff Grey Wet		6	SS	3		236				0 19 32 49
			7	SS	2		235				
							234				
			8	SS	WH		233	4			
232.3											
7.2	CLAYEY SILT, trace sand, trace gravel Soft Grey Wet		9	SS	1		232				
230.8							231				
8.7	SILT, trace to some sand, trace clay Very loose Grey Wet		10	SS	3		230				0 11 85 4
229.1											
10.6	SAND and GRAVEL Compact Grey Wet		11	SS	25/0.15		229				
	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 0.2 m below ground surface (Elev. 239.3 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-46

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136230.7; E 273970.8 | ORIGINATED BY SA

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE August 29, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.5	GROUND SURFACE										
0.0	PEAT (Fibrous to amorphous) Very soft Black Wet		1	SS	1	▽	239				
			2	SS	WH				417		
			3	SS	2		238				
			4	SS	1		237				
235.8			5	SS	WH		236				
3.7	SILTY CLAY, varved Firm Grey Wet		6	SS	3						
			7	SS	1		235				
			8	SS	WH		234				
232.2							233	7			
7.3	CLAYEY SILT, trace gravel Firm Grey Wet		9	SS	5		232				4 0 85 11
230.8							231	20			
8.7	Silty SAND, trace gravel Compact Grey Wet		10	SS	6/0.2						
230.0							230				
9.5	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 0.3 m below ground surface (Elev. 239.2 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-47

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136245.4; E 273978.6 | ORIGINATED BY SA

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE August 30 and 31, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.5	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	1	▽	239				
			2	SS	1						
			3	SS	WH		238		694		
			4	SS	WH		237				
			5	SS	WH		236				
235.8											
3.7	SILTY CLAY Soft to firm Grey Wet		6	SS	3		235				
			7	SS	4						
							234	36			
			8	TO	PM		233				
	Varved below 7.6 m depth.		9	SS	1		232				
							231	4			
			10	SS	WH		230	4			
			11	SS	WH		229				
							228	8			
			12	SS	WH		227				
226.2											
13.3	SILT, trace clay, trace sand Loose to compact Grey Wet		13	SS	8		226			NP	0 1 94 5
							225				

Continued Next Page

+ ³, × ³: Numbers refer to Sensitivity

○ ³% STRAIN AT FAILURE

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H2-47

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136245.4; E 273978.6 ORIGINATED BY SA

DIST HWY 17 BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE August 30 and 31, 2012 CHECKED BY SEMP

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION		NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace clay, trace sand Loose to compact Grey Wet		14	SS	11		224				
223.2											
16.3	END OF BOREHOLE REFUSAL TO FURTHER CASING ADVANCEMENT (HAMMER BOUNCING) Note: 1. Water level at a depth of 0.9 m below ground surface (Elev. 238.6 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-48

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136239.8; E 273994.0 | ORIGINATED BY SA

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE August 29 and 30, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.5	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	WH	▽	239				
			2	SS	1						
			3	SS	WH		238				
			4	SS	1		237				
235.8			5	SS	WH		236		172		
3.7	SILTY CLAY to CLAY, trace sand Soft to firm Grey Wet		6	SS	3						
			7	SS	3		235				0 1 49 50
	Varved below 6.1 m depth.		8	SS	1		234				
			9	SS	WH		233	3			
			10	SS	WH		232	3			
			11	SS	WH		231	3			
			12	SS	WH		230	3			
226.2							229				
13.3	SILT, trace to some clay, trace sand Loose Grey Wet		13	SS	8		228	3		NP	0 1 87 12
							227				
							226				
							225				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-48

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136239.8; E 273994.0 | ORIGINATED BY SA

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE August 29 and 30, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace to some clay, trace sand Loose Grey Wet		14	SS	10		224				
			15	SS	9		223				
221.7							222				
17.8	SAND and SILT, trace clay Loose Grey Wet		16	SS	6		221		○		0 30 69 1
219.3			17	SS	7/0.2		220				
20.2	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 0.8 m below ground surface (Elev. 238.7 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-49

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136234.2; E 274009.3 | ORIGINATED BY ID

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE September 6 and 7, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.6	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Moist to wet		1	SS	WH	▽	239				
			2	SS	1				40		
			3	SS	1		238				
			4	SS	1		237				
			5	SS	1		236				
235.9											
3.7	CLAYEY SILT Very soft to soft Grey Wet		6	SS	1						1 11 46 42
			7	SS	2		235				
234.0							234				
5.6	SILTY CLAY Soft to firm Grey Wet		8	TO	PH		233	+ 5			
			9	SS	1		232				
							231	+ 3			
			10	TO	PH		230	+ 5			
			11	SS	1		229				
							228	+ 5			
			12	SS	1		227				
226.2								+ 7			
13.4	SILT, trace to some clay, trace sand Very loose to loose Grey Wet		13	SS	2		226				
							225				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-49

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136234.2; E 274009.3 | ORIGINATED BY ID

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE September 6 and 7, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace to some clay, trace sand Very loose to loose Grey Wet		14	SS	6		224		○	NP	0 1 90 9
			15	SS	6		223				
			16	SS	10		222				
			17	SS	9		221				
218.7							220				
20.9	SAND and SILT, trace clay Loose to compact Grey Wet		18	SS	8		219				
			19	SS	10		218		○		0 38 61 1
			20	SS	12		217				
214.6							216				
25.0	END OF BOREHOLE Note: 1. Water level at a depth of 0.6 m below ground surface (Elev. 239.0 m) upon completion of drilling.						215				

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

Golder Associates

RECORD OF BOREHOLE No H2-50

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136248.9; E 274017.3 | ORIGINATED BY ID

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE September 5, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.5	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	WH	▽	239				
			2	SS	1						
			3	SS	WH		238				
			4	SS	WH		237				
235.9			5	SS	WH		236				
3.6	SILTY CLAY to CLAY, some sand, trace gravel Soft to firm Grey Wet		6	SS	1		235				4 17 42 37
			7	SS	2						
							234	10			
			8	SS	1		233				
								6			
			9	TO	PH		232				
							231	7			
			10	SS	WH		230				
								6			
			11	TO	PH		229				
							228	6			
			12	SS	1		227				
226.1								11			
13.4	SILT, trace to some clay, trace to some sand Loose Grey Wet		13	SS	4		226			NP	0 0 86 14
							225	13			

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-50

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136248.9; E 274017.3 | ORIGINATED BY ID

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE September 5, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace to some clay, trace to some sand Loose Grey Wet		14	SS	5		224				
			15	SS	6		223				
							222				
			16	SS	8		221		○		0 6 94 0
220.2											
19.3	Silty SAND to SAND Loose Grey Wet		17	SS	8		220				
			18	SS	9		219				
217.1							218				
22.4	Sandy SILT to SILT, trace clay Loose Grey Wet		19	SS	8		217		○		0 18 79 3
							216				
214.5			20	SS	10		215				
25.0	END OF BOREHOLE Note: 1. Water level at a depth of 0.6 m below ground surface (Elev. 238.9 m) upon completion of drilling.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-51

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136264.2; E 274024.9
ORIGINATED BY EHS
DIST _____ HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE September 13, 2012
CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.5	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	1	▽	239				
			2	SS	WH				524		
			3	SS	WH		238				
			4	SS	WH		237				
236.1			5	SS	WH		236				
3.4	CLAYEY SILT, some sand, trace gravel Very soft Grey		6A 6B	SS	1						1 25 29 45
235.4 4.1	Wet SILTY CLAY to CLAY, varved Soft to firm Grey Wet		7	SS	2		235				
							234	11			
			8	TO	PM		233				
								10			
			9	SS	WH		232				
							231	12			
			10	SS	WH		230				
								12			
			11	SS	WH		229				
							228	8			
			12	SS	1		227				
226.0								12			
13.5	SILT, trace to some clay, trace to some sand, trace gravel Loose Grey Wet		13	SS	4		226			NP	0 0 86 14
							225				

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H2-51

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136264.2; E 274024.9 ORIGINATED BY EHS

DIST HWY 17 BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE September 13, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace to some clay, trace to some sand, trace gravel Loose Grey Wet		14	SS	5		224				
			15	SS	5		223				
							222				
			16	SS	10		221	○			1 12 83 4
220.2											
19.3	Silty SAND Loose Grey Wet		17	SS	9		220				
							219				
217.6			18	SS	6		218				
21.9	END OF BOREHOLE Note: 1. Water level at a depth of 0.4 m below ground surface (Elev. 239.1 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-52

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136257.6; E 274040.9 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE September 12, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.5	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	1	▽	239				
			2	SS	2				754		
			3	SS	1		238				
			4	SS	WH		237				
235.9			5	SS	WH		236				
3.6	CLAYEY SILT Stiff Grey Wet		6	SS	2				d		
			7	SS	3		235				
233.6							234	9			
5.9	CLAY, varved Soft to firm Grey Wet		8	SS	1		233				
								14			
			9	SS	WH		232				
							231	16			
			10	SS	WH		230				
								6			
			11	SS	WH		229				
227.5							228	8			
12.0	SILT, trace to some clay, trace sand Very loose to loose Grey Wet		12	SS	2		227			NP	0 1 80 19
								8			
			13	SS	4		226				
							225				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-52

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136257.6; E 274040.9 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE September 12, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace to some clay, trace sand Very loose to loose Grey Wet		14	SS	6		224		○	NP	0 1 91 8
			15	SS	3		223				
221.7							222				
17.8	SAND and SILT, trace clay Loose to compact Grey Wet		16	SS	4		221				
			17	SS	6		220		○		0 66 31 3
			18	SS	12		219				
217.7							218				
21.9	SAND and GRAVEL, trace silt Grey Wet										
	END OF BOREHOLE										

Note:

1. Water level at a depth of 0.3 m below ground surface (Elev. 239.2 m) upon completion of drilling.

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-53

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136251.8; E 274056.3 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE September 11, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.5	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	WH	▽	239				
			2	SS	WH						
			3	SS	1		238				
			4	SS	WH		237		731		
235.9			5	SS	WH		236				
3.6	CLAYEY SILT Stiff Grey Wet		6	SS	2				c		
			7	SS	2		235	7			
233.6							234				
5.9	CLAY, varved Firm Grey Wet		8	SS	2		233	9			
			9	SS	WH		232				
			10	SS	WH		231	9			
			11	SS	WH		230	6			
227.5							229				
12.0	SILT, trace to some clay, trace to some sand Very loose to compact Grey Wet		12	SS	2		228	6			
			13	SS	8		227	2		NP	0 1 75 24
							226			NP	0 1 90 9
							225				

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-53

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136251.8; E 274056.3 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE September 11, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace to some clay, trace to some sand Very loose to compact Grey Wet		14	SS	11		224				
							223				
			15	SS	10				○		0 15 80 5
221.7							222				
17.8	SAND, trace to some silt, trace clay Compact Grey Wet		16	SS	14		221				
220.6											
18.9	END OF BOREHOLE Note: 1. Water level at a depth of 0.3 m below ground surface (Elev. 239.2 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-54

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136266.7; E 274064.2 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE September 10, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.6	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	WH	▽	239				
			2	SS	WH						
			3	SS	WH		238				
			4	SS	WH		237				
236.1			5	SS	WH		236				
3.5	SILTY CLAY to CLAY, trace to some sand, trace gravel Soft to stiff Grey Wet		6	SS	3						
			7	SS	5		235				
	Varved below 5.2 m depth.						234	9			
			8	SS	WH		233				
								13			
			9	SS	WH		232				0 0 34 66
							231	8			
			10	SS	WH		230				
229.2								11			
10.4	SILT, trace to some clay, trace gravel Very loose to loose Grey Wet		11	SS	2		229				
			12	SS	9		228				
226.3							227				NP 0 1 89 10
13.3	Sandy SILT, trace to some clay, trace gravel Loose to compact Grey Wet		13	SS	4		226				
							225				

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-54

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136266.7; E 274064.2 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE September 10, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
223.8			14	SS	13		224				
15.8	END OF BOREHOLE Note: 1. Water level at a depth of 0.4 m below ground surface (Elev. 239.2 m) upon completion of drilling. Water level measured in casing at a height of 0.8 m above ground surface (Elev. 240.4 m) prior to backfilling with grout and cement mixture.										

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

Golder Associates

RECORD OF BOREHOLE No H2-55

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136281.8; E 274071.6 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 9, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.7	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Frozen to wet		1	SS	6		239				
			2	SS	WH						
			3	SS	WH		238		57		
			4	SS	1		237				
236.2			5A 5B	SS	1						
3.5	SILTY CLAY, varved Soft to firm Grey Wet		6	SS	11		236				
			7	SS	6		235				0 3 47 50
			8	SS	WH		234				
			9	SS	WH		233	2			
231.0							232	6			
8.7	SILT, trace to some clay Loose Grey						231				
230.3	Wet		10A 10B	SS	10					NP	
9.4	Sandy SILT, trace to some gravel, trace clay Loose Grey Wet Between 0.2 m and 0.6 m of heave encountered below 9.7 m depth.		11	SS	6		230				
			12	SS	6		229				7 28 61 4
226.4							228				
13.3	SAND and GRAVEL Compact Grey Wet		13	SS	14		227				
			14	SS	30		226				
							225				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-55

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136281.8; E 274071.6 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 9, 2012 | CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
224.6 / 15.1	END OF BOREHOLE Note: 1. Water level at ground surface (Elev. 239.7 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-56

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136275.8; E 274087.5 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 10, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.7	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	1		239				
			2	SS	WH						
			3	SS	WH		238		39?		
236.9			4	SS	WH		237		100		
2.8	SILTY CLAY to CLAY, varved Very soft to firm Grey Wet		5	SS	1						
			6	SS	9		236				
			7	SS	9		235				
			8	SS	WH		234	4			
			9	SS	WH		233	3			
230.9							232	6			
8.8	SILT, trace sand Loose Grey Wet		10A 10B	SS	10		231				
230.3 9.4	Silty SAND, trace clay Compact Grey Wet Approximately 0.1 m of heave encountered below 9.7 m depth.		11	SS	11		230				0 68 29 3
							229				
			12	SS	11		228				
226.9							227				
12.8	END OF BOREHOLE Notes: 1. Water level at ground surface (Elev. 239.7 m) upon completion of drilling. 2. Moved 1.0 m north of Borehole H2-56 and turned N-vane at 5.6 m depth and obtained a Shelby tube at 6.6 m depth below ground surface.										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-57

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136269.9; E 274103.0 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 11, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.6	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	WH		239		42		
			2	SS	WH						
237.4			3	SS	1		238				
2.2	CLAY to SILTY CLAY, varved Firm Grey Wet		4	SS	2		237				
			5	SS	4						
			6	SS	10		236				
			7	SS	2		235	5			
			8	SS	WH		234				
232.4							233	3			
7.2	SILT, trace to some clay, trace sand Loose Grey Wet		9	SS	8		232				0 2 90 8
230.9							231				
8.7	SAND, some silt, trace to some clay, trace gravel Very loose to compact Grey Wet		10	SS	1		230				
			11	SS	7		229				
			12	SS	13		228				2 76 17 5
	Approximately 0.6 m of heave encountered at 12.8 m depth.		13	SS	16		227				
225.0			14	SS	50/0.1		226				
14.6							225				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H2-57

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136269.9; E 274103.0 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 11, 2012 | CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100; ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED; 20 40 60 80 100	w_P w w_L; 20 40 60	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	END OF BOREHOLE SPOON REFUSAL AND REFUSAL TO FURTHER CASING ADVANCEMENT (HAMMER BOUNCING) Note: 1. Water level at ground surface (Elev. 239.6 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H2-58

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136285.3; E 274110.8 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 14 and 15, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.6	GROUND SURFACE										
0.0	PEAT (Fibrous to Amorphous) Very soft Black Wet		1	SS	WH		239		40		
			2	SS	2						
237.4			3	SS	WH		238				
2.2	SILTY CLAY, varved Soft to firm Grey Wet		4	SS	2		237				0 1 26 73
			5	SS	2		236	5			
			6	SS	WH						
			7	SS	WH		235	4			
233.2			8	SS	1		234	7			
6.4	Sandy SILT, trace clay Very loose Grey Wet		9	SS	4		233				0 27 71 2
230.9	Between 0.2 m and 1.5 m of heave encountered below 8.2 m depth.						232				
8.7	SAND, some silt, trace to some gravel, trace clay Loose to compact Grey to brown Wet		10	SS	6		231				
			11	SS	5		230				6 80 12 2
			12	SS	5		229				
			13	SS	12		228				
224.8							227				
14.8							226				
							225				

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H2-58

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136285.3; E 274110.8 ORIGINATED BY GM

DIST HWY 17 BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE May 14 and 15, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
223.8	SAND and GRAVEL Compact Grey Wet		14	SS	15		224				
15.8	END OF BOREHOLE Note: 1. Water level at ground surface (Elev. 239.6 m) upon completion of drilling. 2. Moved 1.0 m south of Borehole H2-58 and obtained a Shelby tube at 5.2 m depth below existing ground surface.										

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

Golder Associates

RECORD OF BOREHOLE No H2-59

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136299.2; E 274118.9 | ORIGINATED BY GM

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 16, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.7	GROUND SURFACE										
0.0	PEAT (Flbrous) Very soft Black Wet		1	SS	2	▽	239				
238.5			2	SS	2				38		
1.2	SILTY CLAY, varved Soft Grey Wet		3	SS	2		238				
			4	SS	WH		237	5			
			5	SS	WH		236	5			
234.8			6	SS	5		235				
4.9	SILT, some sand, trace clay, trace gravel Loose Grey Wet		7	SS	4		234				1 19 77 3
232.5							233				
7.2	SAND, trace to some silt Loose to very dense Grey to brown Wet		8	SS	8		232				
			9	SS	10		231				0 82 14 4
			10	SS	18		230				
	Approximately 0.3 m of heave encountered at 11.3 m depth.						229				
227.0			11	SS	90/0.2		228				
12.7	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 0.3 m below ground surface (Elev. 239.4 m) upon completion of drilling.						227				

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H2-60

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5136293.9; E 274132.6 | ORIGINATED BY AC

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 17, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.8	GROUND SURFACE										
0.0 / 239.3	PEAT (Fibrous to Amorphous) Very soft Black		1	SS	WH						
0.5 / 238.7	Wet Silty SAND, trace clay Loose		2	SS	5		239				
1.1	Grey Wet										
	SILTY CLAY, varved Firm Grey to brown Wet		3	SS	6		238				
			4	SS	1		237				
236.2											
3.6	SILT, trace to some clay, trace sand Loose Grey Wet		5	SS	2		236			NP	
			6	SS	6		235				0 4 88 8
234.2											
5.6	SAND, trace gravel, trace clay Loose to very dense Grey Wet		7	SS	4		234				
			8	SS	6		233				
			9	SS	12		232				1 79 17 3
			10	SS	70		231				
229.3							230				
10.5	END OF BOREHOLE										

Note:

1. Water level at ground surface (Elev. 239.8 m) upon completion of drilling.

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF DCPT No H2-DC1

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136305.5; E 273887.0 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE April 10, 2012 CHECKED BY SEMP

SOIL PROFILE		STRAT PLOT	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		NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
239.6	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0							239				
							238				
237.4											
2.2	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF DCPT No H2-DC2

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136293.3; E 273918.5 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE April 19, 2012 CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
239.7 0.0	GROUND SURFACE										
							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
228.8							229				
10.9	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

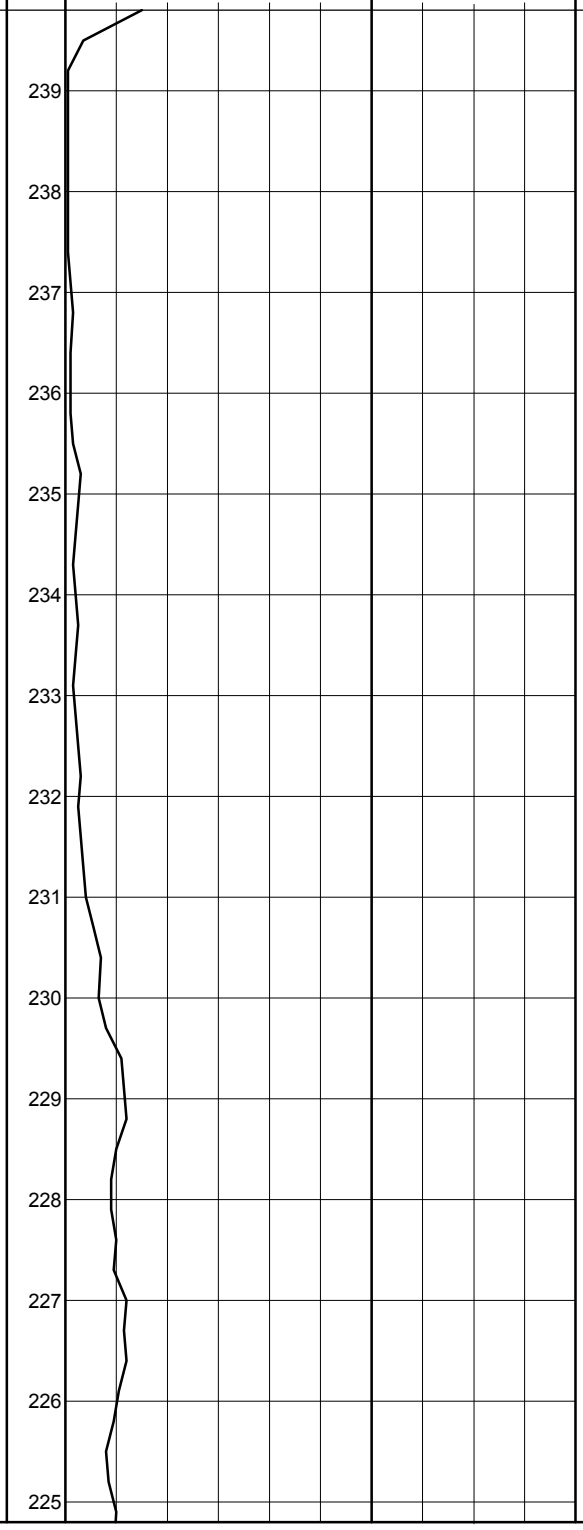
Golder Associates

RECORD OF DCPT No H2-DC3

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136322.4; E 273930.8
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE April 3, 2012
CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
239.8 / 0.0	GROUND SURFACE										



Continued Next Page

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

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

Golder Associates

RECORD OF DCPT No H2-DC3

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136322.4; E 273930.8 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE April 3, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ kN/m^3	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	20 40 60		
224.0											
15.8	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)						224				

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

Golder Associates

RECORD OF DCPT No H2-DC4

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136311.6; E 273965.1
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE March 23, 2012
CHECKED BY SEMP

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			SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	w_P / w / w_L: WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
239.7 / 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60		

239
238
237
236
235
234
233
232
231
230
229
228
227
226
225

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H2-DC4

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136311.6; E 273965.1 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 23, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
216.9							224				
							223				
							222				
							221				
							220				
							219				
							218				
							217				
22.8	END OF DCPT REFUSAL TO FURTHER PENETRATION (112 Blows / 0.3 m)										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED: 20 40 60 80 100
PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT
WATER CONTENT (%): 20 40 60

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

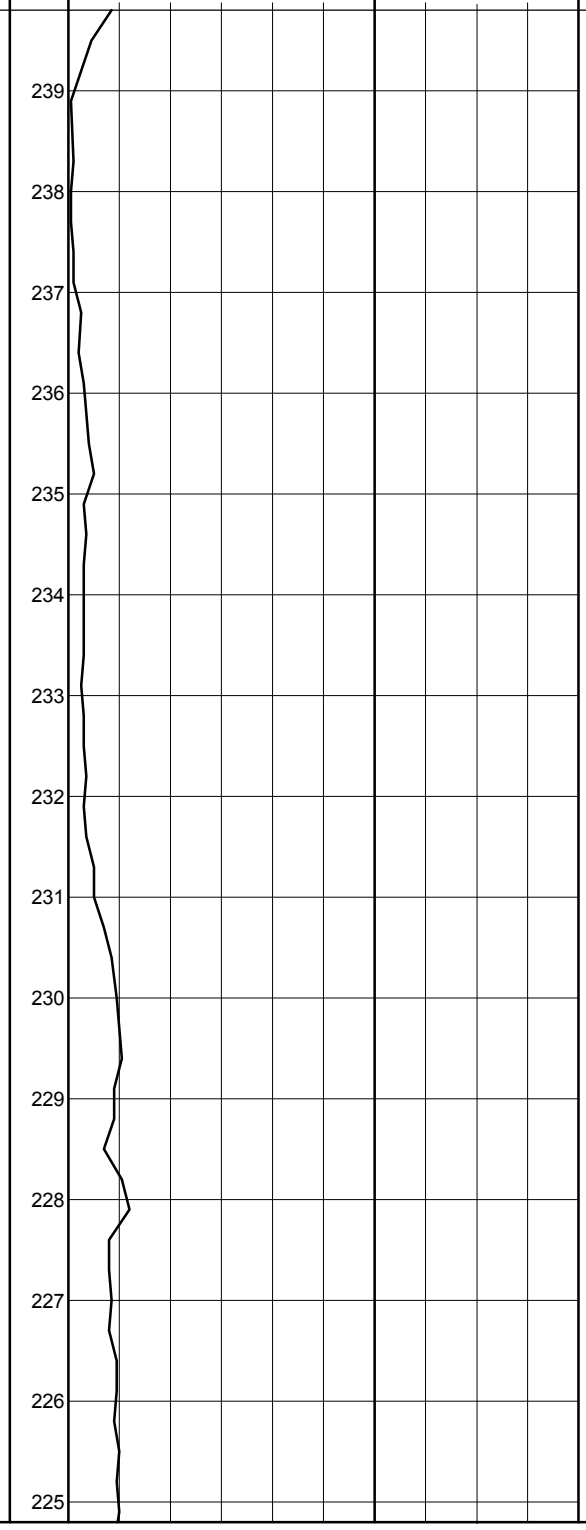
Golder Associates

RECORD OF DCPT No H2-DC5

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136341.6; E 273980.2
ORIGINATED BY EHS
DIST _____ HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE March 13, 2012
CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
239.8 / 0.0	GROUND SURFACE										



Continued Next Page

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

Golder Associates

RECORD OF DCPT No H2-DC5

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136341.6; E 273980.2 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 13, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
							224				
							223				
							222				
							221				
							220				
							219				
							218				
217.0							217	130			
22.8	END OF DCPT REFUSAL TO FURTHER PENETRATION (130 Blows / 0.3 m)										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

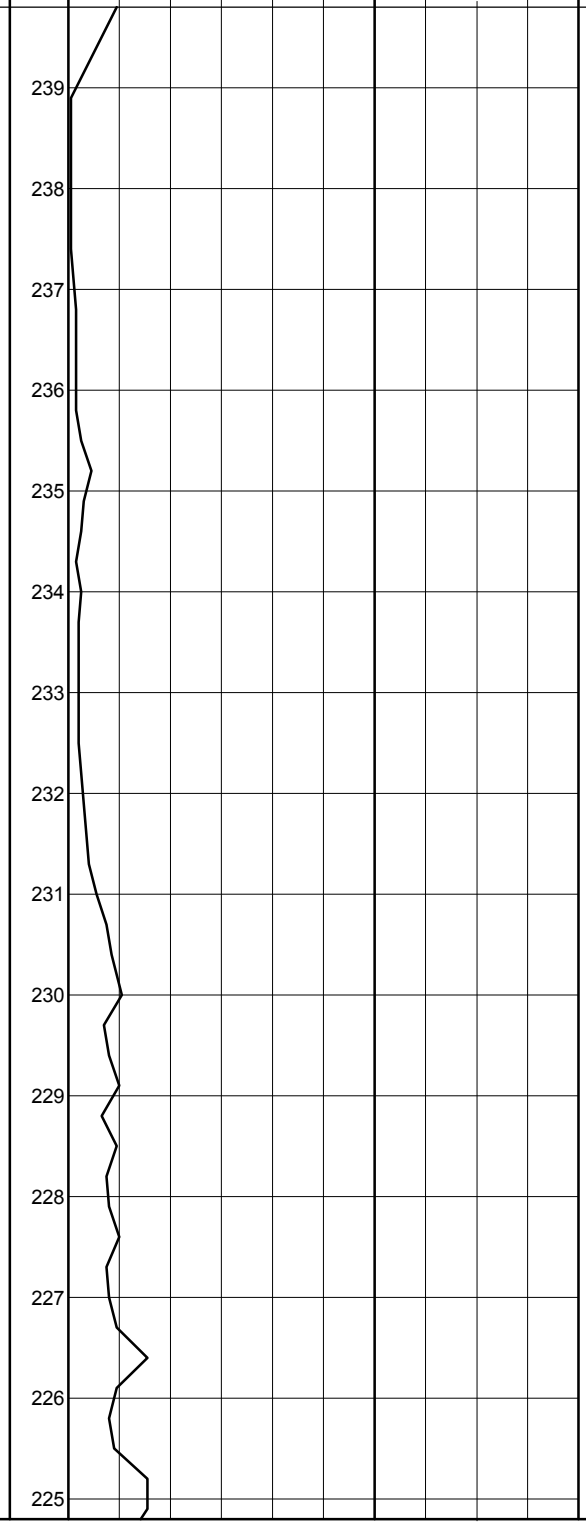
Golder Associates

RECORD OF DCPT No H2-DC6

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136329.7; E 274011.2 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 22, 2012 CHECKED BY SEMP

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
239.8 / 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60		



Continued Next Page

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

Golder Associates

RECORD OF DCPT No H2-DC6

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136329.7; E 274011.2 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 22, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
							224				
							223				
							222				
							221				
							220				
							219				
218.2											
21.6	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.3 m)										

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

Golder Associates

RECORD OF DCPT No H2-DC7

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136360.0; E 274026.6
ORIGINATED BY EHS
DIST _____ HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE March 13, 2012
CHECKED BY SEMP

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			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
239.9 GROUND SURFACE								20 40 60 80 100	20 40 60		
0.0							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
							227				
							226				
							225				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

PROJECT 11-1191-0007

RECORD OF DCPT No H2-DC7

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136360.0; E 274026.6 ORIGINATED BY EHS

DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC

DATUM Geodetic DATE March 13, 2012 CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
							224				
							223				
222.7											
17.2	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

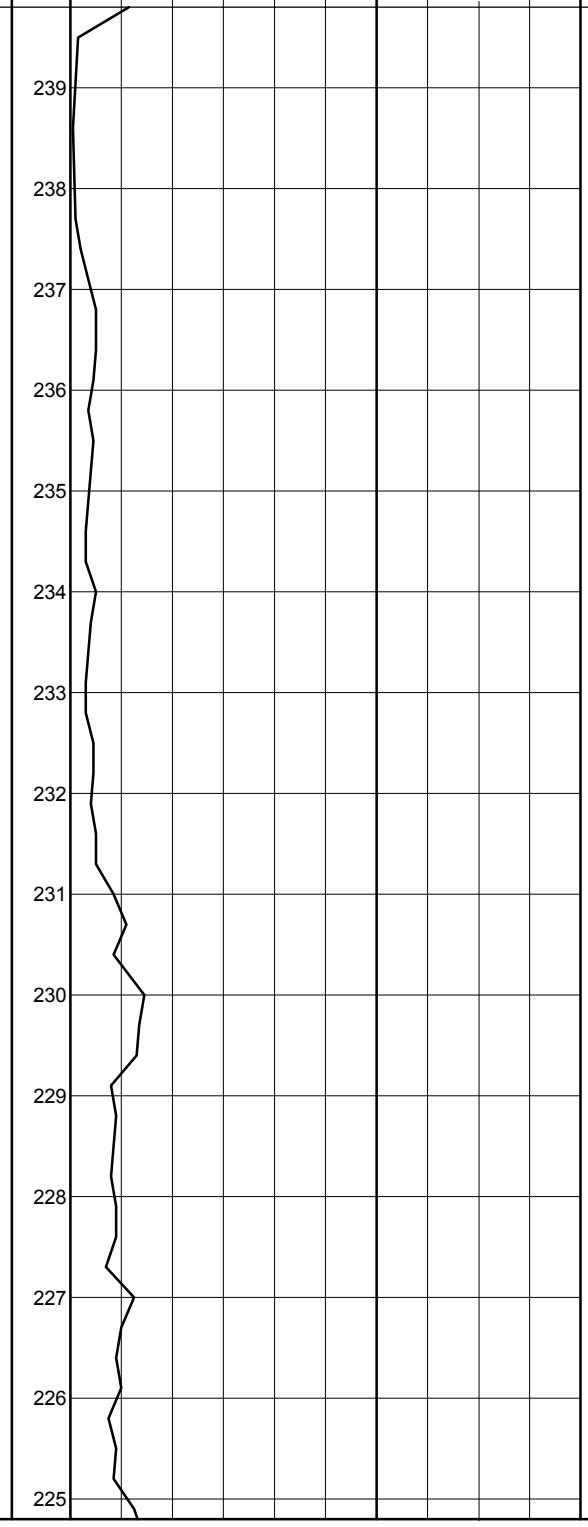
Golder Associates

RECORD OF DCPT No H2-DC8

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136347.4; E 274058.0
ORIGINATED BY EHS
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE March 13, 2012
CHECKED BY SEMP

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			SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED	w_P / w / w_L: WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
239.8 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60		



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

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

Golder Associates

RECORD OF DCPT No H2-DC8

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136347.4; E 274058.0 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 13, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---						224 223 222 221				
220.2 19.6	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

Golder Associates

RECORD OF DCPT No H2-DC9

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136378.3; E 274073.7 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 13, 2012 CHECKED BY SEMP

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			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
240.0	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0											
							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
							227				
							226				
225.1								127			

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H2-DC9

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136378.3; E 274073.7 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 13, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
14.9	END OF DCPT REFUSAL TO FURTHER PENETRATION (127 Blows / 0.25 m)										

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

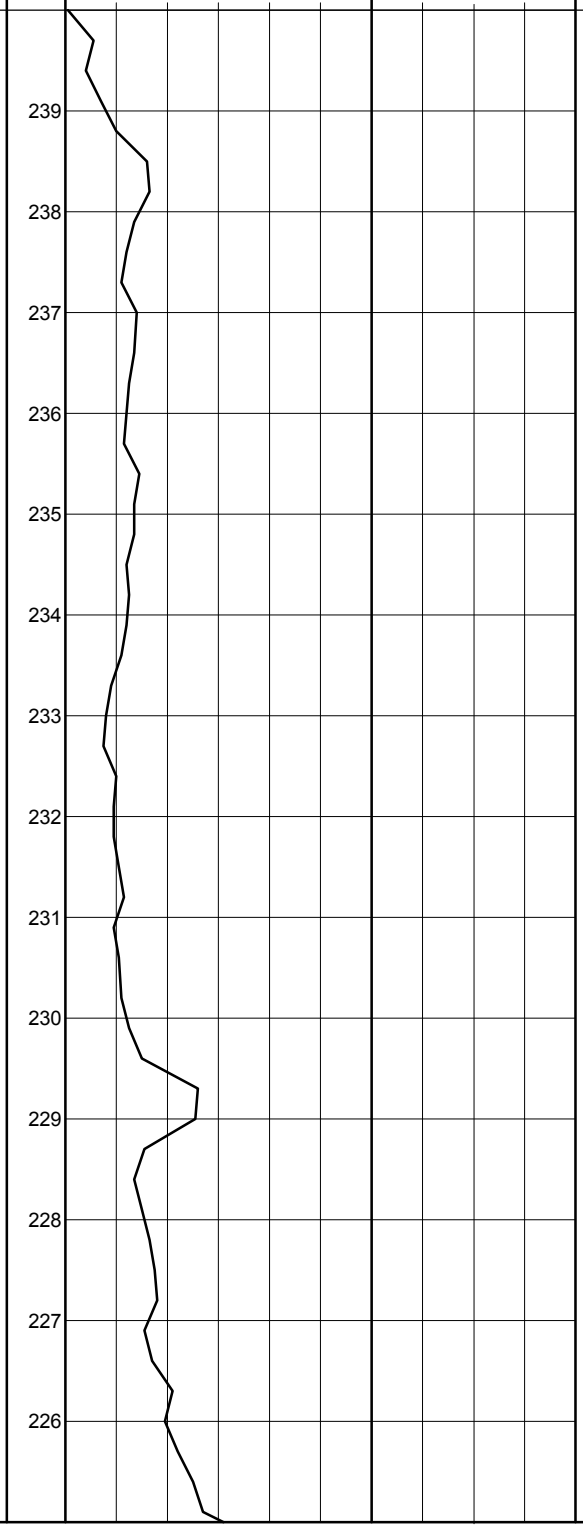
Golder Associates

RECORD OF DCPT No H2-DC10

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136364.5; E 274104.8 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 16, 2012 CHECKED BY SEMP

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
240.0 / 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60		



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

Golder Associates

RECORD OF DCPT No H2-DC10

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136364.5; E 274104.8 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 16, 2012 CHECKED BY SEMP

SOIL PROFILE		STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION		NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
224.2											
15.8	END OF DCPT REFUSAL TO FURTHER PENETRATION (103 Blows / 0.3 m)										

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

Golder Associates

RECORD OF DCPT No H2-DC11

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136270.9; E 273900.5 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE April 10, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.6	GROUND SURFACE										
0.0							239				
							238				
							237				
							236				
							235				
234.0							234				
5.6	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF DCPT No H2-DC12

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136258.6; E 273932.1 ORIGINATED BY GM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE April 20, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.7	GROUND SURFACE										
0.0							239				
							238				
							237				
							236				
							235				
							234				
233.2											
6.5	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

Golder Associates

RECORD OF DCPT No H2-DC13

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136285.9; E 273940.9
ORIGINATED BY EHS
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE April 18, 2012
CHECKED BY SEMP

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			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
239.7 GROUND SURFACE								20 40 60 80 100	20 40 60		
0.0							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
							227				
							226				
							225				

Continued Next Page

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

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

Golder Associates

RECORD OF DCPT No H2-DC13

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136285.9; E 273940.9 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE April 18, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
224.3											
15.4	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

Golder Associates

RECORD OF DCPT No H2-DC14

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136273.5; E 273970.3 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE April 18, 2012 CHECKED BY SEMP

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
239.6 GROUND SURFACE								20 40 60 80 100	20 40 60		
0.0							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
							227				
							226				
							225				

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF DCPT No H2-DC14

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136273.5; E 273970.3 ORIGINATED BY EHS

DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC

DATUM Geodetic DATE April 18, 2012 CHECKED BY SEMP

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			20 40 60 80 100	w_P w w_L	γ	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	WATER CONTENT (%) 20 40 60	kN/m³	
							224				
223.1											
16.5	END OF DCPT Note: 1. DCPT stopped due to possible bent rods.										

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

Golder Associates

RECORD OF DCPT No H2-DC15

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136300.8; E 273976.8
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE March 30, 2012
CHECKED BY SEMP

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	WATER CONTENT (%)		
239.7 / 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60	kN/m³	GR SA SI CL

239 238 237 236 235 234 233 232 231 230 229 228 227 226 225

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H2-DC15

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136300.8; E 273976.8 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 30, 2012 CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---						224 223 222 221 220 219 218 217 216 215				
215.0 24.7	END OF DCPT REFUSAL TO FURTHER PENETRATION (106 Blows / 0.3 m)										

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

Golder Associates

RECORD OF DCPT No H2-DC16

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136285.3; E 274002.2 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 28, 2012 CHECKED BY SEMP

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			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
239.7	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
							227				
							226				
							225				

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H2-DC16

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136285.3; E 274002.2 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 28, 2012 CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---						224 223 222 221 220 219 218 217				
216.5 23.2	END OF DCPT REFUSAL TO FURTHER PENETRATION (105 Blows / 0.3 m)										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF DCPT No H2-DC17

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136315.3; E 274016.6
ORIGINATED BY AC
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE March 22, 2012
CHECKED BY SEMP

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			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
239.8 / 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60		

239
238
237
236
235
234
233
232
231
230
229
228
227
226
225

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H2-DC17

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136315.3; E 274016.6 ORIGINATED BY AC
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 22, 2012 CHECKED BY SEMP

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			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
218.2							224				
							223				
							222				
							221				
							220				
							219				
21.6	END OF DCPT REFUSAL TO FURTHER PENETRATION (107 Blows / 0.3 m)										

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

Golder Associates

RECORD OF DCPT No H2-DC18

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136304.1; E 274048.6 ORIGINATED BY GM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE May 2 and 3, 2012 CHECKED BY SEMP

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			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
239.7 / 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60		

239
238
237
236
235
234
233
232
231
230
229
228
227
226
225

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H2-DC18

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136304.1; E 274048.6 ORIGINATED BY GM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE May 2 and 3, 2012 CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
							224				
							223				
							222				
							221				
							220				
							219				
							218				
							217				
							216				
215.1											
24.6	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.20 m)										

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

Golder Associates

RECORD OF DCPT No H2-DC19

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136333.2; E 274063.5 ORIGINATED BY GM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE May 4, 2013 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT; SHEAR STRENGTH kPa; ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L; WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
240.0	GROUND SURFACE										
0.0											

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF DCPT No H2-DC19

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5136333.2; E 274063.5 ORIGINATED BY GM

DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC

DATUM Geodetic DATE May 4, 2013 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---										
220.0							224				
							223				
							222				
							221				
							220				
20.0	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.23 m)										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m^3

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

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

Golder Associates

RECORD OF DCPT No H2-DC20

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136322.3; E 274095.1 ORIGINATED BY GM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE May 4, 2013 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L	γ kN/m³	GR SA SI CL
239.7	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
							227				
							226				
225.7											
14.0	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

Golder Associates

RECORD OF DCPT No H2-DC21

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136352.8; E 274110.0 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 15, 2012 CHECKED BY SEMP

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
240.3 / 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60		

240
239
238
237
236
235
234
233
232
231
230
229
228
227
226

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H2-DC21

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136352.8; E 274110.0 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE March 15, 2012 CHECKED BY SEMP

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
224.5							225				
15.8	END OF DCPT REFUSAL TO FURTHER PENETRATION (114 Blows / 0.3 m)										

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

Golder Associates

RECORD OF DCPT No H2-DC22

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136236.6; E 273955.0 ORIGINATED BY SA
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE August 31, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
239.5	GROUND SURFACE										
0.0							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
231.1											
8.4	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

Golder Associates

RECORD OF DCPT No H2-DC23

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136224.7; E 273986.3 ORIGINATED BY SA
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE August 30, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
238.9	GROUND SURFACE										
0.0							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
							227				
							226				
224.9							225				
14.0	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF DCPT No H2-DC24

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136254.8; E 274001.6
ORIGINATED BY ID
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE September 4, 2012
CHECKED BY SEMP

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			20 40 60 80 100	w_P w w_L	γ	
239.5 / 0.0	GROUND SURFACE							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	WATER CONTENT (%) 20 40 60	kN/m³	GR SA SI CL

239 238 237 236 235 234 233 232 231 230 229 228 227 226 225

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H2-DC24

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136254.8; E 274001.6 ORIGINATED BY ID
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE September 4, 2012 CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---						224 223 222 221 220 219 218 217 216				
215.1											
24.4	END OF DCPT										

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

Golder Associates

RECORD OF DCPT No H2-DC25

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136243.6; E 274032.6 ORIGINATED BY ID
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE September 6, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L	γ kN/m³	GR SA SI CL
239.8 / 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60		

239
238
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236
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232
231
230
229
228
227
226
225

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H2-DC25

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136243.6; E 274032.6 ORIGINATED BY ID
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE September 6, 2012 CHECKED BY SEMP

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---						224 223 222 221 220 219 218 217 216				
215.4											
24.4	END OF DCPT REFUSAL TO FURTHER PENETRATION (104 Blows / 0.30 m)										

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

Golder Associates

RECORD OF DCPT No H2-DC26

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136273.8; E 274048.0 ORIGINATED BY TM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE September 14, 2012 CHECKED BY SEMP

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
239.6 GROUND SURFACE								20 40 60 80 100	20 40 60		
0.0							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
							227				
							226				
							225				

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H2-DC26

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136273.8; E 274048.0 ORIGINATED BY TM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE September 14, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100; ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED; 20 40 60 80 100	w_P w w_L; 20 40 60	γ kN/m³	GR SA SI CL
--- CONTINUED FROM PREVIOUS PAGE ---							224				
							223				
							222				
							221				
							220				
							219				
							218				
							217				
							216				
215.5											
24.1	END OF DCPT										

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:

Golder Associates

RECORD OF DCPT No H2-DC27

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136261.1; E 274079.6
ORIGINATED BY GM
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE May 8, 2012
CHECKED BY SEMP

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
239.6 GROUND SURFACE								20 40 60 80 100	20 40 60		
0.0							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
							227				
							226				
							225				

Continued Next Page

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

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

Golder Associates

RECORD OF DCPT No H2-DC27

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136261.1; E 274079.6 ORIGINATED BY GM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE May 8, 2012 CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100; SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT w_P w w_L WATER CONTENT (%) 20 40 60		
							224				
							223				
							222				
							221				
220.5											
19.1	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.20 m)										

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

Golder Associates

RECORD OF DCPT No H2-DC28

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136291.0; E 274094.9
ORIGINATED BY GM
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE May 15, 2012
CHECKED BY SEMP

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			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
239.6 / 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60		

239
238
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236
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234
233
232
231
230
229
228
227
226
225

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H2-DC28

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5136291.0; E 274094.9 ORIGINATED BY GM
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE May 15, 2012 CHECKED BY SEMP

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---						224 223				
222.3 17.3	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.28 m)										

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

Golder Associates

RECORD OF DCPT No H2-DC29

1 OF 1 **METRIC**

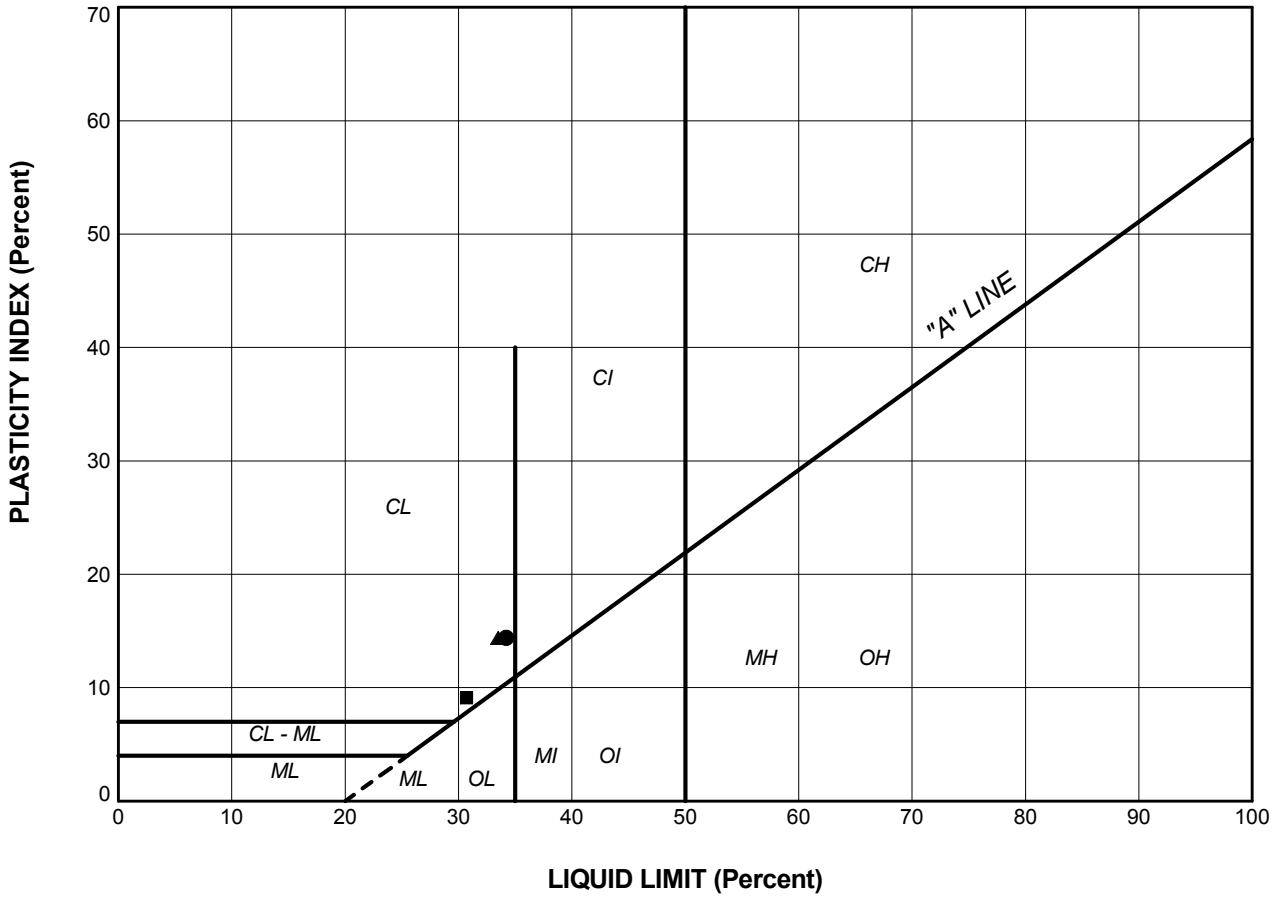
PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5136278.6; E 274126.6
ORIGINATED BY GM
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE May 15, 2012
CHECKED BY SEMP

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			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
239.6	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				
							227				
226.2											
13.4	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.27 m)										

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

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 17/03/14 DATA INPUT:



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H2-1	1	34.2	19.8	14.4
■	H2-1	3	30.7	21.6	9.1
▲	H2-2	2	33.5	19.1	14.4

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (WBL)

TITLE

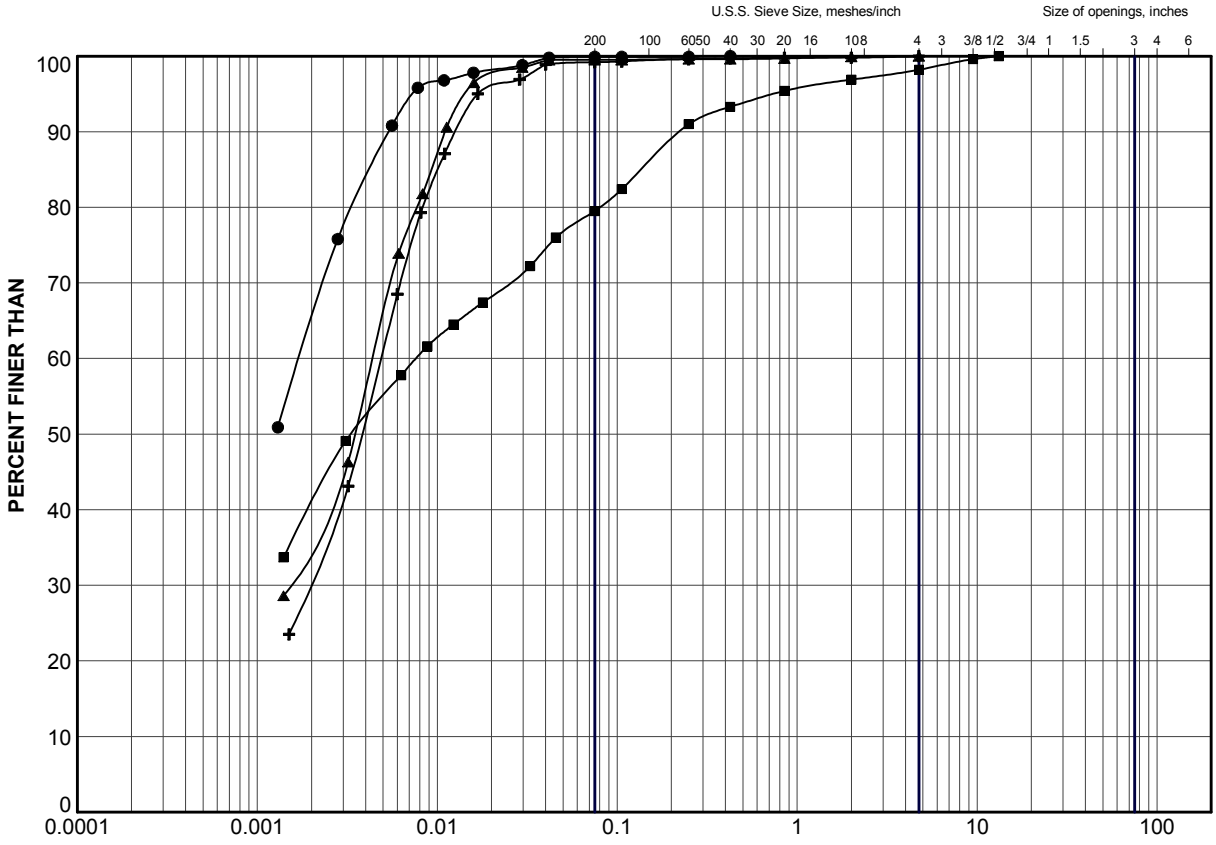
PLASTICITY CHART

CLAYEY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B1**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-7	7	234.3
■	H2-9	6	235.7
▲	H2-15	6	234.3
+	H2-16	5	235.9

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (WBL)

TITLE

GRAIN SIZE DISTRIBUTION

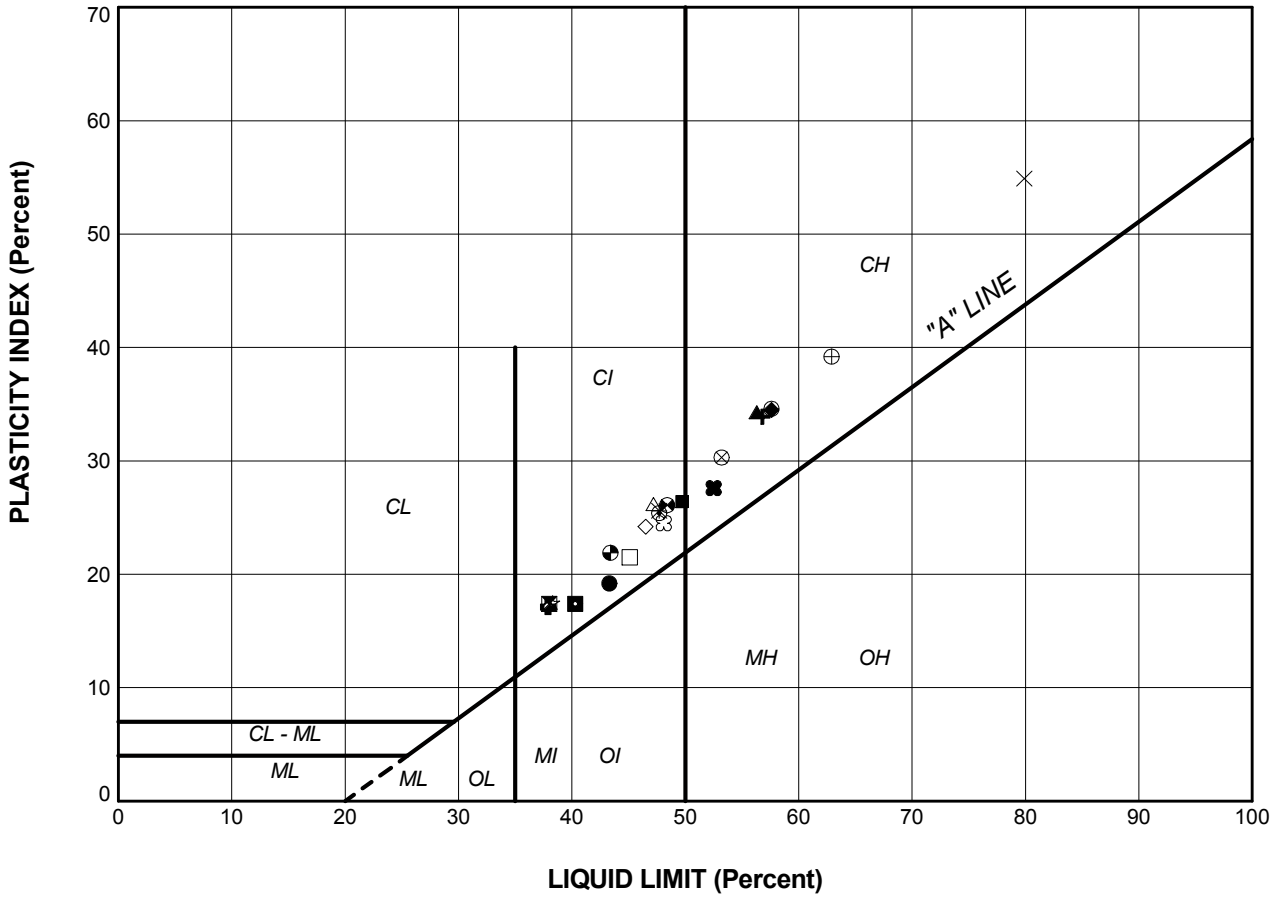
SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE	N/A
CHECK	SEMP	Mar 2014	REV.	
APPR		Mar 2014		

FIGURE B2

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H2-3	4	43.3	24.1	19.2
■	H2-4	6	49.7	23.3	26.4
▲	H2-5	6	56.3	22.0	34.3
✚	H2-6	7	56.8	22.9	33.9
◆	H2-7	7	57.6	23.1	34.5
◇	H2-7	8	46.5	22.3	24.2
○	H2-8	8	57.6	23.0	34.6
△	H2-9	8	47.2	21.0	26.2
⊗	H2-10	6	53.2	22.9	30.3
⊕	H2-11	6	62.9	23.7	39.2
□	H2-12	3B	45.1	23.6	21.5
⊖	H2-12	5	48.4	22.3	26.1
◔	H2-13	7	43.4	21.5	21.9
☆	H2-14	8	38.3	20.8	17.5
⊠	H2-15	4	48.1	23.6	24.5
⧓	H2-16	3	38.0	20.6	17.4
⊙	H2-17	4	47.7	22.3	25.4
✪	H2-17	6	37.9	20.8	17.1
×	H2-18	3	79.9	25.0	54.9
✱	H2-19	4	52.5	24.9	27.6
▣	H2-20	2	40.3	22.9	17.4
✳	H2-21	3	47.7	22.1	25.6

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (WBL)

TITLE

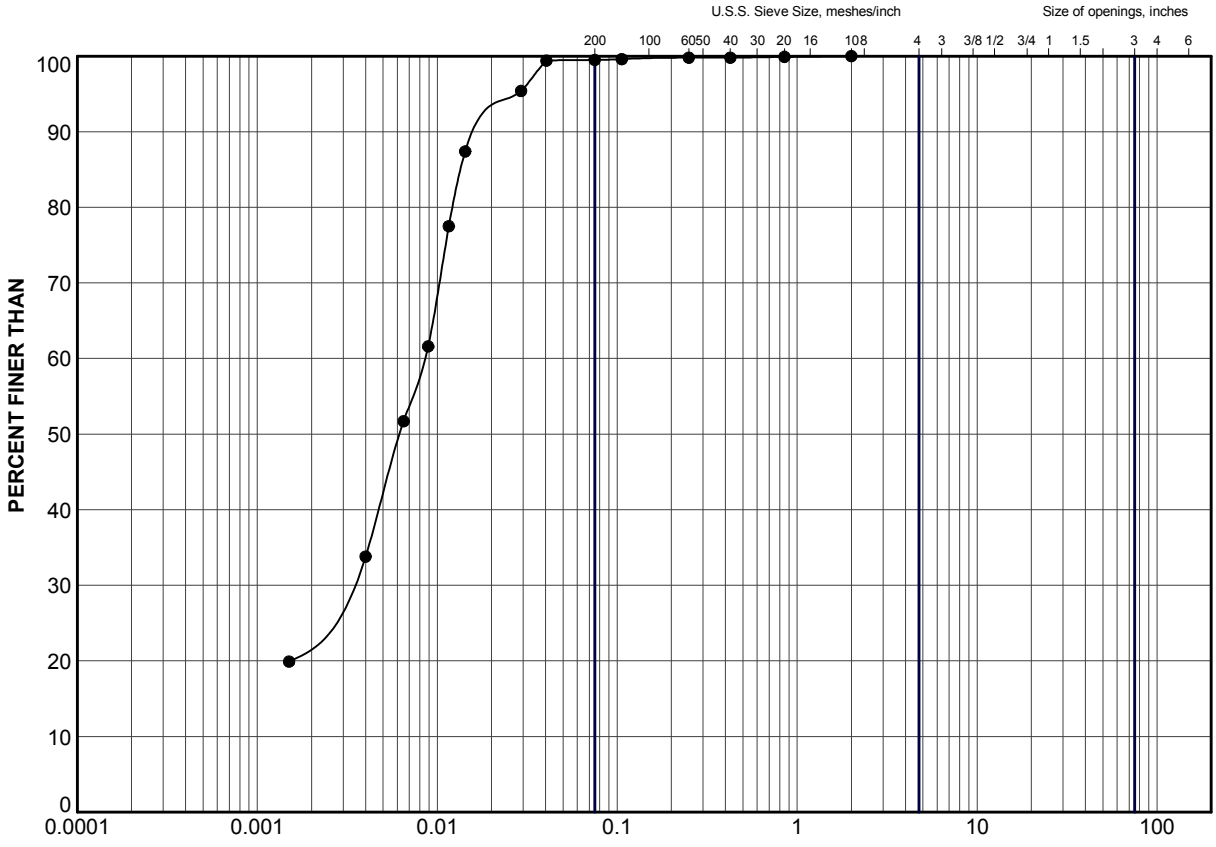
PLASTICITY CHART

SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	TB	Mar 2014	SCALE	N/A	REV.
CHECK	SEMP	Mar 2014			
APPR		Mar 2014	**FIGURE**	**B3**	

SUD-MTO PL (NEW) 25 GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-19	6	235.3

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (WBL)

TITLE

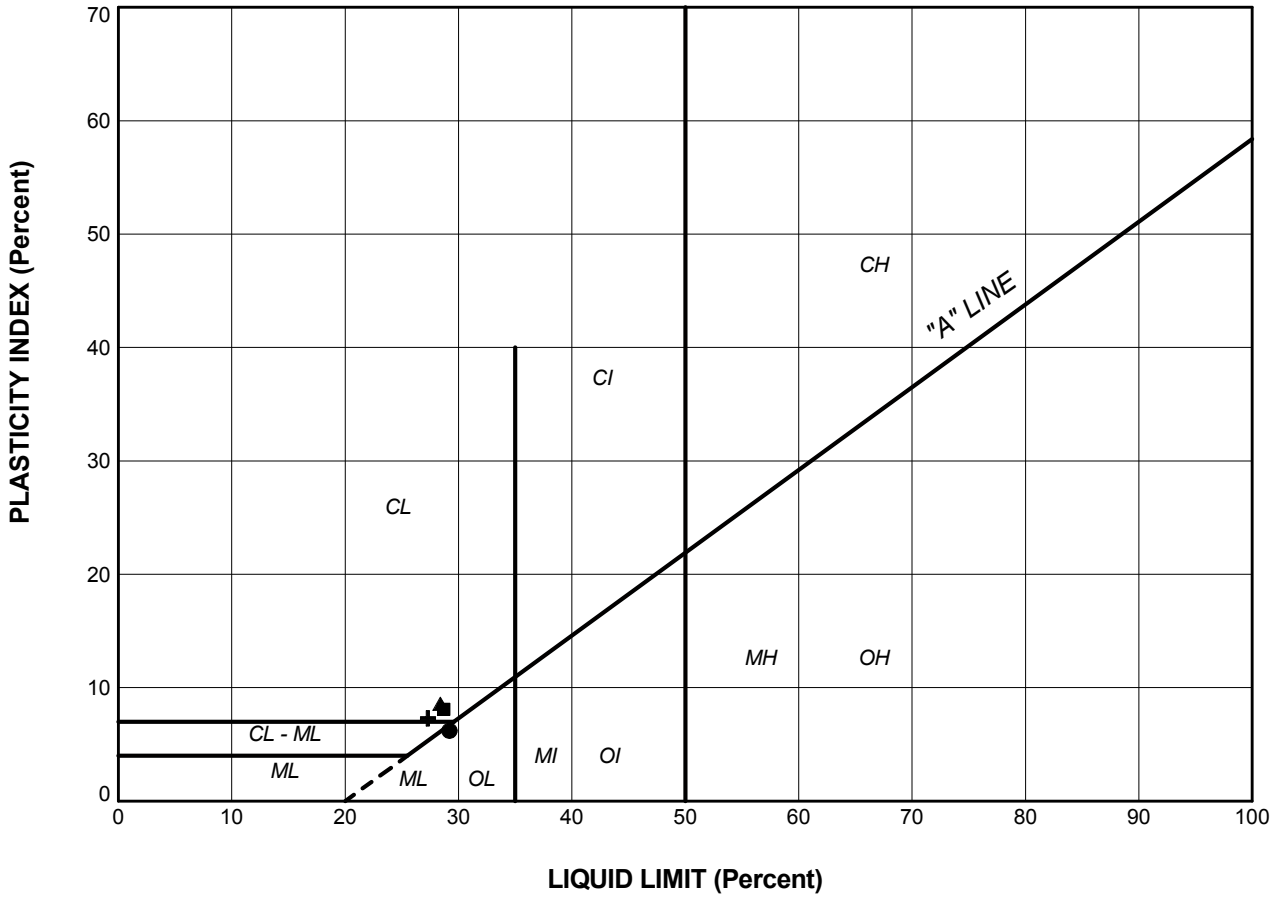
GRAIN SIZE DISTRIBUTION

CLAYEY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B4**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H2-8	10	29.2	23.0	6.2
■	H2-11	8	28.7	20.6	8.1
▲	H2-18	7	28.4	19.8	8.6
+	H2-20	5	27.3	20.0	7.3

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (WBL)

TITLE

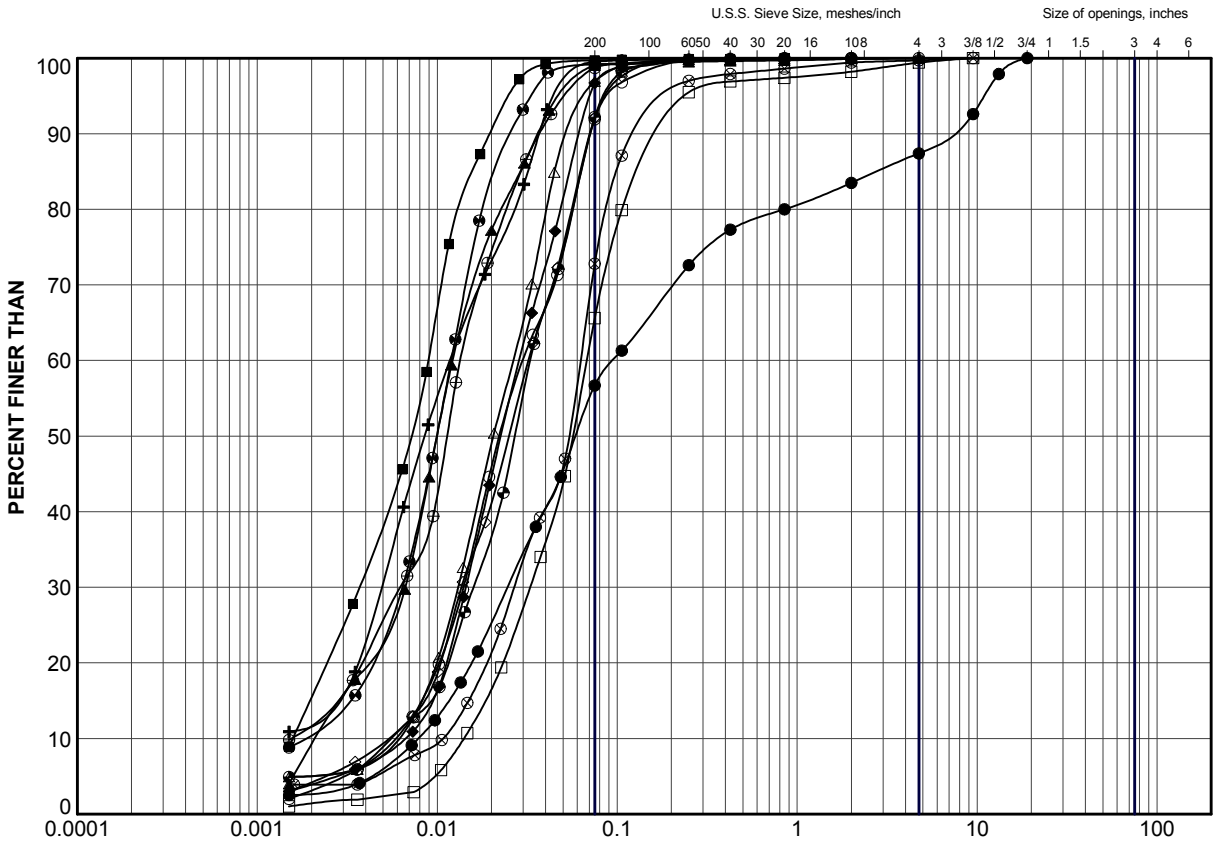
PLASTICITY CHART

CLAYEY SILT to SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B5**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-2	6	234.1
■	H2-3	5B	235.8
▲	H2-4	8	231.8
✚	H2-5	8	231.9
◆	H2-7	11	227.4
◇	H2-8	12	227.4
○	H2-9	11	227.3
△	H2-10	11	227.3
⊗	H2-10	14	222.8
⊕	H2-11	9	230.4
□	H2-11	13	224.3
◓	H2-12	7	232.0
◕	H2-13	9	230.5

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (WBL)

TITLE

GRAIN SIZE DISTRIBUTION

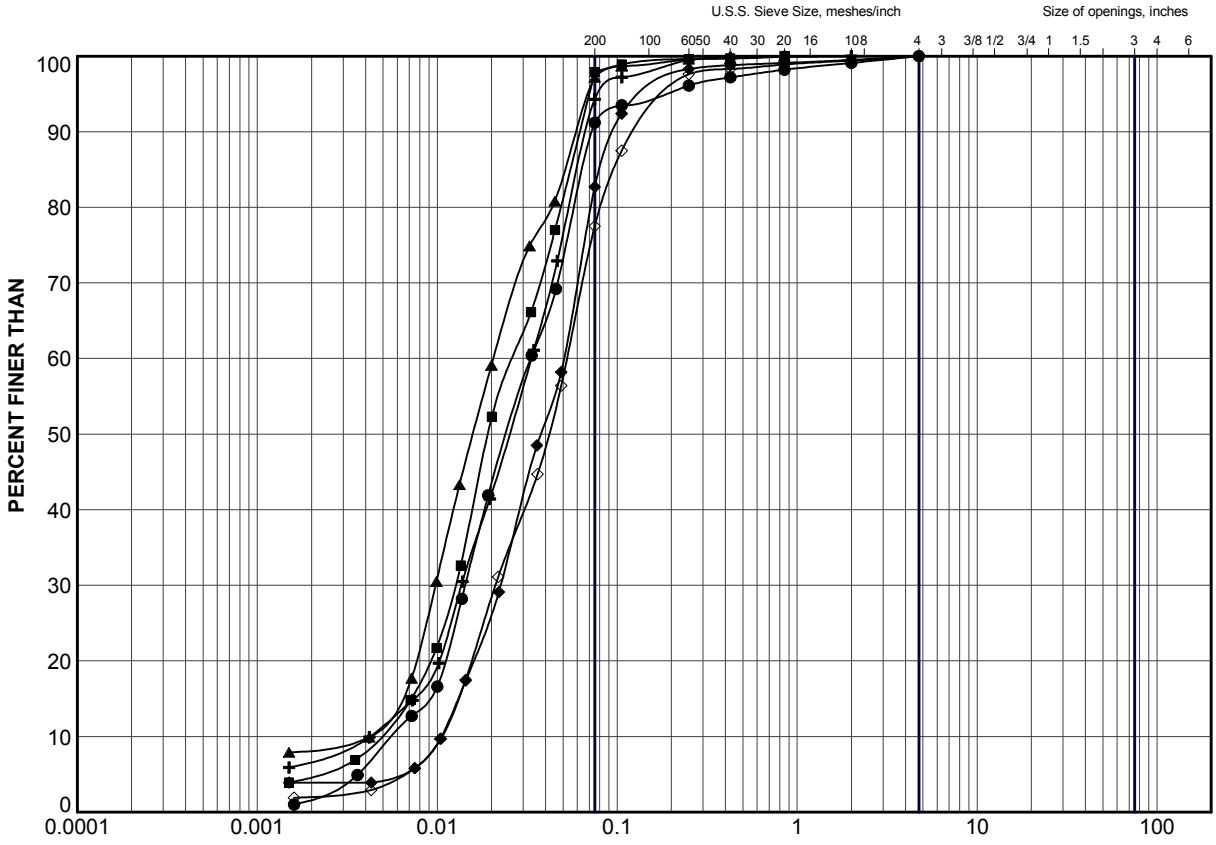
SILT to SANDY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	TB	Mar 2014	SCALE	N/A	REV.
CHECK	SEMP	Mar 2014			
APPR		Mar 2014			

FIGURE B6.1

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-16	7	233.6
■	H2-17	7	232.0
▲	H2-18	8	232.2
+	H2-19	8	232.3
◆	H2-20	8	231.0
◇	H2-21	7	233.9

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (WBL)

TITLE

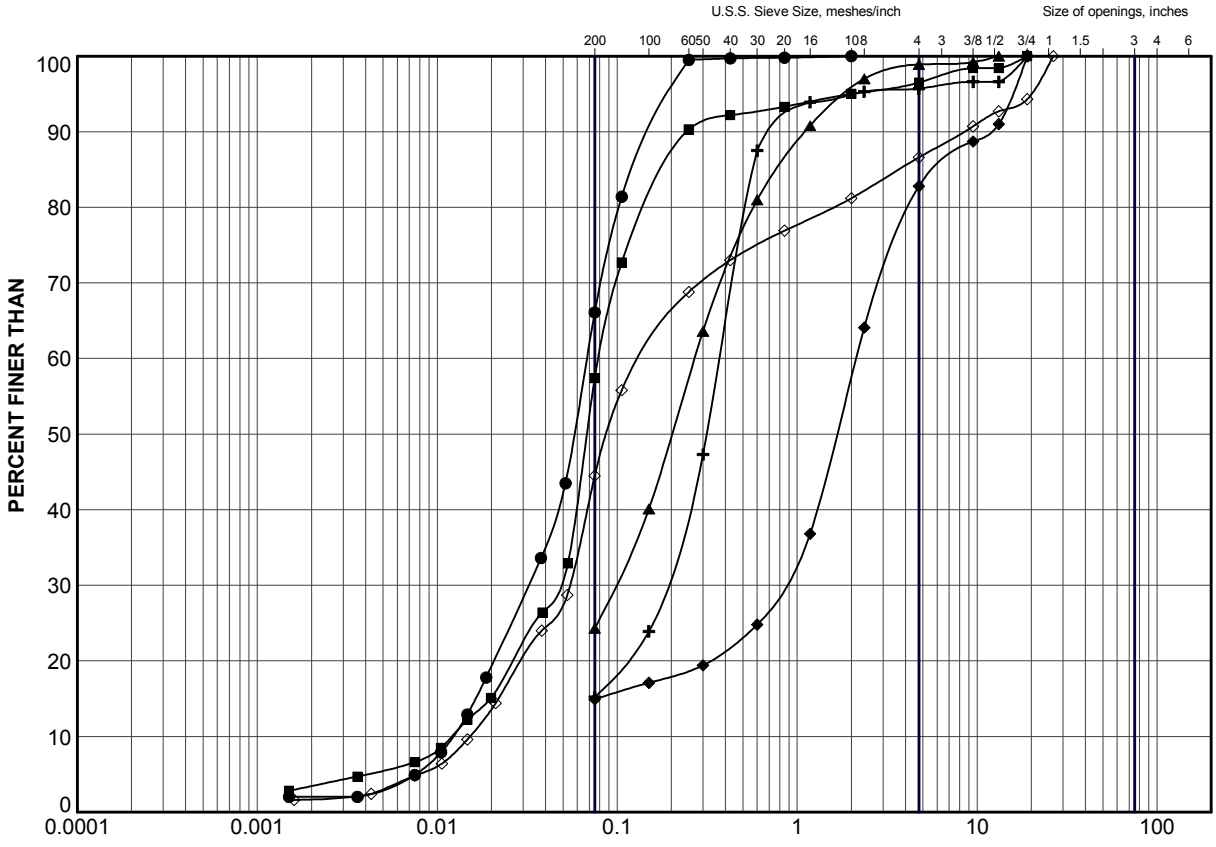
GRAIN SIZE DISTRIBUTION

SILT to SANDY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B6.2**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-6	12	227.3
■	H2-8	14	224.4
▲	H2-14	11	228.1
+	H2-15	9	228.9
◆	H2-17	9	228.9
◇	H2-20	10	227.9

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (WBL)

TITLE

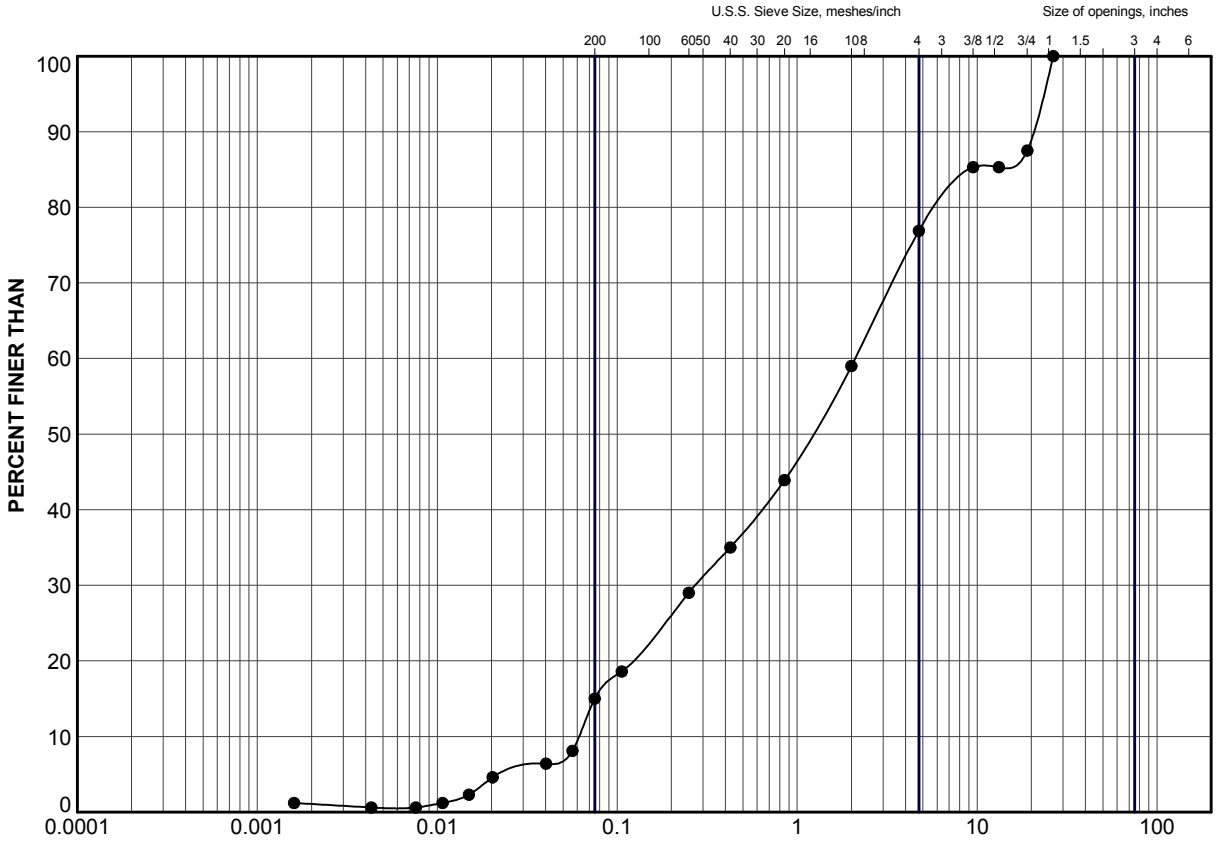
GRAIN SIZE DISTRIBUTION

SAND and SILT to SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B7**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-19	12	226.2

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (WBL)

TITLE

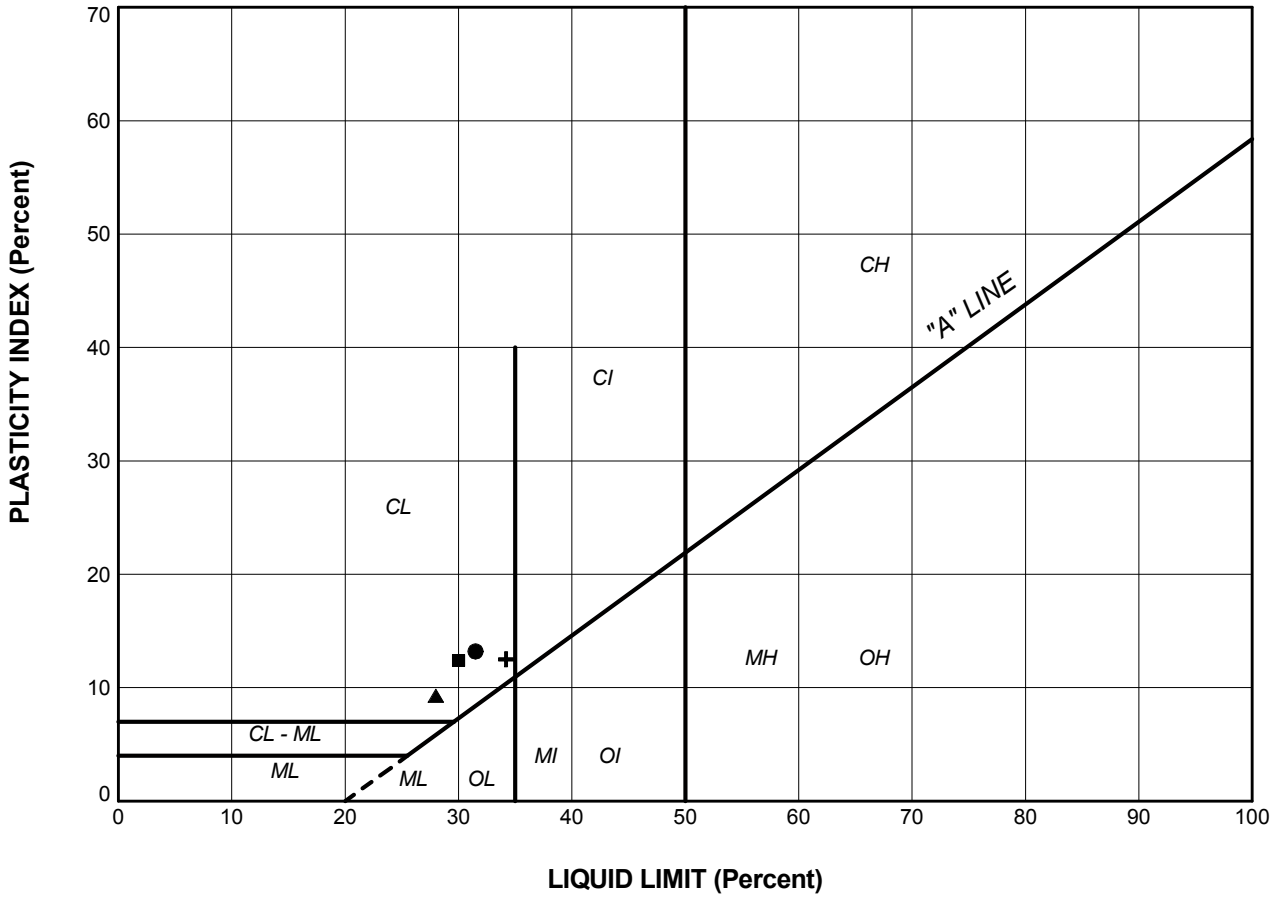
GRAIN SIZE DISTRIBUTION

GRAVELLY SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B8**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H2-23	3	31.5	18.3	13.2
■	H2-30	6	30.0	17.6	12.4
▲	H2-31	6	28.0	18.7	9.3
+	H2-43	2	34.2	21.7	12.5

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (EBL)

TITLE

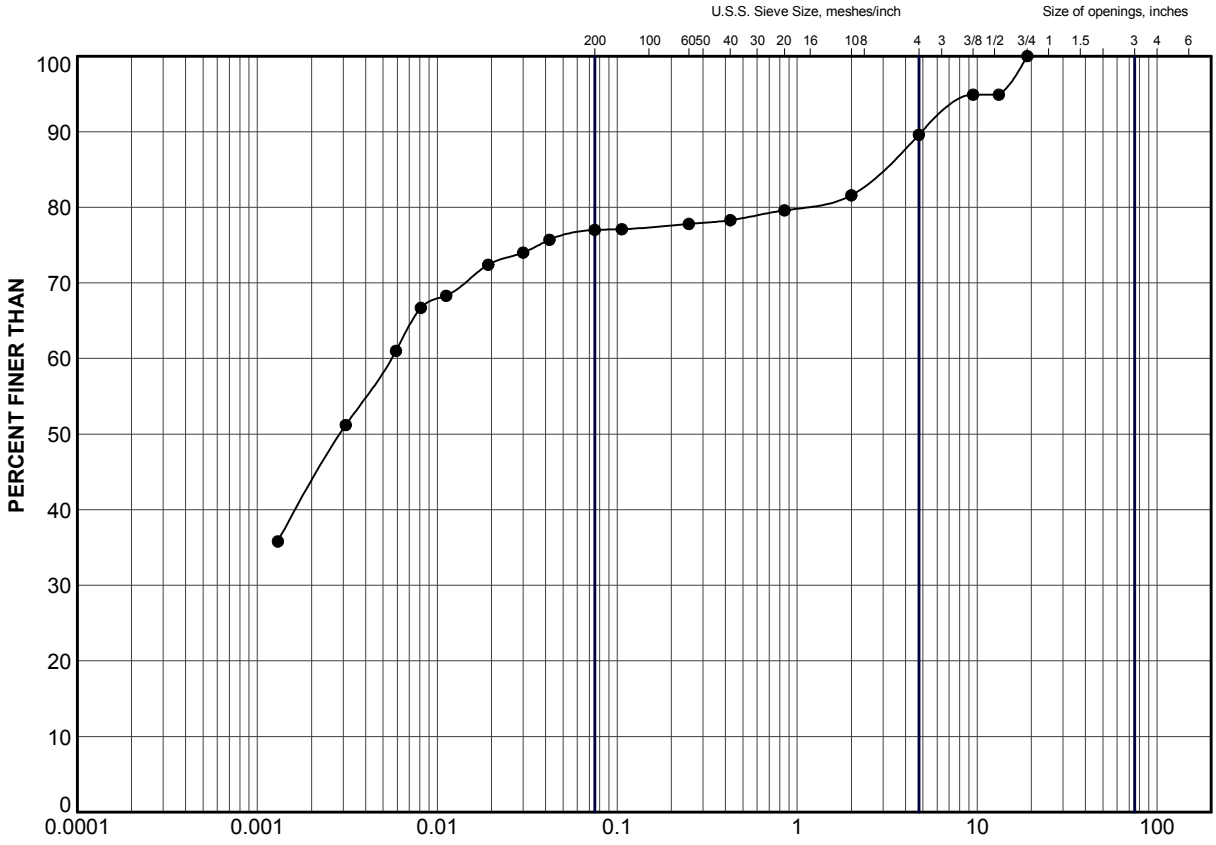
PLASTICITY CHART

CLAYEY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B9**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-35	7A	235.0

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (EBL)

TITLE

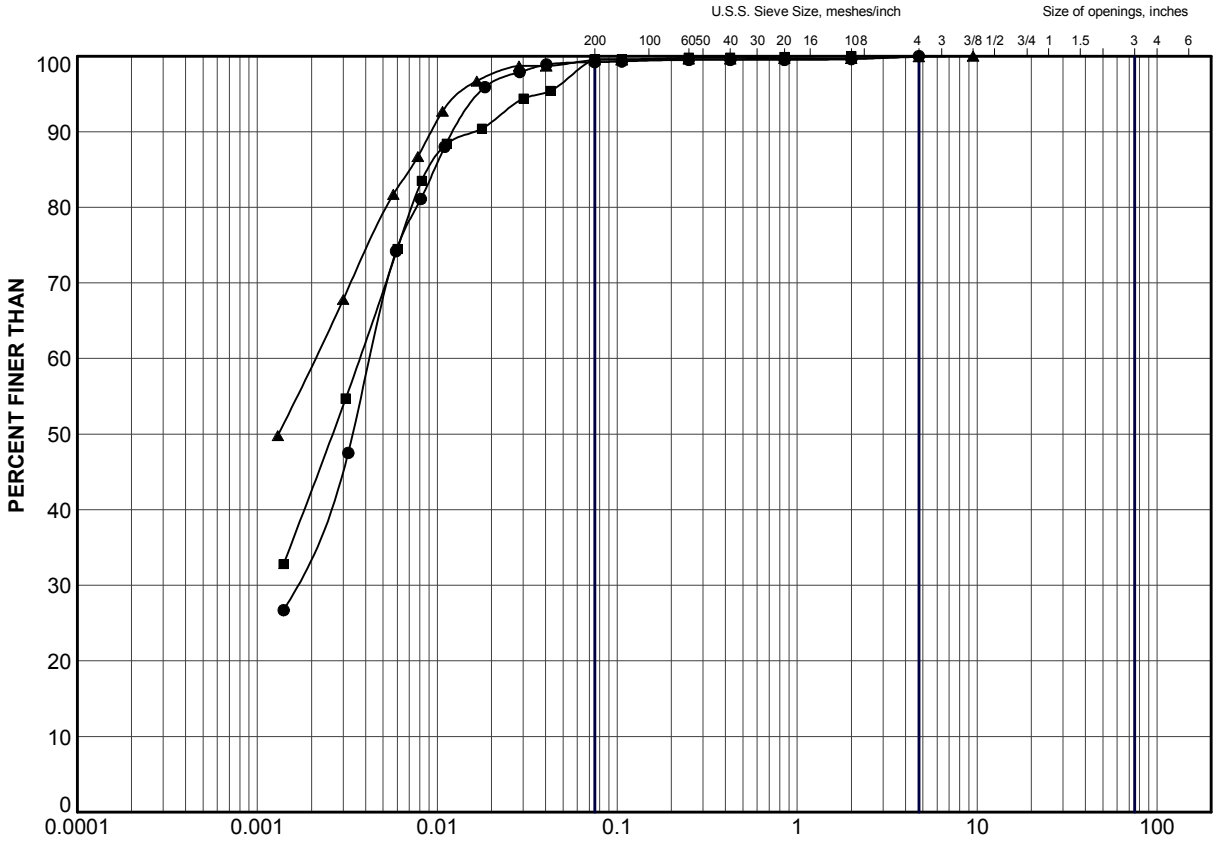
GRAIN SIZE DISTRIBUTION

CLAYEY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B10**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-28	9	230.3
■	H2-30	10	230.2
▲	H2-34	7	234.8

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (EBL)

TITLE

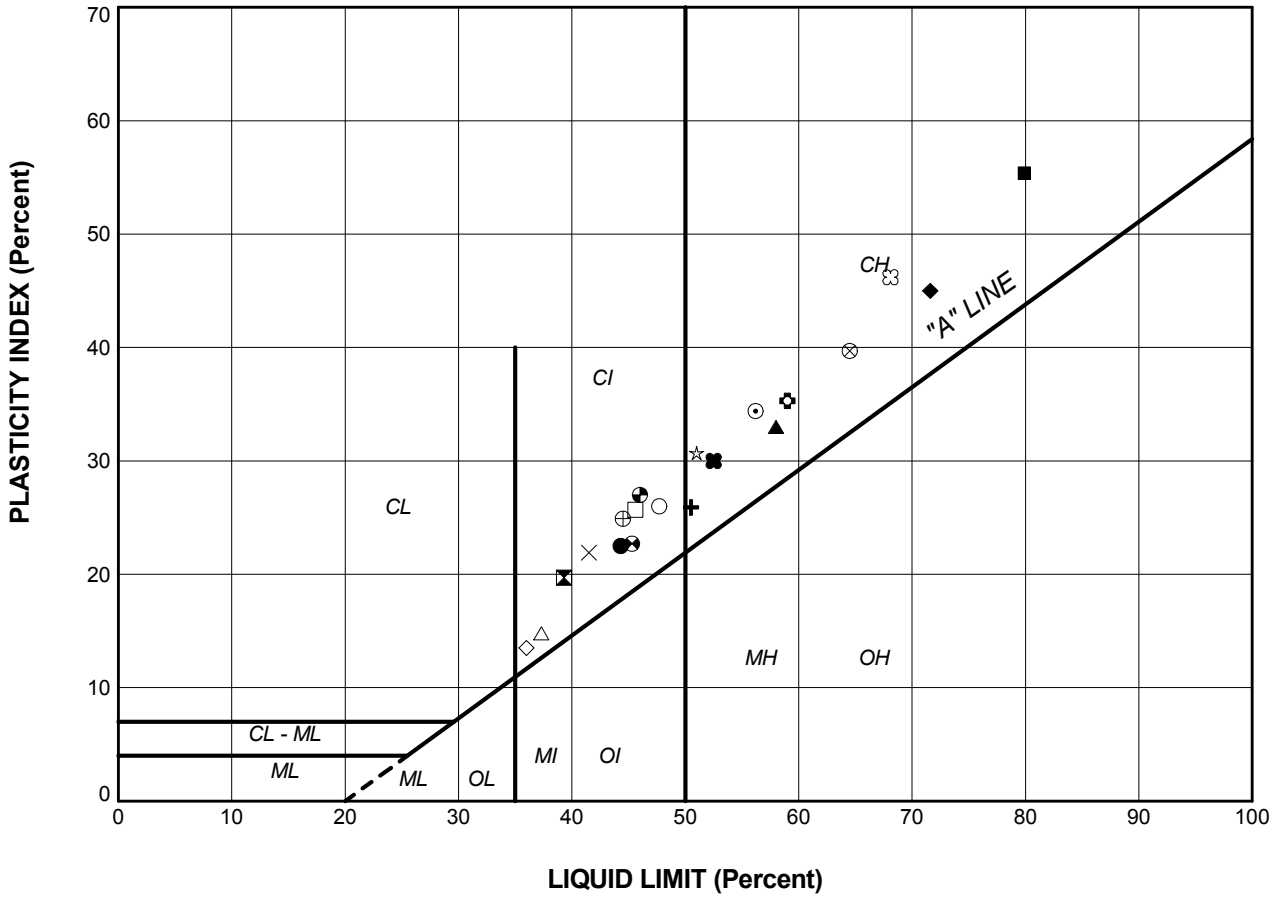
GRAIN SIZE DISTRIBUTION

SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B11**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H2-25	6	44.3	21.8	22.5
■	H2-26	6	79.9	24.5	55.4
▲	H2-26	7	58.0	25.0	33.0
✚	H2-27	6	50.5	24.6	25.9
◆	H2-28	7	71.6	26.6	45.0
◇	H2-28	9	36.0	22.5	13.5
○	H2-29	6	47.7	21.7	26.0
△	H2-29	10	37.3	22.5	14.8
⊗	H2-31	8	64.5	24.8	39.7
⊕	H2-32	7	44.5	19.6	24.9
□	H2-33	7	45.6	19.9	25.7
◓	H2-34	7	45.3	22.6	22.7
◔	H2-34	8	46.0	19.0	27.0
☆	H2-35	7B	51.0	20.3	30.7
⊠	H2-35	8	68.1	21.9	46.2
⧓	H2-36	5B	39.3	19.6	19.7
⊙	H2-36	8	56.2	21.8	34.4
✿	H2-36	8A	59.0	23.7	35.3
×	H2-37	6	41.5	19.6	21.9
✱	H2-38	6	52.5	22.5	30.0

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (EBL)

TITLE

PLASTICITY CHART

SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	TB	Mar 2014	SCALE	N/A	REV.
CHECK	SEMP	Mar 2014			
APPR		Mar 2014	**FIGURE B12**		

SUD-MTO PL (NEW) 25 GLDR_LDN.GDT

CONSOLIDATION TEST SUMMARY

FIGURE B13

SAMPLE IDENTIFICATION

Project Number:	11-1191-0007	Sample Number:	7
Borehole Number:	H2-26	Sample Depth, m:	6.4

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	2		
Date Started	3-May-12		
Date Completed	25-May-12		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.526	Unit Weight, kN/m^3	16.55
Sample Diameter, cm	6.351	Dry Unit Weight, kN/m^3	10.19
Area, cm^2	31.68	Specific Gravity, measured	2.78
Volume, cm^3	80.02	Solids Height, cm	0.945
Water Content, %	62.32	Volume of Solids, cm^3	29.94
Wet Mass, g	135.02	Volume of Voids, cm^3	50.08
Dry Mass, g	83.18		

TEST COMPUTATIONS

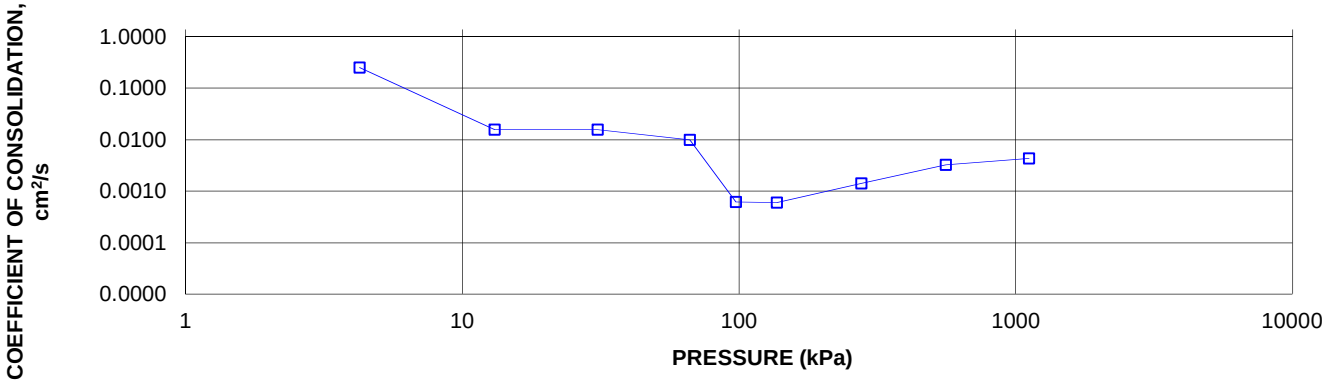
Pressure	Primary	Corr. Height	Void	Average Height	t_{90}	cv.	mv	k	Total Work
kPa	Consolidation	cm	Ratio	cm	sec	cm^2/s	m^2/kN	cm/s	kJ/m3
0	0	2.526	1.673	2.526					
4	0.02	2.524	1.671	2.525	5	0.2503	1.64E-04	4.03E-06	0.001
13	0.02	2.522	1.668	2.523	86	0.0156	9.37E-05	1.43E-07	0.009
31	0.04	2.518	1.664	2.520	86	0.0156	8.80E-05	1.34E-07	0.043
66	0.10	2.508	1.654	2.513	135	0.0099	1.11E-04	1.08E-07	0.234
97	0.15	2.493	1.638	2.501	2160	0.0006	1.92E-04	1.16E-08	0.723
137	0.15	2.478	1.622	2.486	2160	0.0006	1.50E-04	1.00E-08	1.447
277	1.40	2.339	1.474	2.408	866	0.0014	3.94E-04	5.47E-08	13.109
558	0.88	2.251	1.381	2.295	346	0.0032	1.24E-04	3.93E-08	28.820
1117	0.77	2.174	1.300	2.212	240	0.0043	5.45E-05	2.31E-08	57.478
558	-0.08	2.181	1.308	2.177					
136	-0.43	2.224	1.353	2.203					
31	-0.32	2.256	1.387	2.240					
4	-0.35	2.291	1.423	2.273					

Note:
k calculated using c_v based on t_{90} values.

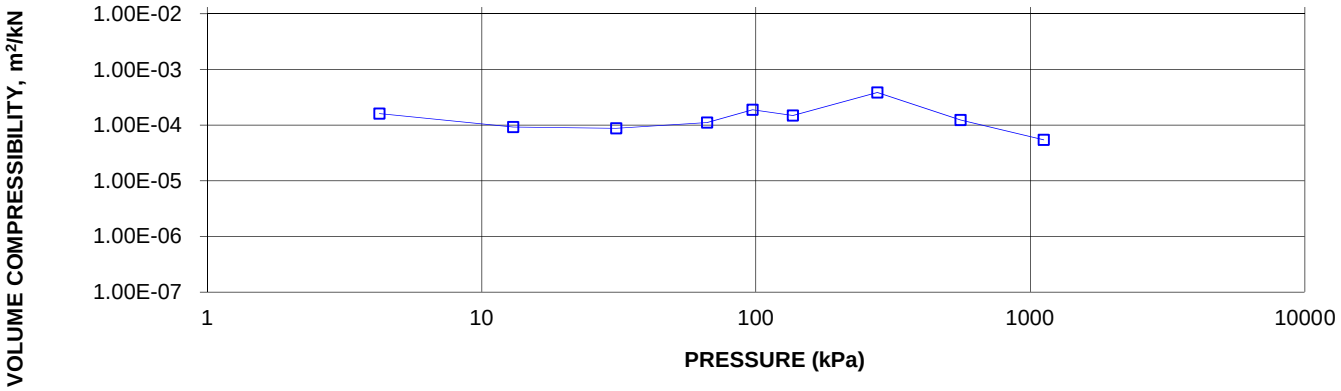
SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	2.291	Unit Weight, kN/m^3	15.49
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	11.24
Area, cm^2	31.68	Specific Gravity, measured	2.78
Volume, cm^3	72.56	Solids Height, cm	0.945
Water Content, %	37.82	Volume of Solids, cm^3	29.94
Wet Mass, g	114.64	Volume of Voids, cm^3	42.62
Dry Mass, g	83.18		

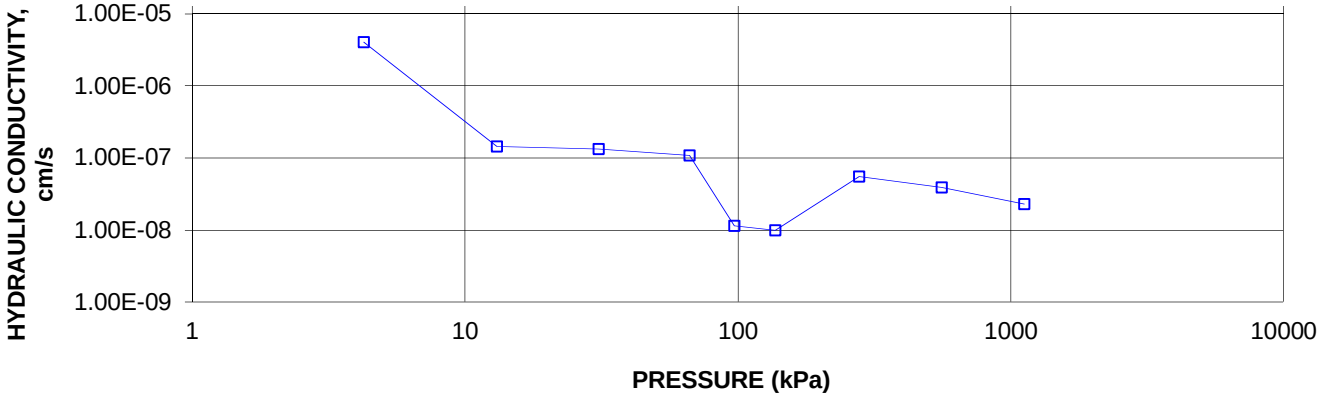
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH H2-26 SA 7



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH H2-26 SA 7

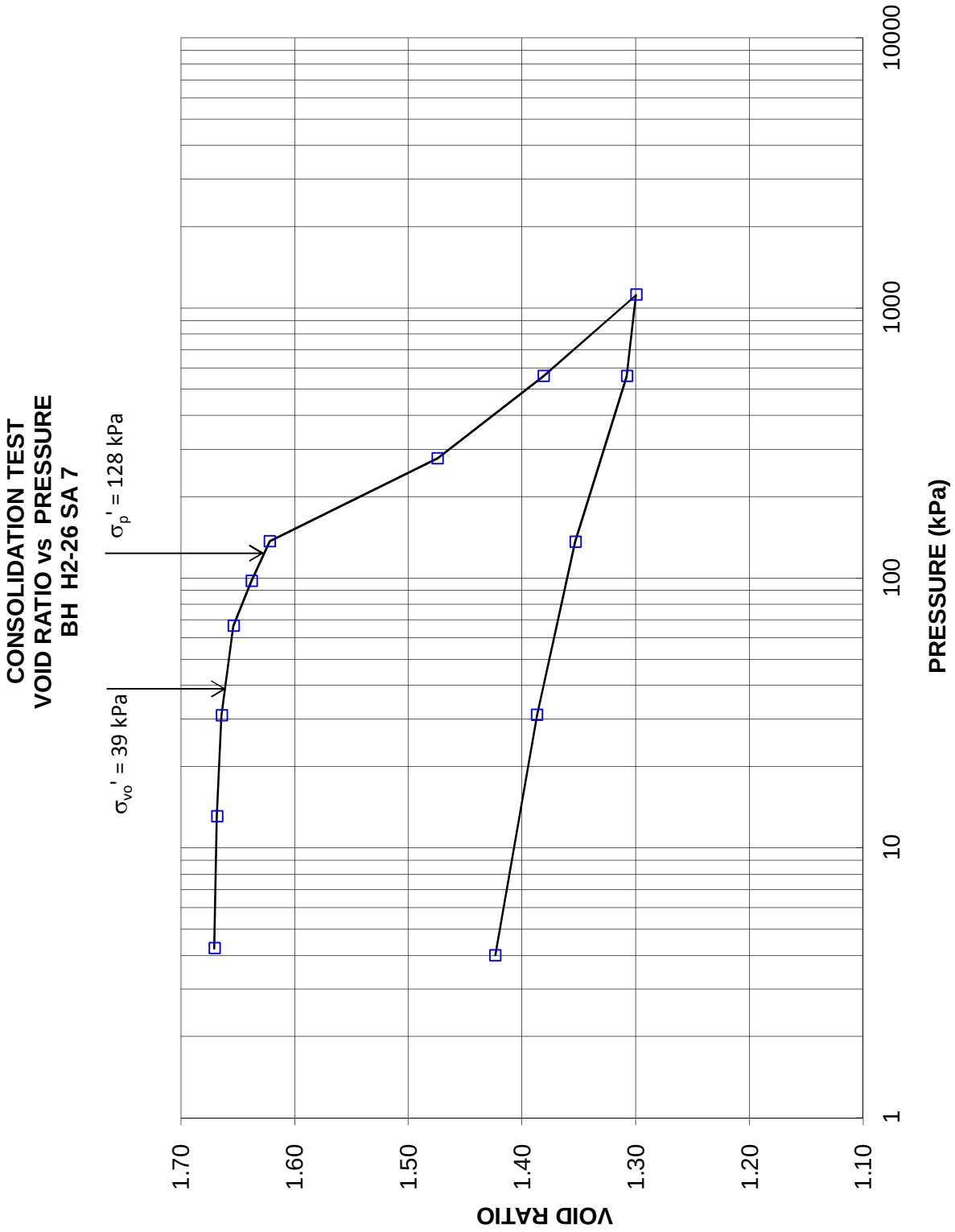


CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH H2-26 SA 7



CONSOLIDATION TEST
VOID RATIO VS LOG PRESSURE

FIGURE B13
Pg. 3 of 4



Project No. 11-1191-0007

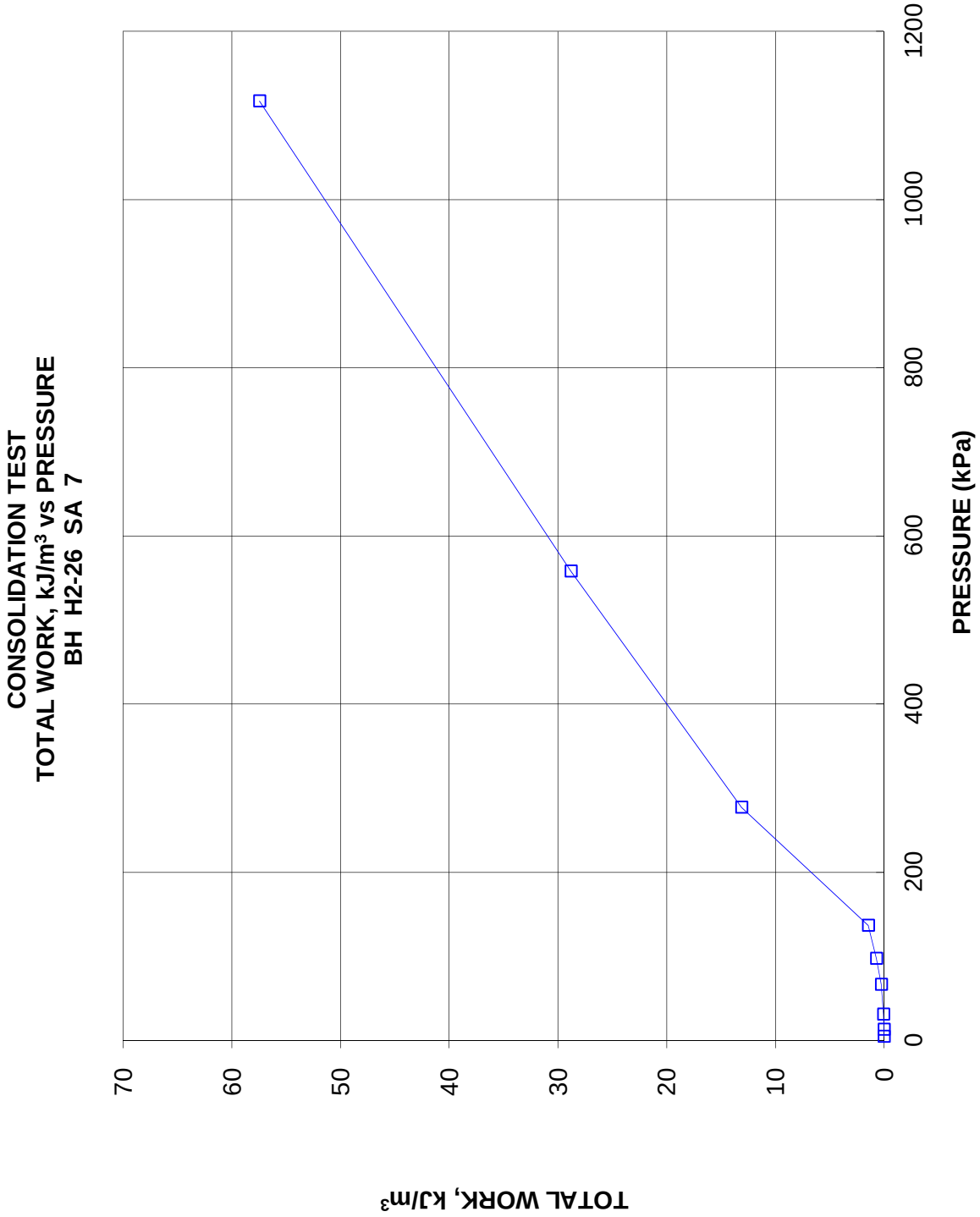
Prepared By: TG

Golder Associates

Checked By:

CONSOLIDATION TEST
TOTAL WORK VS PRESSURE

FIGURE B13
Pg. 4 of 4



Project No: 11-1191-0007

Prepared By: TG

Golder Associates

Checked By:

CONSOLIDATION TEST SUMMARY

FIGURE B14

SAMPLE IDENTIFICATION

Project Number:	11-1191-0007	Sample Number:	8
Borehole Number:	H2-36	Sample Depth, m:	7.7

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	2		
Date Started	July 6/12		
Date Completed	July 24/12		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.526	Unit Weight, kN/m^3	15.62
Sample Diameter, cm	6.351	Dry Unit Weight, kN/m^3	8.69
Area, cm^2	31.68	Specific Gravity, Measured	2.77
Volume, cm^3	80.02	Solids Height, cm	0.807
Water Content, %	79.76	Volume of Solids, cm^3	25.57
Wet Mass, g	127.45	Volume of Voids, cm^3	54.45
Dry Mass, g	70.90		

TEST COMPUTATIONS

Pressure	Primary	Corr. Height	Void	Average Height	t_{90}	cv.	mv	k	Total Work
kPa	Consolidation	cm	Ratio	cm	sec	cm^2/s	m^2/kN	cm/s	kJ/m3
0	0	2.526	2.130	2.526					
4	0.15	2.511	2.111	2.518	1009	0.0013	1.44E-03	1.88E-07	0.013
13	0.09	2.502	2.100	2.506	1058	0.0013	3.95E-04	4.86E-08	0.043
31	0.22	2.480	2.073	2.491	1325	0.0010	4.89E-04	4.76E-08	0.237
66	0.35	2.445	2.029	2.462	960	0.0013	3.92E-04	5.14E-08	0.922
97	0.17	2.428	2.008	2.436	2940	0.0004	2.19E-04	9.18E-09	1.490
137	0.15	2.413	1.990	2.420	2160	0.0006	1.50E-04	1.01E-08	2.250
277	2.54	2.159	1.675	2.286	5415	0.0002	7.16E-04	1.43E-08	24.029
558	1.54	2.005	1.484	2.082	3110	0.0003	2.17E-04	6.29E-09	53.813
277	-0.11	2.016	1.498	2.010					
137	-0.17	2.032	1.518	2.024					
31	-0.42	2.074	1.570	2.053					
4	-0.40	2.115	1.620	2.094					

Note:
k calculated using c_v based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

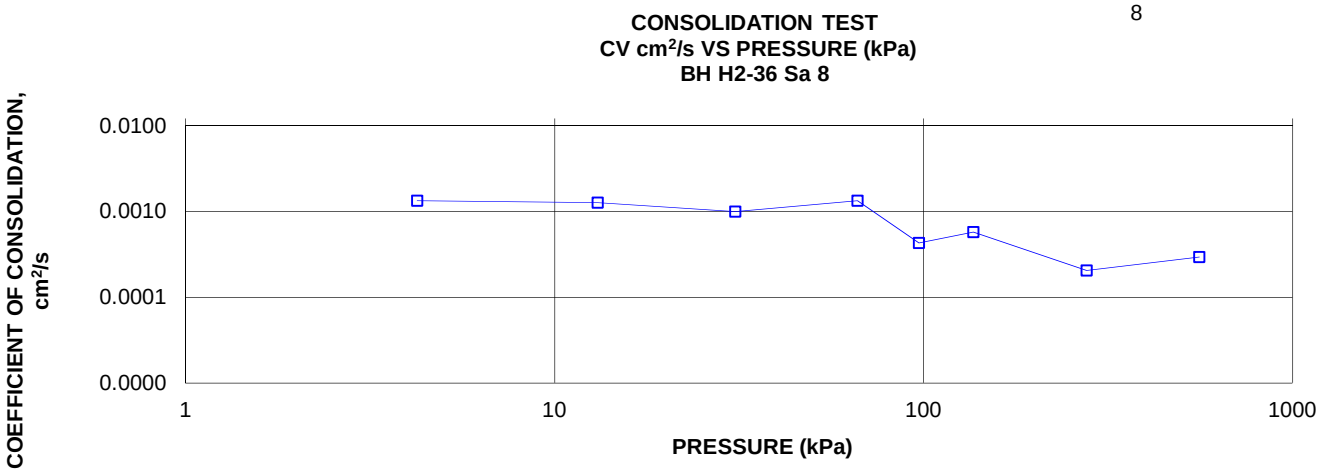
Sample Height, cm	2.115	Unit Weight, kN/m^3	15.34
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	10.38
Area, cm^2	31.68	Specific Gravity, Measured	2.77
Volume, cm^3	66.99	Solids Height, cm	0.807
Water Content, %	47.83	Volume of Solids, cm^3	25.57
Wet Mass, g	104.81	Volume of Voids, cm^3	41.42
Dry Mass, g	70.9		

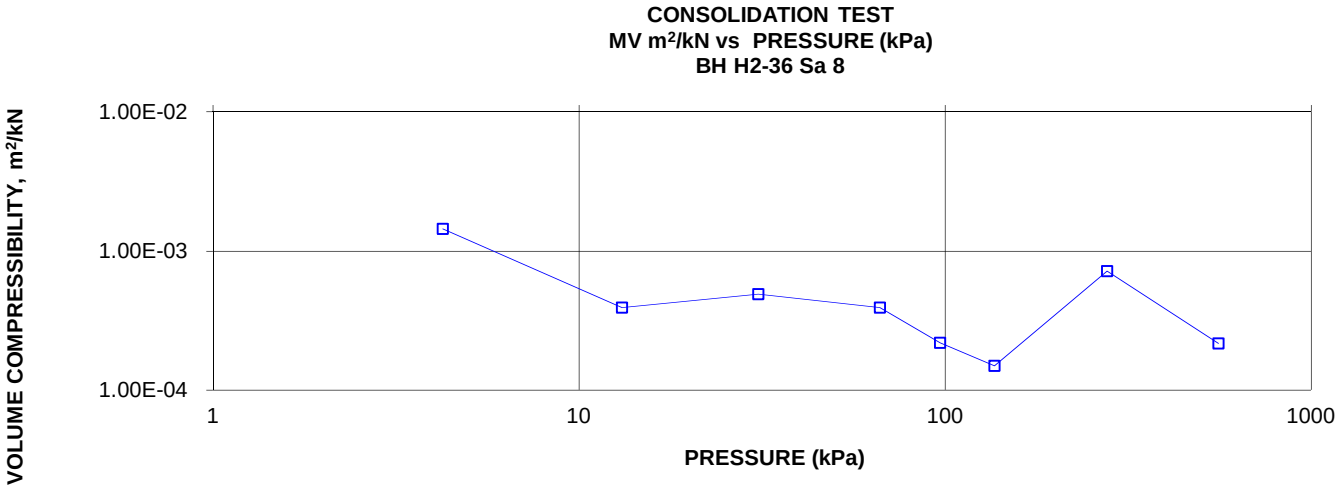
Prepared By: SL

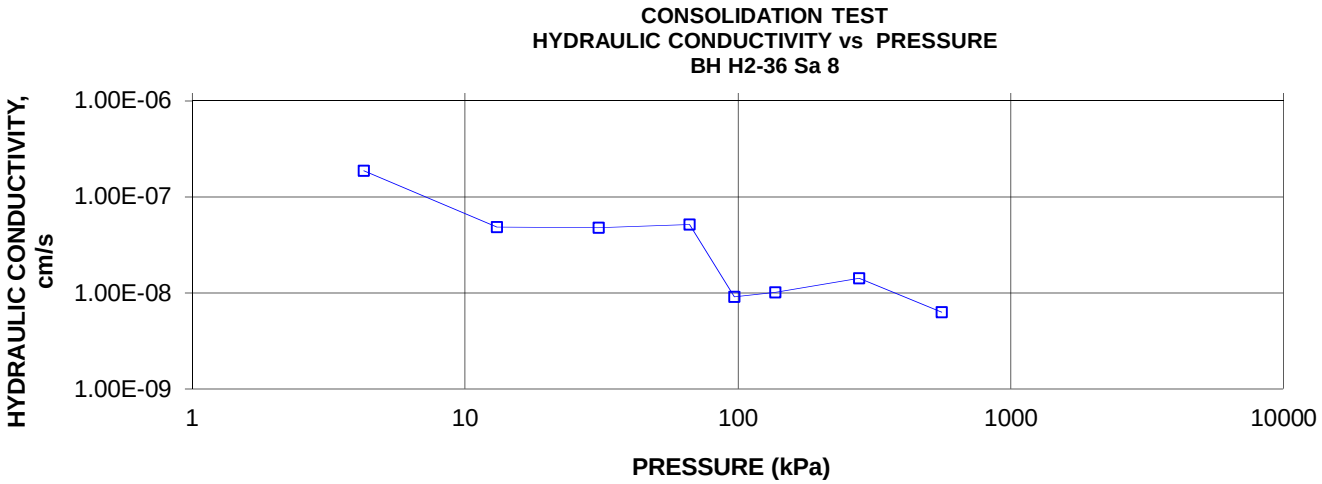
Golder Associates

Checked By:

8

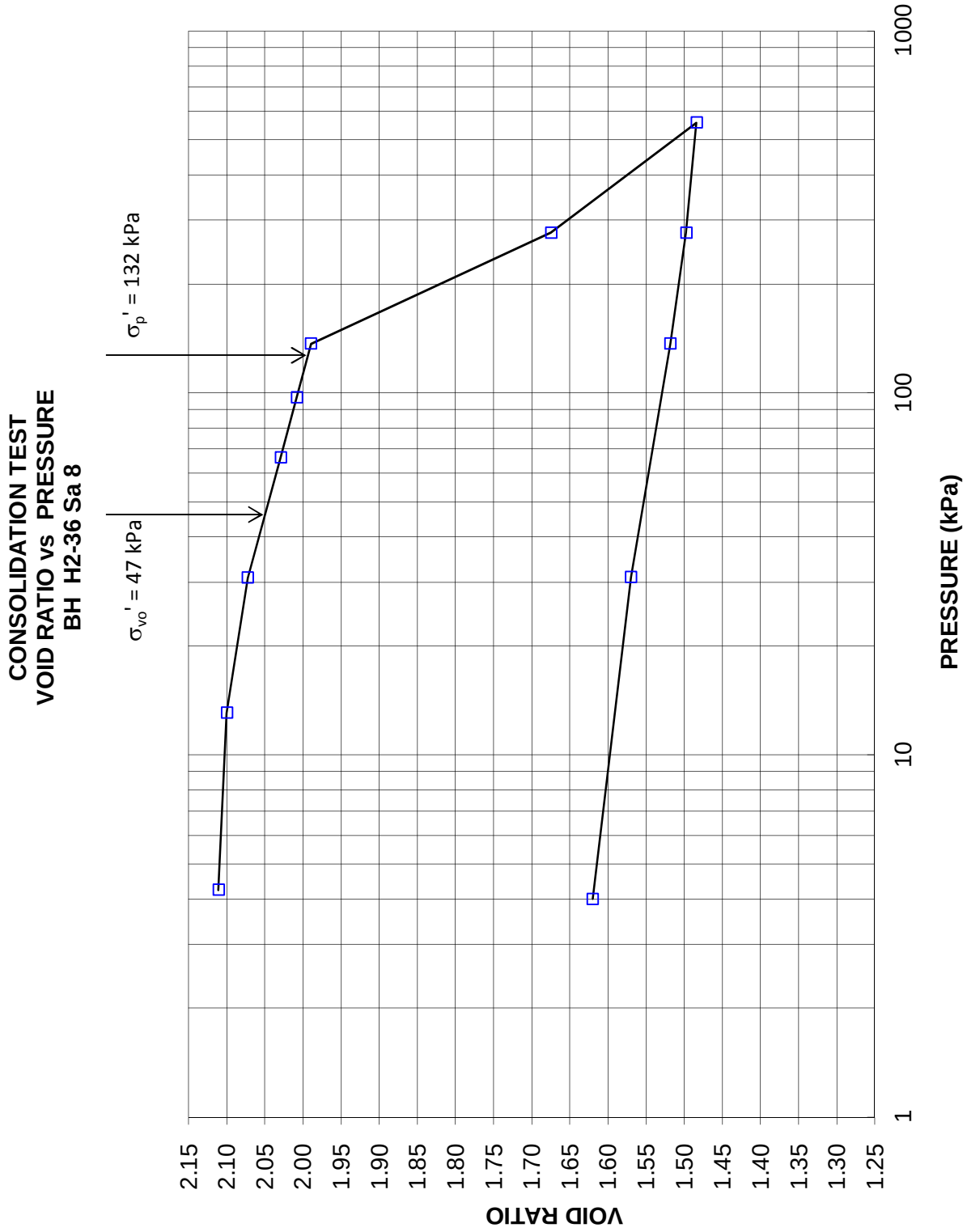

CONSOLIDATION TEST
CV cm²/s VS PRESSURE (kPa)
BH H2-36 Sa 8
COEFFICIENT OF CONSOLIDATION, cm²/s
0.0100
0.0010
0.0001
0.0000
1
10
100
1000
PRESSURE (kPa)


CONSOLIDATION TEST
MV m²/kN vs PRESSURE (kPa)
BH H2-36 Sa 8
VOLUME COMPRESSIBILITY, m²/kN
1.00E-02
1.00E-03
1.00E-04
1
10
100
1000
PRESSURE (kPa)


CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH H2-36 Sa 8
HYDRAULIC CONDUCTIVITY, cm/s
1.00E-06
1.00E-07
1.00E-08
1.00E-09
1
10
100
1000
10000
PRESSURE (kPa)

CONSOLIDATION TEST
VOID RATIO VS LOG PRESSURE

FIGURE B14
Pg. 3 of 4



Project No. 11-1191-0007

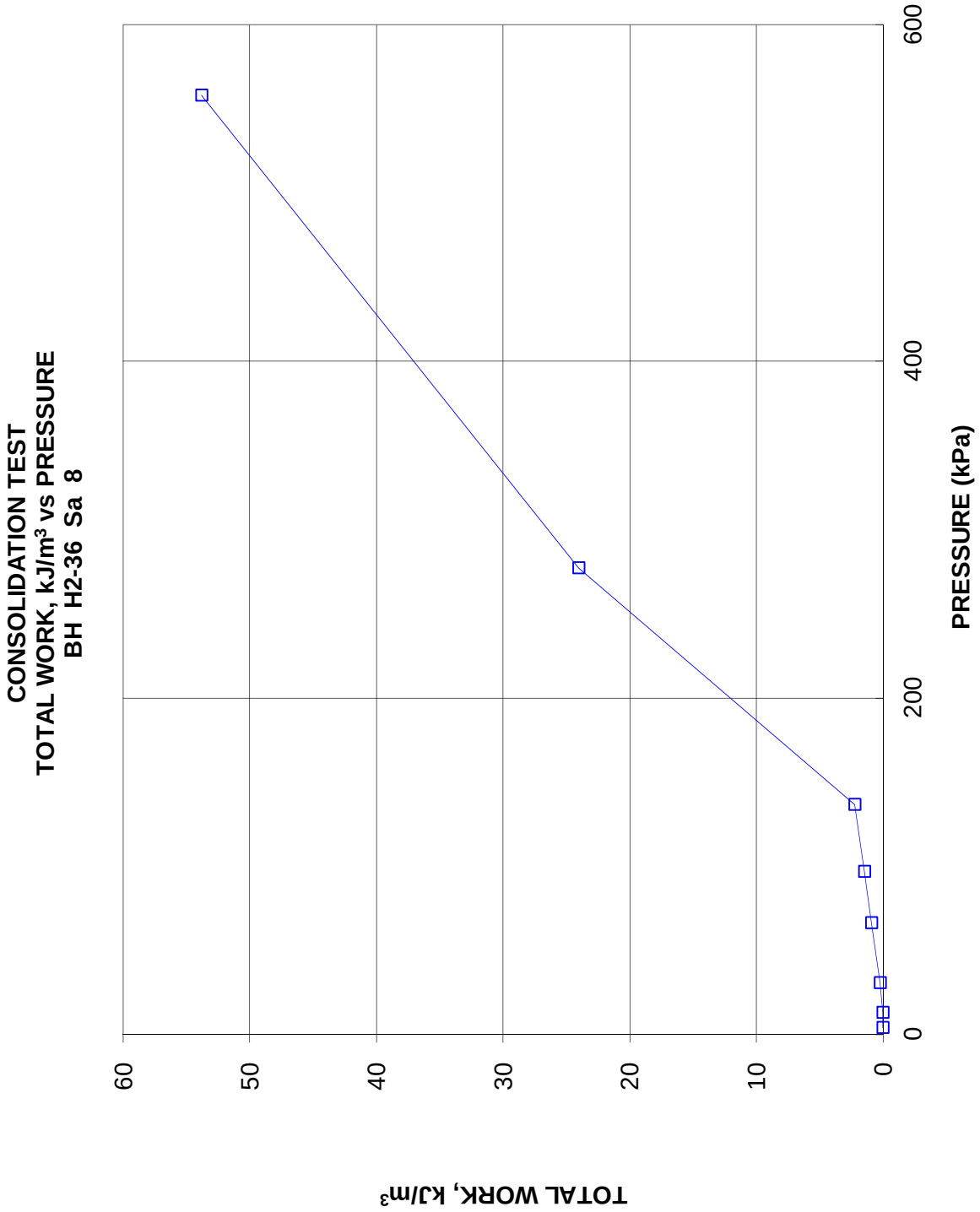
Prepared By: SL

Golder Associates

Checked By:

CONSOLIDATION TEST
TOTAL WORK VS PRESSURE

FIGURE B14
Pg. 4 of 4

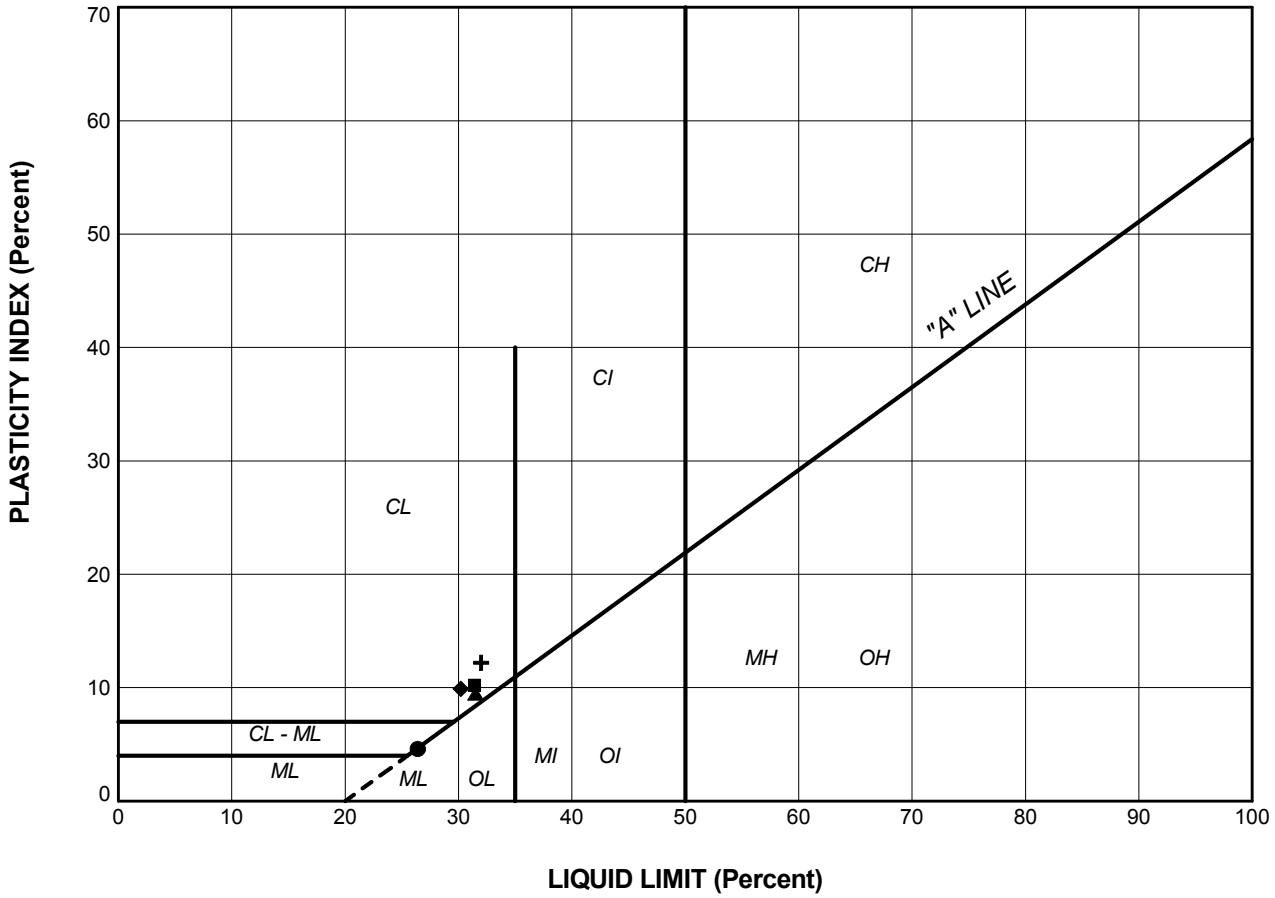


Project No: 11-1191-0007

Prepared By: SL

Golder Associates

Checked By:



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H2-26	8	26.4	21.8	4.6
■	H2-32	11	31.4	21.2	10.2
▲	H2-33	10	31.5	22.0	9.5
+	H2-34	11	32.0	19.8	12.2
◆	H2-41	4	30.2	20.3	9.9

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (EBL)

TITLE

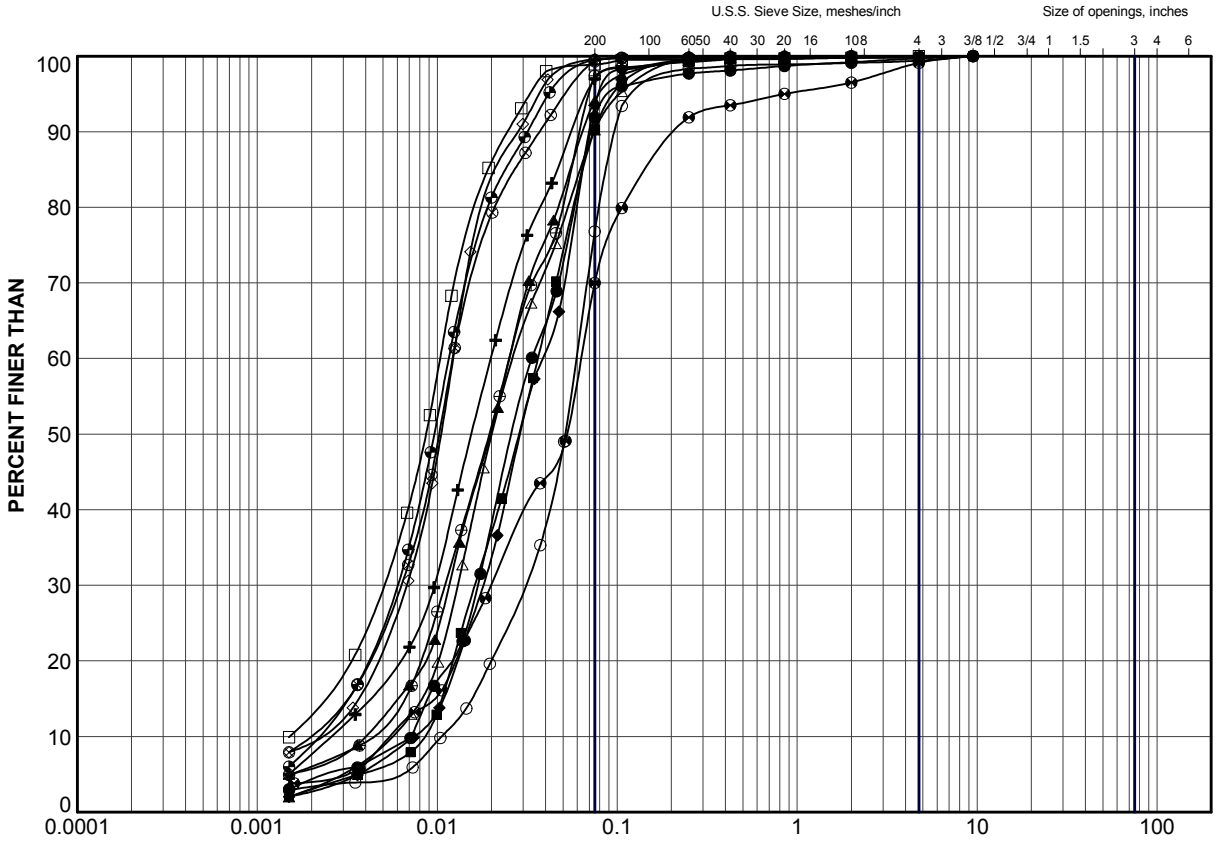
PLASTICITY CHART

CLAYEY SILT to SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B15**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-22	4	237.7
■	H2-24	4	237.0
▲	H2-28	11	227.3
✚	H2-29	13	225.8
◆	H2-30	16	221.1
◇	H2-31	12	225.7
○	H2-32	14	224.3
△	H2-33	14	222.4
⊗	H2-34	13	225.7
⊕	H2-35	12	225.7
□	H2-36	10	228.8
◓	H2-36	12	225.8
◕	H2-37	11	228.9

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (EBL)

TITLE

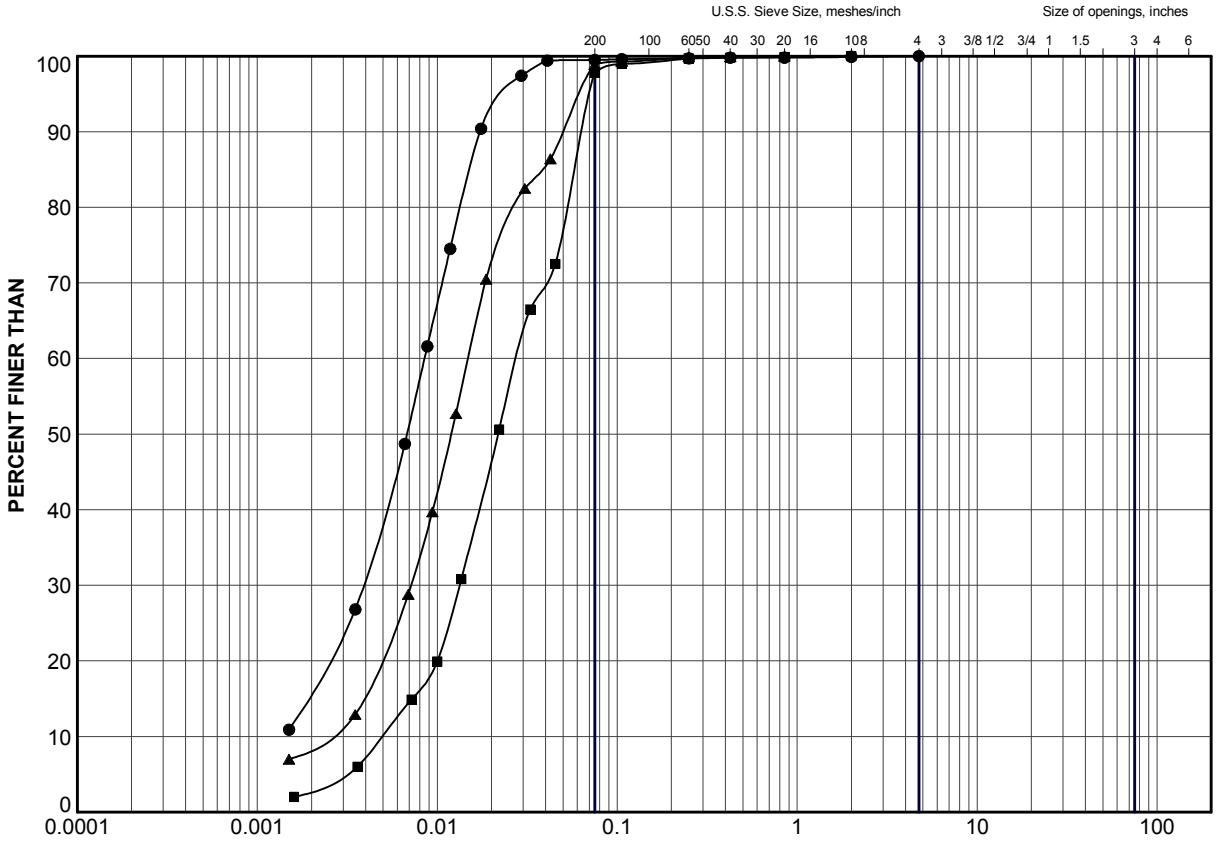
GRAIN SIZE DISTRIBUTION

SILT to SANDY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B16.1**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-38	9	231.9
■	H2-42	4B	239.1
▲	H2-43	3	240.3

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (EBL)

TITLE

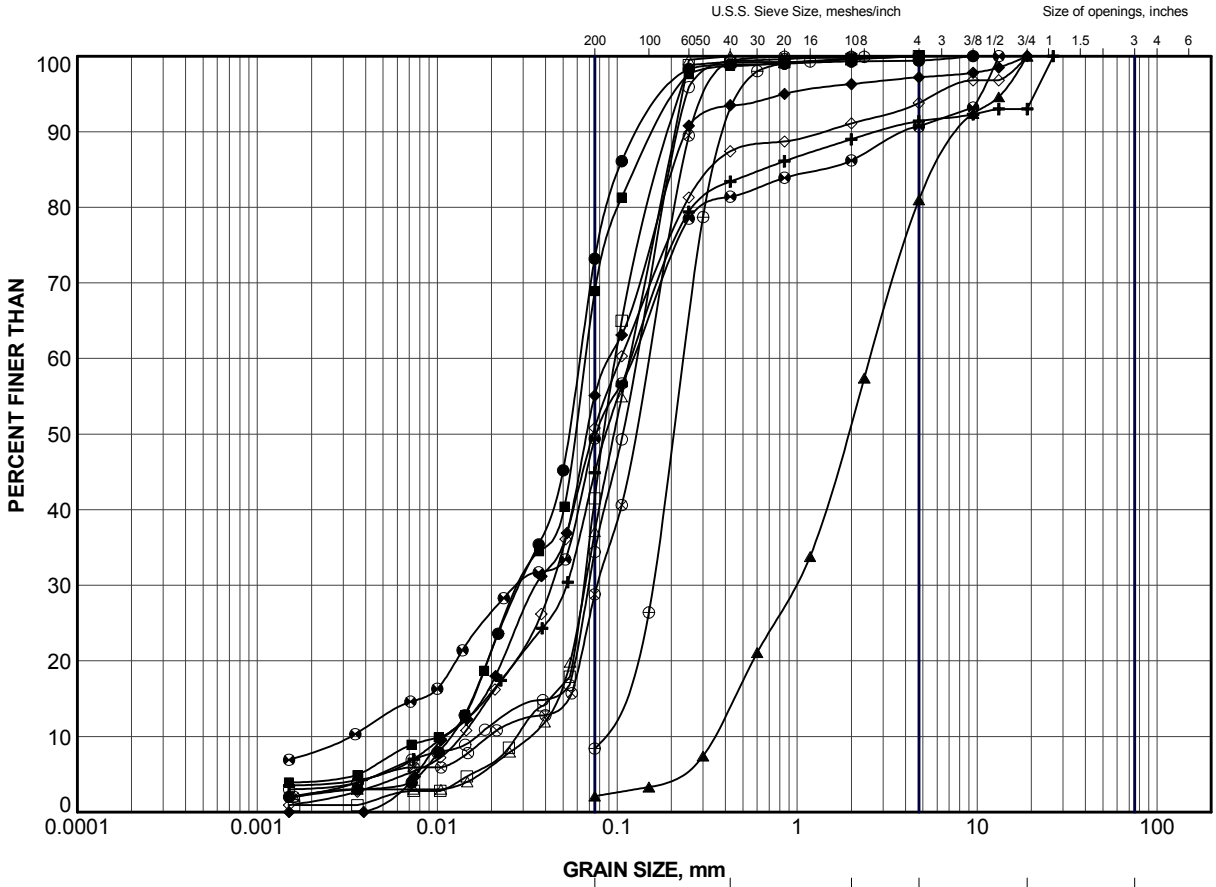
GRAIN SIZE DISTRIBUTION

SILT to SANDY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B16.2**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-23	5	236.3
■	H2-30	19	216.5
▲	H2-32	16	221.2
✚	H2-34	17	219.6
◆	H2-37	14	224.4
◇	H2-38	12	227.3
○	H2-39	10	230.4
△	H2-40	8	231.9
⊗	H2-41	6	233.7
⊕	H2-42	7	236.9
□	H2-42	10	232.4
◓	H2-43	4	239.5

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (EBL)

TITLE

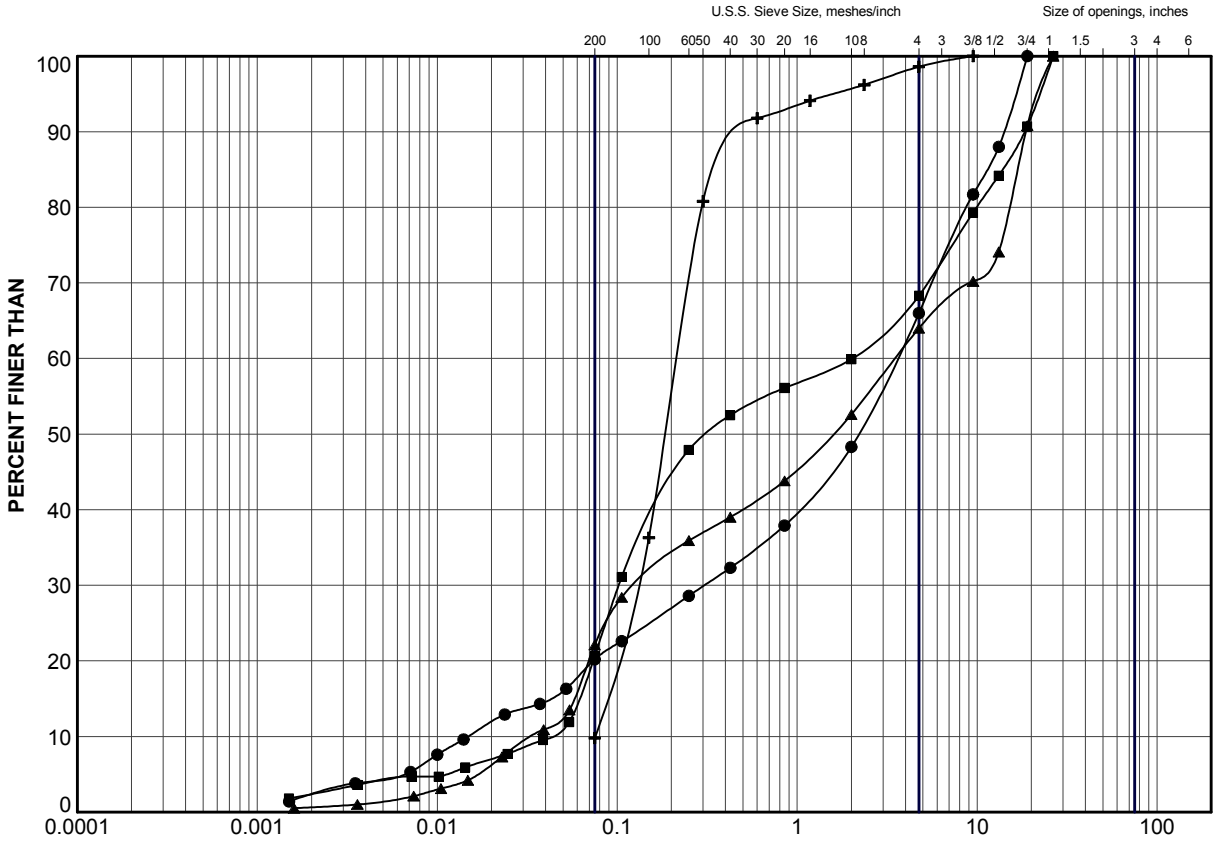
GRAIN SIZE DISTRIBUTION

SAND and SILT to SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B17**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-25	9	230.4
■	H2-29	16	221.4
▲	H2-40	10	229.0
✚	H2-41	9	229.1

PROJECT

HIGHWAY 17
STA 13+140 TO 13+390 (EBL)

TITLE

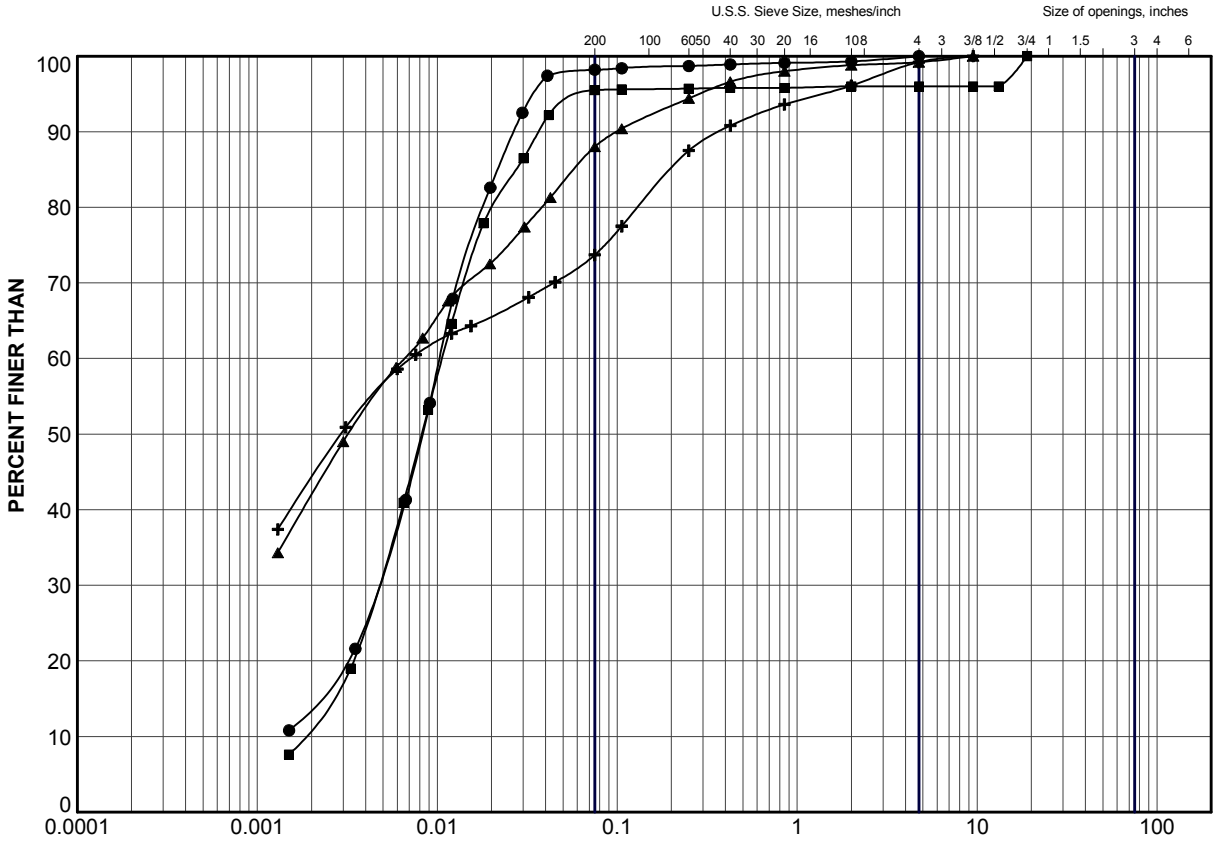
GRAIN SIZE DISTRIBUTION

GRAVELLY SAND to SAND and GRAVEL

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B18**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-44	6	234.7
■	H2-46	9	231.6
▲	H2-49	6	235.5
✚	H2-51	6A	235.5

PROJECT

HIGHWAY 17
ST. POTHIER ROAD
STA 9+400 TO 9+600

TITLE

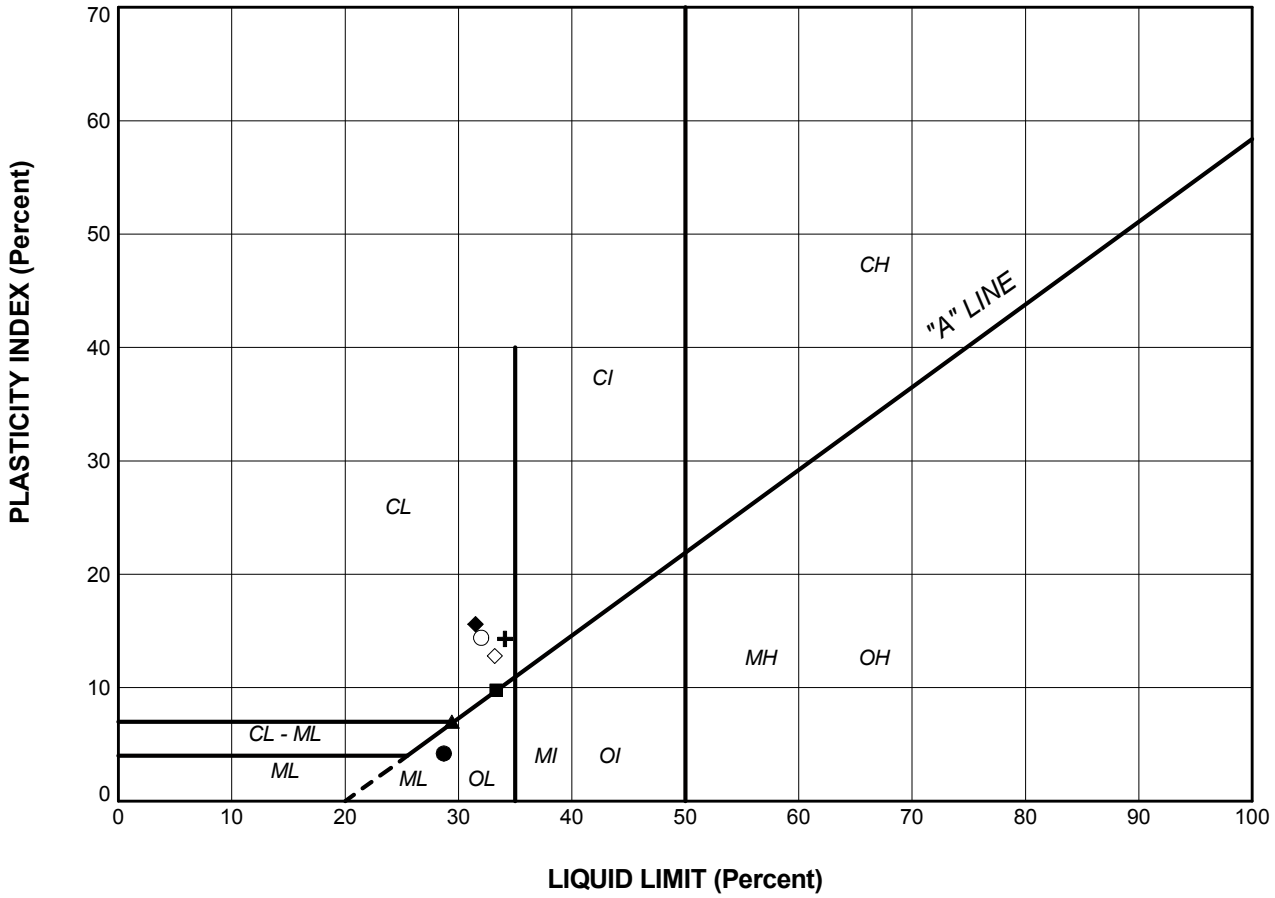
GRAIN SIZE DISTRIBUTION

CLAYEY SILT to SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B19**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H2-44	6	28.7	24.5	4.2
■	H2-45	9	33.3	23.5	9.8
▲	H2-46	9	29.4	22.4	7.0
+	H2-49	6	34.1	19.8	14.3
◆	H2-51	6A	31.5	15.9	15.6
◇	H2-52	6	33.2	20.4	12.8
○	H2-53	6	32.0	17.6	14.4

PROJECT

HIGHWAY 17
ST. POTHIER ROAD
STA 9+400 TO 9+600

TITLE

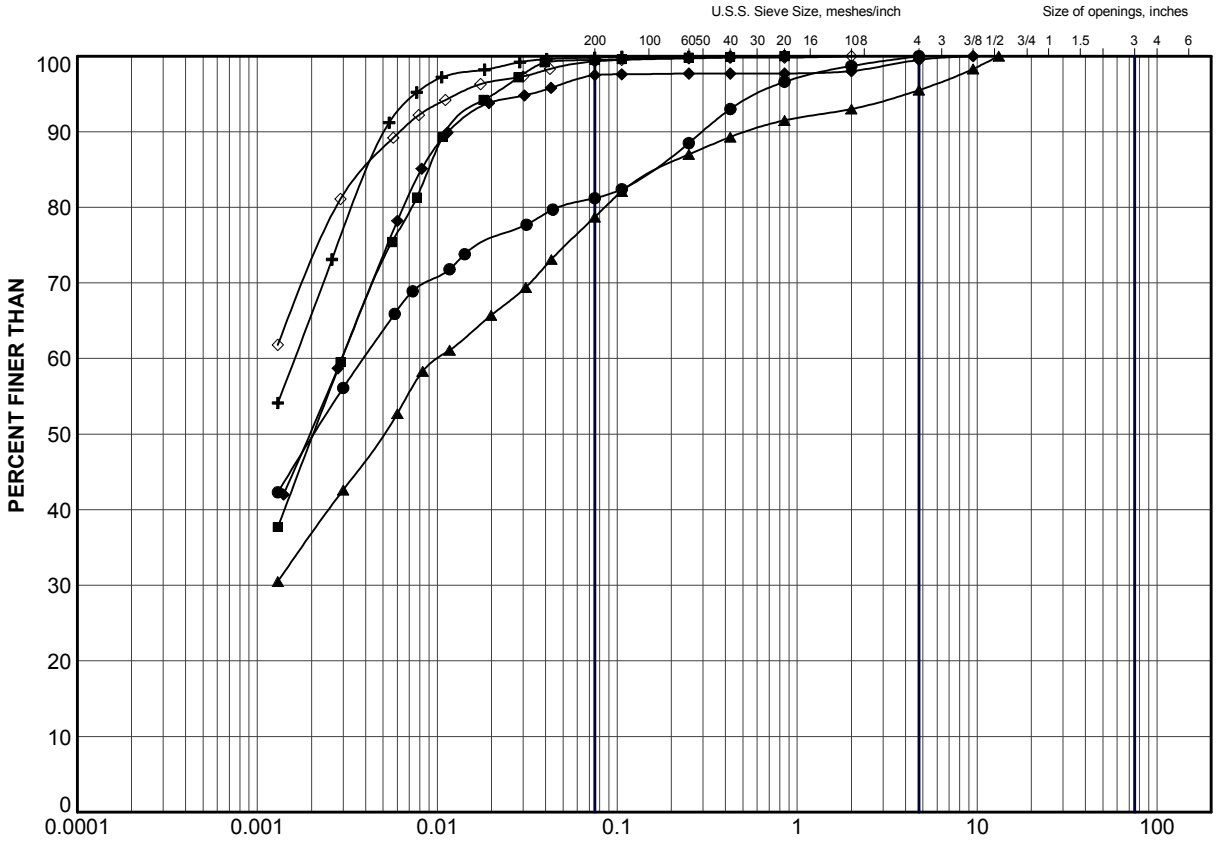
PLASTICITY CHART

CLAYEY SILT to SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B20**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-45	6	235.4
■	H2-48	7	234.6
▲	H2-50	6	235.4
✚	H2-54	9	231.7
◆	H2-55	7	234.8
◇	H2-58	4	237.0

PROJECT

HIGHWAY 17
ST. POTHIER ROAD
STA 9+400 TO 9+600

TITLE

GRAIN SIZE DISTRIBUTION

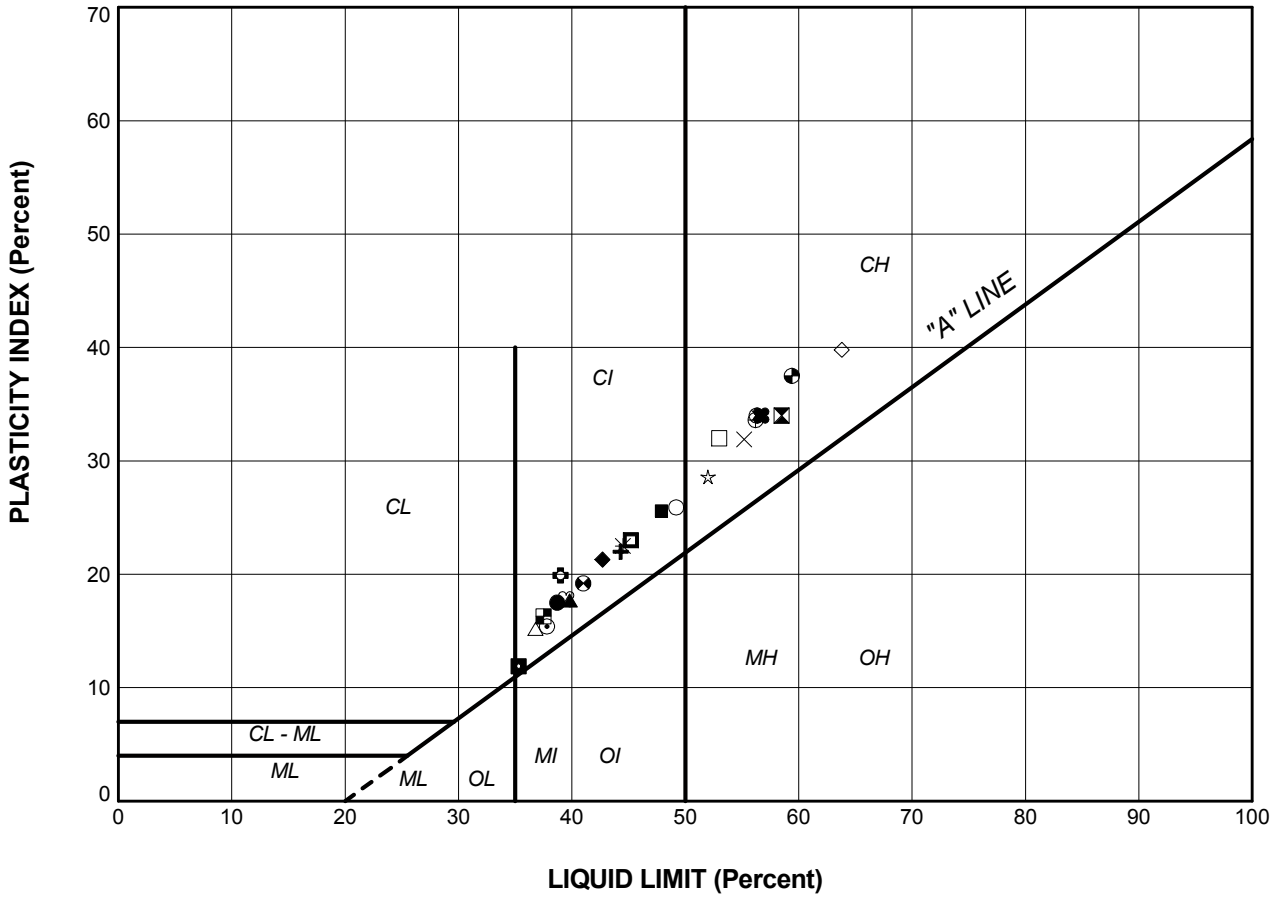
SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	TB	Mar 2014	SCALE	N/A	REV.
CHECK	SEMP	Mar 2014			
APPR		Mar 2014			

FIGURE B21

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H2-45	6	38.7	21.2	17.5
■	H2-46	6	47.9	22.3	25.6
▲	H2-47	7	39.8	22.1	17.7
✚	H2-47	10	44.3	22.3	22.0
◆	H2-48	7	42.7	21.4	21.3
◇	H2-48	10	63.8	24.0	39.8
○	H2-49	11	49.2	23.3	25.9
△	H2-50	6	36.8	21.6	15.2
⊗	H2-50	8	56.3	22.3	34.0
⊕	H2-50	10	56.2	22.6	33.6
□	H2-51	9	53.0	21.0	32.0
⊖	H2-51	11	41.0	21.8	19.2
◕	H2-52	9	59.4	21.9	37.5
☆	H2-53	10	52.0	23.4	28.6
⊠	H2-54	6	39.5	21.7	17.8
⊠	H2-54	9	58.5	24.5	34.0
⊙	H2-55	9	37.8	22.4	15.4
✿	H2-56	5	39.0	19.1	19.9
×	H2-56	8	55.2	23.3	31.9
✱	H2-57	6	56.7	22.7	34.0
⊡	H2-57	8	35.3	23.4	11.9
✳	H2-58	6	44.5	22.0	22.5
◘	H2-59	4	45.2	22.2	23.0
◪	H2-60	4	37.5	21.2	16.3

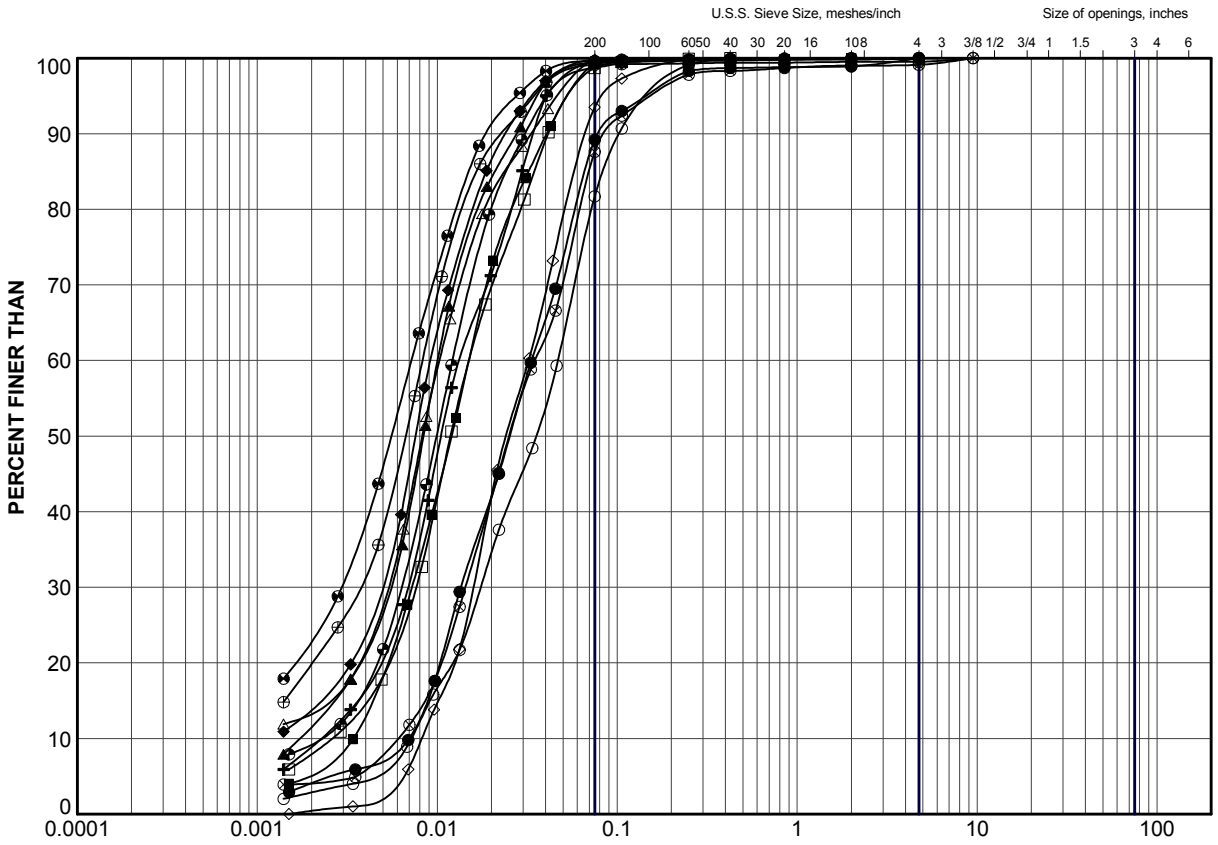
PROJECT
HIGHWAY 17
ST. POTHIER ROAD
STA 9+400 TO 9+600

TITLE
PLASTICITY CHART
SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	TB	Mar 2014	SCALE	N/A	REV.
CHECK	SEMP	Mar 2014			
APPR		Mar 2014	**FIGURE B22**		

SUD-MTO PL (NEW) 25 GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-45	10	230.1
■	H2-47	13	225.5
▲	H2-48	13	225.5
✚	H2-49	14	224.1
◆	H2-50	13	225.5
◇	H2-50	16	220.9
○	H2-50	19	216.3
△	H2-51	13	225.5
⊗	H2-51	16	220.9
⊕	H2-52	12	227.0
□	H2-52	14	224.0
◓	H2-53	12	227.0
◕	H2-53	13	225.5

PROJECT

HIGHWAY 17
ST. POTHIER ROAD
STA 9+400 TO 9+600

TITLE

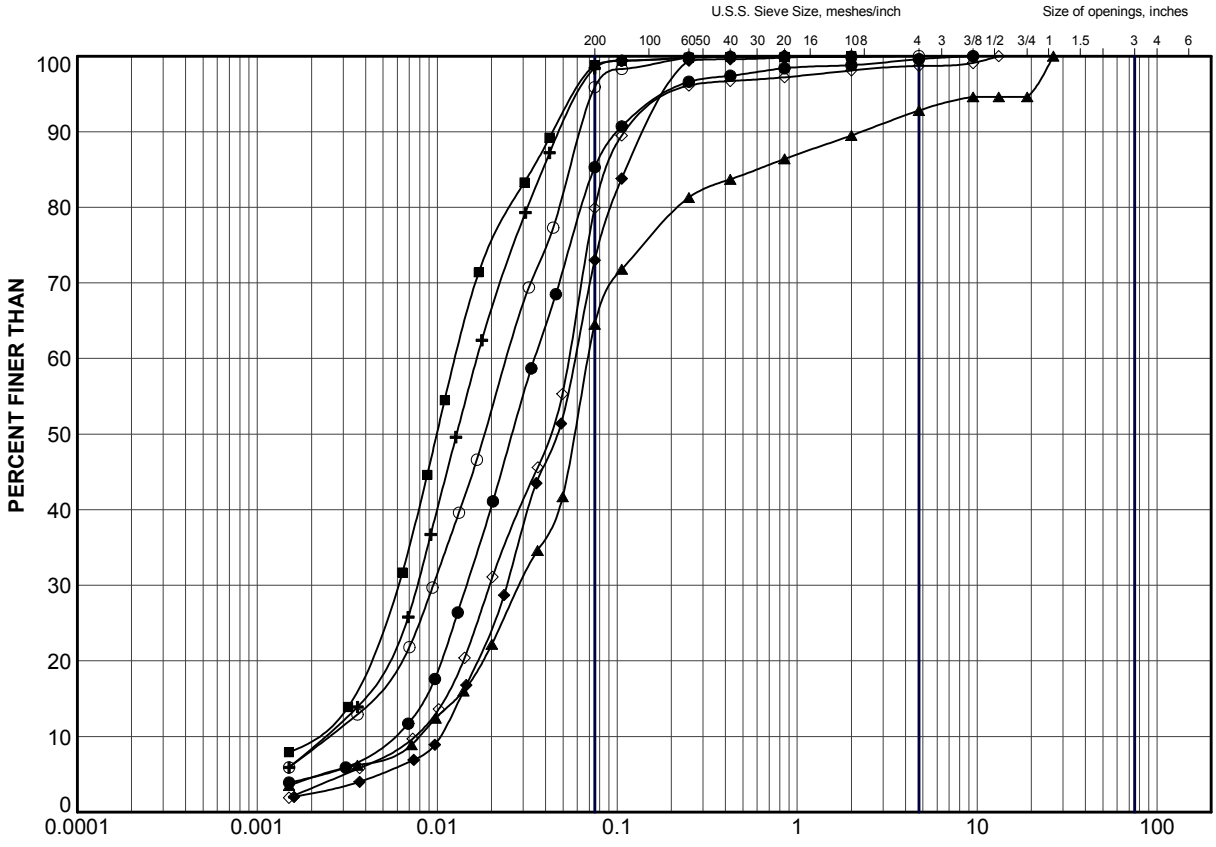
GRAIN SIZE DISTRIBUTION

SILT to SANDY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	TB	Mar 2014	SCALE	N/A	REV.
CHECK	SEMP	Mar 2014			
APPR		Mar 2014	**FIGURE B23.1**		

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-53	15	222.4
■	H2-54	12	227.1
▲	H2-55	12	227.2
+	H2-57	9	231.7
◆	H2-58	9	231.7
◇	H2-59	7	233.3
○	H2-60	6	234.9

PROJECT

HIGHWAY 17
ST. POTHIER ROAD
STA 9+400 TO 9+600

TITLE

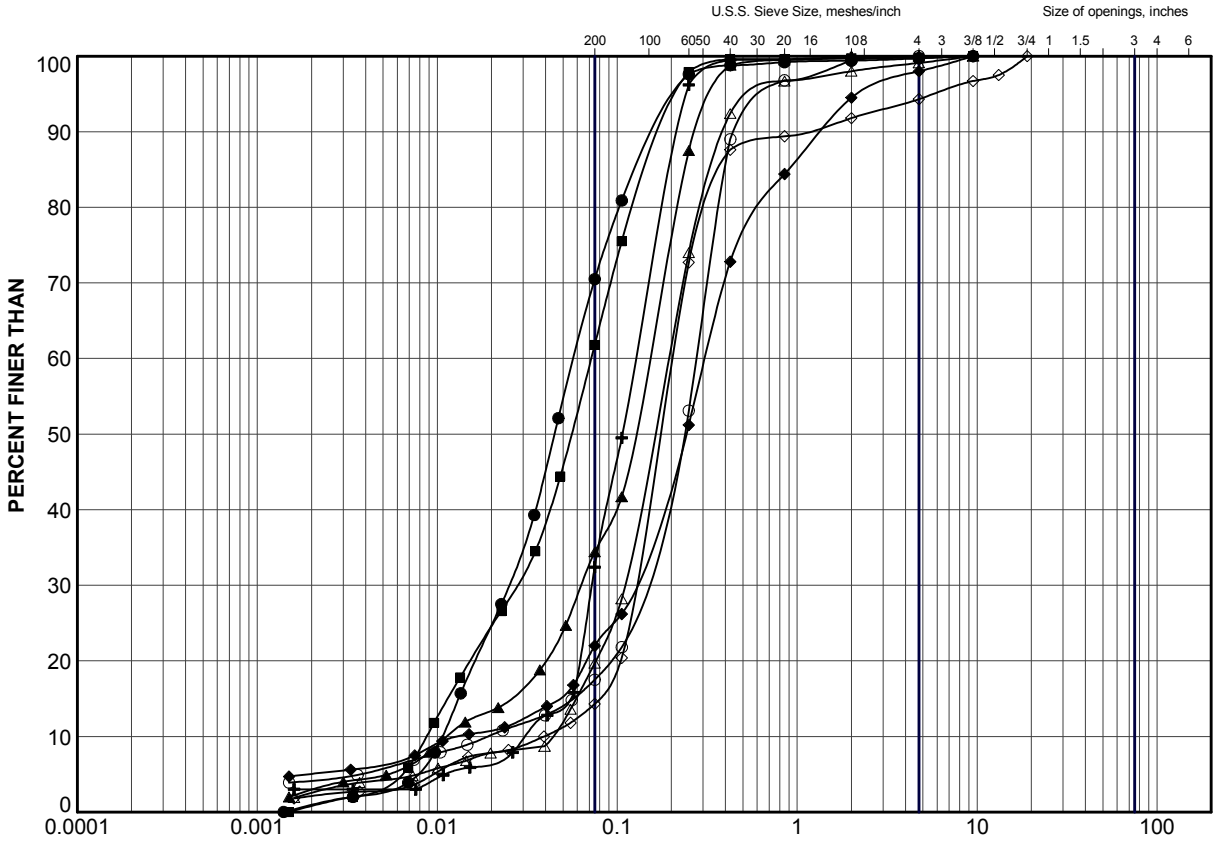
GRAIN SIZE DISTRIBUTION

SILT to SANDY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE N/A	REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014	**FIGURE B23.2**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H2-48	16	220.9
■	H2-49	19	216.4
▲	H2-52	17	219.4
✚	H2-56	11	228.7
◆	H2-57	12	227.1
◇	H2-58	11	228.6
○	H2-59	9	230.3
△	H2-60	9	230.4

PROJECT

HIGHWAY 17
ST. POTHIER ROAD
STA 9+400 TO 9+600

TITLE

GRAIN SIZE DISTRIBUTION

SAND and SILT to SAND

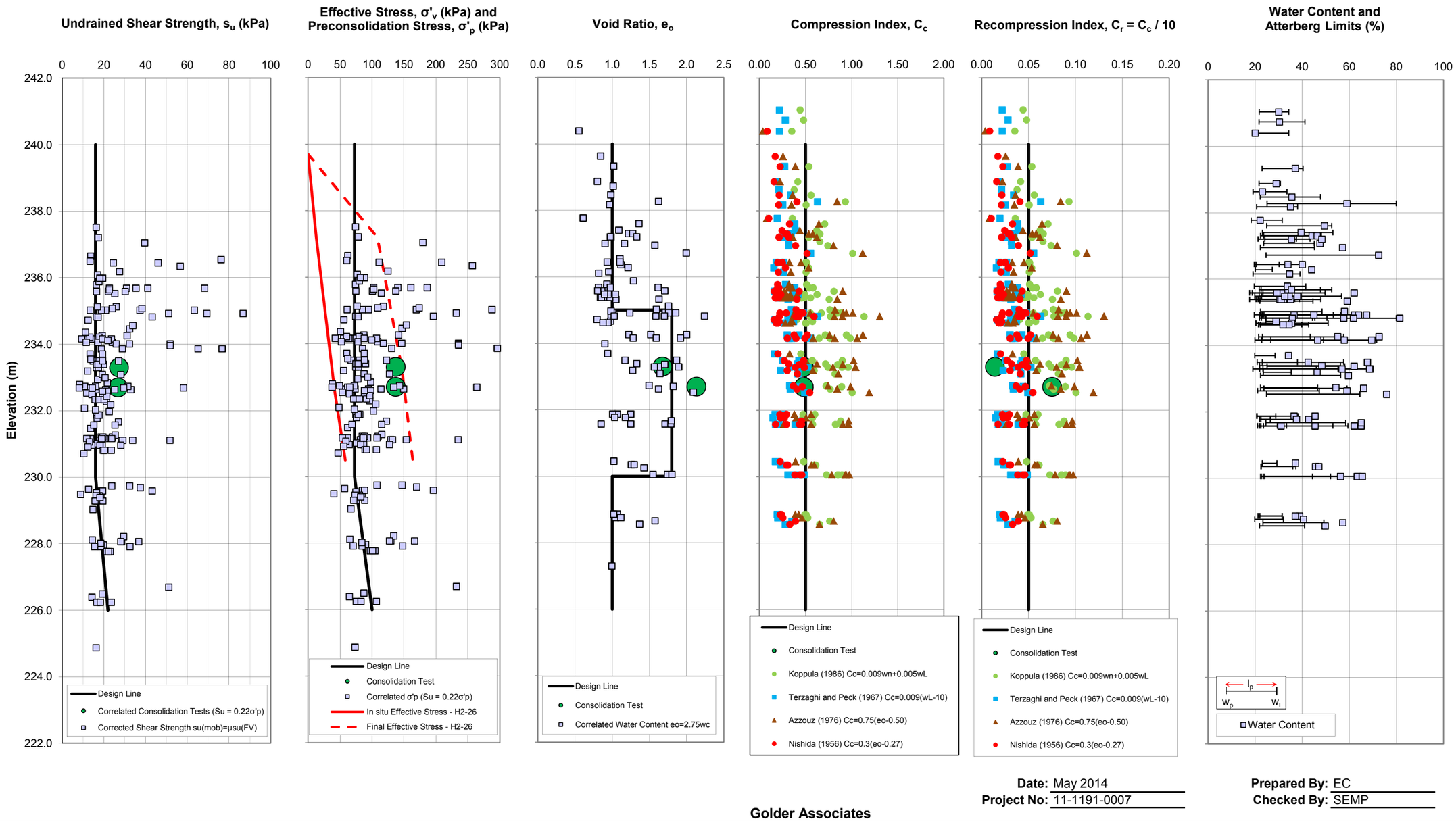
Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Mar 2014	SCALE	N/A REV.
CHECK	SEMP	Mar 2014		
APPR		Mar 2014		**FIGURE B24**

SUD-MTO GSD (NEW) GLDR_LDN.GDT

SUMMARY PLOT OF ENGINEERING PARAMETERS FOR COHESIVE DEPOSITS
Highway 17 - STA 13+140 to 13+390 Township of Louise (H2)
St. Pothier Road - STA 9+400 to 9+600 Township of Louise (H2)

FIGURE B25



Date: May 2014
Project No: 11-1191-0007

Prepared By: EC
Checked By: SEMP

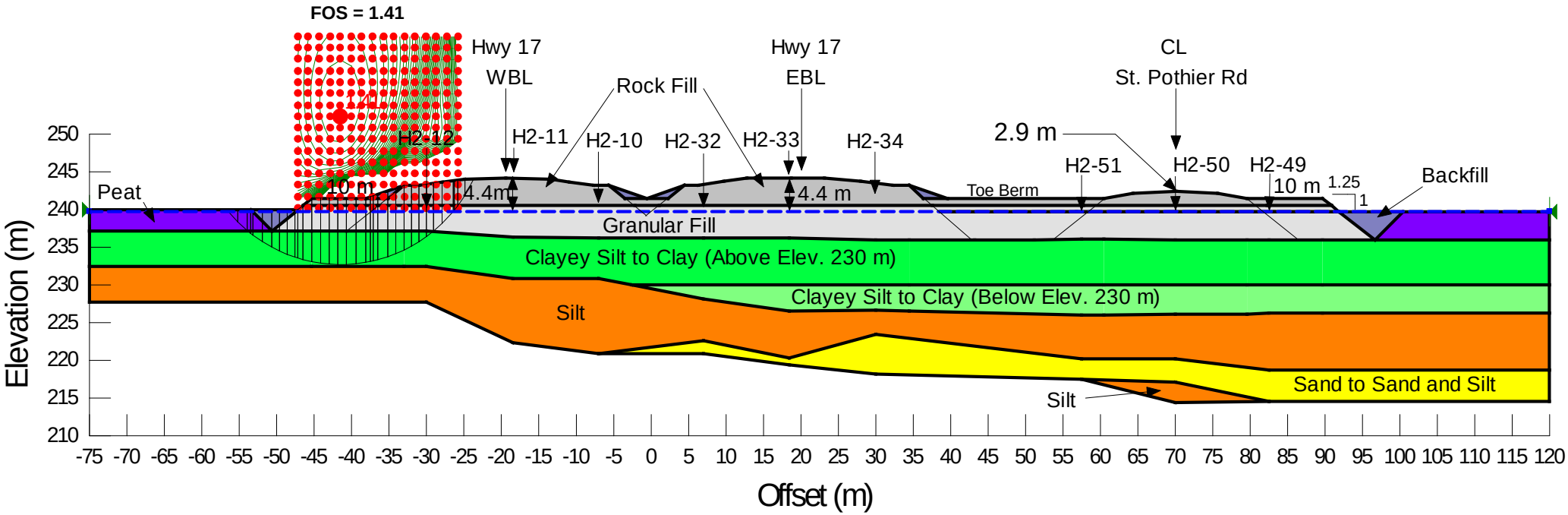
Golder Associates

https://capws.golder.com/sites/capws2/P111910007mtoHwy17FourLaningSudbury/Phases and Tasks/Analysis/[11-1191-0007-Parameters and Design Lines.xlsx]Swamp H3 Plots - Final

Stability Analysis
STA 13+260 – WBL North Side
Stage 1 Embankment Height (10 m Toe Berms)

Figure B26

Material Name	Unit Weight (kN/m³)	Cohesion (kPa)	Friction Angle (°)
New Granular Fill (BWT)	20	-	35
New Rock Fill	19	-	40
Peat	12	1	27
Backfill	12	1	27
Clayey Silt to Clay (Above Elev. 230 m)	16.2	16	-
Clayey Silt to Clay (Below Elev. 230 m)	16.2	16 – 22	-
Silt	18	-	28
Sand to Sand and Silt	18	-	28



Date: July 6, 2015
Project No. 11-1191-0007

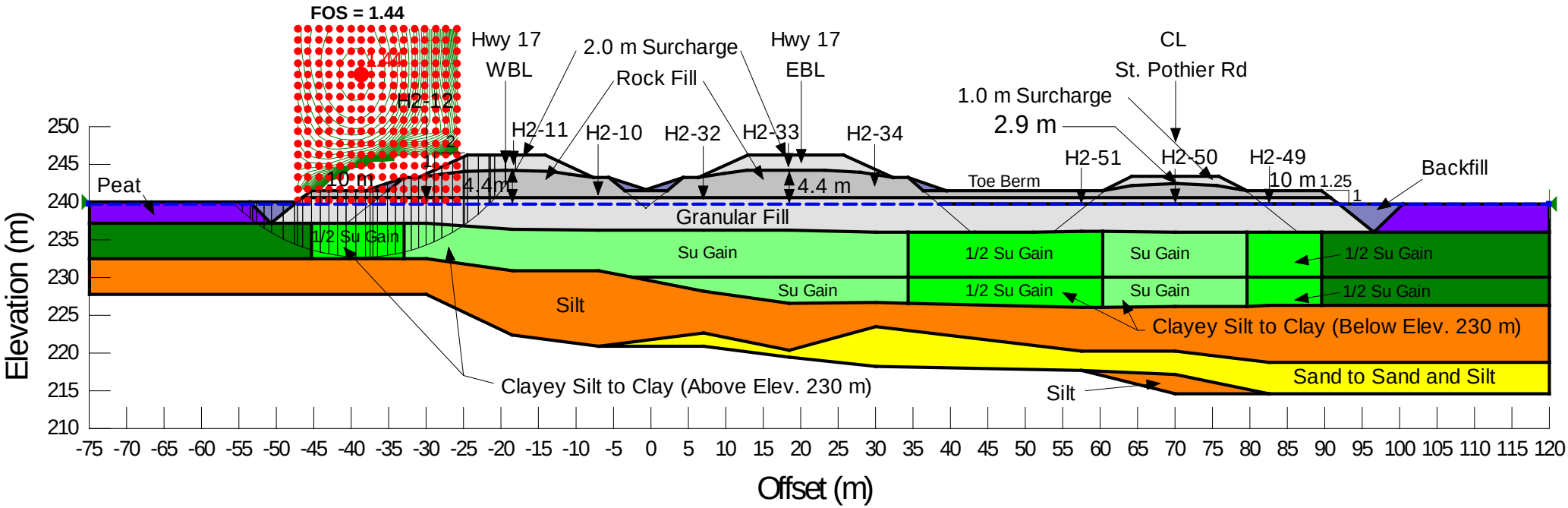
Analysis By: MT **Reviewed By:** SEMP

Golder Associates

Stability Analysis
STA 13+260 – WBL North Side
Stage 2 – 2.0 m Surcharge with Strength Gain

Figure B27

Material Name		Unit Weight (kN/m³)	Cohesion (kPa)	Friction Angle (°)
New Granular Fill (BWT)		20	-	35
New Rock Fill		19	-	40
Peat		12	1	27
Backfill		12	1	27
Clayey Silt to Clay (Above Elev. 230 m)	No Strength Gain	16.2	16	-
	EBL& WBL Strength Gain	16.2	26 – 32	-
	St. Pothier Road Strength Gain	16.2	20 – 26	-
Clayey Silt to Clay (Below Elev. 230 m)	No Strength Gain	16.2	16 – 22	-
	EBL& WBL Strength Gain	16.2	32 – 36	-
	St. Pothier Road Strength Gain	16.2	26 – 31	-
Silt		18	-	28
Sand to Sand and Silt		18	-	28



Date: July 6, 2015
Project No. 11-1191-0007

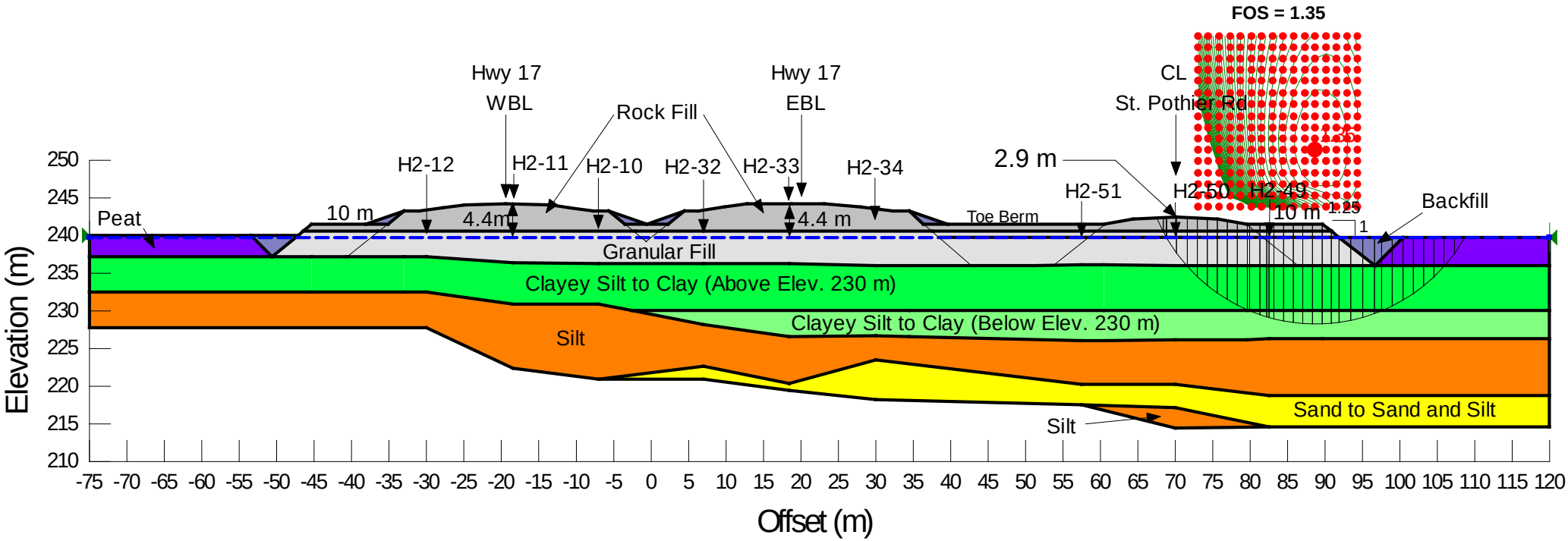
Analysis By: MT **Reviewed By:** SEMP

Golder Associates

Stability Analysis
STA 9+480 – St. Pothier Road South Side
Stage 1 Embankment Height (10 m Toe Berms)

Figure B28

Material Name	Unit Weight (kN/m³)	Cohesion (kPa)	Friction Angle (°)
New Granular Fill (BWT)	20	-	35
New Rock Fill	19	-	40
Peat	12	1	27
Backfill	12	1	27
Clayey Silt to Clay (Above Elev. 230 m)	16.2	16	-
Clayey Silt to Clay (Below Elev. 230 m)	16.2	16 – 22	-
Silt	18	-	28
Sand to Sand and Silt	18	-	28



Date: July 6, 2015
Project No. 11-1191-0007

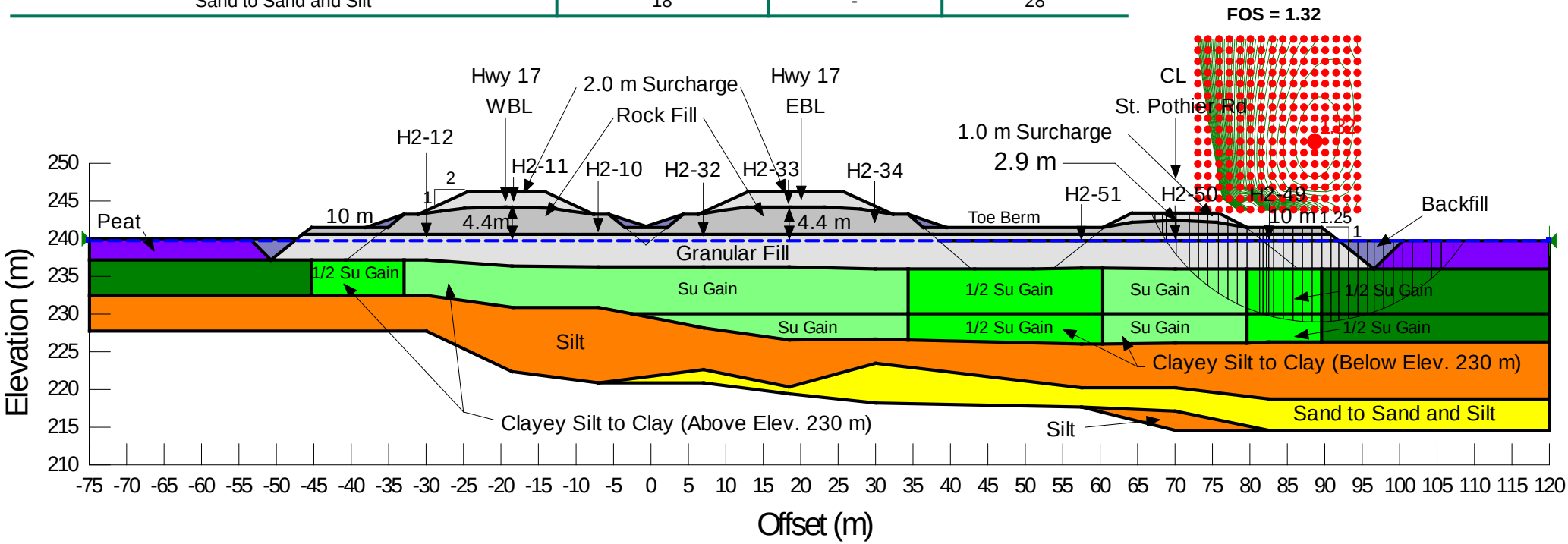
Analysis By: MT **Reviewed By:** SEMP

Golder Associates

Stability Analysis
STA 9+480 – St. Pothier Road South Side
Stage 2 – 1.0 m Surcharge with Strength Gain

Figure B29

Material Name		Unit Weight (kN/m³)	Cohesion (kPa)	Friction Angle (°)
New Granular Fill (BWT)		20	-	35
New Rock Fill		19	-	40
Peat		12	1	27
Backfill		12	1	27
Clayey Silt to Clay (Above Elev. 230 m)	No Strength Gain	16.2	16	-
	EBL& WBL Strength Gain	16.2	26 – 32	-
	St. Pothier Road Strength Gain	16.2	20 – 26	-
Clayey Silt to Clay (Below Elev. 230 m)	No Strength Gain	16.2	16 – 22	-
	EBL& WBL Strength Gain	16.2	32 – 36	-
	St. Pothier Road Strength Gain	16.2	26 – 31	-
Silt		18	-	28
Sand to Sand and Silt		18	-	28



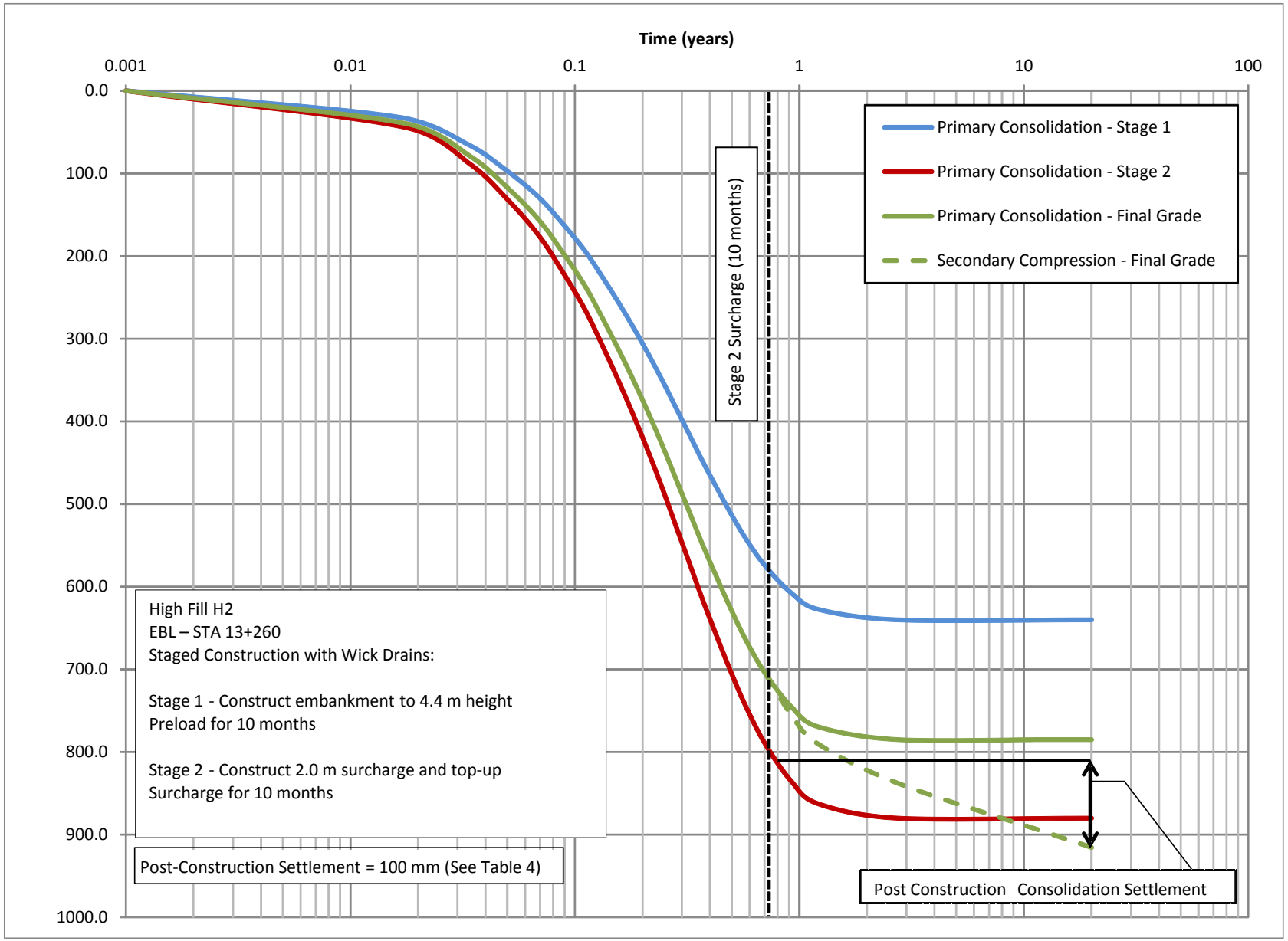
Date: July 6, 2015
Project No. 11-1191-0007

Analysis By: MT **Reviewed By:** SEMP

Golder Associates

Settlement Analysis
STA 13+260 – EBL
Settlement vs. log Time – Staged Construction

Figure B30



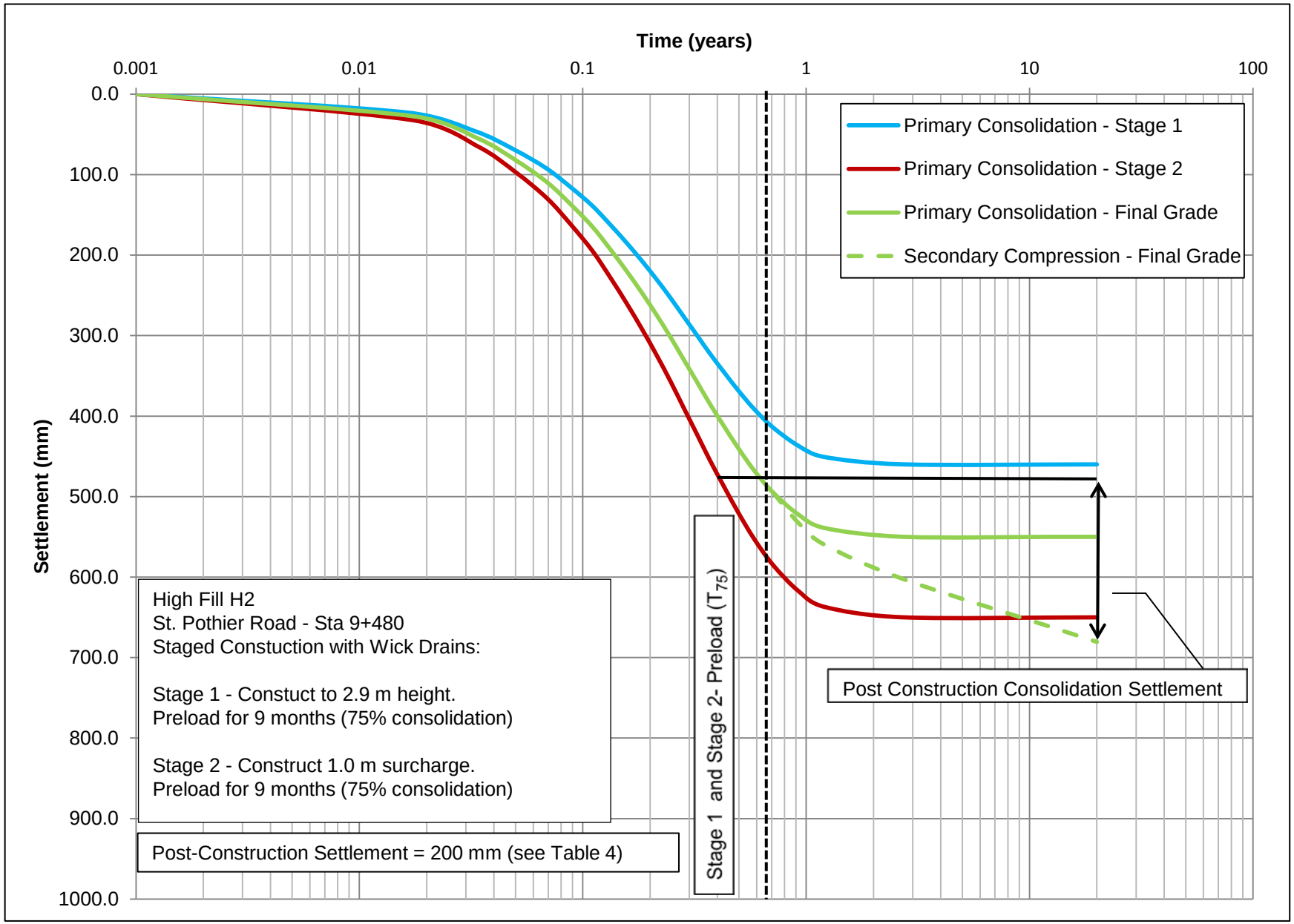
Date: July 6, 2015
Project No. 11-1191-0007

Analysis By: MT **Reviewed By:** SEMP

Golder Associates

Settlement Analysis
STA 9+480 – St. Pothier Road
Settlement vs. log Time – Staged Construction

Figure B31



Date: July 6, 2015
Project No. 11-1191-0007

Analysis By: MT **Reviewed By:** SEMP

Golder Associates

APPENDIX C

HIGHWAY 17 WBL – STA 13+900 TO 14+200 AND HIGHWAY 17 EBL – STA 13+900 TO 14+200 (HIGH FILL H3)

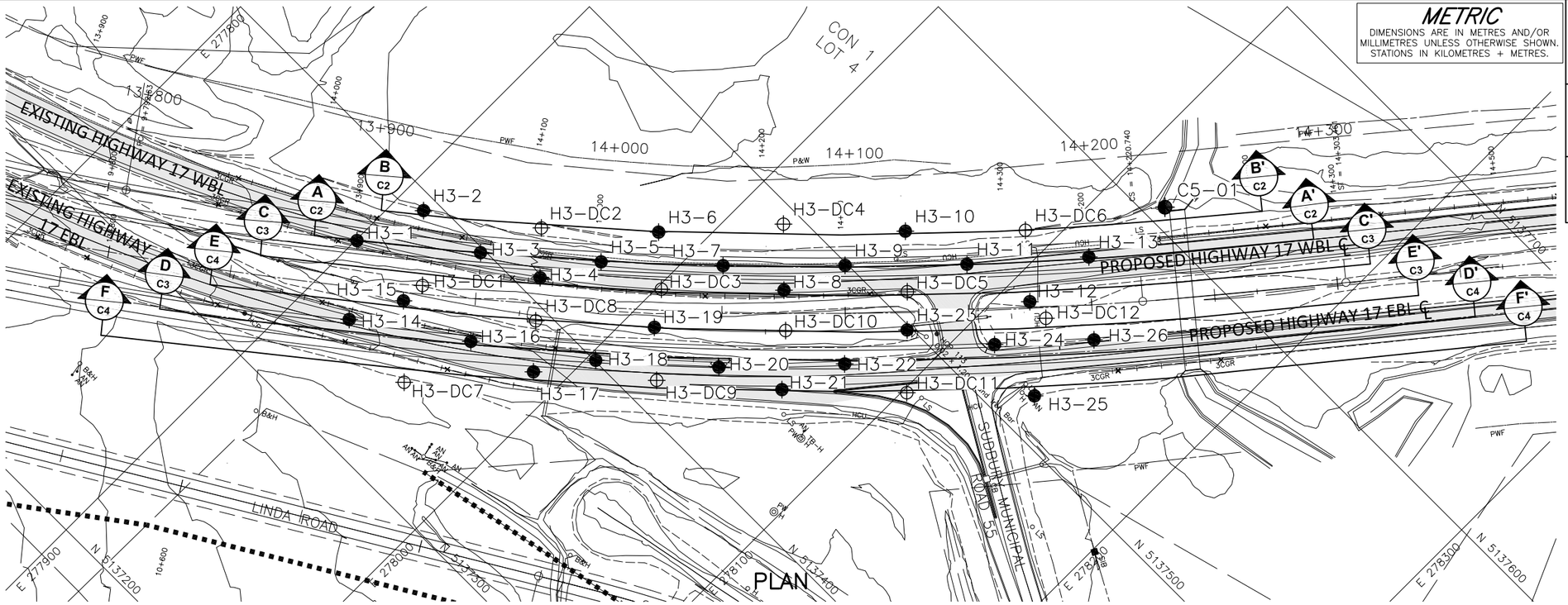
Table C1: Evaluation of Settlement Mitigation Options
Highway 17 – STA 13+900 to 14+200 (High Fill Area H3)

Stability/Settlement Mitigation Option	Option No.	Rank	Advantages	Disadvantages	Relative Costs	Risks/Consequences
Consolidation and Maintenance ■ 6 year preload period	A	1	■ Standard embankment construction operation – no need for specialized material or equipment.	■ **Does not meet MTO's Settlement Criteria** ■ Contractor will have to remobilize to site in order to re-grade. ■ Significant wait period is required before settlement is mitigated. ■ Instrumentation and monitoring program required to assess end of preload period.	■ Remobilization costs required for re-grading.	■ There will be no impact on the construction schedule ■ Very low risk of not achieving stability of preload embankments on weak/soft foundation soils. ■ Low risk of experiencing unexpected post-construction settlements (i.e. creep). ■ Low risk that unexpected post-construction settlements create an unsafe travelled laneway.
Partial Embankment Sub-Excavation and Lightweight Fill (EPS) ■ A 2.0 m zone of EPS	B	NP	■ Meets MTO's Settlement Criteria ■ Creates a negligible load on subsoils thereby inducing negligible settlement of foundations soils. ■ Re-grading is not required	■ Expensive material compared to conventional embankment fill. ■ Will need to sub-excavate some of the existing embankment material.	■ Relative cost of EPS fill is about an order of magnitude higher than fill required for the other options. ■ 7,500 m3 x $200/m3 = $1,500,000.	■ There will be a minimal impact on the construction schedule ■ Very low risk of not achieving stability of preload embankments and final EPS embankments on weak/soft foundation soils. ■ Low risk of experiencing unexpected post-construction settlements (i.e. creep).

NP: Not Practical

Prepared By: SEMC **Reviewed By:** JMAC

MINISTRY OF TRANSPORTATION, ONTARIO



SCALE
20 0 20 40 m

METRIC

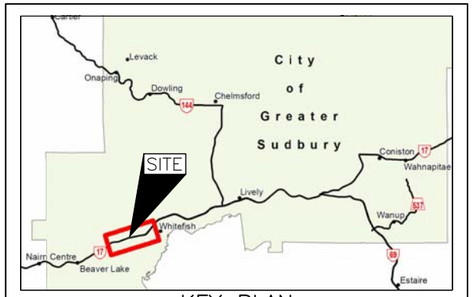
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 156-98-00

SHEET

HIGHWAY 17 4 LANING
HWY 17 WBL – STA 13+900 TO 14+200
HWY 17 EBL – STA 13+900 TO 14+200
BOREHOLE LOCATIONS

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



KEY PLAN
10 0 10 20 km

LEGEND

- Borehole
- Dynamic Cone Penetration Test

NOTES

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

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

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans provided in digital format by DM Wills, drawing files EBL & WBL PROFILES .dwg received on Feb 28, 2013 and 581_contours.dwg received Jan 17, 2012.

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H3-1	248.2	5137366.3	277900.4
H3-2	243.5	5137394.0	277910.9
H3-3	246.2	5137398.3	277939.3
H3-4	246.0	5137408.2	277963.6
H3-5	244.9	5137430.2	277976.5
H3-6	242.8	5137455.2	277984.5
H3-7	244.0	5137464.1	278012.6
H3-8	244.7	5137474.5	278037.0
H3-9	243.8	5137499.1	278047.4
H3-10	242.4	5137526.2	278054.9
H3-11	243.8	5137534.4	278082.1
H3-12	242.4	5137541.7	278110.8
H3-13	243.9	5137571.4	278114.9
H3-14	248.1	5137341.5	277920.8
H3-15	243.1	5137362.4	277931.0
H3-16	246.4	5137370.0	277962.0
H3-17	246.3	5137379.3	277988.6
H3-18	245.2	5137400.4	278003.2
H3-19	241.8	5137426.7	278010.6
H3-20	244.3	5137433.7	278040.5

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H3-21	244.4	5137445.4	278065.0
H3-22	244.0	5137470.7	278075.6
H3-23	241.9	5137498.4	278083.8
H3-24	243.8	5137519.3	278113.0
H3-25	242.2	5137516.0	278139.2
H3-26	243.8	5137549.1	278140.1
H3-DC1	242.9	5137372.2	277932.1
H3-DC2	242.9	5137422.8	277949.7
H3-DC3	244.6	5137439.6	278001.6
H3-DC4	242.4	5137493.3	278018.0
H3-DC5	244.2	5137509.4	278072.8
H3-DC6	241.9	5137560.9	278089.1
H3-DC7	244.2	5137339.2	277954.6
H3-DC8	241.8	5137394.5	277974.7
H3-DC9	245.2	5137412.1	278026.4
H3-DC10	241.9	5137463.4	278049.1
H3-DC11	243.4	5137480.3	278101.7
H3-DC12	242.4	5137541.5	278120.2

LICENCED PROFESSIONAL ENGINEER
S.E.M. POOT
90471921
APR 15, 2015
PROVINCE OF ONTARIO

LICENCED PROFESSIONAL ENGINEER
J.M.A.COSTA
APR 15, 2015
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17	PROJECT NO. 11-1191-0007		DIST.
SUBM'D. EC	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. C1

PLOT DATE: June 30, 2015
FILENAME: \\golder.gds\gal\sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0007 HWY 17 4 Laning\11191000740003_H3.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

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

CONT No.
GWP No. 156-98-00

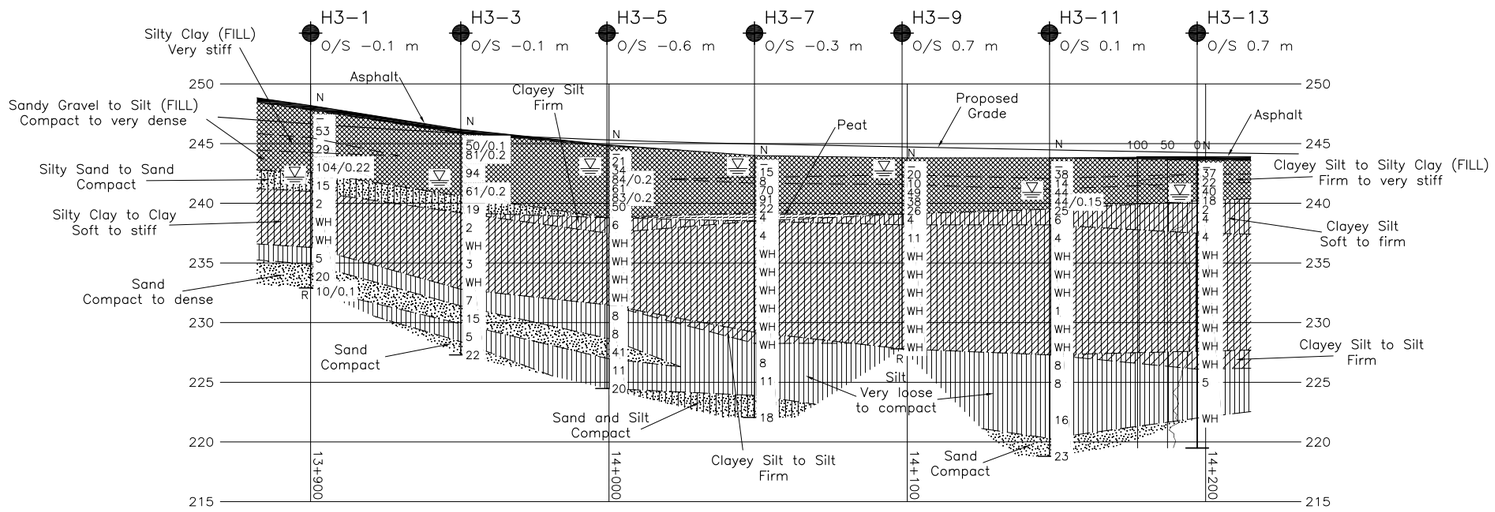
HIGHWAY 17 4 LANING

HWY 17 WBL – STA 13+900 TO 14+200

SOIL STRATA

SHEET

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



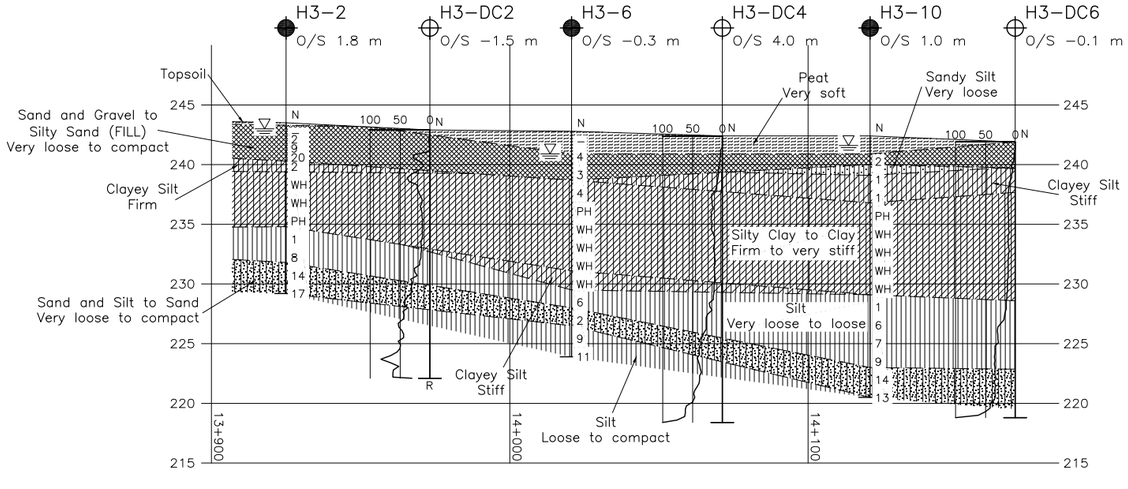
A-A'
C1

CENTRELINE PROFILE

HIGHWAY 17 (WBL)

HORIZONTAL SCALE
20 0 20 40 m

5 0 5 10 m
VERTICAL SCALE



B-B'
C1

NORTH TOE PROFILE

HIGHWAY 17 (WBL)

HORIZONTAL SCALE
20 0 20 40 m

5 0 5 10 m

LEGEND

- Borehole
- Dynamic Cone Penetration Test
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R — Refusal
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H3-1	248.2	5137366.3	277900.4
H3-2	243.5	5137394.0	277910.9
H3-3	246.2	5137398.3	277939.3
H3-5	244.9	5137430.2	277976.5
H3-6	242.8	5137455.2	277984.5
H3-7	244.0	5137464.1	278012.6
H3-9	243.8	5137499.1	278047.4
H3-10	242.4	5137526.2	278054.9
H3-11	243.8	5137534.4	278082.1
H3-13	243.9	5137571.4	278114.9
H3-DC2	242.9	5137422.8	277949.7
H3-DC4	242.4	5137493.3	278018.0
H3-DC6	241.9	5137560.9	278089.1

NOTES

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

The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans provided in digital format by DM Wills, drawing files EBL & WBL PROFILES .dwg received on Feb 28, 2013 and 581_contours.dwg received Jan 17, 2012.

LICENSED PROFESSIONAL ENGINEER S.E.M. POOT 90471921 APR 15, 2015 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.M.A.COSTA APR 15, 2015 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17		PROJECT NO. 11-1191-0007	DIST.
SUBM'D. EC	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. C2

PLOT DATE: April 15, 2015
FILENAME: \\golder.gds\gal\sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0007 HWY 17 4 Laning\11119100074003_H3.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

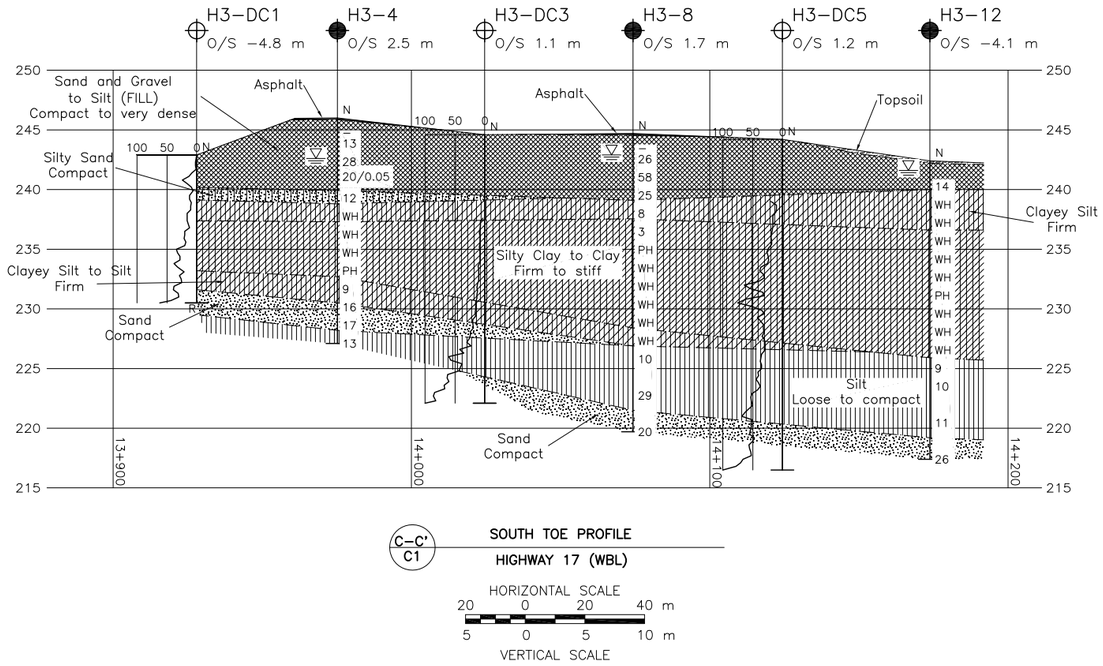
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 156-98-00

HIGHWAY 17 4 LANING
HWY 17 WBL – STA 13+900 TO 14+200
HWY 17 EBL – STA 13+900 TO 14+200
SOIL STRATA

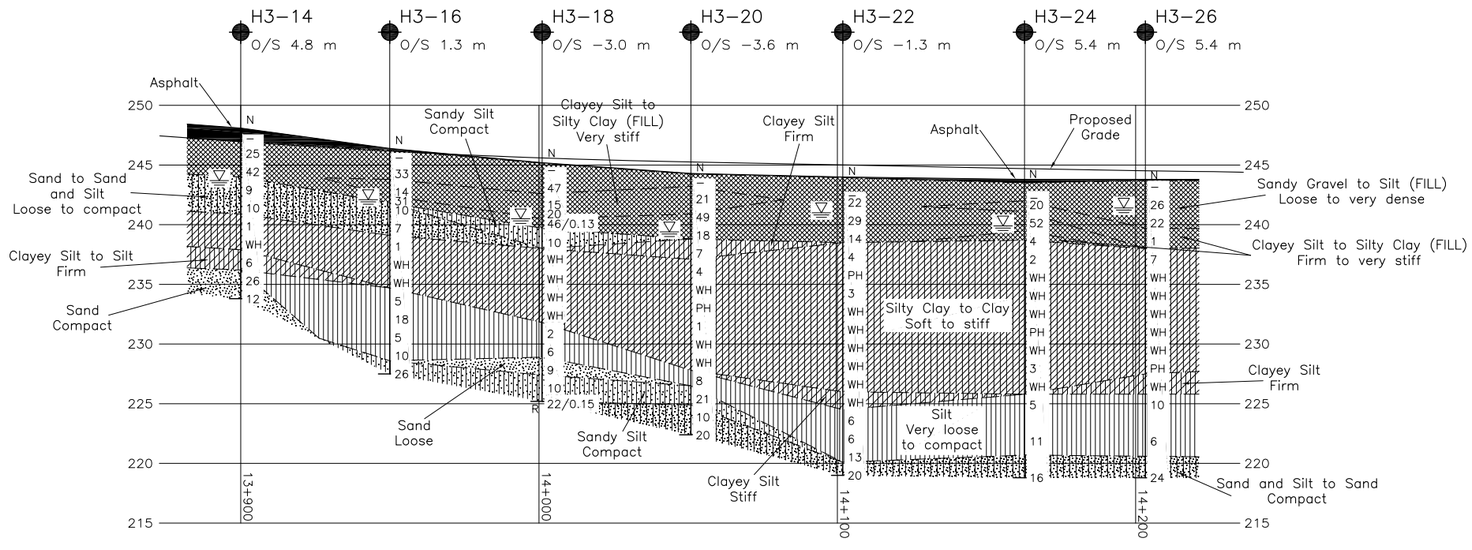
SHEET

Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



C-C'
C1
SOUTH TOE PROFILE
HIGHWAY 17 (WBL)

HORIZONTAL SCALE
20 0 20 40 m
5 0 5 10 m
VERTICAL SCALE



D-D'
C1
CENTRELINE PROFILE
HIGHWAY 17 (EBL)

HORIZONTAL SCALE
20 0 20 40 m
5 0 5 10 m

LEGEND

- Borehole
- Dynamic Cone Penetration Test
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R — Refusal
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H3-4	246.0	5137408.2	277963.6
H3-8	244.7	5137474.5	278037.0
H3-12	242.4	5137541.7	278110.8
H3-14	248.1	5137341.5	277920.8
H3-16	246.4	5137370.0	277962.0
H3-18	245.2	5137400.4	278003.2
H3-20	244.3	5137433.7	278040.5
H3-22	244.0	5137470.7	278075.6
H3-24	243.8	5137519.3	278113.0
H3-26	243.8	5137549.1	278140.1
H3-DC1	242.9	5137372.2	277932.1
H3-DC3	244.6	5137439.6	278001.6
H3-DC5	244.2	5137509.4	278072.8

NOTES

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REFERENCE

Base plans provided in digital format by DM Wills, drawing files EBL & WBL PROFILES .dwg received on Feb 28, 2013 and 581_contours.dwg received Jan 17, 2012.

LICENCED PROFESSIONAL ENGINEER S.E.M. POOT 90471921 APR 15, 2015 PROVINCE OF ONTARIO

LICENCED PROFESSIONAL ENGINEER J.M.A.COSTA APR 15, 2015 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17		PROJECT NO. 11-1191-0007	DIST.
SUBM'D. EC	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. C3

PLOT DATE: April 15, 2015
FILENAME: \\golder.gds\gal\sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0007 HWY 17 4 Laning\11119100074003_H3.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

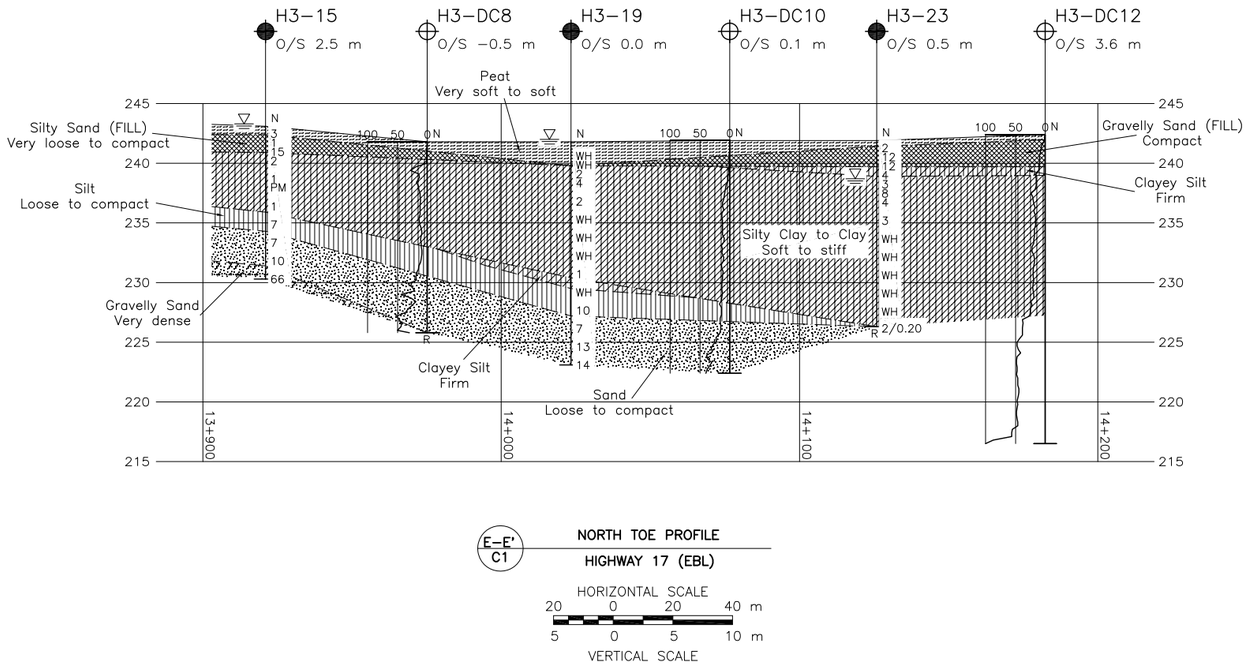
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 156-98-00

HIGHWAY 17 4 LANING
HWY 17 EBL – STA 13+900 TO 14+200
SOIL STRATA

SHEET

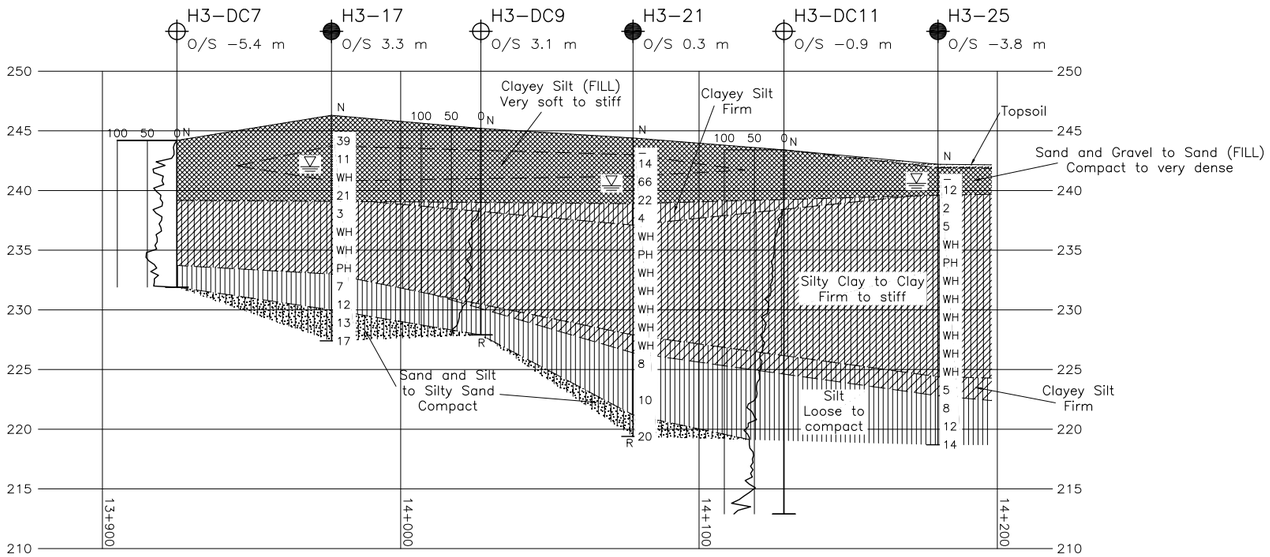
Golder Associates Ltd.
SUDBURY, ONTARIO, CANADA



E-E'
C1

NORTH TOE PROFILE
HIGHWAY 17 (EBL)

HORIZONTAL SCALE
20 0 20 40 m
5 0 5 10 m
VERTICAL SCALE



F-F'
C1

SOUTH TOE PROFILE
HIGHWAY 17 (EBL)

HORIZONTAL SCALE
20 0 20 40 m
5 0 5 10 m

LEGEND

- Borehole
- Dynamic Cone Penetration Test
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- R — Refusal
- WL upon completion of drilling

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
H3-15	243.1	5137362.4	277931.0
H3-17	246.3	5137379.3	277988.6
H3-19	241.8	5137426.7	278010.6
H3-21	244.4	5137445.4	278065.0
H3-23	241.9	5137498.4	278083.8
H3-25	242.2	5137516.0	278139.2
H3-DC7	244.2	5137339.2	277954.6
H3-DC8	241.8	5137394.5	277974.7
H3-DC9	245.2	5137412.1	278026.4
H3-DC10	241.9	5137463.4	278049.1
H3-DC11	243.4	5137480.3	278101.7
H3-DC12	242.4	5137541.5	278120.2

NOTES

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The complete Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS General Conditions.

REFERENCE

Base plans provided in digital format by DM Wills, drawing files 581_base.dwg, GWP156-98-00_B & C Plans.dwg and 581_contours.dwg received Jan 17, 2012.

LICENCED PROFESSIONAL ENGINEER
S.E.M. POOT
90471921
APR 15, 2015
PROVINCE OF ONTARIO

LICENCED PROFESSIONAL ENGINEER
J.M.A.COSTA
APR 15, 2015
PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41I-323

HWY. 17		PROJECT NO. 11-1191-0007	DIST.
SUBM'D. EC	CHKD.	DATE: APR 2015	SITE:
DRAWN: TB	CHKD. SEMP	APPD. JMAC	DWG. C4

PLOT DATE: April 15, 2015
FILENAME: \\golder.gds\gal\sudbury\CAD-GIS\CAD\Projects\2011\11-1191-0007 HWY 17 4 Laning\11119100070A003_H3.dwg

Golder Associates

RECORD OF BOREHOLE No H3-1

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137366.3; E 277900.4 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 22, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
248.2	GROUND SURFACE										
0.0 / 247.8	ASPHALT (370 mm)						248				
0.4 / 247.1	Sandy gravel, trace silt (FILL) Brown Moist		1	AS	-						
1.1 / 245.5	Silt, some gravel, trace to some sand, trace clay (FILL) Very dense Brown Moist		2	SS	53		247				
2.7 / 244.2	Silty clay, some gravel (FILL) Very stiff Brown Moist		3	SS	29		246				
4.0 / 242.6	Sandy gravel, trace silt (FILL) Very dense Brown Wet		4	SS	104/0.22		245				
5.6 / 241.0	Silty SAND, trace to some clay, trace organics Compact Brown to grey Wet		5	SS	15	▽	244				0 69 23 8
7.2 / 236.3	SILTY CLAY, trace sand Firm Grey Wet Varved below 8.7 m depth.		6	SS	2		243				
			7	SS	WH		242	+ 6			
			8	SS	WH		241				
11.9 / 234.9	SILT, trace to some clay Loose Grey Wet		9	SS	5		240	+ 6			
13.3	SAND, trace silt, trace gravel Compact Grey Wet Approximately 0.2 m of heave encountered at 15.2 m depth.		10	SS	20		239				
							238				
							237				
							236				
							235				
							234				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H3-1

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137366.3; E 277900.4 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 22, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
232.9			11	SS	10/0.1		233		○		
15.3	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 6.0 m below ground surface (Elev. 242.2 m) upon completion of drilling.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-2

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137394.0; E 277910.9 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 25, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
243.5	GROUND SURFACE										
0.0	TOPSOIL										
0.2	Silty sand, trace to some gravel (FILL) Very loose to compact Brown Wet		1	AS	-	▽	243				
			2	SS	2				○		11 68 (21)
							242				
			3	SS	9						
							241				
			4	SS	20						
240.3									○		
3.2	CLAYEY SILT Firm Grey Wet		5A 5B	SS	2		240	+ 5			
239.4											
4.1	CLAY Firm to stiff Grey Wet		6	SS	WH		239		○——○		
							238	+ 6			
			7	SS	WH		237	+ 3			
			8	TO	PH		236				
234.8							235	+ 3			
8.7	SILT, trace to some sand, trace to some clay Very loose to loose Grey Wet		9	SS	1		234		○	NP	
			10	SS	8		233				
231.8							232				
11.7	SAND, trace to some silt Compact Grey Wet		11	SS	14		231		○		0 93 (7)
							230				
	Silt seam at 13.9 m depth.		12	SS	17						
229.2											
14.3											

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H3-2

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5137394.0; E 277910.9 ORIGINATED BY LK

DIST HWY 17 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE June 25, 2012 CHECKED BY SEMC

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			SHEAR STRENGTH kPa	WATER CONTENT (%)		
	--- CONTINUED FROM PREVIOUS PAGE ---							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	w_P w w_L	γ kN/m³	GR SA SI CL
	END OF BOREHOLE							20 40 60 80 100	20 40 60		
	Note:										
	1. Water level at a depth of 0.5 m below ground surface (Elev. 243.0 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H3-3

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137398.3; E 277939.3 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 17, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
246.2	GROUND SURFACE								
0.0 / 245.8	ASPHALT (350 mm)								
0.4	Gravelly sand, some silt (FILL) Very dense Brown Moist to wet Encountered a 0.2 m cobble at 1.1 m depth.		1	AS	-				
			2	SS	50/0.1				
			3	SS	81/0.2				
243.6									
2.6	Silty sand, trace gravel (FILL) Very dense Brown Moist		4	SS	94				
242.1									
4.1	Gravelly sand, some silt (FILL) Very dense Brown Moist to wet		5	SS	61/0.2	▽			
240.6									
5.6	SAND, trace to some silt, trace clay Compact Brown Wet		6	SS	19				
239.2									
7.0	SILTY CLAY, trace sand Firm to stiff Grey Wet		7	SS	2				
			8	SS	WH				
	Varved above 10.8 m depth.		9	SS	3				
			10	SS	WH				0 1 66 33
232.8									
13.4	SILT, trace to some clay Loose Grey Wet		11	SS	7				
231.4									
14.8									

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

ELEVATION SCALE: 246 245 244 243 242 241 240 239 238 237 236 235 234 233 232

+ 8 (238) + 7 (236) + 5 (235) + 11 (233)

○ (238)

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No H3-3

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137398.3; E 277939.3 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 17, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND, trace to some silt Compact Grey Wet		12	SS	15		231		○		0 95 (5)
229.9											
16.3	SILT, trace clay Loose Grey Wet		13	SS	5		230				
228.4							229				
17.8	SAND, trace to some silt Compact Grey Wet		14	SS	22		228				
227.3											
18.9	END OF BOREHOLE Note: 1. Water level at a depth of 4.3 m below ground surface (Elev. 241.9 m) upon completion of drilling.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-4

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137408.2; E 277963.6 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 21 and 22, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
246.0	GROUND SURFACE										
0.0	ASPHALT (150 mm)										
0.2	Sand, some gravel, some silt, trace clay (FILL) Compact Brown Moist		1	AS	-		245				
			2	SS	13		244		○		14 73 12 1
243.3											
2.7	Silt, some sand, trace gravel (FILL) Compact Brown Moist to wet		3	SS	28	▽	243				
242.0											
4.0	Sand and gravel, containing blast rock (FILL) Compact Brown Wet		4	SS	20/0.05		242				
							241				
239.9											
6.1	Silty SAND, some organics, some gravel Compact Grey Wet		5	SS	12		240				
238.8											
7.2	CLAYEY SILT Firm Grey Wet		6	SS	WH		239				
							238	+ 3			
237.3											
8.7	CLAY Firm Grey Wet		7	SS	WH		237				
							236	+ 4			
			8	SS	WH		235				
								+ 4			
			9	TO	PH		234				
232.7							233	+ 5			
13.3	CLAYEY SILT to SILT Firm Grey Wet		10	SS	9		232		H ○		

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H3-4

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137408.2; E 277963.6 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 21 and 22, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
230.5											
15.5	SAND, trace to some silt Compact Grey Wet		11	SS	16		230				
			12	SS	17		229		○		0 95 5 0
228.2											
17.8	SILT, trace sand, trace clay Compact Grey Wet		13	SS	13		228				
227.1											
18.9	END OF BOREHOLE Note: 1. Water level at a depth of 3.4 m below ground surface (Elev. 242.6 m) upon completion of drilling.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-5

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137430.2; E 277976.5 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 16, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
244.9	GROUND SURFACE								
0.0	ASPHALT (100 mm)								
0.1	Sand and gravel, trace to some silt (FILL) Compact to dense Brown Moist Approximately 0.2 m thick silty clay fill layer encountered at 2.3 m depth.		1	AS	-		244		56 35 (9)
			2	SS	21				
			3	SS	34	▽	243		
242.5									
2.4	Silty sand, trace gravel (FILL) Very dense Grey Wet		4	SS	84/0.2		242		
			5	SS	61				
241.2									
3.7	Gravelly sand, trace silt, containing blast rock (FILL) Very dense Grey Wet		6	SS	83/0.2		241		
			7	SS	50		240		
238.8									
6.1	CLAYEY SILT, trace sand Firm Grey Wet		8	SS	6		239		
237.5									
7.4	SILTY CLAY, varved Firm Grey Wet		9	SS	WH		238		
			10	SS	WH		237		
			11	SS	WH		236		
			12	SS	WH		235		
231.5							234		
13.4	SILT, trace to some clay Loose Grey Wet		13	SS	8		233		
							232		
							231		
							230		

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

+ 5 (238 m); + 4 (237 m); + 4 (235 m); + 6 (234 m); + 4 (232 m); ○ (241 m); ○ (237 m); ○ (232 m)

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H3-5

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5137430.2; E 277976.5 ORIGINATED BY EHS

DIST HWY 17 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE May 16, 2012 CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace to some clay Loose Grey Wet		14	SS	8				○		0 0 90 10
228.7							229				
16.2	SAND Dense Grey Wet		15	SS	41		228				
227.0							227				
17.9	SILT, trace to some sand, trace clay Compact Grey Wet		16	SS	11		226				
224.5			17	SS	20		225				
20.4	END OF BOREHOLE Note: 1. Water level at a depth of 2.0 m below ground surface (Elev. 242.9 m) upon completion of drilling.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-6

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137455.2; E 277984.5 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 26, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
242.8	GROUND SURFACE								
0.0	PEAT (Fibrous), some sand, some silt, trace gravel Very soft Black Moist		1	AS	-		242		
240.9			2	SS	4	▽	241		
1.9	Sand and gravel, some silt (FILL) Very loose Brown Wet		3	SS	3		240		
238.7							239		
4.1	SILTY CLAY, trace sand Firm Grey Wet		4	SS	4		238		
			5	TO	PH		237		
			6	SS	WH		236		
	Varved below 8.7 m.		7	SS	WH		235		0 1 22 77
			8	SS	WH		234		
231.1							233		
11.7	CLAYEY SILT Stiff Grey Wet		9	SS	WH		232		
229.5							231		
13.3	SILT, some sand, trace to some clay Loose Grey Wet		10	SS	6		230		
228.0							229		
14.8							228		

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

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

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

WATER CONTENT (%) (20 40 60)

Continued Next Page

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-6

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137455.2; E 277984.5 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 26, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND and SILT, trace to some clay Very loose Grey Wet		11	SS	2		227		○		0 46 49 5
226.5											
16.3	SILT, some sand, trace clay Loose to compact Grey Wet		12	SS	9		226				
							225				
223.9			13	SS	11		224				
18.9	END OF BOREHOLE Note: 1. Water level at a depth of 1.9 m below ground surface (Elev. 240.9 m) upon completion of drilling.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-7

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
DIST HWY 17
DATUM Geodetic
LOCATION N 5137464.1; E 278012.6
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring
DATE May 15, 2012
ORIGINATED BY EHS
COMPILED BY EC
CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES
244.0	GROUND SURFACE			
0.0	Sandy gravel to sand, trace silt (FILL) Compact Brown Moist to wet	1	AS	-
		2	SS	15
242.2		3	SS	8
1.8	Clayey silt, trace to some gravel, trace sand (FILL) Firm			
241.7				
2.3	Brown Wet	4	SS	70
	Gravelly sand to sand, trace silt (FILL) Compact to very dense Brown Wet	5	SS	91
		6	SS	22
239.2		7	SS	4
4.9	PEAT SAND, some organics, trace silt Loose			
238.5	Grey			
5.5	Wet CLAY Firm Grey Wet	8	SS	4
	Varved below 9.1 m depth.	9	SS	WH
		10	SS	WH
		11	SS	WH
		12	SS	WH
		13	SS	WH
229.2				
14.8				

GROUND WATER CONDITIONS: ▽

ELEVATION SCALE: 243, 242, 241, 240, 239, 238, 237, 236, 235, 234, 233, 232, 231, 230

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)
GR SA SI CL
0 3 55 42

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

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Golder Associates

RECORD OF BOREHOLE No H3-7

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137464.1; E 278012.6 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 15, 2012 | CHECKED BY SEMC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
228.3	CLAYEY SILT to SILT Firm Grey Wet		14	SS	WH		228		○		0 2 82 16
15.7	SILT, some sand, trace to some clay Loose to compact Grey Wet		15	SS	8		227				
			16	SS	11		226				
223.9							225				
20.1	SAND and SILT, trace clay Compact Grey Wet						224				
							223				
222.1			17	SS	18				○		0 42 56 2
21.9	END OF BOREHOLE Note: 1. Water level at a depth of 1.1 m below ground surface (Elev. 242.9 m) upon completion of drilling.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-8

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137474.5; E 278037.0 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 18 and 19, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
244.7	GROUND SURFACE					
0.0	ASPHALT (150 mm)					
0.2	Silty sand and gravel (FILL) Compact Brown Moist to wet		1	AS	-	
			2	SS	26	▽
242.1						
2.6	Gravelly sand, some silt containing blast rock (FILL) Compact to very dense Grey to brown Wet		3	SS	58	
			4	SS	25	
239.1						
5.6	CLAYEY SILT Firm Grey Wet		5	SS	8	
237.6						
7.2	SILTY CLAY Firm to stiff Grey Wet		6	SS	3	
			7	TO	PH	
			8	SS	WH	
			9	SS	WH	
	Varved below 13.3 m depth.		10	SS	WH	

ELEVATION SCALE: 244, 243, 242, 241, 240, 239, 238, 237, 236, 235, 234, 233, 232, 231, 230

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

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

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

Continued Next Page

Golder Associates

RECORD OF BOREHOLE No H3-8

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137474.5; E 278037.0 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 18 and 19, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY CLAY Firm to stiff Grey Wet		11	SS	WH		229				
228.4											
16.3	CLAYEY SILT Firm Grey Wet		12	SS	WH		228	4			
226.9							227	1			
17.8	SILT, trace to some clay, trace sand Compact Grey Wet		13	SS	10		226				0 1 89 10
							225				
							224				
			14	SS	29		223				
221.5							222				
23.2	SAND, trace silt Compact Grey Wet						221				
			15	SS	20		220				
219.7											
25.0	END OF BOREHOLE Note: 1. Water level at a depth of 1.8 m below ground surface (Elev. 242.9 m) upon completion of drilling.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-9

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137499.1; E 278047.4 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 14, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
243.8	GROUND SURFACE										
0.0	Sandy gravel to sand, trace silt (FILL) Compact Brown Moist to wet		1	AS	-						
			2	SS	20	▽	243				
242.4											
1.4	Clayey silt, trace sand, trace gravel (FILL) Stiff Brown		3	SS	10		242				
241.6	Wet										
2.2	Gravelly sand, some silt (FILL) Compact to dense Brown Wet		4	SS	49		241				
			5	SS	38				○		23 64 (13)
			6	SS	26		240				
239.1											
4.7	CLAYEY SILT, some organics Firm Grey Wet		7	SS	4		239				
238.2											
5.6	SILTY CLAY, trace sand Soft to firm Grey Wet Sample 8 "N" value affected by caved gravel in split-spoon.		8	SS	11		238				
			9	SS	WH		237		⊢○⊣		
							236	+ 2			
	Varved below 9.1 m depth.		10	SS	WH		235				
							234	+ 8			
			11	SS	WH		233				
							232	+ 9			
			12	SS	WH		231	+ 10			
			13	SS	WH		230				
							229	+ 4			

Continued Next Page

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-9

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137499.1; E 278047.4 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 14, 2012 | CHECKED BY SEMC

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
			14	SS	WH		228		o		
227.8	Spoon attempted at 16.0 m depth.										
16.0	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 1.1 m below ground surface (Elev. 242.7 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H3-10

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137526.2; E 278054.9 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 27 and 28, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
242.4	GROUND SURFACE						242			
0.0	PEAT (Fibrous), some silt Black Wet					▽				
240.9							241			
1.5	Sand and gravel (FILL) Very loose Grey Wet		1	SS	2					
240.0							240			
2.4	Sandy SILT, trace organics Very loose Grey Wet									
239.1			2	SS	1		239			
3.3	CLAYEY SILT Stiff Grey Wet							>100		
			3	SS	1		238		○	
236.8								5		
5.6	SILTY CLAY Firm Grey Wet						237			
			4	TO	PH					
	Varved below 7.2 m depth.						236	4		
			5	SS	WH		235			
								5		
							234			
			6	SS	WH		233		○	
								6		
							232			
			7	SS	WH					
							231	4		
			8	SS	WH		230			
229.1								5		
13.3	SILT, some clay, trace sand Very loose to loose Grey Wet						229			
			9	SS	1				○	NP	0 1 82 17
							228			

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 30/06/15 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-10

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137526.2; E 278054.9 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 27 and 28, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, some clay, trace sand Very loose to loose Grey Wet		10	SS	6		227				
			11	SS	7		226				
			12	SS	9		225				
223.0							224				
19.4	SAND and SILT, trace clay Compact Grey Wet		13	SS	14		223	○			0 37 61 2
			14	SS	13		222				
220.5							221				
21.9	END OF BOREHOLE Note: 1. Water level at a depth of 0.8 m below ground surface (Elev. 241.6 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H3-11

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5137534.4; E 278082.1
ORIGINATED BY EHS
DIST _____ HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE May 10 and 11, 2012
CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
243.8	GROUND SURFACE										
0.0	Gravelly sand, trace silt, containing blast rock (FILL) Dense Brown to grey Moist		1	AS	-		243		○		
			2	SS	38						
242.1											
1.7	Clayey silt, trace sand (FILL) Stiff Grey to brown Moist		3	SS	14		242				
241.2			4	SS	44						
2.6	Gravelly sand, trace silt, containing blast rock (FILL) Compact to dense Brown Wet		5	SS	44/0.15	▽	241				
239.6			6A 6B	SS	25		240		○		
4.3	PEAT (Fibrous)										
	CLAYEY SILT, some organics Firm Brown to grey Wet		7	SS	6		239				
238.2											
5.6	SILTY CLAY, trace sand Soft to firm Grey Wet		8	SS	4		238				
			9	SS	WH		237	5			
			10	SS	WH		236	5			
			11	SS	WH		235				
			12	SS	1		234	12			
			13	SS	WH		233	4			
							232				
							231	5			
							230				
							229	5			

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No H3-11

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137534.4; E 278082.1 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 10 and 11, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY CLAY, trace sand Soft to firm Grey Wet Varved at 15.2 m depth.		14	SS	WH		228	+ 3			
227.3											
16.5	SILT, trace to some clay Loose to compact Grey Wet		15	SS	8		227		○		0 0 87 13
			16	SS	8		226				
							225				
							224				
							223				
			17	SS	16		222				
220.3							221				
23.5	SAND, trace silt Compact Grey Wet						220				
218.8			18	SS	23		219				
25.0	END OF BOREHOLE Note: 1. Water level at a depth of 2.9 m below ground surface (Elev. 240.9 m) upon completion of drilling.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-12

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137541.7; E 278110.8 | ORIGINATED BY LK

DIST — | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 13, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
242.4	GROUND SURFACE					
0.0	Sandy TOPSOIL					
0.2	Silty sand to sand, some gravel, containing blast rock (FILL) Compact Brown to grey Moist to wet		1	SS	14	▽
240.0						
2.4	CLAYEY SILT, trace sand, trace organics Firm Grey Wet		2	SS	WH	
			3	SS	WH	
236.6						
5.8	SILTY CLAY Firm to stiff Grey Wet		4	SS	WH	
			5	SS	WH	
			6	SS	WH	
			7	TO	PH	
			8	SS	WH	
			9	SS	WH	
	Varved below 14.8 m depth.					

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

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

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

WATER CONTENT (%) (20 40 60)

UNIT WEIGHT γ kN/m^3

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

ELEVATION SCALE: 242, 241, 240, 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228

Plotted values: 8, 4, 5, 5, 5, 4, 10, 3; UNIT WEIGHT 18.1

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H3-12

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5137541.7; E 278110.8 ORIGINATED BY LK

DIST HWY 17 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE June 13, 2012 CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY CLAY Firm to stiff Grey Wet		10	SS	WH		227	+3			
225.9											
16.5	SILT, trace to some clay Loose to compact Grey Wet		11	SS	9		226		○		0 0 85 15
							225				
			12	SS	10		224				
							223				
							222				
			13	SS	11		221				
219.2							220				
23.2	SAND, trace to some silt Compact Grey Wet						219				
			14	SS	26		218				
217.4											
25.0	END OF BOREHOLE Note: 1. Water level at a depth of 0.8 m below ground surface (Elev. 241.6 m) upon completion of drilling.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-13

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137571.4; E 278114.9 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers | COMPILED BY EC

DATUM Geodetic | DATE May 8, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
243.9	GROUND SURFACE						
0.0 / 243.6	ASPHALT (320 mm)						
0.3	Sand and gravel, trace to some silt (FILL) Dense Brown Wet		1	AS	-		
			2	SS	37		
242.5							
1.5	Silty clay, trace sand, trace organics (FILL) Very stiff Brown to grey Moist		3	SS	22		
241.7							
2.2	Sand, trace silt, trace clay (FILL) Compact to dense Brown Wet		4	SS	40		
			5	SS	18	▽	
240.2							
3.7	CLAYEY SILT, some organics Soft to firm Grey to black Wet		6	SS	2		
			7	SS	4		
237.5			8A 8B	SS	4		
6.4	SILTY CLAY Soft to stiff Grey Wet						
			9	SS	WH		
			10	SS	WH		
			11	SS	WH		
	Varved below 12.1 m depth.		12	SS	WH		
			13	SS	WH		

DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100)

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

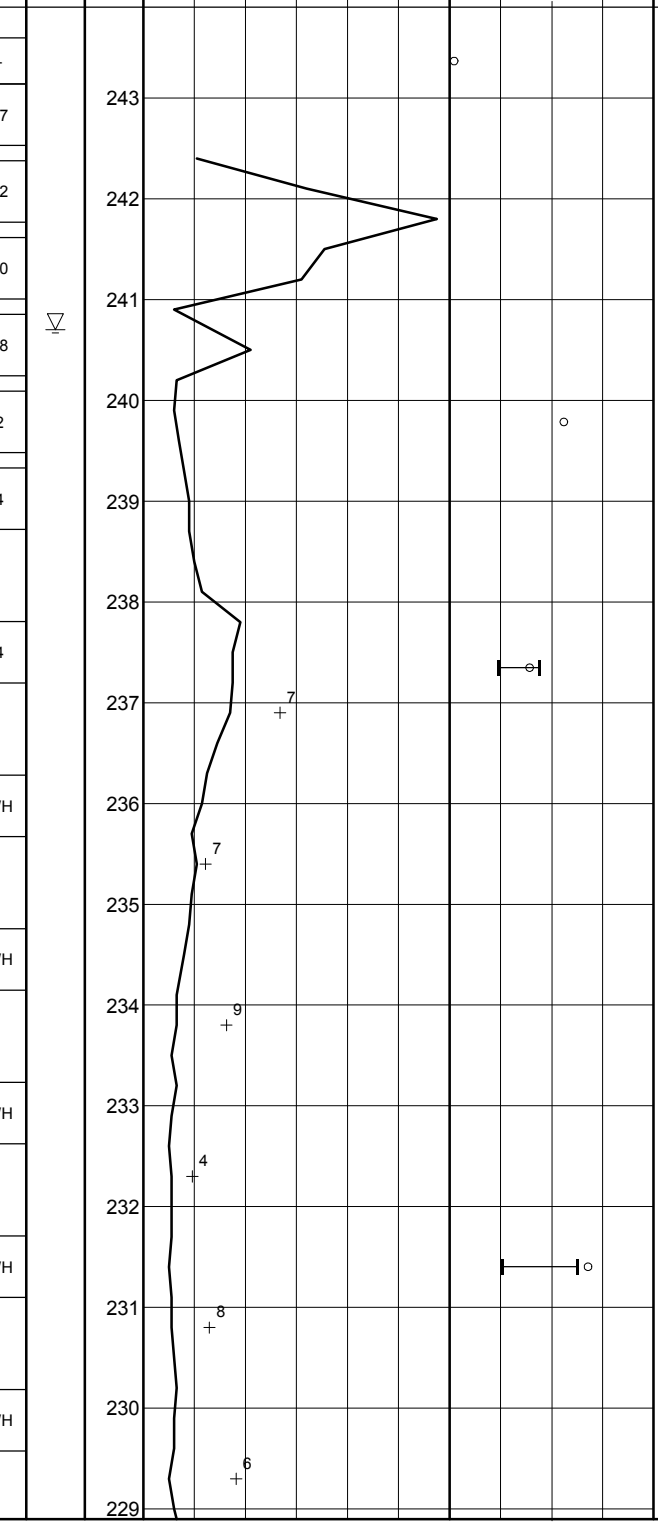
PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L

WATER CONTENT (%) (20 40 60)

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
45	45		(10)



Continued Next Page

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H3-13

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5137571.4; E 278114.9 ORIGINATED BY EHS

DIST HWY 17 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers COMPILED BY EC

DATUM Geodetic DATE May 8, 2012 CHECKED BY SEMC

SOIL PROFILE ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY CLAY Soft to stiff Grey Wet		14	SS	WH		228	+ 9			
227.6											
16.3	CLAYEY SILT to SILT Very loose to loose Grey to brown Wet		15	SS	WH		227	+ 5			
226.1							226				
17.8	SILT, trace to some clay Very loose to loose Grey Wet		16	SS	5		225		○		0 0 88 12
							224				
							223				
222.0			17	SS	WH		222				
21.9	END OF BOREHOLE										
219.5							221				
							220				
24.4	END OF DCPT Note: 1. Water level at a depth of 3.2 m below ground surface (Elev. 240.7 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H3-14

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137341.5; E 277920.8 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 23, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
248.1	GROUND SURFACE						248				
0.0 / 247.8	ASPHALT (330 mm)										
0.3	Sandy gravel to sand, trace silt (FILL) Compact to dense Brown Moist		1	AS	-		247				
			2	SS	25		246				
			3	SS	42		245				
244.0							244				
4.1	SAND to SAND and SILT, trace organics, trace clay Loose to compact Brown to grey Moist to wet		4	SS	9	▽	243				
			5	SS	10		242		○		
240.9							241				
7.2	SILTY CLAY, varved Firm Grey Wet		6	SS	1		240	+ 4			
			7	SS	WH		239				
237.9							238	+ 9			
10.2	CLAYEY SILT to SILT Firm Grey Wet		8	SS	6		237		○		0 0 85 15
236.2											
11.9	SAND, trace to some silt Compact Grey Wet		9	SS	26		236				
			10	SS	12		235				
233.8							234				
14.3											

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H3-14

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5137341.5; E 277920.8 ORIGINATED BY EHS

DIST HWY 17 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE May 23, 2012 CHECKED BY SEMC

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			20 40 60 80 100	w_P w w_L	γ	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	WATER CONTENT (%) 20 40 60	kN/m³	
	END OF BOREHOLE										
	Note:										
	1. Water level at a depth of 4.4 m below ground surface (Elev. 243.7 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H3-15

1 OF 1 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137362.4; E 277931.0 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 19 and 20, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE
243.1	GROUND SURFACE						
0.0 / 242.4	Sandy PEAT (Fibrous) Soft Brown Wet		1	SS	3		243
0.7	Silty sand, trace to some clay (FILL) Very loose to compact Brown Wet		2	SS	1		242
240.9	Some organics above 1.5 m depth.		3	SS	15		241
2.2	CLAY, varved Soft to stiff Grey Wet		4	SS	2		240
			5	SS	1		239
			6	TO	PM		238
235.9			7	SS	1		237
7.2 / 234.3	SILT, trace to some clay Loose Grey Wet		8	SS	7		236
8.8	SAND, some silt Loose to compact Grey Wet Approximately 0.6 m of heave encountered at 9.7 m depth.		9	SS	7		235
			10	SS	10		234
231.4							233
11.7 / 230.3	Gravelly SAND Very dense Grey Wet		11	SS	66		232
12.8	END OF BOREHOLE Note: 1. Ponded water 0.2 m above ground surface (Elev. 243.3 m).						231

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

	GR	SA	SI	CL
3	0	63	29	8
10	0	82		(18)

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-16

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137370.0; E 277962.0 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 24, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
246.4	GROUND SURFACE						246				
0.0	ASPHALT (75 mm)										
0.2	Sandy gravel to sand, trace silt (FILL) Dense Brown Moist		1	AS	-						
			2	SS	33		245				
	Approximately 150 mm of asphalt encountered at 2.1 m depth.										
243.8							244				
2.6	Clayey silt, trace sand, trace gravel (FILL) Very stiff Grey to brown Moist		3	SS	14						
242.4							243				
4.0	Sand, trace to some gravel, trace silt, trace organics (FILL) Dense Grey to brown Wet		4	SS	31	▽					
241.8							242				
4.6	Silty SAND, some clay, trace organics Loose to compact Grey to brown Wet		5	SS	10						
	Clayey silt layers below 6.4 m depth.						241				
			6	SS	7		240			OC=0.8%	0 54 30 16
239.1							239				
7.3	CLAY, varved Firm Grey Wet		7	SS	1			6			
			8	SS	WH		238				
								5			
			9	SS	WH		237				
234.7							236				
11.7	SILT, trace sand, trace to some clay Loose to compact Grey Wet		10	SS	5			5			
							235				
			11	SS	18		234				
							233				
							232				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H3-16

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5137370.0; E 277962.0
ORIGINATED BY EHS
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE May 24, 2012
CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILT, trace sand, trace to some clay Loose to compact Grey Wet		12	SS	5		231		○		0 2 88 10
			13	SS	10		230				
228.6							229				
17.8	Sandy SILT Compact Grey Wet		14	SS	26		228				
227.5											
18.9	END OF BOREHOLE Note: 1. Water level at a depth of 4.3 m below ground surface (Elev. 242.1 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H3-17

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137379.3; E 277988.6 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 6, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
246.3	GROUND SURFACE						246				
0.0	Gravelly sand, trace to some silt, containing blast rock (FILL) Dense Brown Moist		1	AS	-		245				
			2	SS	39				○		29 61 (10)
243.7							244				
2.6	Clayey silt, trace sand (FILL) Very soft to stiff Brown to grey Moist to wet		3	SS	11		243				
			4	SS	WH	▽	242				
240.8							241				
5.5	Gravelly sand, trace to some silt, containing blast rock (FILL) Compact Brown Moist		5	SS	21		240				
239.1							239				
7.2	SILTY CLAY, varved Firm to stiff Grey Wet		6	SS	3						
			7	SS	WH		238	+ 5			
			8	SS	WH		237	+ 5			
			9	TO	PH		236				
233.0							235	+ 4			
13.3	SILT, trace to some clay, trace sand Loose to compact Grey Wet		10	SS	7		234	+ 5			
							233				
							232				

Continued Next Page

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-17

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137379.3; E 277988.6 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 6, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
	SILT, trace to some clay, trace sand Loose to compact Grey Wet		11	SS	12		231		○		0 5 83 12
230.0											
16.3	Silty SAND, trace clay, trace gravel Compact Grey Wet		12	SS	13		230				
							229				
227.4			13	SS	17		228				
18.9	END OF BOREHOLE Note: 1. Water level at a depth of 4.6 m below ground surface (Elev. 241.7 m) upon completion of drilling.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-18

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137400.4; E 278003.2 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 28, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
245.2 / 0.0	GROUND SURFACE							
0.1	ASPHALT (50 mm)							
	Gravelly sand, trace silt, containing blast rock (FILL) Brown Moist	1	AS	-				
244.1								
1.1	Sandy silt, some clay, trace gravel, containing blast rock (FILL) Dense Brown Moist	2	SS	47	4	29	48	19
242.6								
2.6	Clayey silt, trace sand, trace gravel (FILL) Very stiff Brown Wet	3	SS	15				
		4	SS	20				
240.5		5	SS	46/0.13				
4.7	Gravelly sand, trace silt, containing blast rock (FILL) Dense Grey Wet							
239.7								
5.5	Sandy SILT, some gravel, trace clay Compact Grey Moist	6	SS	10				
238.0								
7.2	CLAY Firm Grey Wet	7	SS	WH				
		8	SS	WH				
		9	SS	WH				
		10	SS	WH				
231.8								
13.4	SILT Very loose to loose Grey Wet	11	SS	2				

ELEVATION SCALE: 245, 244, 243, 242, 241, 240, 239, 238, 237, 236, 235, 234, 233, 232, 231

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GROUND WATER CONDITIONS

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 30/06/15 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-18

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137400.4; E 278003.2 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 28, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
	SILT Very loose to loose Grey Wet		12	SS	6		230		○		0 1 87 12
228.9											
16.3	SAND, some silt Loose Grey Wet		13	SS	9		229				
227.4							228				
17.8	Sandy SILT Compact Grey Wet		14	SS	10		227				
225.2			15	SS	22/0.15		226				
20.0	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 4.7 m below ground surface (Elev. 240.5 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H3-19

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5137426.7; E 278010.6
ORIGINATED BY EHS
DIST HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE June 18, 2012
CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L WATER CONTENT (%) 20 40 60	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
241.8	GROUND SURFACE										
0.0	PEAT (Fibrous) Very soft Black Wet		1	SS	WH		241		390		
239.8			2	SS	WH		240				
2.0	SILTY CLAY Firm to stiff Grey Wet		3	SS	2		239				
			4	SS	4						
							238	6			
			5	SS	2		237	4			
	Varved below 6.1 m depth.		6	SS	WH		236				
							235	6			
			7	SS	WH		234	7			
			8	SS	WH		233				
							232	5			
			9	SS	1		231				
230.4								2			
11.4	CLAYEY SILT Firm Grey Wet						230				
229.5			10	SS	WH						
12.3	SILT, trace to some clay, trace sand Compact Grey Wet						229				
			11	SS	10		228				0 4 85 11
227.2											
14.6							227				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H3-19

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137426.7; E 278010.6 | ORIGINATED BY EHS

DIST | HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 18, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND, some silt Loose to compact Grey Wet		12	SS	7		226				
			13	SS	13		225				
							224				
223.1			14	SS	14				○		0 81 (19)
18.7	END OF BOREHOLE Note: 1. Ponded water at 0.2 m above ground surface (Elev. 242.0 m).										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-20

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137433.7; E 278040.5 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 29, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
244.3	GROUND SURFACE						244				
0.0 / 0.1	ASPHALT (60 mm)										
	Gravelly sand (FILL) Brown Moist		1	AS	-						
243.2							243				
1.1	Silty clay, trace sand (FILL) Very stiff Brown Moist		2	SS	21						
							242				
240.9			3A / 3B	SS	49		241				
3.4	Sand and gravel, trace silt (FILL) Compact to dense Grey to brown Moist to wet										
			4	SS	18	▽	240				
238.8							239				
5.5	CLAYEY SILT Firm Grey Wet		5	SS	7		238				
237.1											
7.2	SILTY CLAY Soft to firm Grey Wet		6	SS	4		237				
							236	5			
			7	SS	WH		235				0 0 47 53
								5			
			8	TO	PH		234				
							233	5			
			9	SS	1		232				
								4			
			10	SS	WH		231				
							230	3			

Continued Next Page

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

SUD-MTO 001 11-1191-0007.GPJ GAL-MISS.GDT 10/04/14 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-20

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137433.7; E 278040.5 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 29, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
	SILTY CLAY Soft to firm Grey Wet		11	SS	WH		229				
227.8							228	+ 3			
16.5	SILT, trace to some clay Loose to compact Grey Wet		12	SS	8		227		○		0 0 89 11
226.5											
17.8	Sandy SILT Compact Grey Wet		13	SS	21		226				
224.9							225				
19.4	Silty SAND to SAND and SILT Compact Grey Wet		14	SS	10		224				
			15	SS	20		223				
222.4											
21.9	END OF BOREHOLE Note: 1. Water level at a depth of 4.9 m below ground surface (Elev. 239.4 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H3-21

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137445.4; E 278065.0 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 7, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
244.4	GROUND SURFACE					
0.0	Gravelly sand, some silt (FILL) Brown Moist		1	AS	-	
243.0						
1.4	Clayey silt, trace to some sand, trace gravel (FILL) Stiff Grey to brown Moist		2	SS	14	
241.2			3A			
3.2	Sand to sand and gravel, some silt, containing blast rock (FILL) Compact to very dense Brown to grey Moist to wet		3B	SS	66	▽
			4	SS	22	
238.9						
5.5	CLAYEY SILT, trace sand, trace organics Firm Grey Wet		5	SS	4	
237.1						
7.3	CLAY Firm Grey Wet		6	SS	WH	
			7	TO	PH	
			8	SS	WH	
			9	SS	WH	
			10	SS	WH	

ELEVATION SCALE: 244, 243, 242, 241, 240, 239, 238, 237, 236, 235, 234, 233, 232, 231, 230

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

GR	SA	SI	CL
4	9	64	23

Continued Next Page

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

PROJECT 11-1191-0007

RECORD OF BOREHOLE No H3-21

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5137445.4; E 278065.0 ORIGINATED BY LK

DIST HWY 17 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring COMPILED BY EC

DATUM Geodetic DATE June 7, 2012 CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	CLAY Firm Grey Wet		11	SS	WH		229	4			
227.9							228				
16.5	CLAYEY SILT Firm Grey Wet		12	SS	WH		227	4			
226.4							226				
18.0	SILT, trace to some clay, trace sand Loose to compact Grey Wet		13	SS	8		225				
							224				
			14	SS	10		223		○		0 3 91 6
221.2							222				
23.2	SAND and SILT Compact Grey Wet						221				
			15	SS	20		220				
219.4											
25.0	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 4.0 m below ground surface (Elev. 240.4 m) upon completion of drilling.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-22

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5137470.7; E 278075.6
ORIGINATED BY LK
DIST HWY 17
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE May 30 and 31, 2012
CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
244.0	GROUND SURFACE					
0.0 / 0.1	ASPHALT (60 mm)					
	Silty sand (FILL) Brown Moist		1	AS	-	
242.5 / 1.5	Silt, some sand (FILL) Compact Brown Moist		2	SS	22	
241.4 / 2.6	Sand, some gravel, trace silt (FILL) Compact Grey Wet		3	SS	29	▽
			4	SS	14	
238.5 / 5.5	SILTY CLAY to CLAY Firm Grey Wet		5	SS	4	
			6	TO	PH	
			7	SS	3	
			8	SS	WH	
			9	SS	WH	
			10	SS	WH	

ELEVATION SCALE: 243, 242, 241, 240, 239, 238, 237, 236, 235, 234, 233, 232, 231, 230

DYNAMIC CONE PENETRATION RESISTANCE PLOT
20 40 60 80 100

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

PLASTIC LIMIT w_P | NATURAL MOISTURE CONTENT w | LIQUID LIMIT w_L
WATER CONTENT (%)
20 40 60

UNIT WEIGHT γ kN/m³

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

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H3-22

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137470.7; E 278075.6 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 30 and 31, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (20 40 60 80 100): ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY CLAY to CLAY Firm Grey Wet		11	SS	WH		228	3			
			12	SS	WH		227	1			
226.0											
18.0	CLAYEY SILT Stiff Grey Wet		13	SS	WH		226				
224.5							225	2			
19.5	SILT, trace to some clay, trace sand Loose to compact Grey Wet		14	SS	6		224		○		0 0 88 12
			15	SS	6		223				
			16	SS	13		222				
220.1							221		○		0 4 88 8
23.9	Silty SAND Compact Grey Wet		17	SS	20		220				
219.0							219				
25.0	END OF BOREHOLE Note: 1. Water level at a depth of 3.0 m below ground surface (Elev. 241.0 m) upon completion of drilling.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-23

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137498.4; E 278083.8 | ORIGINATED BY EHS

DIST _____ HWY 17 | BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 12 and 13, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	NUMBER	TYPE	"N" VALUES	GR	SA	SI	CL
241.9	GROUND SURFACE							
0.0	PEAT (Fibrous) Soft Black Wet	1	SS	2				
241.4 / 0.5	Gravelly sand, some silt, trace clay (FILL) Compact Brown Wet	2	SS	12	22	60	15	3
		3	SS	12				
239.7 / 2.2	CLAYEY SILT, trace sand Firm Grey Wet	4	SS	4				
238.9 / 3.0	SILTY CLAY to CLAY Stiff Grey Wet	5	SS	3				
		6	SS	8				
		7	SS	4				
		8	SS	3				
	Varved below 9.1 m depth.	9	SS	WH				
		10	SS	WH				
		11	SS	WH				
		12	SS	WH				
		13	SS	WH				

STRAT PLOT | GROUND WATER CONDITIONS

ELEVATION SCALE: 241, 240, 239, 238, 237, 236, 235, 234, 233, 232, 231, 230, 229, 228, 227

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100

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

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

WATER CONTENT (%): 20 40 60

UNIT WEIGHT γ kN/m³

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

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

Continued Next Page

Golder Associates

RECORD OF BOREHOLE No H3-23

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5137498.4; E 278083.8
ORIGINATED BY EHS
DIST HWY 17
BOREHOLE TYPE Portable Equipment, NW Casing, Wash Boring
COMPILED BY EC
DATUM Geodetic
DATE June 12 and 13, 2012
CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
226.3			14	SS	2/0.20						
15.6	END OF BOREHOLE SPOON REFUSAL (HAMMER BOUNCING) Note: 1. Water level at a depth of 3.2 m below ground surface (Elev. 238.7 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No H3-24

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137519.3; E 278113.0 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 4 and 5, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
243.8	GROUND SURFACE										
0.0 / 243.5	ASPHALT (350 mm)										
0.3	Sand, some silt, trace gravel (FILL) Compact Brown Moist		1	AS	-		243		○		5 77 (18)
242.0			2	SS	20		242				
1.8	Silty clay, trace sand (FILL) Stiff Brown Moist										
241.1			3	SS	52		241				
2.7	Sand some silt, trace gravel (FILL) Very dense Brown Moist					▽	240				
239.5			4A 4B	SS	4		239		○		
4.3	Silty clay (FILL) Firm Grey Wet										
238.7			5	SS	2		238				
5.1	SILTY CLAY Firm Grey Wet Trace organics above 5.2 m depth.		6	SS	WH		237	+ 5			
							236		○		
			7	SS	WH		235	+ 4			
			8	SS	WH		234	+ 5			
			9	TO	PH		233	+ 6			18.4
			10	SS	WH		232		○		
							231	+ 5			
							230				
							229	+ 4			

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H3-24

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137519.3; E 278113.0 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 4 and 5, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY CLAY Firm Grey Wet Trace organics above 5.2 m depth.		11	SS	3		228	+ 3			
			12	SS	WH		227				
225.8							226	+ 2			
18.0	SILT, trace to some clay, trace sand Loose to compact Grey Wet		13	SS	5		225				
			14	SS	11		224		○	NP	0 2 92 6
220.7							223				
23.1	SAND, trace to some silt Compact Grey Wet						222				
			15	SS	16		221				
218.8							220				
25.0	END OF BOREHOLE Note: 1. Water level at a depth of 3.9 m below ground surface (Elev. 239.9 m) upon completion of drilling.						219				

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF BOREHOLE No H3-25

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137516.0; E 278139.2 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 8 and 11, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
242.2	GROUND SURFACE						242				
0.0 / 241.9	TOPSOIL										
0.3	Sand, some gravel, some silt (FILL) Compact Brown Moist to wet		1	AS	-		241				
			2	SS	12	▽			○		18 67 (15)
239.6							240				
2.6	SILTY CLAY to CLAY Firm to stiff Grey Wet Trace organics above 3.7 m depth.		3	SS	2		239	+ 5			
			4	SS	5		238				
			5	SS	WH		237	+ 5			
			6	TO	PH		236	+ 5			
			7	SS	WH		235				
			8	SS	WH		234	+ 5			
			9	SS	WH		233				
			10	SS	WH		232	+ 3			
							231				
								+ 4			
							230				
							229	+ 4			
							228				
								+ 5			

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H3-25

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137516.0; E 278139.2 | ORIGINATED BY LK

DIST | HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE June 8 and 11, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---									
	SILTY CLAY to CLAY Firm to stiff Grey Wet		11	SS	WH		227			
							226	3		
			12	SS	WH		225			
224.4								3		
17.8	CLAYEY SILT Firm Grey Wet		13	SS	5		224		⊢○	0 1 82 17
222.8							223			
19.4	SILT, trace to some sand, trace clay Loose to compact Grey Wet		14	SS	8		222			
			15	SS	12		221			
							220			
218.7			16	SS	14		219			
23.5	END OF BOREHOLE Note: 1. Water level at a depth of 1.6 m below ground surface (Elev. 240.6 m) upon completion of drilling.									

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

Golder Associates

RECORD OF BOREHOLE No H3-26

1 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137549.1; E 278140.1 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 31 to June 4, 2012 | CHECKED BY SEMP

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: ○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
243.8	GROUND SURFACE										
0.0	ASPHALT (90 mm)										
0.1	Gravelly sand, some silt (FILL) Compact Brown Moist to wet		1	AS	-		243		○		41 47 (12)
			2	SS	26	▽	242				
			3	SS	22		241				
239.7							240				
4.1	Clayey silt, trace sand (FILL) Very stiff Grey Wet		4	SS	1		239				
238.0							238				
5.8	SILTY CLAY Firm to stiff Grey Wet		5	SS	7		237	3			
			6	SS	WH		236	3	⊖		
			7	SS	WH		235				
			8	SS	WH		234	5			
			9	SS	WH		233	5			
			10	SS	WH		232				
							231	4			
							230				
							229	4			

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No H3-26

2 OF 2 **METRIC**

PROJECT 11-1191-0007 | G.W.P. 156-98-00 | LOCATION N 5137549.1; E 278140.1 | ORIGINATED BY LK

DIST _____ HWY 17 | BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers, NW Casing, Wash Boring | COMPILED BY EC

DATUM Geodetic | DATE May 31 to June 4, 2012 | CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (20 40 60)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SILTY CLAY Firm to stiff Grey Wet		11	TO	PH		228				
227.5											
16.3	CLAYEY SILT Firm Grey Wet		12	SS	WH		227				
225.8							226	+ 2			
18.0	SILT, trace clay, trace sand Loose to compact Grey Wet		13	SS	10		225				
			14	SS	6		224		○		0 3 94 3
220.6							223				
23.2	SAND and SILT to SAND, some gravel Compact Grey Wet		15	SS	24		222				
218.8							221				
25.0	END OF BOREHOLE Note: 1. Water level at a depth of 2.4 m below ground surface (Elev. 241.4 m) upon completion of drilling.						220				
							219				

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 28/11/13 DATA INPUT:

Golder Associates

RECORD OF DCPT No H3-DC1

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137372.2; E 277932.1 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 21, 2012 CHECKED BY SEMC

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			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
242.9	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0							242				
							241				
							240				
							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
230.5											
12.4	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 08/11/13 DATA INPUT:

Golder Associates

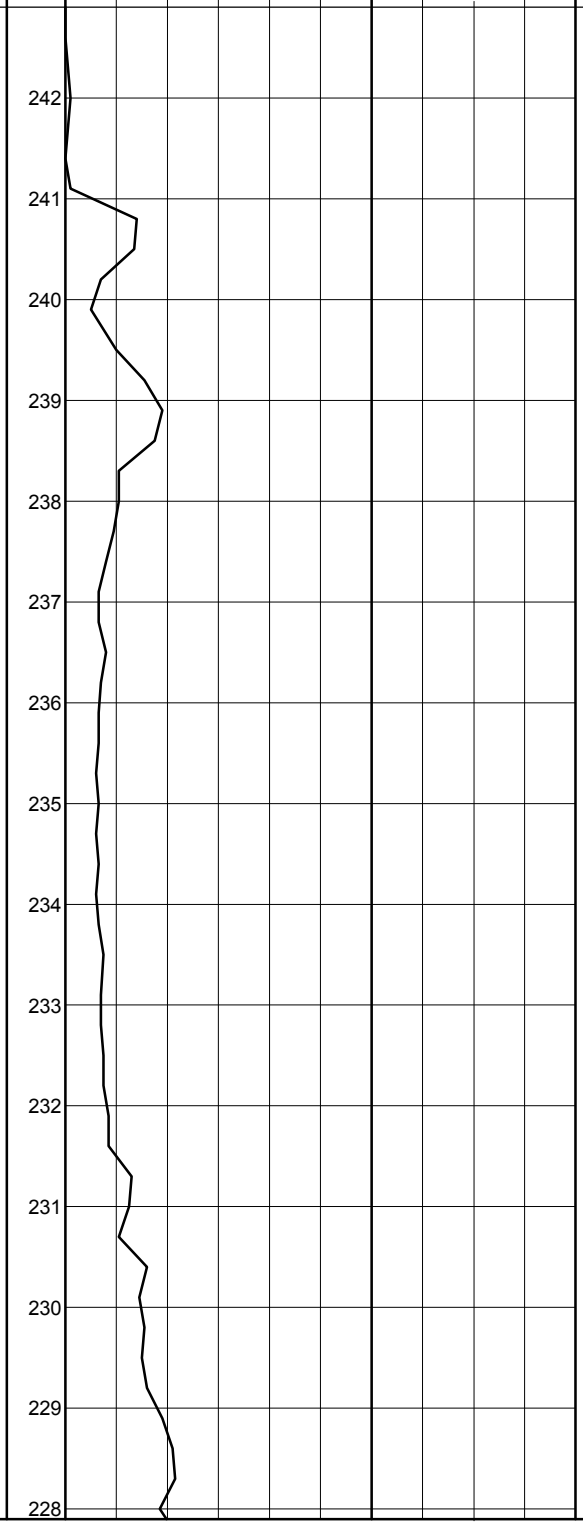
RECORD OF DCPT No H3-DC2

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5137422.8; E 277949.7
ORIGINATED BY LK
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE June 26, 2012
CHECKED BY SEMC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
242.9 / 0.0	GROUND SURFACE									γ kN/m^3	GR SA SI CL

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED: 20 40 60 80 100
PLASTIC LIMIT w_P — NATURAL MOISTURE CONTENT w — LIQUID LIMIT w_L
WATER CONTENT (%): 20 40 60



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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 08/11/13 DATA INPUT:

Golder Associates

RECORD OF DCPT No H3-DC2

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137422.8; E 277949.7 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 26, 2012 CHECKED BY SEMC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100			
	--- CONTINUED FROM PREVIOUS PAGE ---							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	w_P w w_L	γ kN/m³	GR SA SI CL
							227				
							226				
							225				
							224				
							223				
222.1											
20.8	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 08/11/13 DATA INPUT:

Golder Associates

RECORD OF DCPT No H3-DC3

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137439.6; E 278001.6 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 20, 2012 CHECKED BY SEMC

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
244.6 GROUND SURFACE								20 40 60 80 100	20 40 60		
0.0							244				
							243				
							242				
							241				
							240				
							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H3-DC3

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137439.6; E 278001.6 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 20, 2012 CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
							229				
							228				
							227				
							226				
							225				
							224				
							223				
222.1											
22.5	END OF DCPT REFUSAL TO FURTHER PENETRATION Note: 1. Augered through embankment fill and advanced DCPT starting at 6.1 m depth below ground surface.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 08/11/13 DATA INPUT:

Golder Associates

RECORD OF DCPT No H3-DC4

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137493.3; E 278018.0 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 27, 2012 CHECKED BY SEMC

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
242.4 / 0.0	GROUND SURFACE						242	20 40 60 80 100	20 40 60		
							241				
							240				
							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H3-DC4

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137493.3; E 278018.0 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 27, 2012 CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
218.4							227, 226, 225, 224, 223, 222, 221, 220, 219				
24.0	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.28 m)										

DYNAMIC CONE PENETRATION RESISTANCE PLOT: 20 40 60 80 100
SHEAR STRENGTH kPa: ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED; 20 40 60 80 100
WATER CONTENT (%): 20 40 60

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 08/11/13 DATA INPUT:

Golder Associates

RECORD OF DCPT No H3-DC5

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137509.4; E 278072.8 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 18, 2012 CHECKED BY SEMC

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
244.2 GROUND SURFACE								20 40 60 80 100	20 40 60		
0.0							244				
							243				
							242				
							241				
							240				
							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H3-DC5

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137509.4; E 278072.8 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 18, 2012 CHECKED BY SEMC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L	γ kN/m^3	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---						229	20 40 60 80 100	20 40 60		
							228				
							227				
							226				
							225				
							224				
							223				
							222				
							221				
							220				
							219				
							218				
							217				
216.5											
27.7	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.28 m) Note: 1. Augered through embankment fill and advanced DCPT starting at 4.6 m depth below ground surface.										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 08/11/13 DATA INPUT:

Golder Associates

RECORD OF DCPT No H3-DC6

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5137560.9; E 278089.1
ORIGINATED BY LK
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE June 28, 2012
CHECKED BY SEMC

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
241.9 0.0	GROUND SURFACE						241 240 239 238 237 236 235 234 233 232 231 230 229 228 227				

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H3-DC6

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137560.9; E 278089.1 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 28, 2012 CHECKED BY SEMC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100			
	--- CONTINUED FROM PREVIOUS PAGE ---							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	w_P w w_L	γ kN/m³	GR SA SI CL
							226	20 40 60 80 100	20 40 60		
							225				
							224				
							223				
							222				
							221				
							220				
218.8							219				
23.1	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.28 m)										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 08/11/13 DATA INPUT:

Golder Associates

RECORD OF DCPT No H3-DC7

1 OF 1 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137339.2; E 277954.6 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 21, 2012 CHECKED BY SEMC

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
244.2 GROUND SURFACE								20 40 60 80 100	20 40 60		
0.0							244				
							243				
							242				
							241				
							240				
							239				
							238				
							237				
							236				
							235				
							234				
							233				
231.9							232				
12.3	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 08/11/13 DATA INPUT:

Golder Associates

RECORD OF DCPT No H3-DC8

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137394.5; E 277974.7 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 19, 2012 CHECKED BY SEMC

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
241.8 / 0.0	GROUND SURFACE							20 40 60 80 100	20 40 60		

241
240
239
238
237
236
235
234
233
232
231
230
229
228
227

Continued Next Page

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

Golder Associates

PROJECT 11-1191-0007

RECORD OF DCPT No H3-DC8

2 OF 2 **METRIC**

G.W.P. 156-98-00 LOCATION N 5137394.5; E 277974.7 ORIGINATED BY EHS

DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC

DATUM Geodetic DATE June 19, 2012 CHECKED BY SEMC

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			SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100 / 20 40 60 80 100	20 40 60		
225.8							226				
16.0	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING)										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 08/11/13 DATA INPUT:

Golder Associates

RECORD OF DCPT No H3-DC9

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137412.1; E 278026.4 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 12, 2012 CHECKED BY SEMC

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			20 40 60 80 100	w_P w w_L	γ	
245.2 / 0.0	GROUND SURFACE							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	WATER CONTENT (%) 20 40 60	kN/m³	GR SA SI CL

245 244 243 242 241 240 239 238 237 236 235 234 233 232 231

Continued Next Page

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 08/11/13 DATA INPUT:

Golder Associates

RECORD OF DCPT No H3-DC9

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137412.1; E 278026.4 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 12, 2012 CHECKED BY SEMC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20 40 60 80 100	w_P w w_L	γ kN/m^3	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	20 40 60		
							230				
							229				
227.9							228				
17.3	END OF DCPT REFUSAL TO FURTHER PENETRATION (HAMMER BOUNCING) Note: 1. Augered through embankment fill and advanced DCPT starting at 6.1 m depth below ground surface.										

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

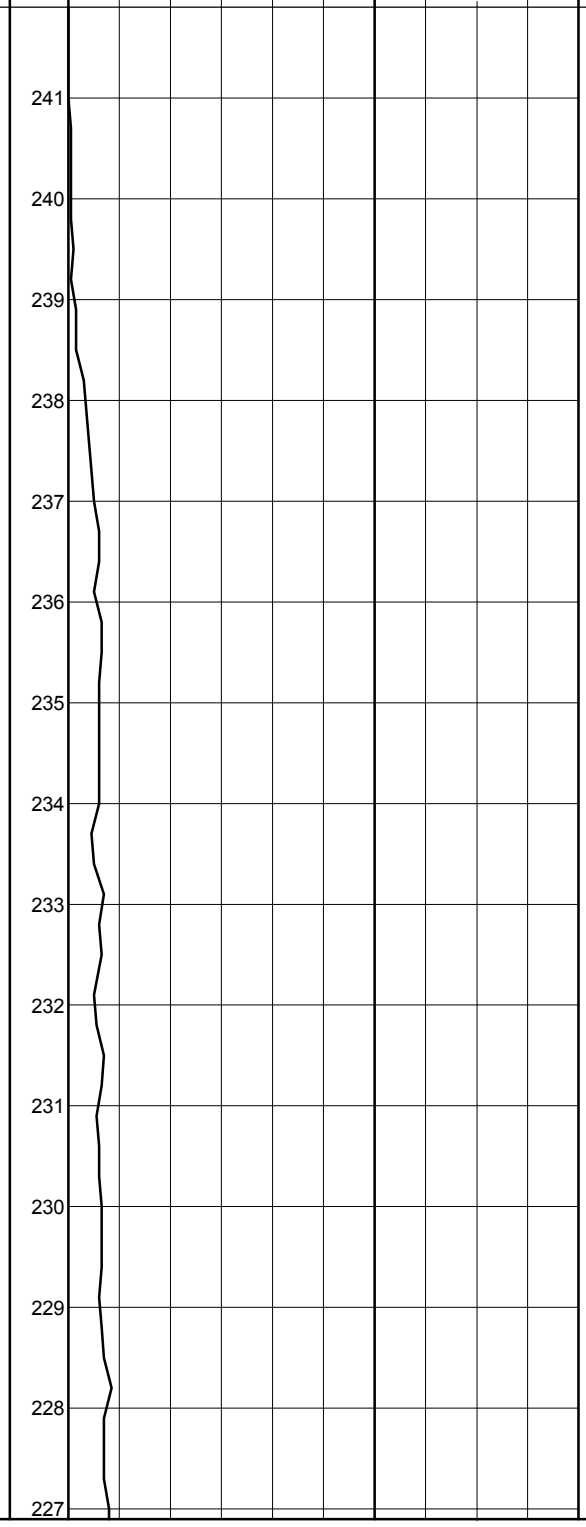
Golder Associates

RECORD OF DCPT No H3-DC10

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137463.4; E 278049.1 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 14, 2012 CHECKED BY SEMC

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m³	GR SA SI CL
241.9 GROUND SURFACE											
0.0											



Continued Next Page

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 08/11/13 DATA INPUT:

Golder Associates

RECORD OF DCPT No H3-DC10

2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137463.4; E 278049.1 ORIGINATED BY EHS
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 14, 2012 CHECKED BY SEMC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	w_P w w_L 20 40 60	γ kN/m³	GR SA SI CL
							226 225 224 223				
222.4 19.5	END OF DCPT										

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

Golder Associates

RECORD OF DCPT No H3-DC11

1 OF 3 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00
LOCATION N 5137480.3; E 278101.7
ORIGINATED BY LK
DIST HWY 17
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY EC
DATUM Geodetic
DATE June 12, 2012
CHECKED BY SEMC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa	PLASTIC LIMIT / NATURAL MOISTURE CONTENT / LIQUID LIMIT / WATER CONTENT (%)	UNIT WEIGHT	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						
243.4 / 0.0	GROUND SURFACE										

SHEAR STRENGTH kPa: ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED

WATER CONTENT (%): w_P PLASTIC LIMIT, w NATURAL MOISTURE CONTENT, w_L LIQUID LIMIT

UNIT WEIGHT γ kN/m^3

GR SA SI CL

Continued Next Page

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

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

Golder Associates

RECORD OF DCPT No H3-DC11

2 OF 3 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137480.3; E 278101.7 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 12, 2012 CHECKED BY SEMC

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	w_P w w_L WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---						228	20 40 60 80 100	20 40 60		
							227				
							226				
							225				
							224				
							223				
							222				
							221				
							220				
							219				
							218				
							217				
							216				
							215				
							214				

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H3-DC11

3 OF 3 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137480.3; E 278101.7 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 12, 2012 CHECKED BY SEMC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: "N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa (○ UNCONFINED, ● QUICK TRIAXIAL, + FIELD VANE, × REMOULDED)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%)	UNIT WEIGHT γ kN/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60		
212.9							213				
30.5	END OF DCPT Note: 1. Augered through embankment fill and advanced DCPT starting at 4.9 m depth below ground surface.										

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

Golder Associates

RECORD OF DCPT No H3-DC12

1 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137541.5; E 278120.2 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 14, 2012 CHECKED BY SEMC

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			SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED	WATER CONTENT (%)	γ kN/m^3	GR SA SI CL
242.4 GROUND SURFACE								20 40 60 80 100	20 40 60		
0.0							242				
							241				
							240				
							239				
							238				
							237				
							236				
							235				
							234				
							233				
							232				
							231				
							230				
							229				
							228				

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 08/11/13 DATA INPUT:

Continued Next Page

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

Golder Associates

RECORD OF DCPT No H3-DC12

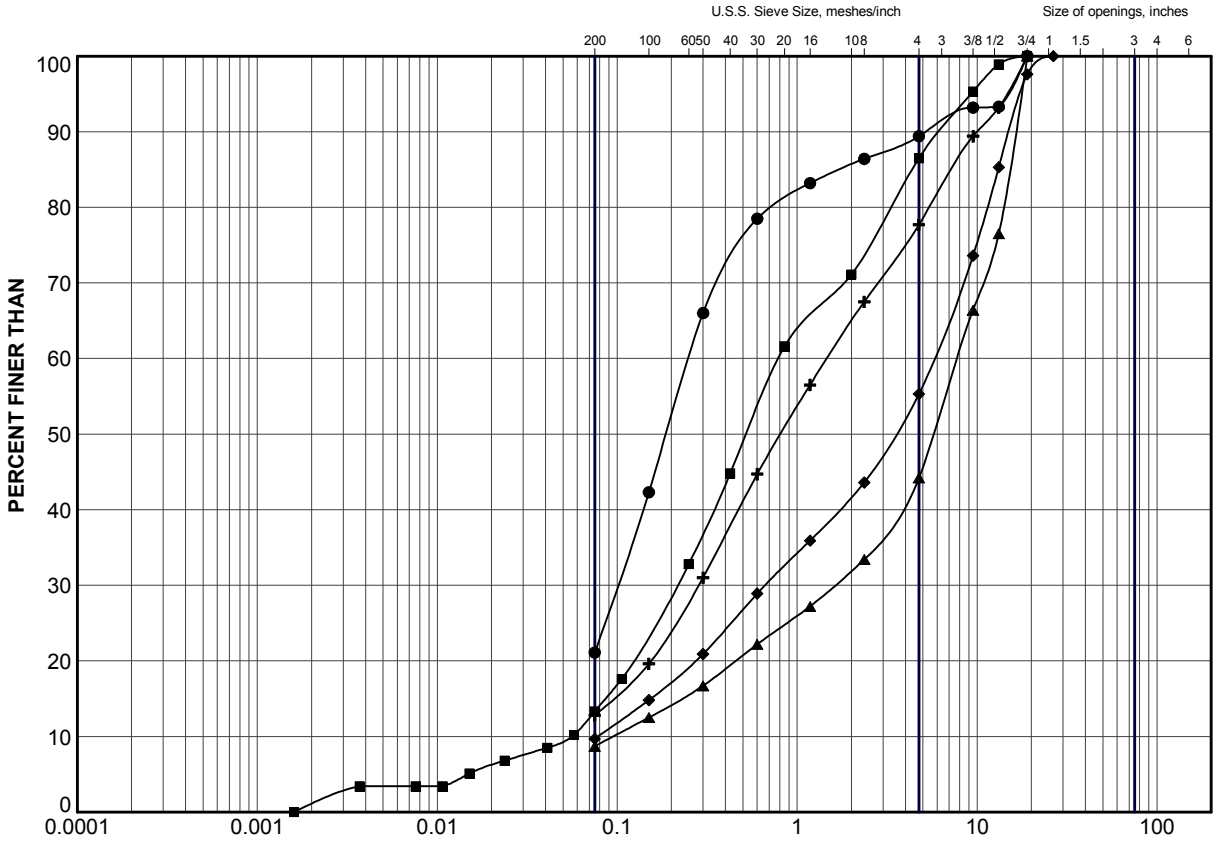
2 OF 2 **METRIC**

PROJECT 11-1191-0007
G.W.P. 156-98-00 LOCATION N 5137541.5; E 278120.2 ORIGINATED BY LK
DIST HWY 17 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY EC
DATUM Geodetic DATE June 14, 2012 CHECKED BY SEMC

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			20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED ● QUICK TRIAXIAL + FIELD VANE × REMOULDED 20 40 60 80 100	w_P w w_L WATER CONTENT (%) 20 40 60	γ kN/m³	GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---						227				
							226				
							225				
							224				
							223				
							222				
							221				
							220				
							219				
							218				
							217				
216.5 25.9	END OF DCPT REFUSAL TO FURTHER PENETRATION (100 Blows / 0.28 m)										

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

SUD_MTO 003 11-1191-0007.GPJ GAL-MISS.GDT 08/11/13 DATA INPUT:



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H3-2	2	242.5
■	H3-4	2	244.2
▲	H3-5	1	244.5
✚	H3-9	5	240.5
◆	H3-13	1	243.4

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (WBL)

TITLE

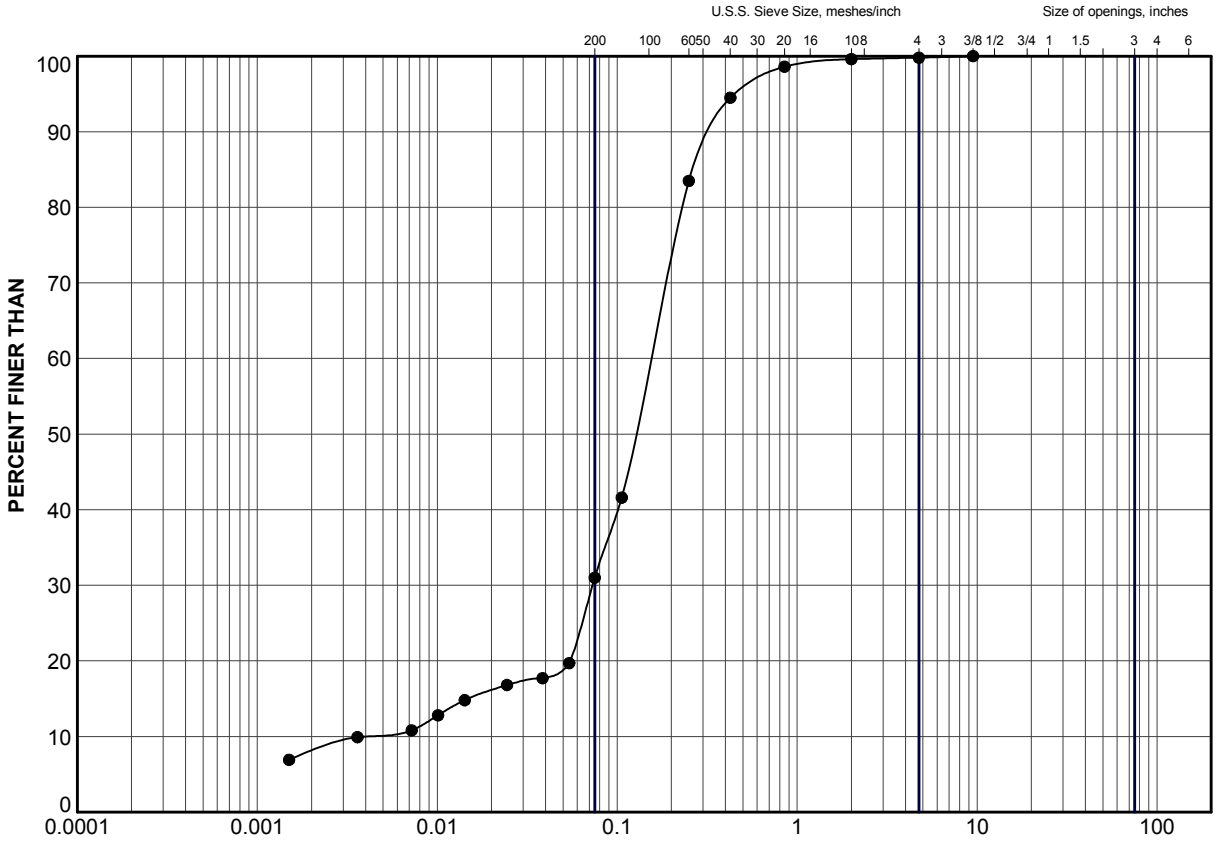
GRAIN SIZE DISTRIBUTION

SANDY GRAVEL to SILTY SAND (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMP	Nov 2013		
APPR		Nov 2013	**FIGURE C1**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H3-1	5	241.8

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (WBL)

TITLE

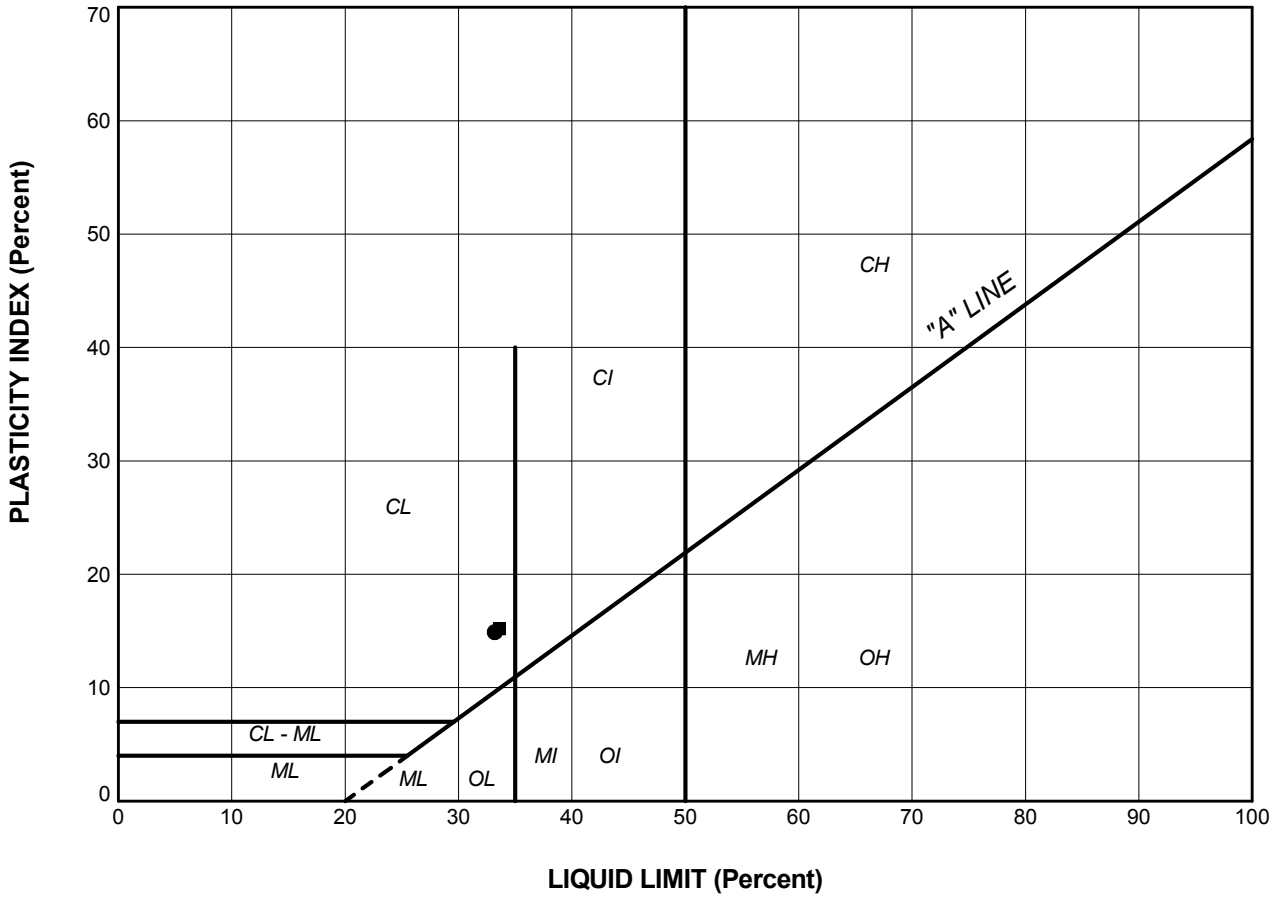
GRAIN SIZE DISTRIBUTION

SILTY SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMC	Nov 2013		
APPR		Nov 2013	**FIGURE C2**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LIQUID LIMIT (Percent)

SOIL TYPE	**PLASTICITY**
C = Clay	L = Low
M = Silt	I = Intermediate
O = Organic	H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H3-10	3	33.2	18.3	14.9
■	H3-12	3	33.6	18.4	15.2

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (WBL)

TITLE

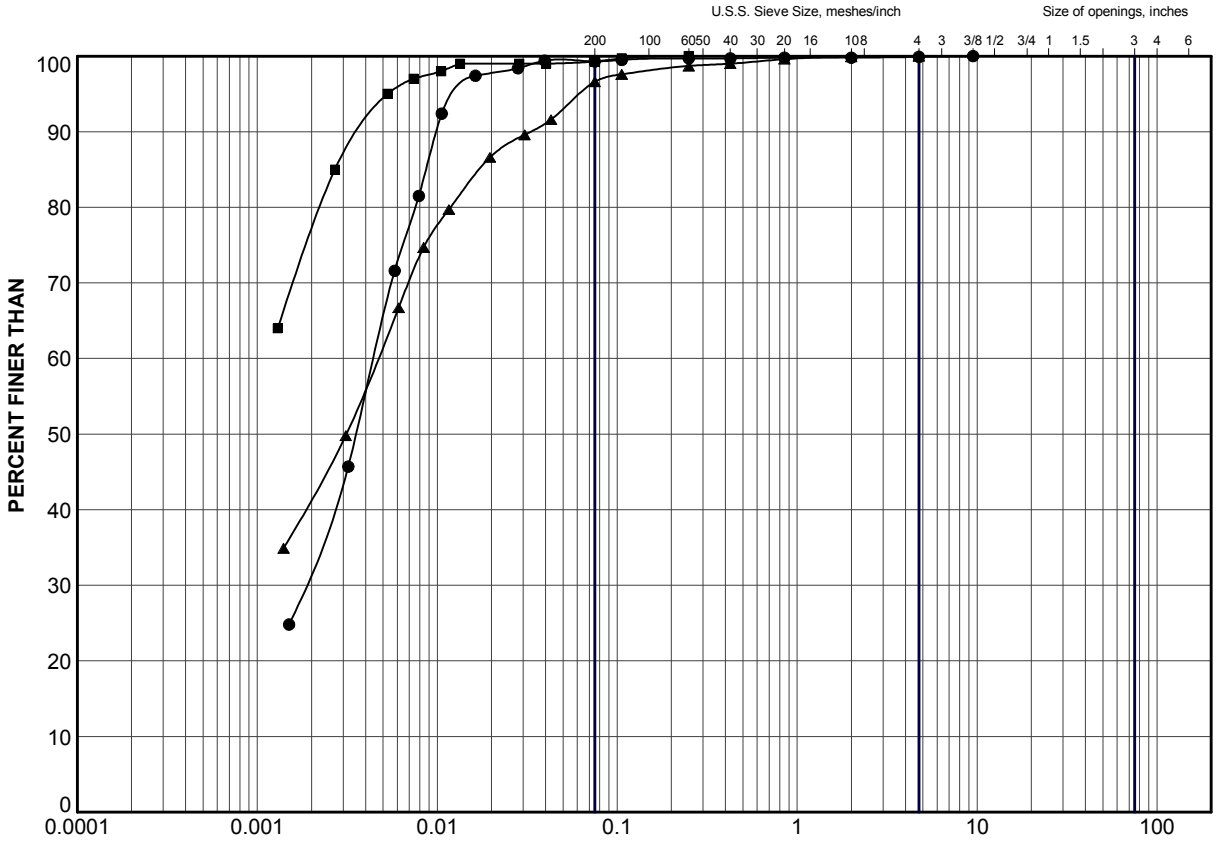
PLASTICITY CHART

CLAYEY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMC	Nov 2013		
APPR		Nov 2013	**FIGURE C3**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H3-3	10	233.7
■	H3-6	7	233.4
▲	H3-7	8	237.6

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (WBL)

TITLE

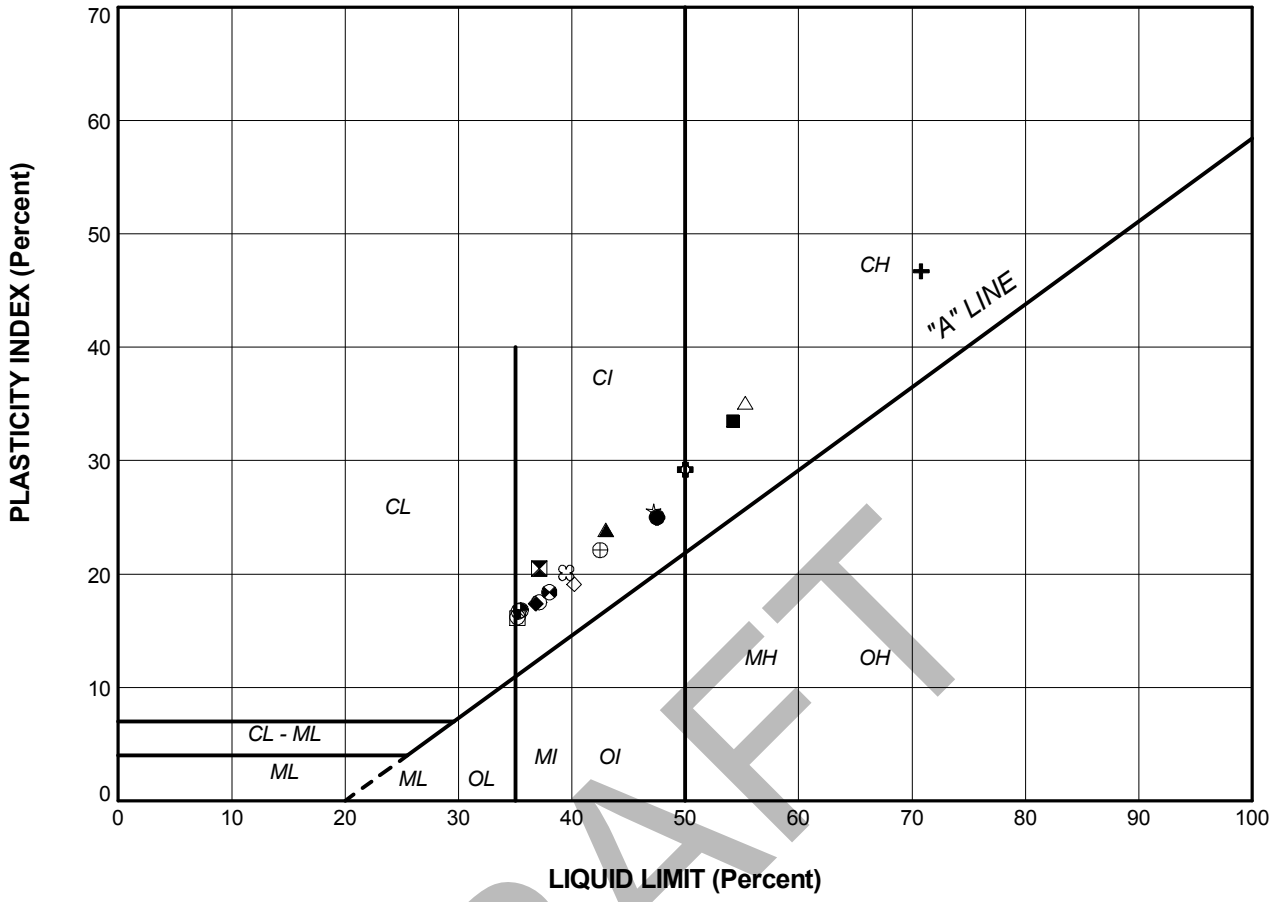
GRAIN SIZE DISTRIBUTION

SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMC	Nov 2013		
APPR		Nov 2013	**FIGURE C4**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H3-1	7	47.5	22.5	25.0
■	H3-2	6	54.2	20.7	33.5
▲	H3-3	7	43.0	19.1	23.9
✚	H3-4	8	70.8	24.1	46.7
◆	H3-5	9	36.8	19.4	17.4
◇	H3-5	12	40.2	21.1	19.1
○	H3-6	4	37.1	19.6	17.5
△	H3-7	11	55.3	20.2	35.1
⊗	H3-8	6	35.3	18.6	16.7
⊕	H3-8	11	42.5	20.4	22.1
□	H3-9	9	35.2	19.1	16.1
⊖	H3-9	14	38.0	19.6	18.4
◴	H3-11	9	35.5	18.7	16.8
☆	H3-11	13	47.2	21.6	25.6
⊠	H3-12	6	39.5	19.4	20.1
⊠	H3-12	7	37.1	16.6	20.5
⊙	H3-13	8B	35.2	19.0	16.2
✪	H3-13	12	50.0	20.8	29.2

DRAFT

PROJECT
HIGHWAY 17
STA 13+900 TO 14+200 (WBL)

TITLE
PLASTICITY CHART
SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.		11-1191-0007	FILE No.	11-1191-0007.GPJ	
DRAWN	TB	Oct 2014	SCALE	N/A	REV.
CHECK	SEMP	Oct 2014			
APPR		Oct 2014	**FIGURE**	**C5**	

SUD-MTO PL (NEW) 25 GLDR_LDN.GDT

CONSOLIDATION TEST SUMMARY

FIGURE C6

SAMPLE IDENTIFICATION

Project Number:	11-1191-0007	Sample Number:	7
Borehole Number:	H3-12	Sample Depth, m:	11

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	2		
Date Started	January 10, 2013		
Date Completed	January 24, 2013		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.526	Unit Weight, kN/m^3	18.08
Sample Diameter, cm	6.351	Dry Unit Weight, kN/m^3	12.77
Area, cm^2	31.68	Specific Gravity, Measured	2.78
Volume, cm^3	80.02	Solids Height, cm	1.184
Water Content, %	41.60	Volume of Solids, cm^3	37.50
Wet Mass, g	147.52	Volume of Voids, cm^3	42.52
Dry Mass, g	104.18		

TEST COMPUTATIONS

Pressure	Primary	Corr. Height	Void	Average Height	t_{90}	cv.	mv	k	Total Work
kPa	Consolidation	cm	Ratio	cm	sec	cm^2/s	m^2/kN	cm/s	kJ/m3
0	0	2.526	1.134	2.526					
4	0.04	2.522	1.130	2.524	540	0.0025	4.01E-04	9.82E-08	0.004
13	0.02	2.519	1.128	2.521	240	0.0056	1.08E-04	5.97E-08	0.012
31	0.07	2.513	1.122	2.516	375	0.0036	1.49E-04	5.23E-08	0.070
66	0.13	2.500	1.112	2.506	346	0.0039	1.42E-04	5.35E-08	0.315
137	0.24	2.476	1.091	2.488	470	0.0028	1.36E-04	3.72E-08	1.297
277	1.65	2.311	0.952	2.393	2693	0.0005	4.65E-04	2.05E-08	15.085
558	1.05	2.206	0.864	2.258	470	0.0023	1.47E-04	3.32E-08	33.967
1117	0.86	2.120	0.791	2.163	821	0.0012	6.07E-05	7.19E-09	66.542
558	-0.01	2.121	0.792	2.121					
137	-0.21	2.143	0.810	2.132					
31	-0.28	2.171	0.834	2.157					
4	-0.26	2.197	0.856	2.184					

Note:
k calculated using c_v based on t_{90} values.

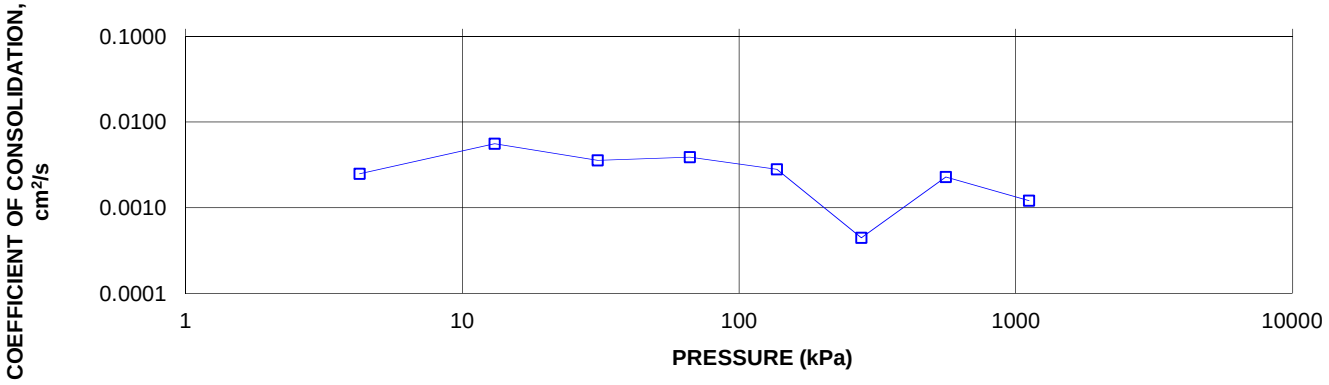
SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	2.197	Unit Weight, kN/m^3	18.60
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	14.68
Area, cm^2	31.68	Specific Gravity, Measured	2.78
Volume, cm^3	69.59	Solids Height, cm	1.184
Water Content, %	26.72	Volume of Solids, cm^3	37.50
Wet Mass, g	132.02	Volume of Voids, cm^3	32.09
Dry Mass, g	104.18		

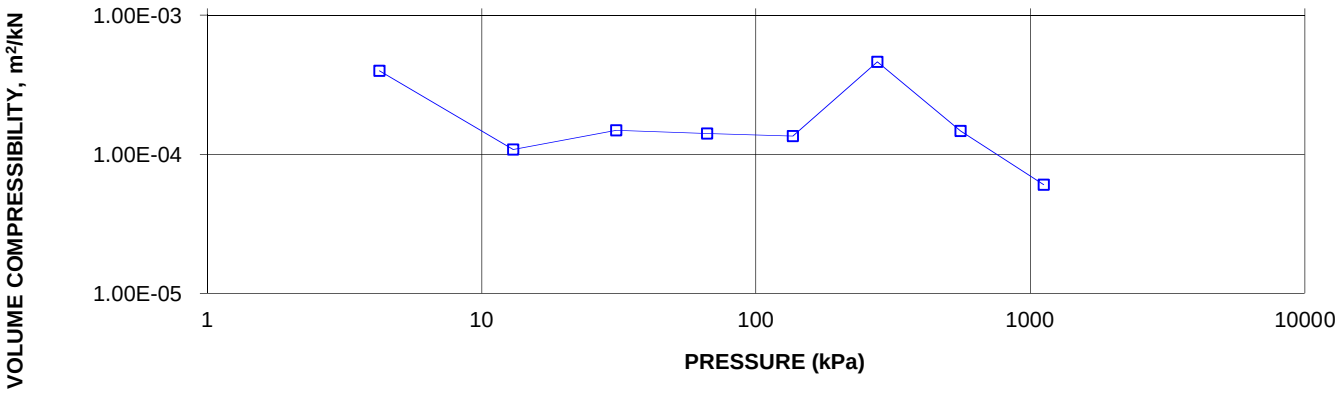
CONSOLIDATION TEST SUMMARY

FIGURE C6
Pg. 2 of 4

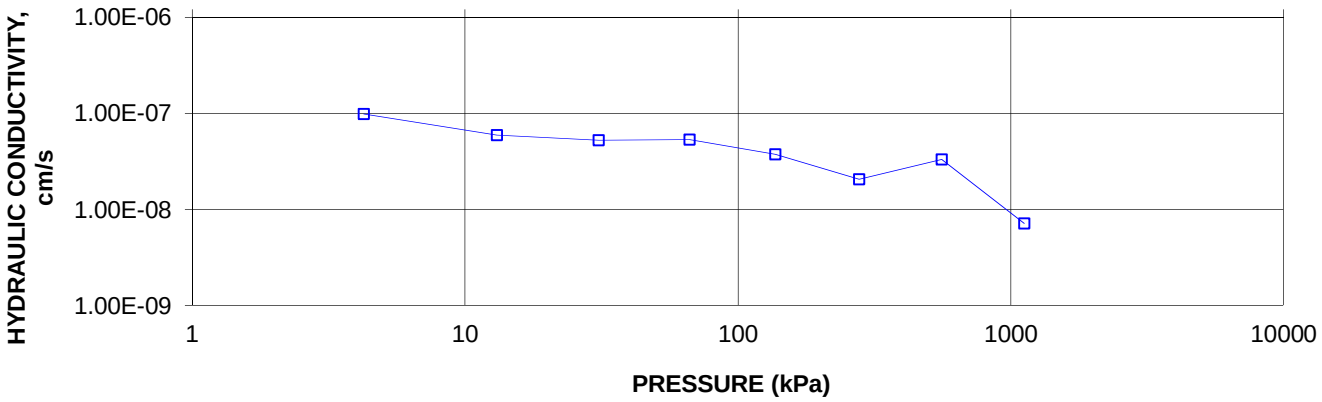
CONSOLIDATION TEST
CV cm^2/s VS PRESSURE (kPa)
BH H3-12 Sa 7



CONSOLIDATION TEST
MV m^2/kN vs PRESSURE (kPa)
BH H3-12 Sa 7



CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH H3-12 Sa 7

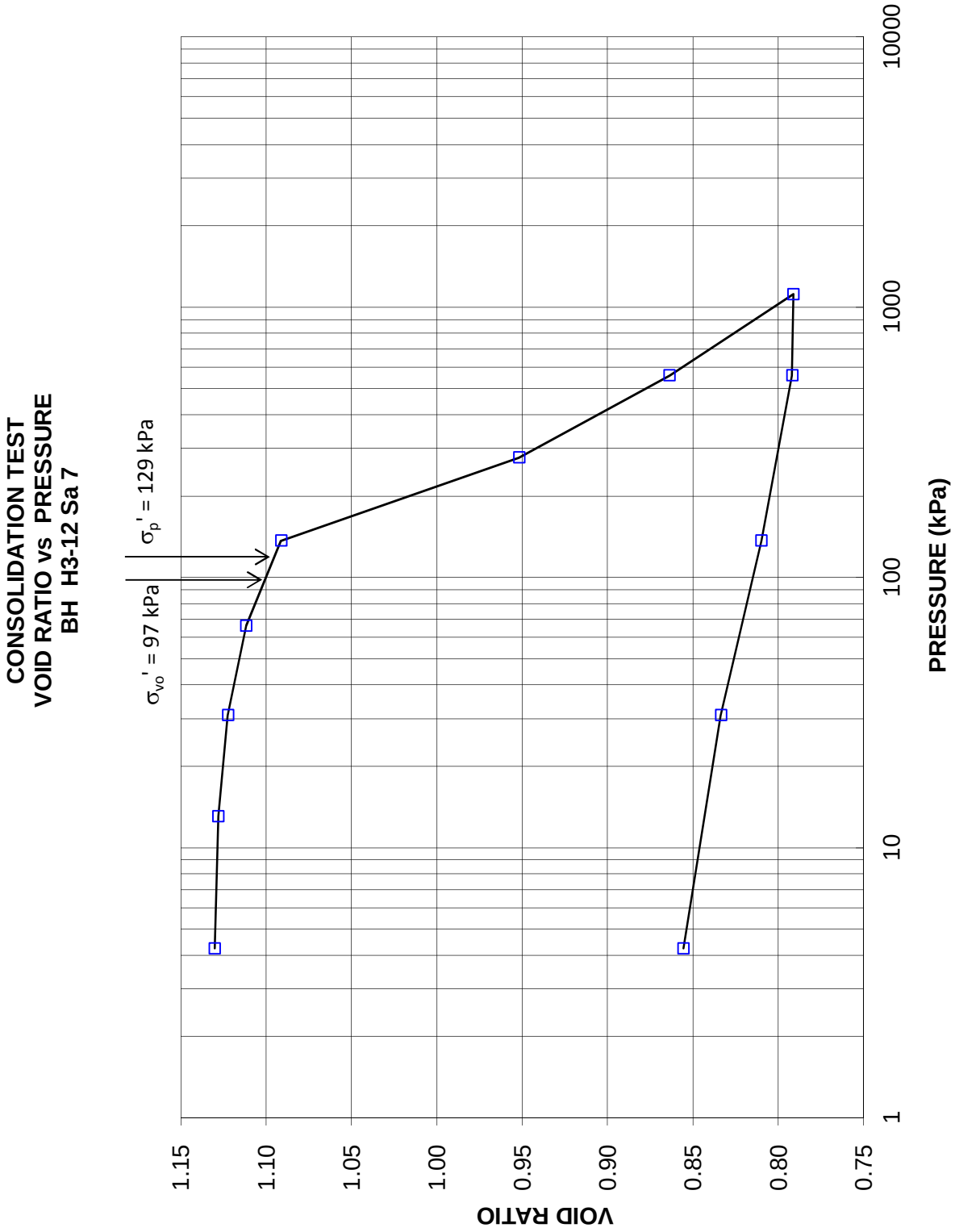


Project No. 11-1191-0007
Prepared By: TG

Golder Associates

Checked By:

CONSOLIDATION TEST VOID RATIO VS LOG PRESSURE	FIGURE C6 Pg. 3 of 4



Project No. 11-1191-0007

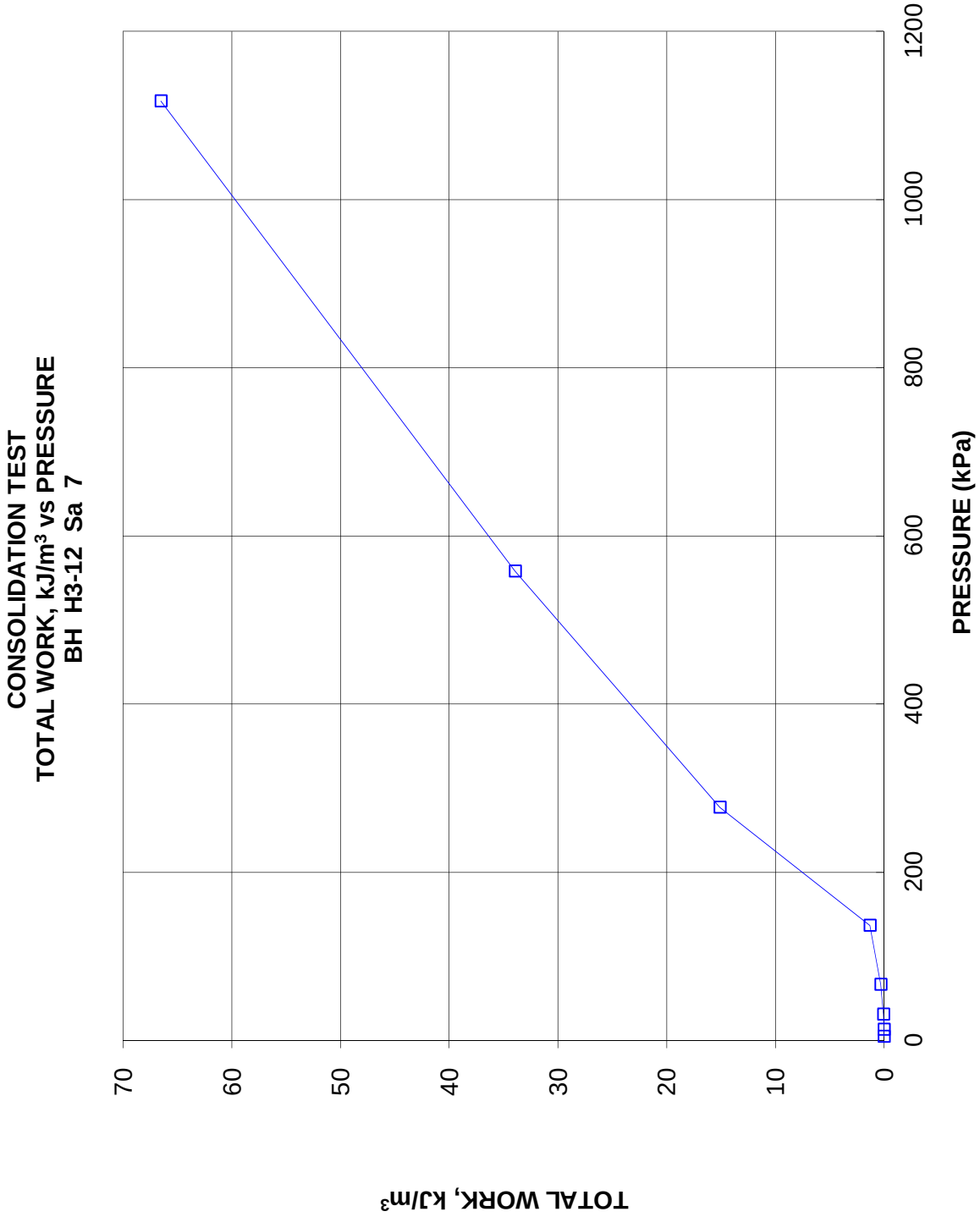
Prepared By: TG

Golder Associates

Checked By:

CONSOLIDATION TEST
TOTAL WORK VS PRESSURE

FIGURE C6
Pg. 4 of 4

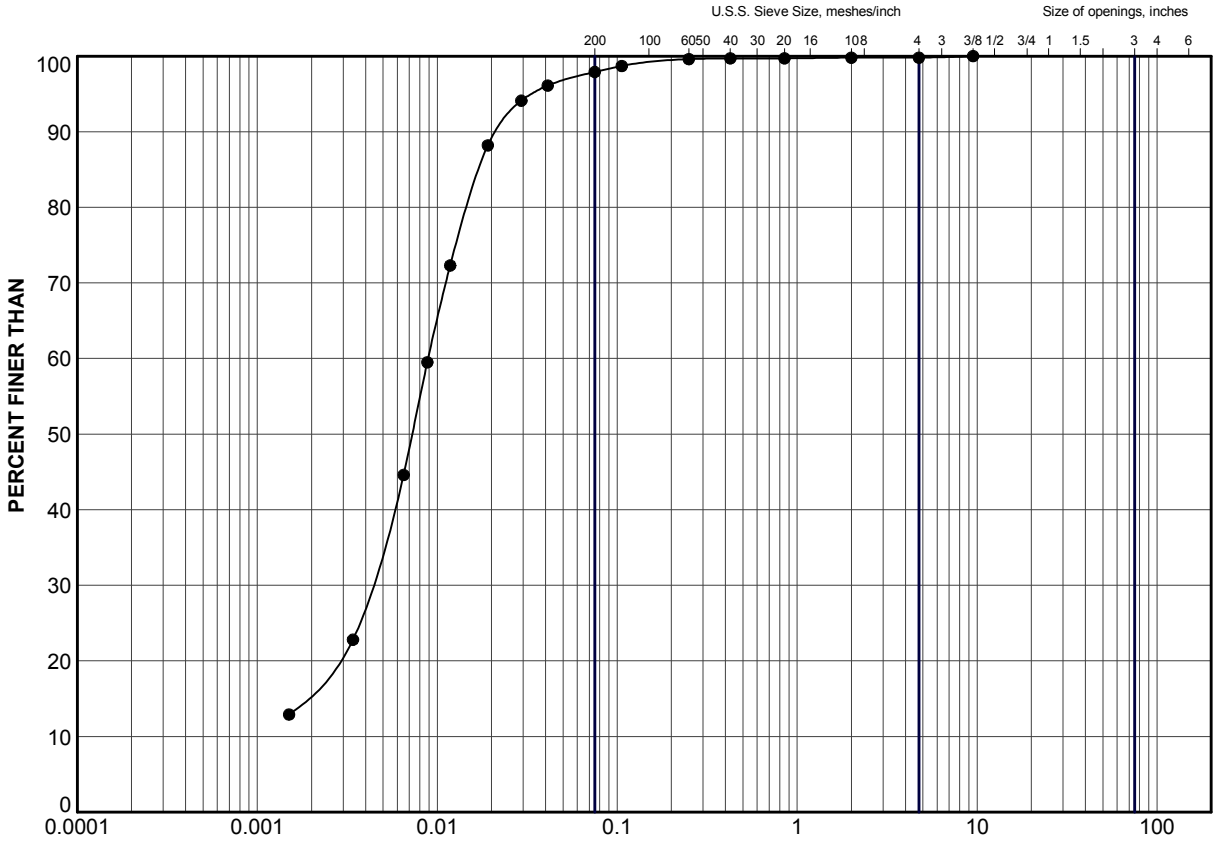


Project No: 11-1191-0007

Prepared By: TG

Golder Associates

Checked By:



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H3-7	14	228.5

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (WBL)

TITLE

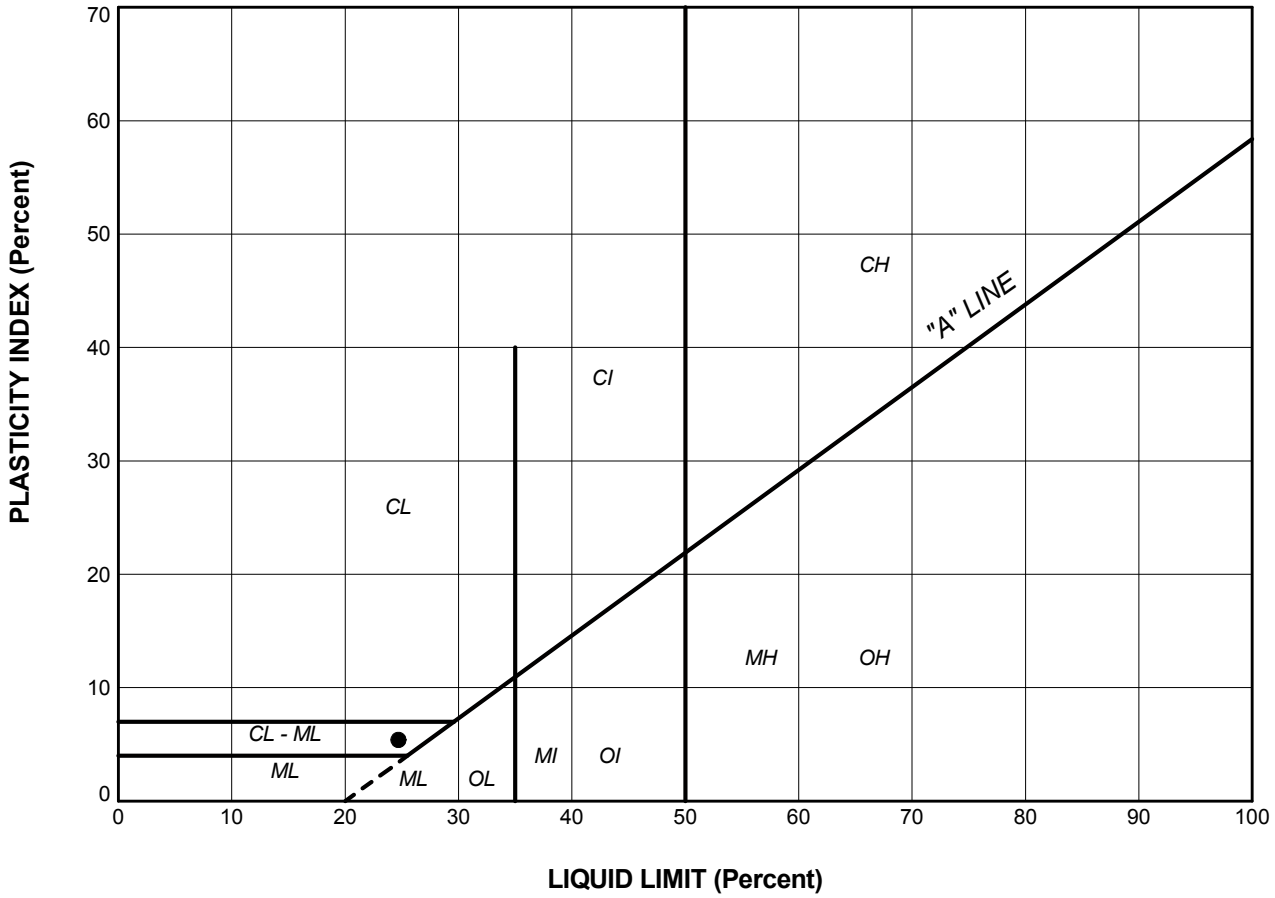
GRAIN SIZE DISTRIBUTION

CLAYEY SILT to SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMC	Nov 2013		
APPR		Nov 2013	**FIGURE C7**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H3-4	10	24.7	19.3	5.4

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (WBL)

TITLE

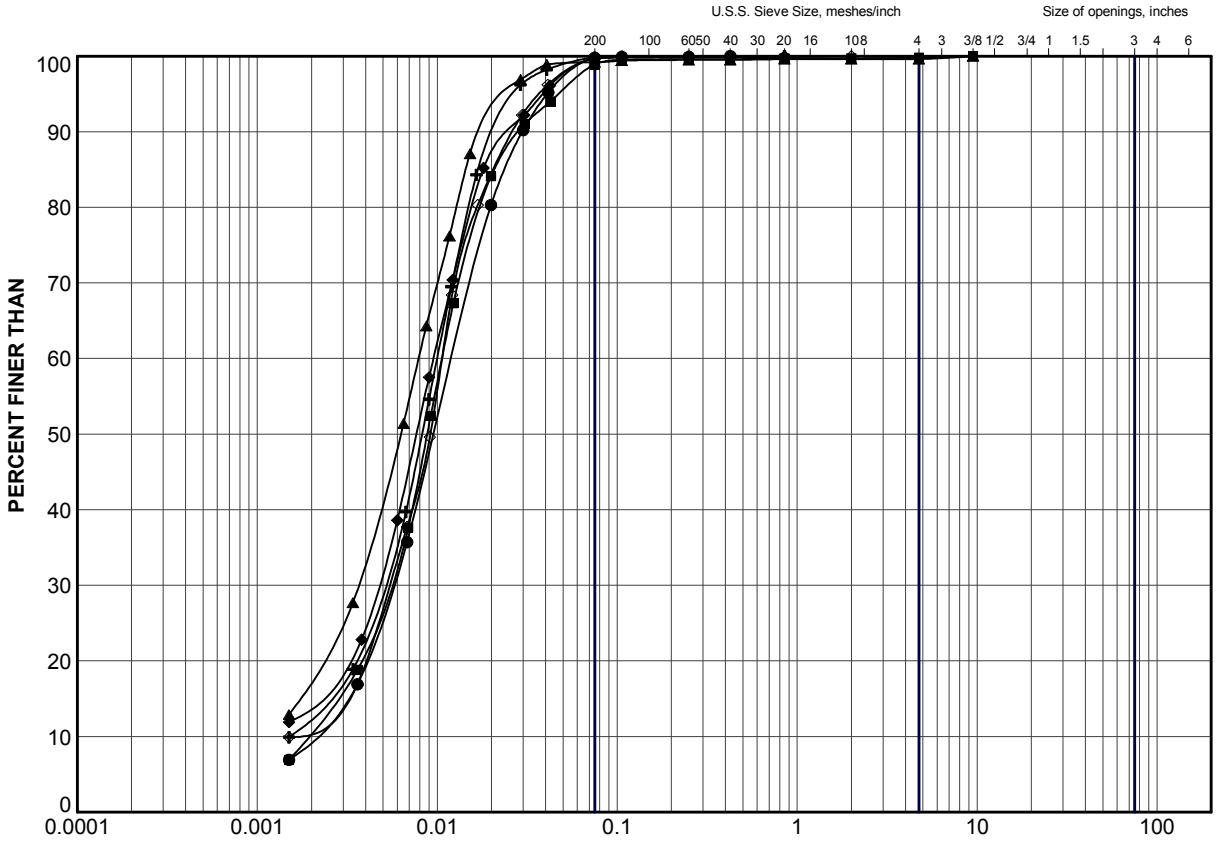
PLASTICITY CHART

CLAYEY SILT to SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMC	Nov 2013		
APPR		Nov 2013	**FIGURE C8**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H3-5	14	229.4
■	H3-8	13	226.1
▲	H3-10	9	228.4
✚	H3-11	15	226.7
◆	H3-12	11	225.3
◇	H3-13	16	225.3

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (WBL)

TITLE

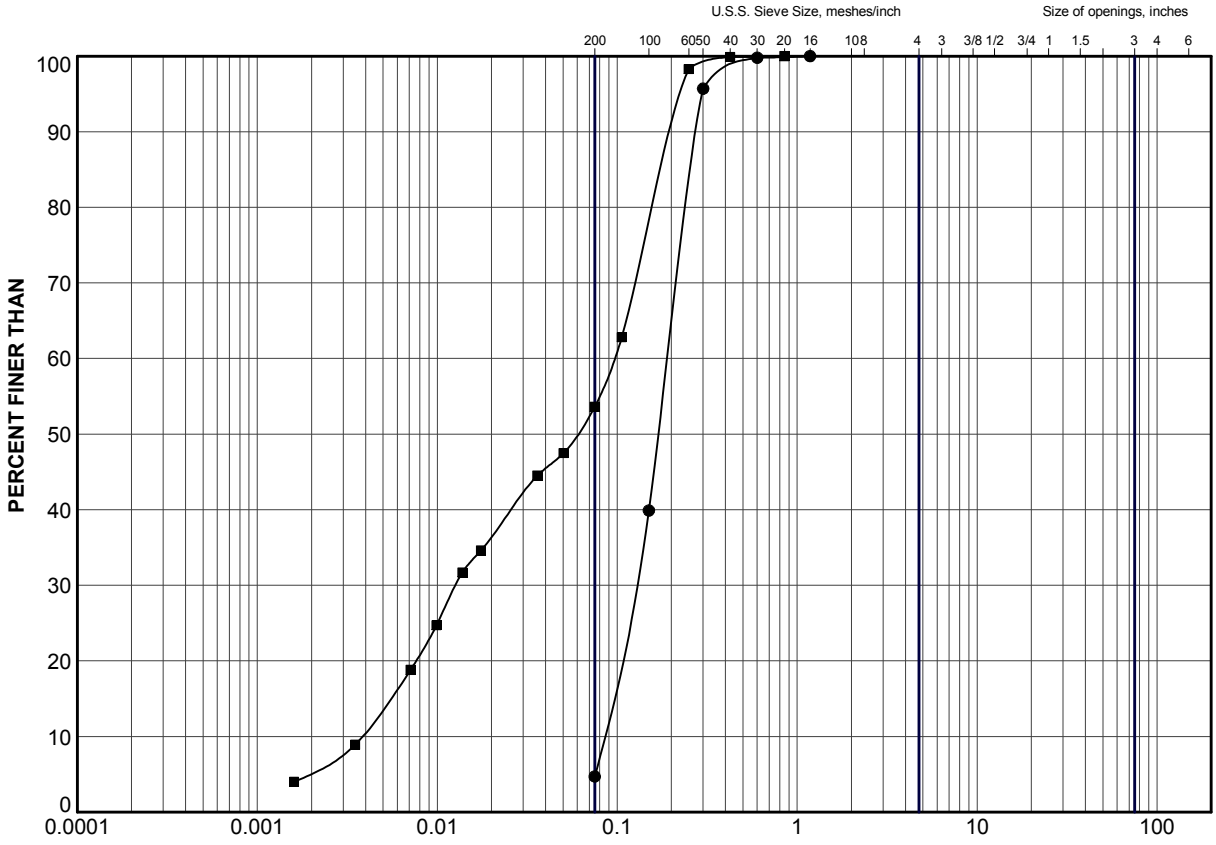
GRAIN SIZE DISTRIBUTION

SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMC	Nov 2013		
APPR		Nov 2013	**FIGURE C9**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H3-3	12	230.7
■	H3-6	11	227.3

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (WBL)

TITLE

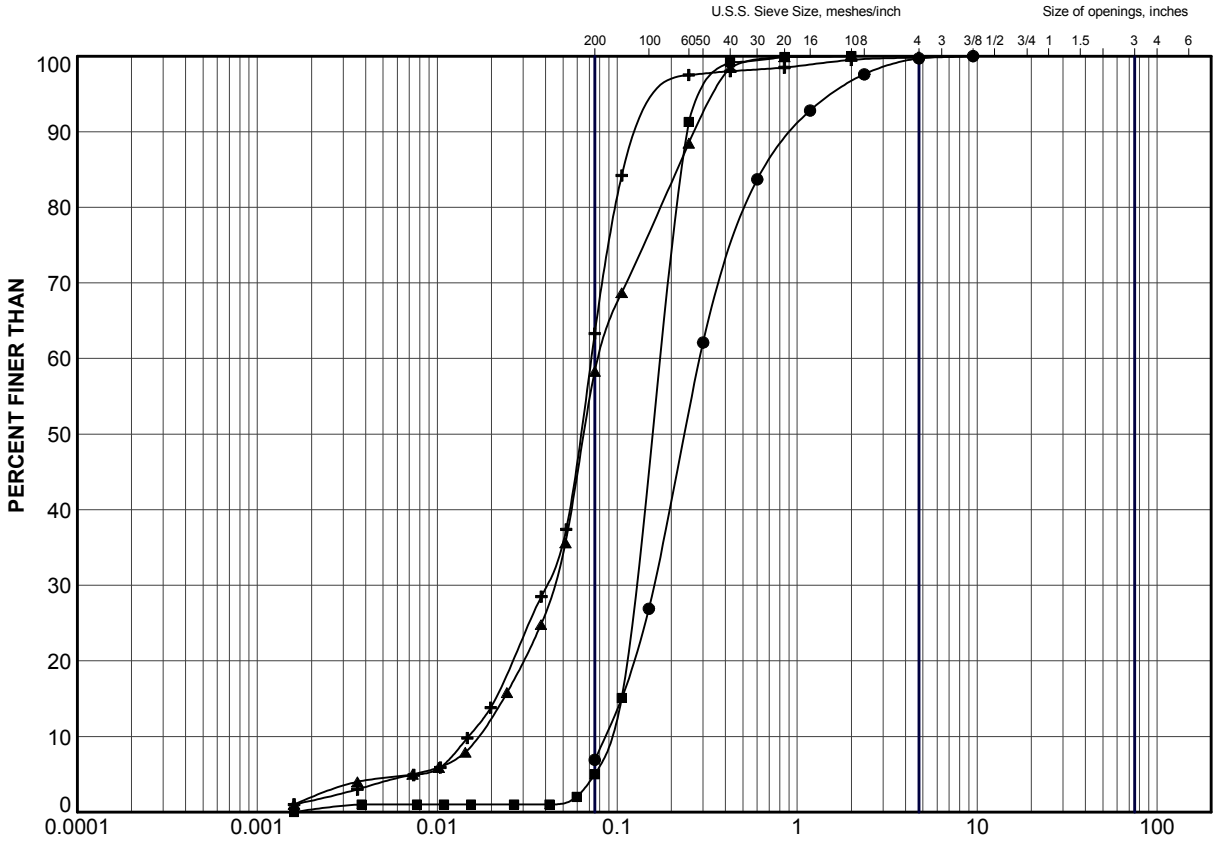
GRAIN SIZE DISTRIBUTION

SAND to SAND and SILT (INTERLAYER)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMC	Nov 2013		
APPR		Nov 2013	**FIGURE C10**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H3-2	11	231.0
■	H3-4	12	228.9
▲	H3-7	17	222.4
✚	H3-10	13	222.3

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (WBL)

TITLE

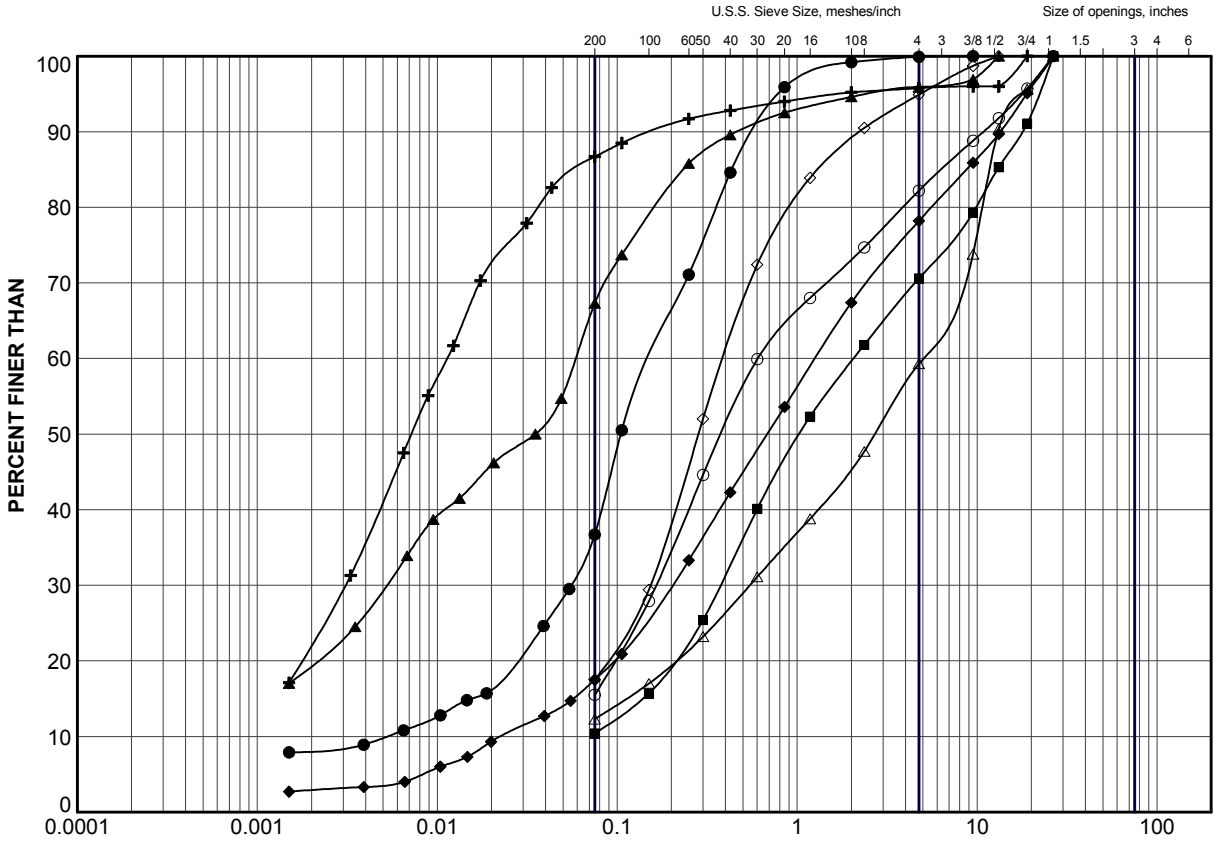
GRAIN SIZE DISTRIBUTION

SAND to SAND and SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMC	Nov 2013		
APPR		Nov 2013	**FIGURE C11**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H3-15	3	241.3
■	H3-17	2	244.5
▲	H3-18	2	243.4
✚	H3-21	3A	241.3
◆	H3-23	2	240.8
◇	H3-24	1	242.6
○	H3-25	2	240.4
△	H3-26	1	243.5

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (EBL)

TITLE

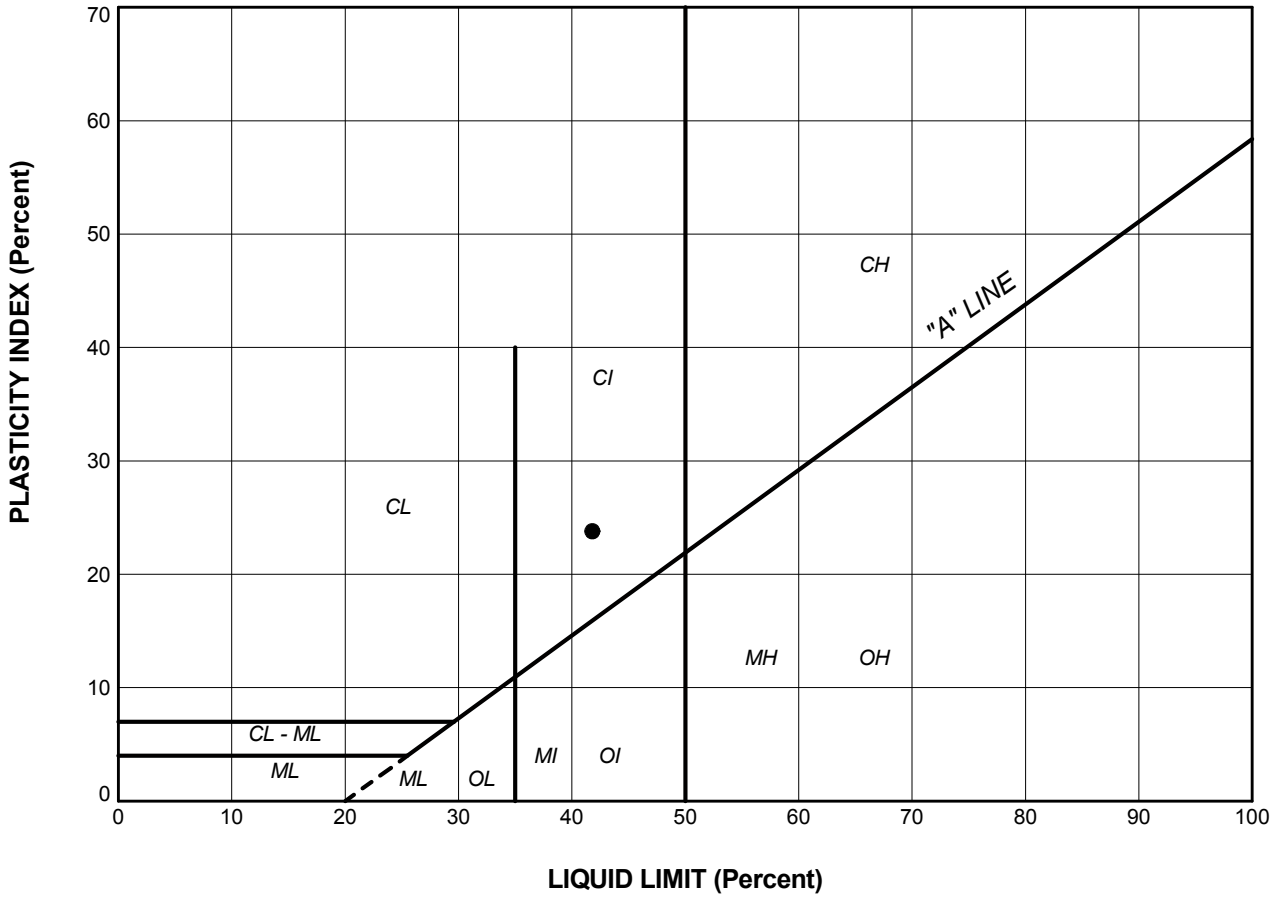
GRAIN SIZE DISTRIBUTION

SAND and GRAVEL to CLAYEY SILT (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMC	Nov 2013		
APPR		Nov 2013	**FIGURE C12**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H3-20	3A	41.8	18.0	23.8

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (EBL)

TITLE

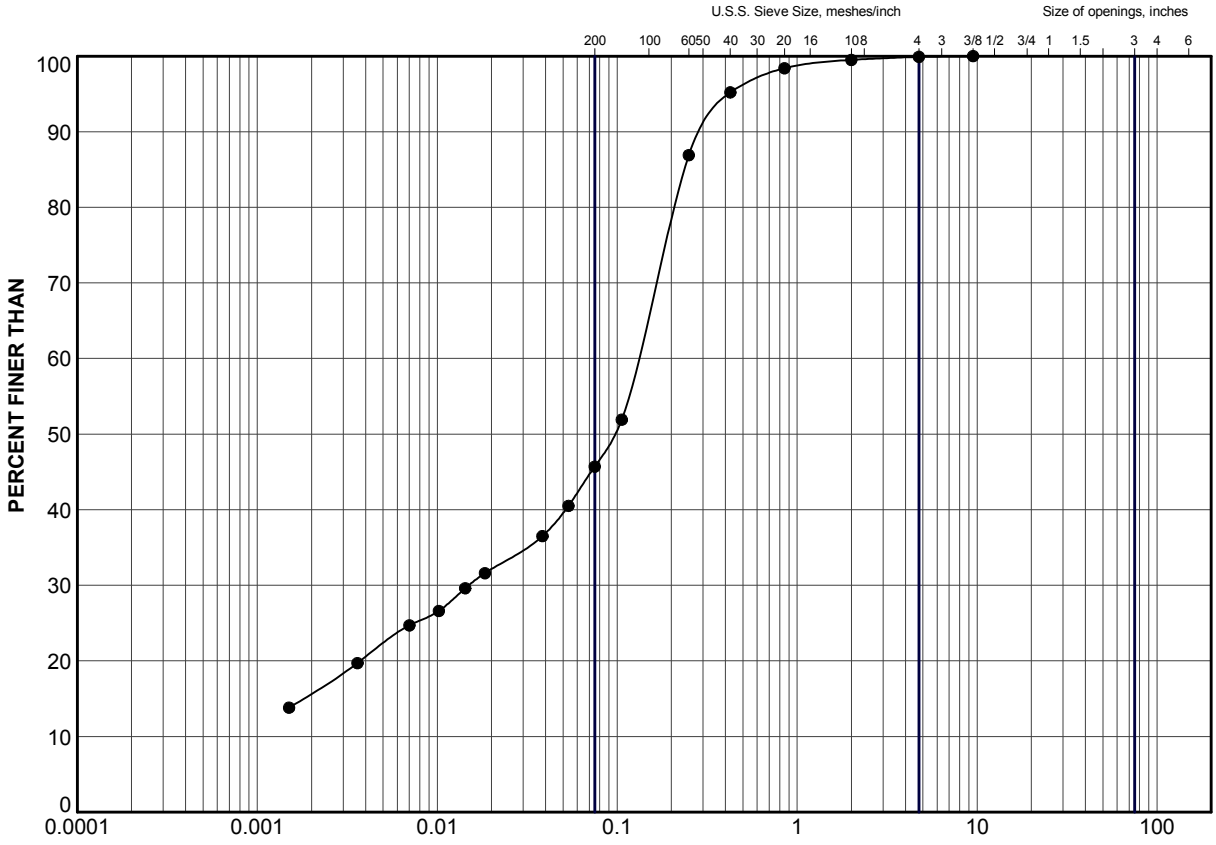
PLASTICITY CHART

SILTY CLAY (FILL)

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMC	Nov 2013		
APPR		Nov 2013	**FIGURE C13**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H3-16	6	240.0

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (EBL)

TITLE

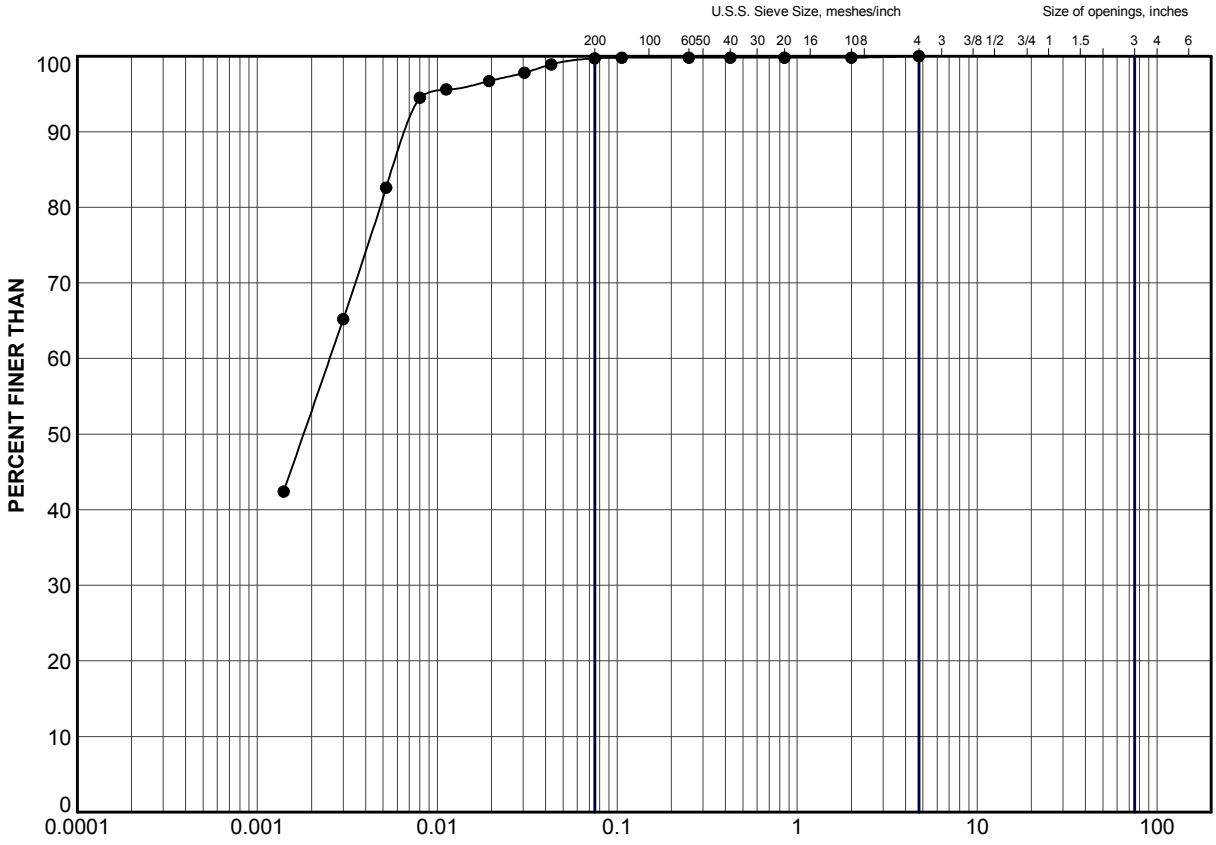
GRAIN SIZE DISTRIBUTION

SILTY SAND

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMC	Nov 2013		
APPR		Nov 2013	**FIGURE C14**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H3-20	7	234.9

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (EBL)

TITLE

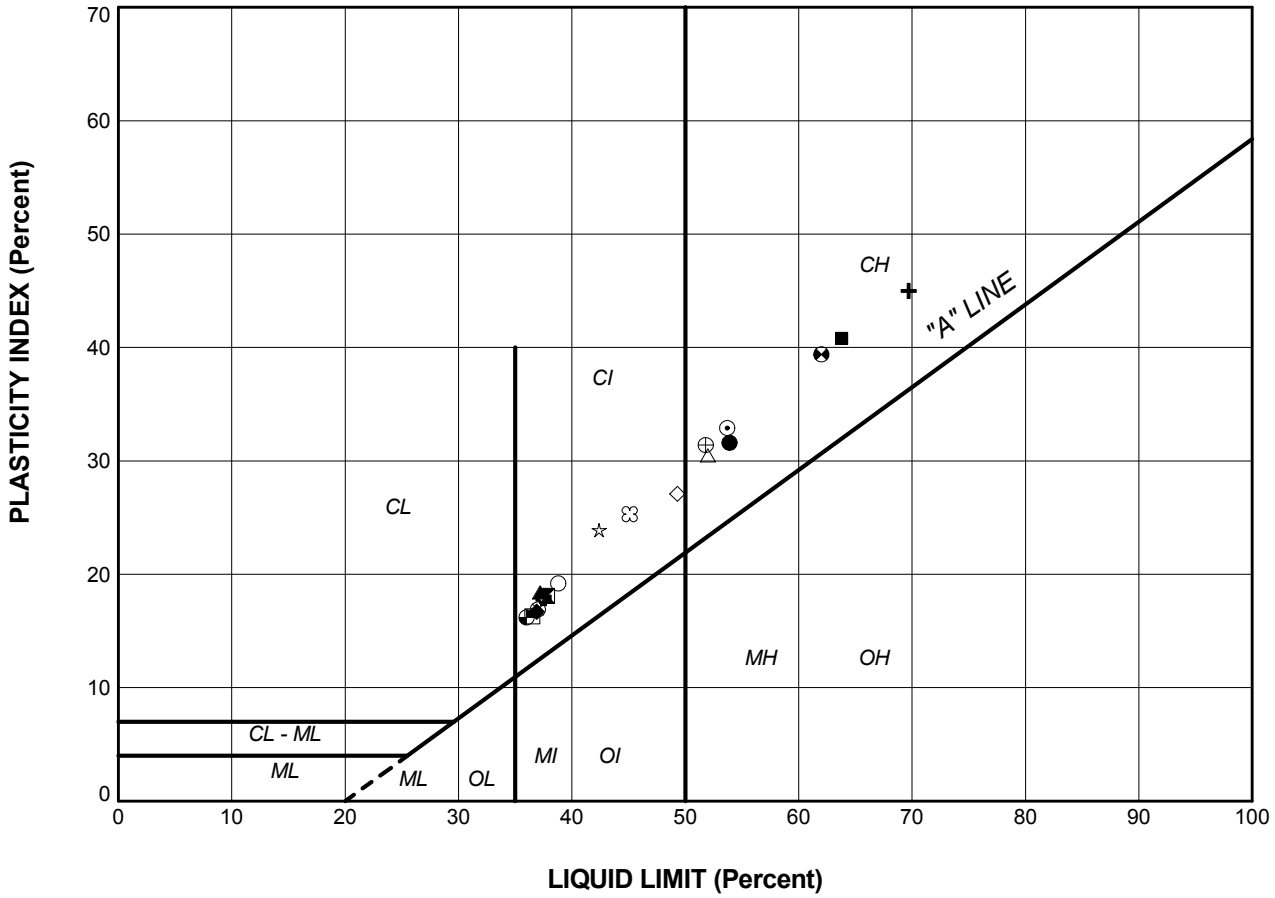
GRAIN SIZE DISTRIBUTION

SILTY CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Jun 2015	SCALE	N/A
CHECK	SEMC	Jun 2015	REV.	
APPR		Jun 2015	**FIGURE**	**C15**

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H3-15	5	53.9	22.3	31.6
■	H3-16	8	63.8	23.0	40.8
▲	H3-17	6	37.2	18.8	18.4
✚	H3-18	9	69.7	24.7	45.0
◆	H3-19	4	36.9	20.2	16.7
◇	H3-19	8	49.3	22.2	27.1
○	H3-20	6	38.8	19.6	19.2
△	H3-21	8	52.0	21.5	30.5
⊗	H3-22	5	37.0	20.1	16.9
⊕	H3-22	10	51.8	20.4	31.4
□	H3-23	6	36.5	20.2	16.3
◓	H3-23	11	62.0	22.6	39.4
◕	H3-24	6	36.0	19.8	16.2
☆	H3-24	9	42.4	18.5	23.9
⊠	H3-24	11	45.1	19.8	25.3
◙	H3-25	5	37.8	19.7	18.1
⊙	H3-25	9	53.7	20.8	32.9
✿	H3-26	6	37.5	19.6	17.9

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (EBL)

TITLE

PLASTICITY CHART

SILTY CLAY to CLAY

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	TB	Nov 2013	SCALE	N/A	REV.
CHECK	SEMC	Nov 2013			
APPR		Nov 2013	**FIGURE C16**		

SUD-MTO PL (NEW) 25 GLDR_LDN.GDT

CONSOLIDATION TEST SUMMARY

FIGURE C17

SAMPLE IDENTIFICATION

Project Number:	11-1191-0007	Sample Number:	9
Borehole Number:	H3-24	Sample Depth, m:	12.5

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	1		
Date Started	Sept. 28/12		
Date Completed	Oct. 12/12		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.544	Unit Weight, kN/m^3	18.38
Sample Diameter, cm	6.353	Dry Unit Weight, kN/m^3	12.64
Area, cm^2	31.70	Specific Gravity, Measured	2.76
Volume, cm^3	80.64	Solids Height, cm	1.186
Water Content, %	45.45	Volume of Solids, cm^3	37.60
Wet Mass, g	151.18	Volume of Voids, cm^3	43.04
Dry Mass, g	103.94		

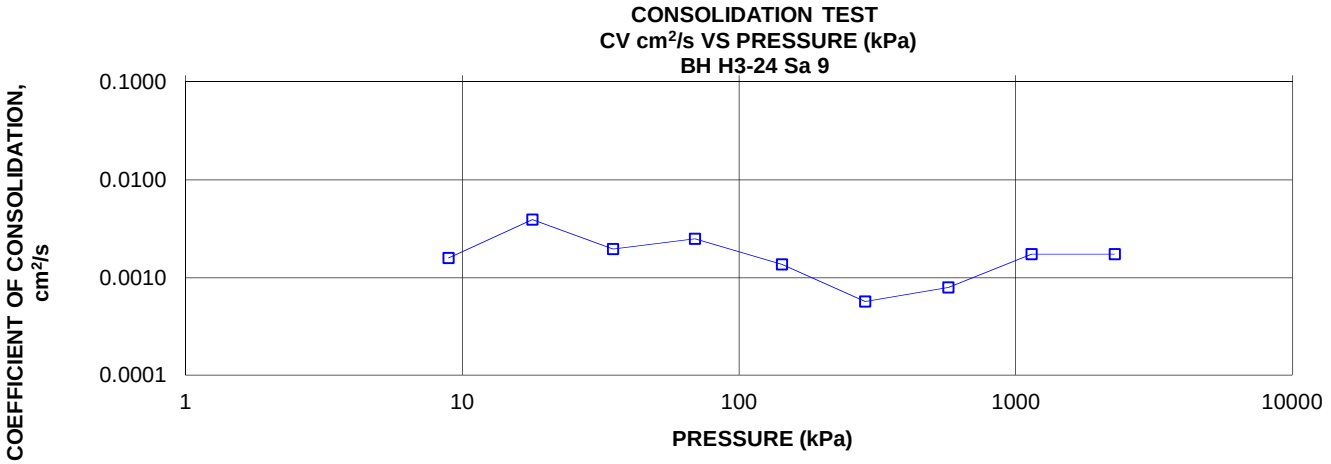
TEST COMPUTATIONS

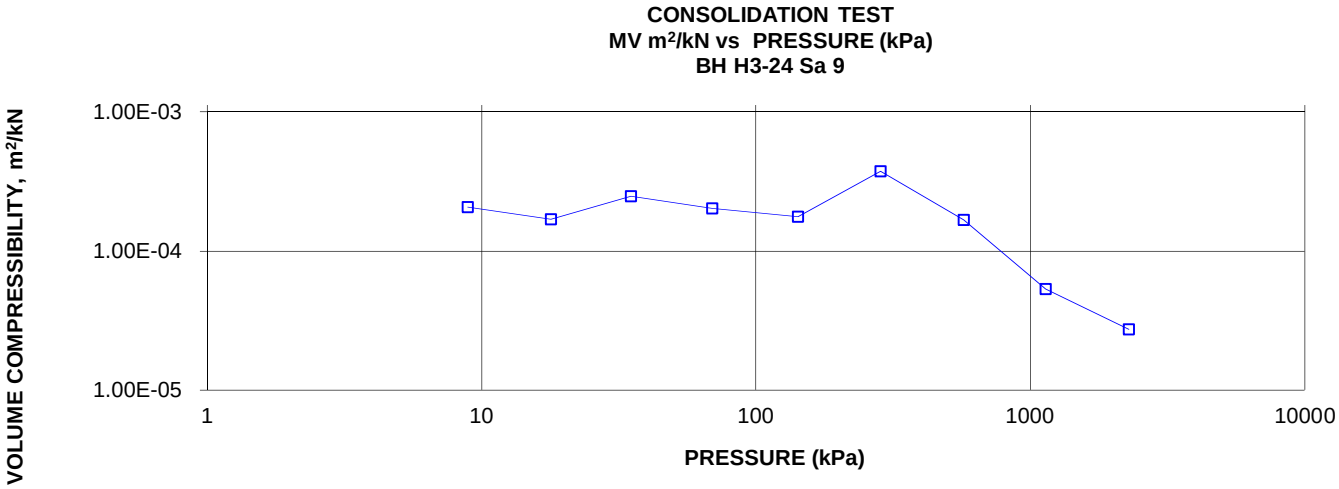
Pressure	Primary	Corr. Height	Void	Average Height	t_{90}	cv.	mv	k	Total Work
kPa	Consolidation	cm	Ratio	cm	sec	cm^2/s	m^2/kN	cm/s	kJ/m3
0	0	2.544	1.144	2.544					
9	0.05	2.539	1.140	2.541	866	0.0016	2.08E-04	3.23E-08	0.008
18	0.04	2.535	1.137	2.537	346	0.0039	1.69E-04	6.54E-08	0.029
35	0.11	2.524	1.128	2.530	694	0.0020	2.49E-04	4.77E-08	0.142
69	0.18	2.507	1.113	2.515	540	0.0025	2.03E-04	4.94E-08	0.506
143	0.33	2.474	1.085	2.490	960	0.0014	1.77E-04	2.37E-08	1.900
285	1.35	2.339	0.972	2.406	2160	0.0006	3.73E-04	1.70E-08	12.371
570	1.22	2.217	0.869	2.278	1382	0.0008	1.68E-04	1.31E-08	34.682
1140	0.77	2.140	0.804	2.178	577	0.0017	5.32E-05	9.09E-09	64.384
2279	0.79	2.060	0.737	2.100	540	0.0017	2.73E-05	4.64E-09	127.655
1140	-0.06	2.066	0.742	2.063					
285	-0.23	2.090	0.762	2.078					
69	-0.27	2.117	0.785	2.103					
18	-0.33	2.150	0.812	2.133					
9	-0.12	2.161	0.822	2.156					

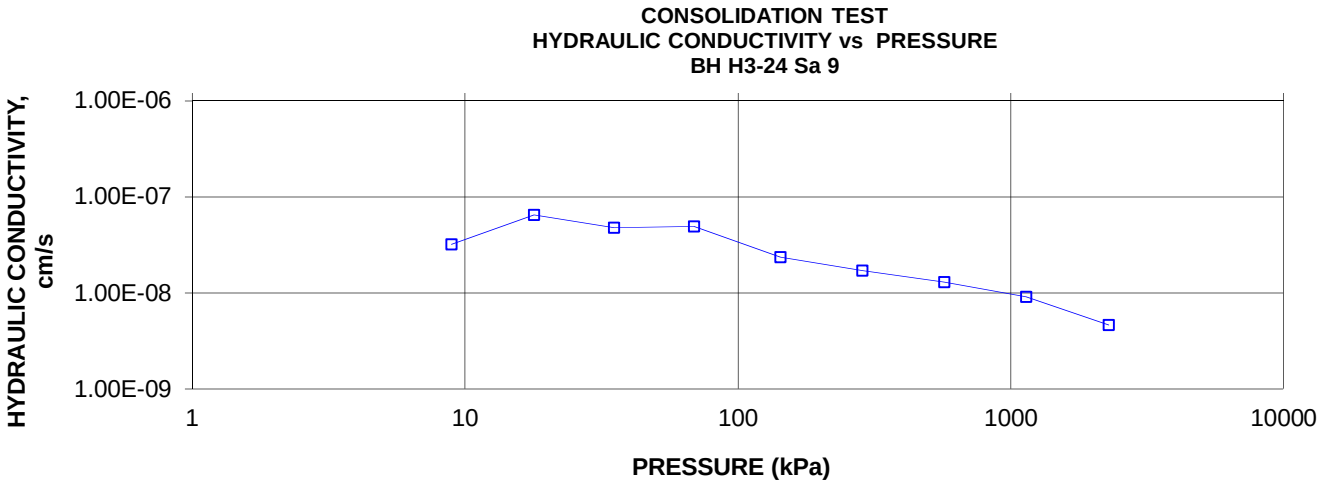
Note:
k calculated using c_v based on t_{90} values.

SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	2.161	Unit Weight, kN/m^3	18.79
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m^3	14.88
Area, cm^2	31.70	Specific Gravity, Measured	2.76
Volume, cm^3	68.52	Solids Height, cm	1.186
Water Content, %	26.33	Volume of Solids, cm^3	37.60
Wet Mass, g	131.31	Volume of Voids, cm^3	30.92
Dry Mass, g	103.94		

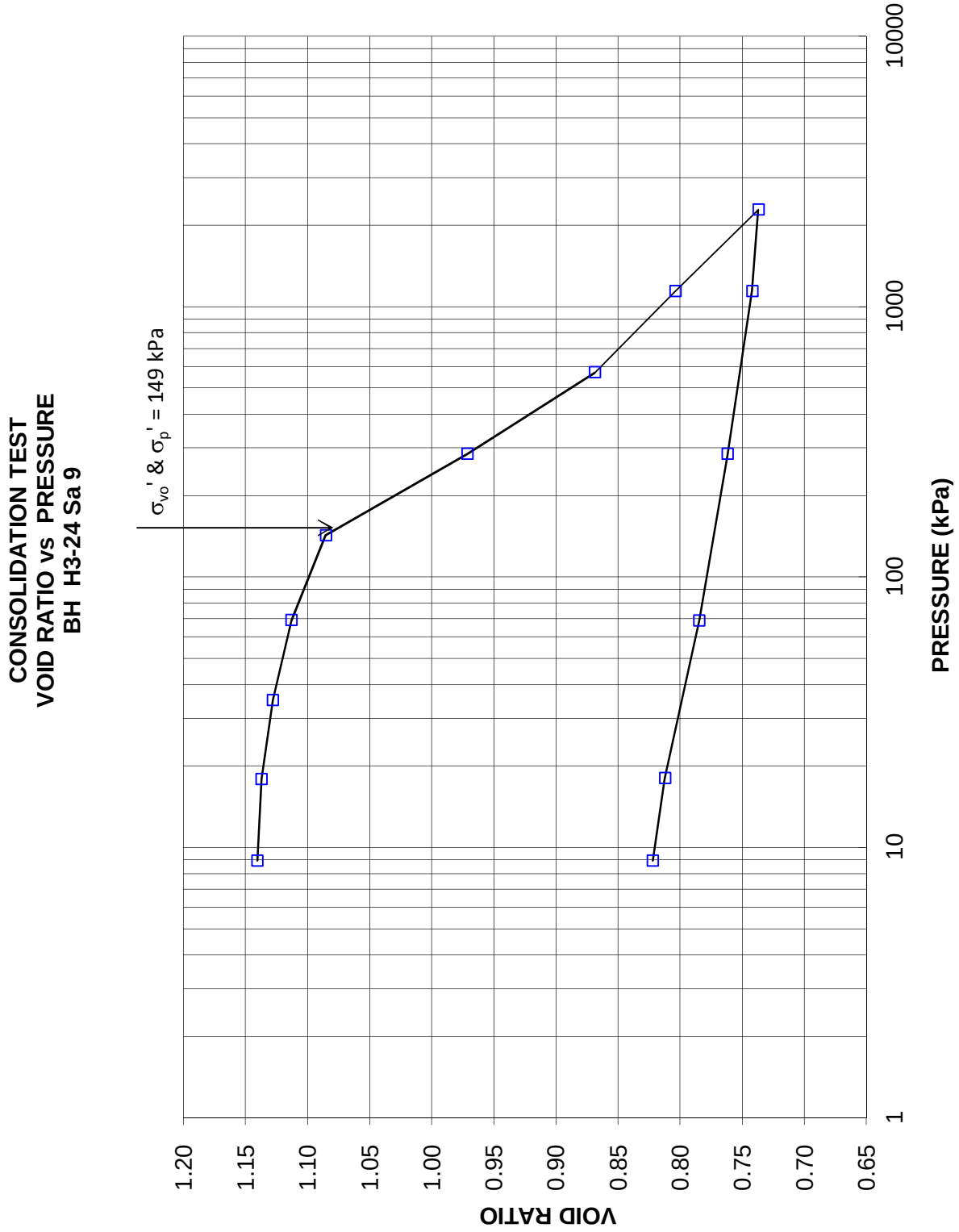

CONSOLIDATION TEST
CV cm²/s VS PRESSURE (kPa)
BH H3-24 Sa 9
COEFFICIENT OF CONSOLIDATION, cm²/s
0.1000
0.0100
0.0010
0.0001
1
10
100
1000
10000
PRESSURE (kPa)


CONSOLIDATION TEST
MV m²/kN vs PRESSURE (kPa)
BH H3-24 Sa 9
VOLUME COMPRESSIBILITY, m²/kN
1.00E-03
1.00E-04
1.00E-05
1
10
100
1000
10000
PRESSURE (kPa)


CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs PRESSURE
BH H3-24 Sa 9
HYDRAULIC CONDUCTIVITY, cm/s
1.00E-06
1.00E-07
1.00E-08
1.00E-09
1
10
100
1000
10000
PRESSURE (kPa)

CONSOLIDATION TEST
VOID RATIO VS LOG PRESSURE

FIGURE C17
Pg. 3 of 4



Project No. 11-1191-0007

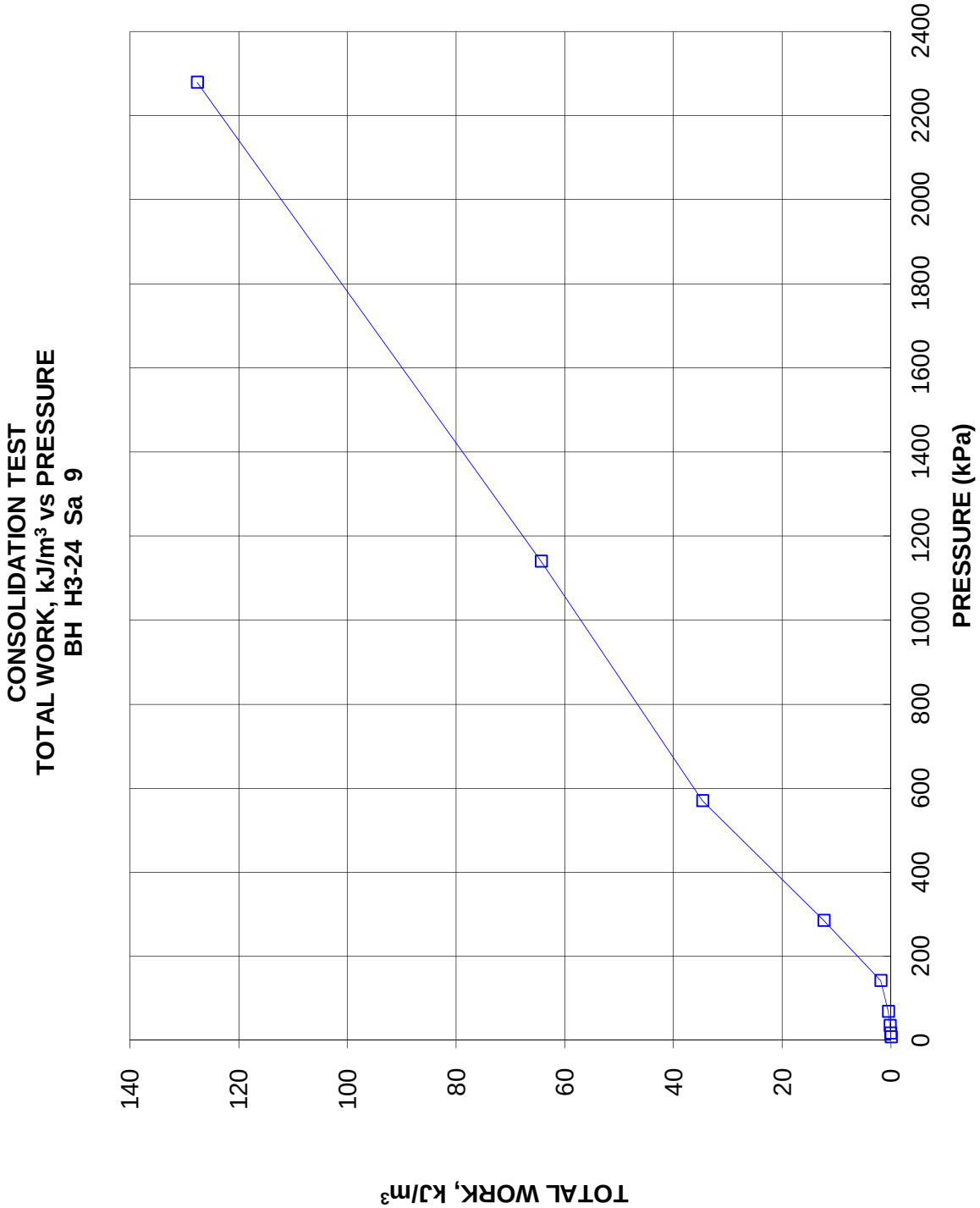
Prepared By: TG

Golder Associates

Checked By:

CONSOLIDATION TEST
TOTAL WORK VS PRESSURE

FIGURE C17
Pg. 4 of 4

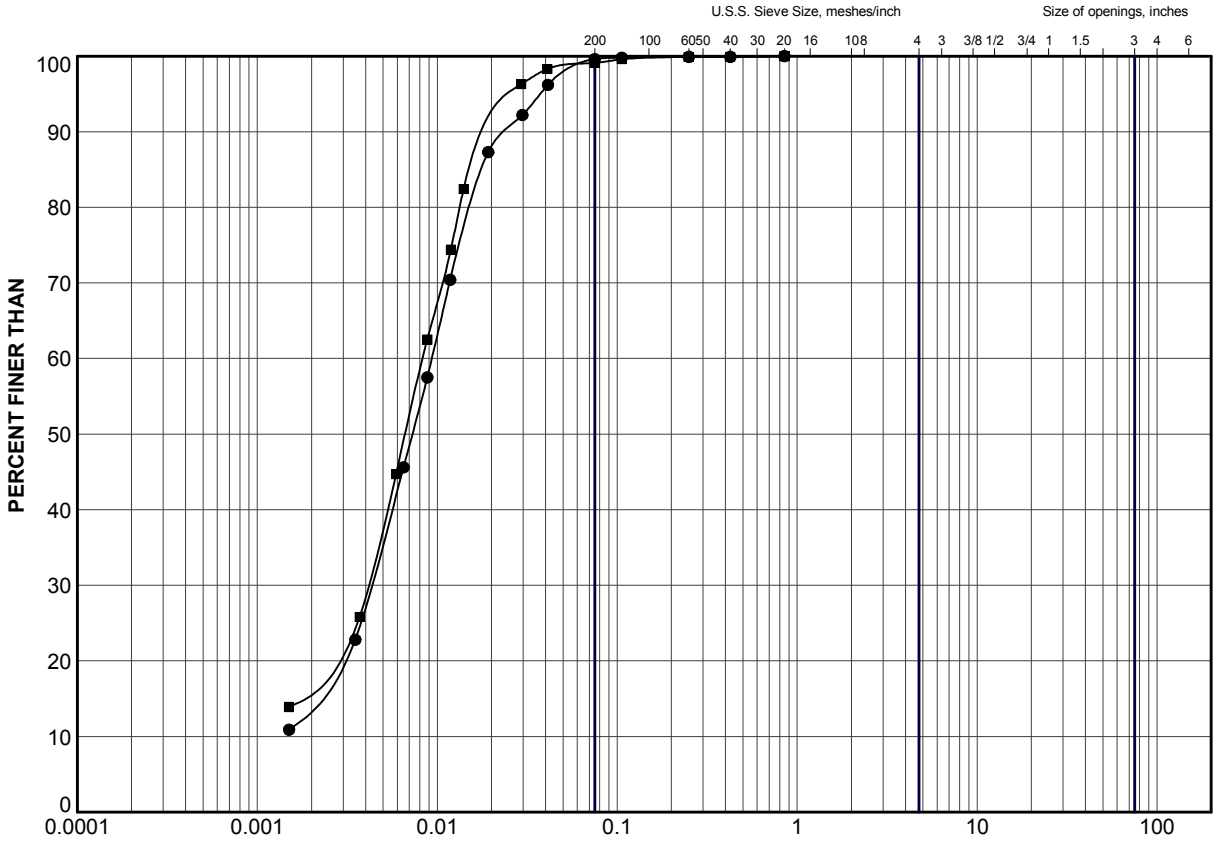


Project No: **11-1191-0007**

Prepared By: TG

Golder Associates

Checked By:



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H3-14	8	237.1
■	H3-25	13	223.6

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (EBL)

TITLE

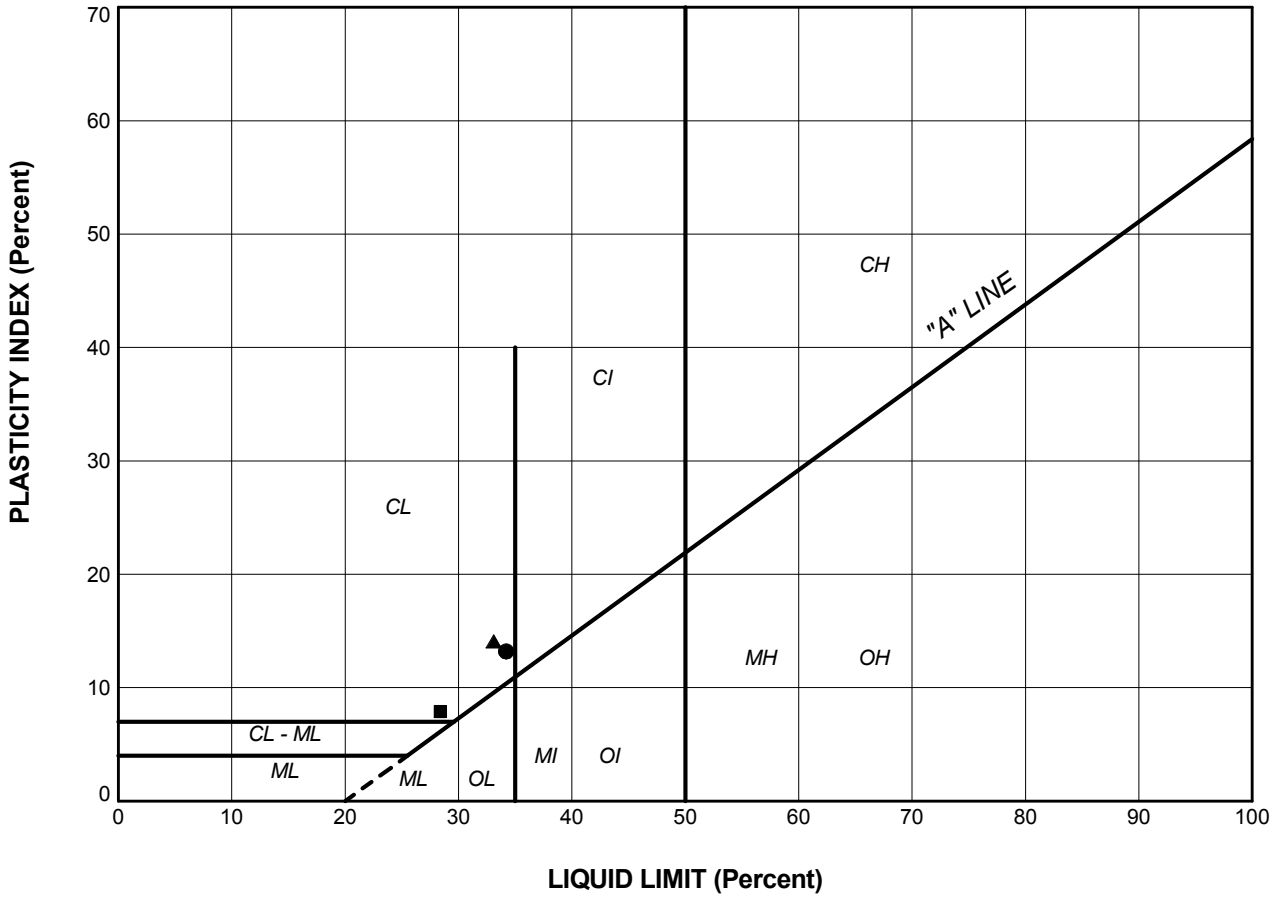
GRAIN SIZE DISTRIBUTION

CLAYEY SILT to SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	TB	Nov 2013	SCALE	N/A	REV.
CHECK	SEMC	Nov 2013			
APPR		Nov 2013	**FIGURE C18**		

SUD-MTO GSD (NEW) GLDR_LDN.GDT



SOIL TYPE
C = Clay
M = Silt
O = Organic

PLASTICITY
L = Low
I = Intermediate
H = High

LEGEND

SYMBOL	BOREHOLE	SAMPLE	LL(%)	PL(%)	PI
●	H3-21	12	34.2	21.0	13.2
■	H3-25	13	28.4	20.5	7.9
▲	H3-26	12	33.1	19.0	14.1

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (EBL)

TITLE

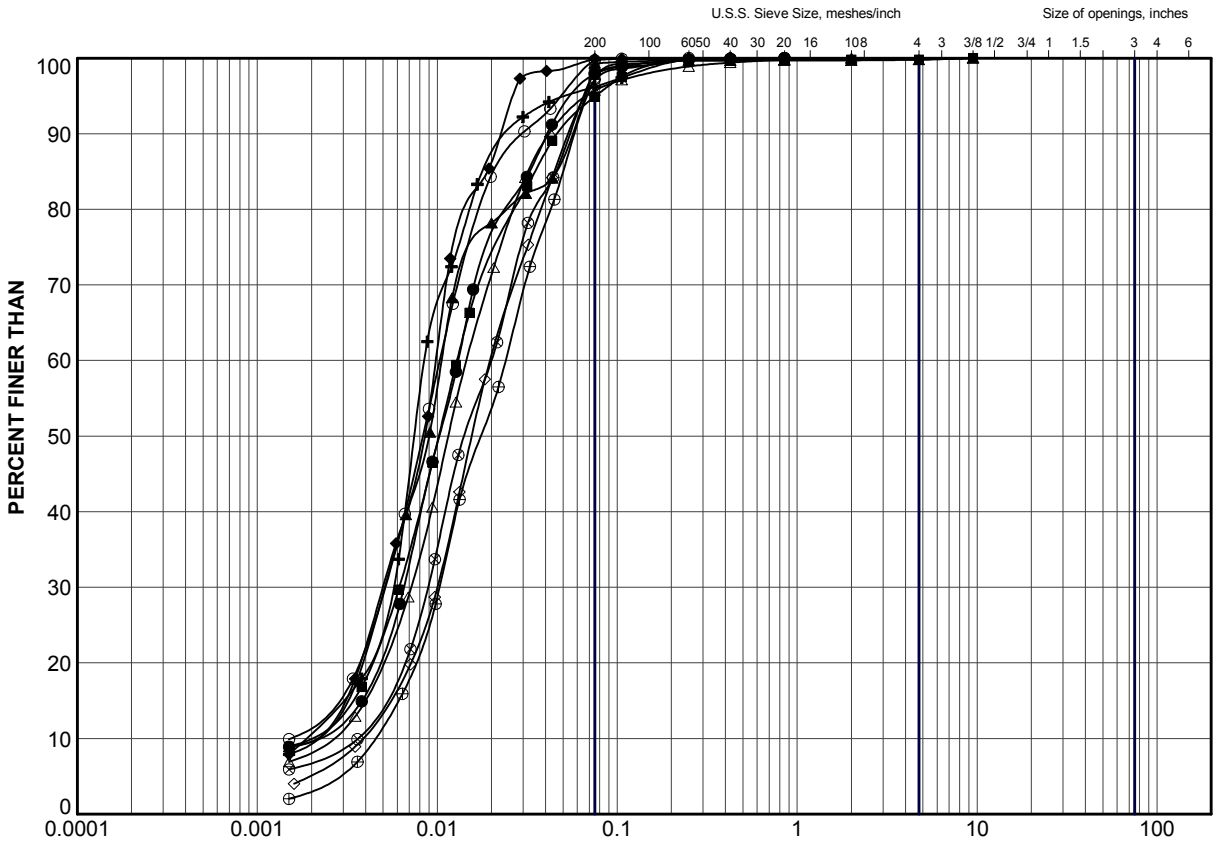
PLASTICITY CHART

CLAYEY SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMC	Nov 2013		
APPR		Nov 2013	**FIGURE C19**	

SUD-MTO PL (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H3-16	12	230.9
■	H3-17	11	230.8
▲	H3-18	12	229.7
✚	H3-19	11	228.0
◆	H3-20	12	227.2
◇	H3-21	14	222.8
○	H3-22	14	223.9
△	H3-22	16	220.8
⊗	H3-24	14	222.2
⊕	H3-26	14	222.2

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (EBL)

TITLE

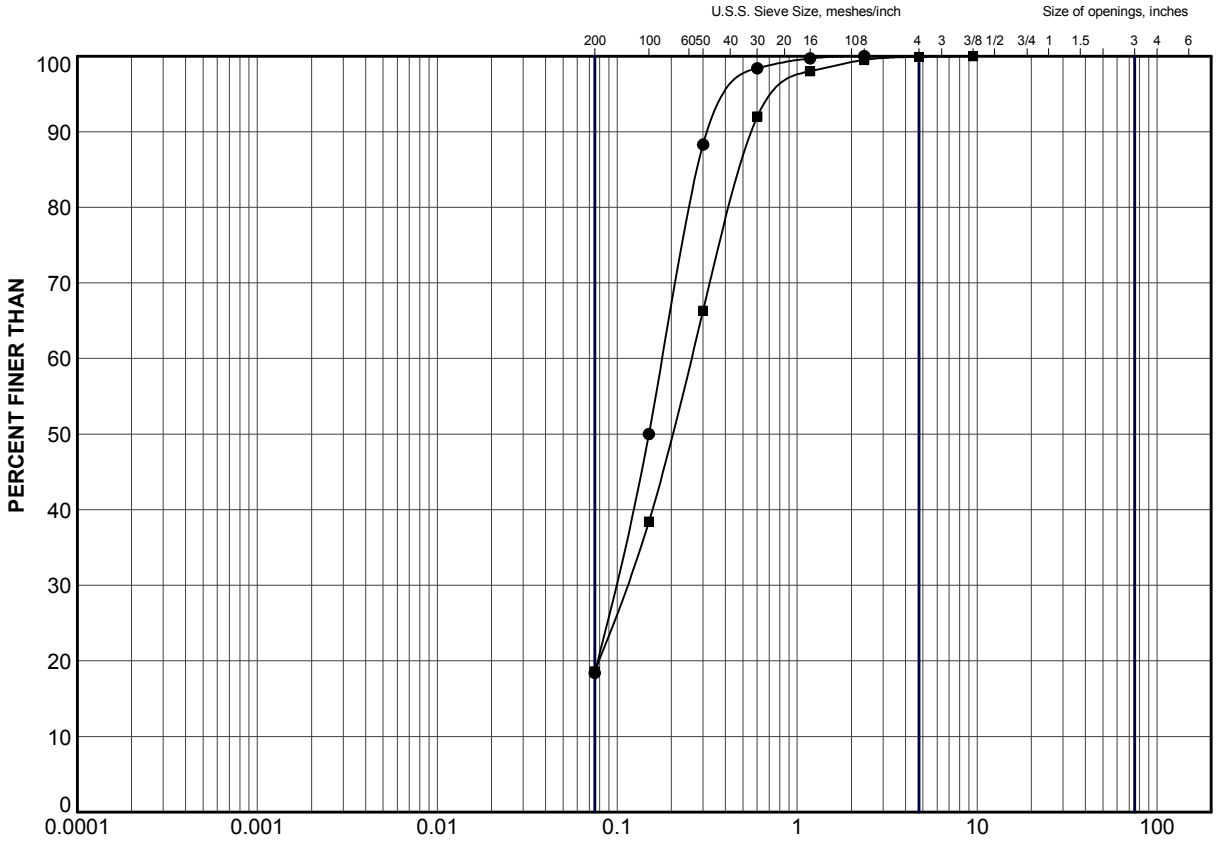
GRAIN SIZE DISTRIBUTION

SILT

Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ
DRAWN	TB	Nov 2013	SCALE N/A	REV.
CHECK	SEMC	Nov 2013		
APPR		Nov 2013	**FIGURE C20**	

SUD-MTO GSD (NEW) GLDR_LDN.GDT



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEV (m)
●	H3-15	10	232.1
■	H3-19	14	223.4

PROJECT

HIGHWAY 17
STA 13+900 TO 14+200 (EBL)

TITLE

GRAIN SIZE DISTRIBUTION

SAND

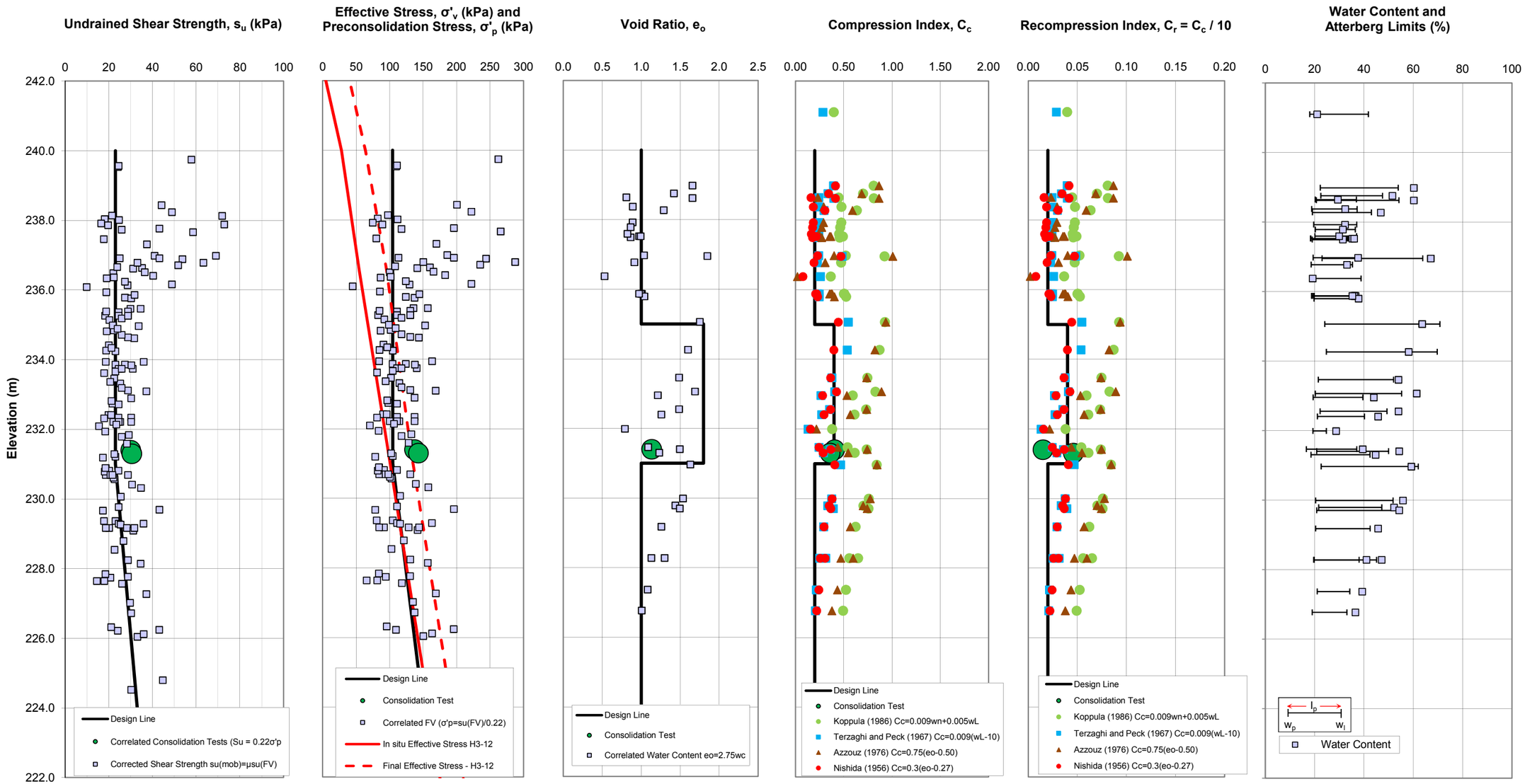
Golder Associates
SUDBURY, ONTARIO

PROJECT No.	11-1191-0007		FILE No.	11-1191-0007.GPJ	
DRAWN	TB	Nov 2013	SCALE	N/A	REV.
CHECK	SEMC	Nov 2013			
APPR		Nov 2013	**FIGURE C21**		

SUD-MTO GSD (NEW) GLDR_LDN.GDT

SUMMARY PLOT OF ENGINEERING PARAMETERS FOR COHESIVE DEPOSITS
Highway 17 - STA 13+900 to 14+200 Township of Denison (H3)

FIGURE C22



Date: May 2014
Project No: 11-1191-0007

Prepared By: EC
Checked By: SEMP

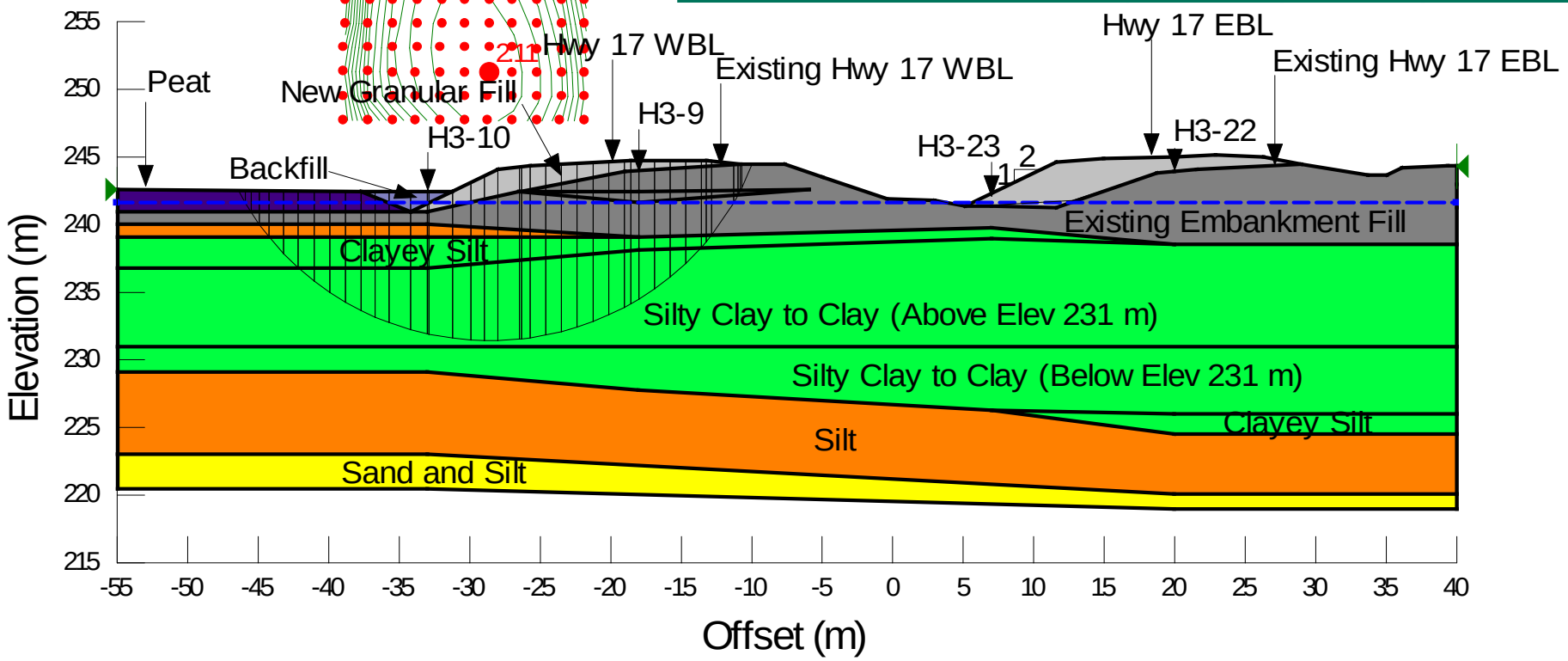
Golder Associates

https://capws.golder.com/sites/capws2/P111910007mtoHwy17FourLaningSudbury/Phases and Tasks/Analysis/[11-1191-0007-Parameters and Design Lines.xlsx]Swamp H3 Plots - Final

Stability Analysis
STA 14+100 – WBL – North Side

Figure C23

Material Name	Unit Weight (kN/m³)	Cohesion (kPa)	Friction Angle (degrees)
New Granular Fill	21	-	35
Existing Embankment Fill (Granular)	21	-	33
Existing Embankment Fill (Cohesive)	20	-	30
Peat	12	1	27
Backfill	12	1	27
Silty Clay to Clay (Above Elev 231 m)	18.2	23	-
Silty Clay to Clay (Below Elev 231 m)	18.2	23 – 33	-
Silt	18	-	28
Sand and Silt	18	-	28



Date: July 6, 2015
Project No. 11-1191-0007

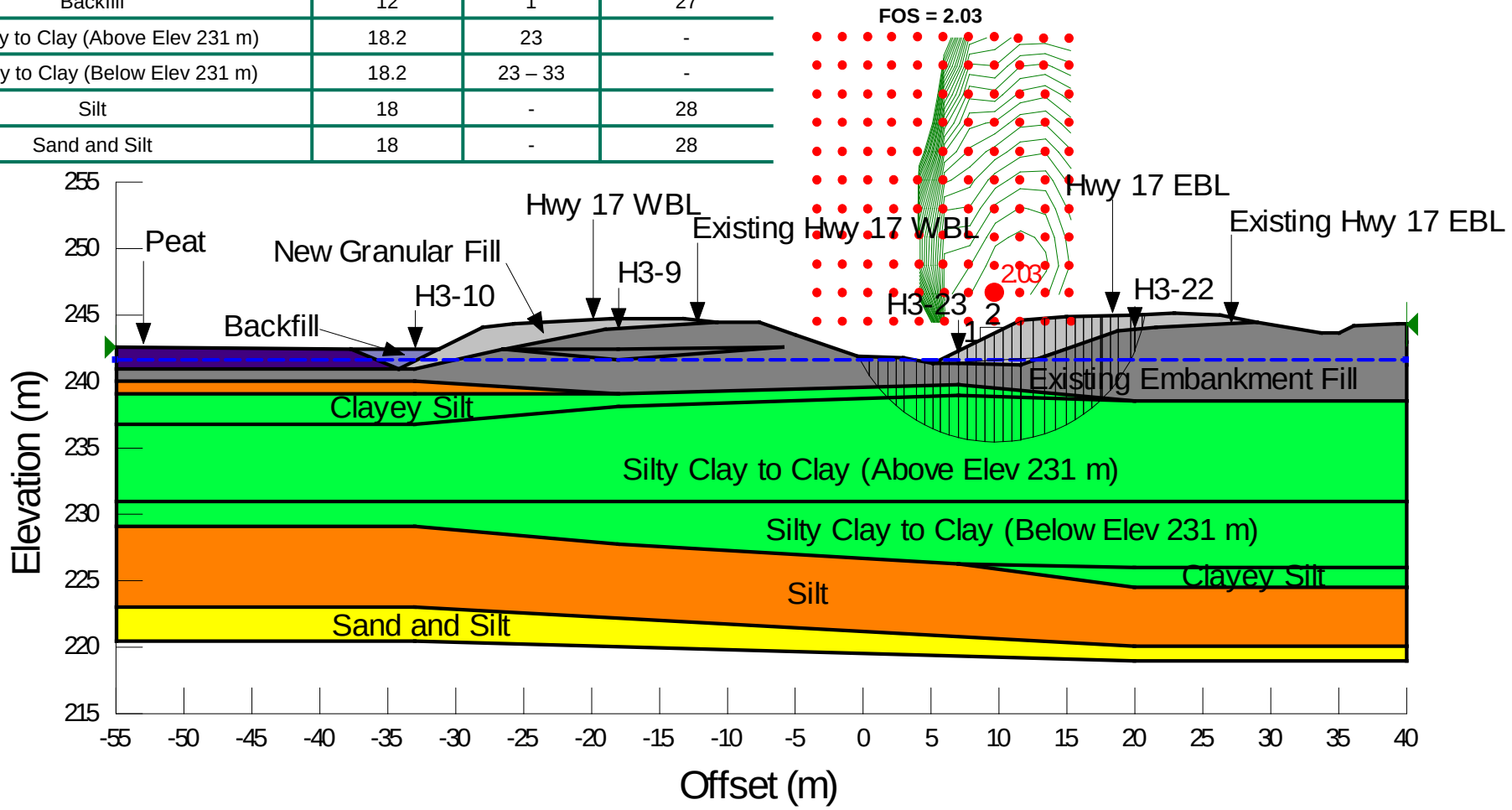
Analysis By: AC **Reviewed By:** SEMP

Golder Associates

Stability Analysis
STA 14+100 – EBL – North Side

Figure C24

Material Name	Unit Weight (kN/m³)	Cohesion (kPa)	Friction Angle (degrees)
New Granular Fill	21	-	35
Existing Embankment Fill (Granular)	21	-	33
Existing Embankment Fill (Cohesive)	20	-	30
Peat	12	1	27
Backfill	12	1	27
Silty Clay to Clay (Above Elev 231 m)	18.2	23	-
Silty Clay to Clay (Below Elev 231 m)	18.2	23 – 33	-
Silt	18	-	28
Sand and Silt	18	-	28



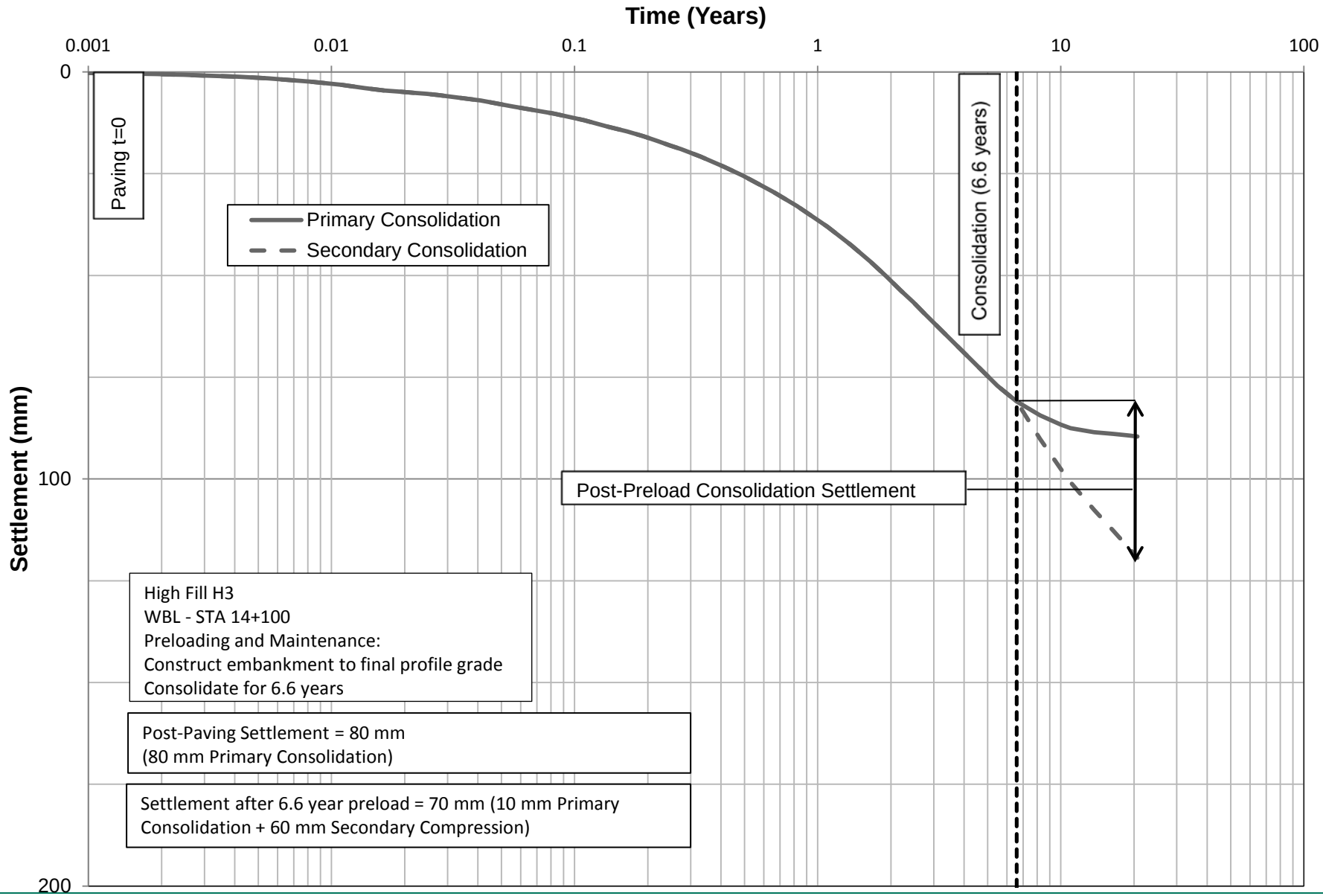
Date: July 6, 2015
Project No. 11-1191-0007

Analysis By: AC **Reviewed By:** SEMP

Golder Associates

Settlement Analysis
STA 14+100 – WBL
Settlement vs. log Time – Consolidation and Maintenance

Figure C25



Date: July 6, 2015
Project No. 11-1191-0007

Analysis By: AC **Reviewed By:** SEMP

Golder Associates

APPENDIX D

NON-STANDARD SPECIAL PROVISIONS AND OPERATIONAL CONSTRAINTS

EXCAVATION OF ORGANICS – Item No.

Non-Standard Special Provision

Scope

This non-standard special provision outlines the procedures(s) to be used for excavating organic deposits at the following areas:

- Highway 17 EBL/WBL – STA 12+220 to 12+570 (High Fill H1)
- Highway 17 EBL/WBL – STA 13+140 to 13+390 (High Fill H2)
- St. Pothier Road – STA 9+400 to 9+600 (High Fill H2)
- Highway 17 EBL/WBL – STA 13+900 to 14+200 (High Fill H3)

The excavation procedures to be followed are:

- Work may be carried out simultaneously starting from both ends of the swamp and progressing towards the centre along the embankment footprint;
- Removal of the organic deposits and backfilling of the excavation shall be carried out simultaneously in accordance with OPSS 209. The limits of the removal of organics is described elsewhere in the Contract Documents.

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.

RIGID EXPANDED POLYSTYRENE EMBANKMENT FILL - Item No. 46

Special Provision

1. SCOPE

This special provision covers the requirements for the supply and construction of the rigid expanded polystyrene backfill and associated works as shown on the Contract Drawings.

As part of the work under this item, the Contractor shall supply and place 100 mm of mortar sand, polyethylene sheeting, and reinforced concrete top slab above the EPS at the abutments as shown on the Contract Drawings.

2. REFERENCES

This special provision refers to the following standards, specifications or publications.

National Standards of Canada

CAN/CGSB - 51.20 M87

ASTM

ASTM D1621 Test Method for Compressive Properties of Rigid Cellular Plastics

ASTM C203 Test Method for Breaking Load and Flexural Properties of Block Type Thermal Insulation

ASTM C177 Test Method for Steady State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Apparatus

ASTM D2842 Test Method for Water Absorption by Rigid Cellular Plastics

ASTM D2863 Test Method for Measuring the Minimum Oxygen Content

ASTM D2126 Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging

OPSS - Ontario Provincial Standard Specification

OPSS 212 Borrow

OPSS 501 Compaction

OPSS 517 Dewatering

OPSS 904 Concrete in Approach Slabs

OPSS 1010 Aggregates – Granular A,B,M, and Selected Subgrade Material

OPSS 1605 Expanded Extruded Polystyrene Pavement Insulation

OPSS 1860 Geotextiles

3. SUBSURFACE CONDITIONS

The subsurface conditions at the site are described in the Foundation Investigation Report for this Contract.

4. DEFINITIONS

For the purpose of this special provision, the following definitions apply:

Rigid Expanded Polystyrene

Molded rigid blocks produced by a process of pre-expansion, aging and forming of petroleum based raw material.

Rigid Extruded Expanded Polystyrene

Rigid boards made by extrusion of expanded polystyrene beads.

Production Lot

The quantity of rigid polystyrene blocks produced in a continuous period of manufacturing the same grade and thickness of product within the same production day.

Quality Verification Engineer

An Engineer with a minimum of five (5) years experience related to the design and/or construction of expanded polystyrene systems of similar scope to that in the Contract, or alternatively has demonstrated expertise by providing satisfactory quality verification services for the work at a minimum of two (2) projects of similar scope to the Contract. The Quality Verification Engineer shall be retained by the Contractor to ensure conformance with the contract documents and issue of certificate(s) of conformance.

5. QUALIFICATION

The Contractor shall have on site at the commencement of the work, a representative of the supplier of the rigid expanded polystyrene to advise on recommended construction procedure.

The Contractor shall maintain liaison with the supplier throughout the construction of the embankment for advice and guidance as required. Periodic site visits by the supplier should be coordinated as required.

6. SUBMISSION AND DESIGN REQUIREMENTS

6.1 Submission of Shop Drawings

At least three weeks before the commencement of work, the Contractor shall submit to the Contract Administrator six copies of the shop drawings and method statement signed and sealed by the Quality

Verification Engineer that provides full details of materials and construction procedure.

6.2 Delivery, Storage, Handling and Protection

The Contractor shall submit the method of delivery, storage, handling and protection from damage by weather, traffic, construction staging and other causes as per the rigid expanded polystyrene manufacturers' requirement.

6.3 Construction

The contractor shall submit full details of the following:

a. The method of foundation excavation and preparation.

b. Construction of leveling/drainage layer (granular base and mortar sand) as shown on the Contract Drawings.

c. The method of placement of expanded polystyrene blocks including temporary ballasting and protection of blocks during installation. The shop drawings shall indicate laying pattern and block dimensions on a layer by layer basis.

d. The method and limits of placement of polyethylene sheeting.

e. The method of placement of the reinforced 30MPa concrete top slab.

f. The method of placement of subbase material.

g. The method of placement of side slope cover.

6.4 Quality Verification Engineer

1. The Contractor shall submit details of the sequence and method of installation to the Quality Verification Engineer for review. The submittals shall satisfy the specifications and at a minimum include a detailed description of proposed installation procedures. The details shall be submitted at least three weeks prior to the installation of the rigid expanded polystyrene embankments. The Contractor shall also submit to the Contract Administrator, for information purposes, details of the sequence and method of installation. The submittals shall satisfy the specifications and at a minimum contain the above information as provided to the Contractor's Quality Verification Engineer.

2. The Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by the Quality Verification Engineer a minimum of one week prior to commencement of work under this item. The Certificate shall state that the installation procedures are in conformance with the requirements and specifications of the contract documents. Quality test certificates for each production lot supplied, showing compliance with all requirements of this special provision shall be obtained by the Contractor and submitted to the Contract Administrator prior to installation. Upon completion of the Expanded Polystyrene Backfill the Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by the Quality Verification Engineer stating that the Expanded Polystyrene Embankment has been constructed in

conformance with the installation procedures and specifications of the contract documents.

7.0 MATERIALS

7.1 Granular Leveling Pad

The leveling pad shall consist of mortar sand with gradation and physical requirements as specified in OPSS 1004.

7.2 Rigid Expanded Polystyrene

7.2.1 General

7.2.1.1 The Contractor shall submit:

1. A general statement as to the type, composition, and method of production of the material.

2. The manufacturer's name, address, phone number, identification of a contact person and description of experience background in the manufacturing of the rigid expanded polystyrene.

3. Certification of compliance of physical and mechanical properties.

4. An identification of a laboratory accredited by the Standards Council of Canada to conduct the testing of the physical and mechanical properties of the rigid expanded polystyrene.

5. The physical and mechanical properties of the rigid expanded polystyrene including:

    1) Geometry
    2) Nominal Density
    3) Compressive Strength
    4) Flexural Strength
    5) Thermal Resistance
    6) Dimensional Stability
    7) Flammability
    8) Water Absorption

6. Aging and durability characteristics of the polystyrene including the chemical, biological and ultra-violet degradation resistance of the rigid polystyrene.

7. A sample of the expanded polystyrene material to the Quality Verification Engineer for review.

8. To the Contract Administrator a Certificate of Conformance sealed and signed by the Quality Verification Engineer a minimum of one week prior to commencement of work under this item. The Certificate shall state that the expanded polystyrene material is in conformance with the requirements and specifications of the contract documents.

7.2.1.2 Production Lots

Each block of the same production lot shall be stamped with the same production code showing plant

identification, type and date of production. The polystyrene shall be free from defects affecting serviceability.

7.2.2 Detail Requirements

Requirements shall be as shown in Table 1 and as described below.

Table 1 – Material Properties

Property	**Unit**	**Requirements**	**Test Procedure**
Geometry - Linear - Flatness - Squareness - Thickness	mm	1200 x 600 x 300 with tolerances ± 1% 10 mm in 3 m ± 0.5% -3, +5	
Compressive Strength	kPa (min)	115	ASTM D1621 (Procedure A)
Flexural Strength	kPa (min)	240	ASTM C203
Dimensional Stability	% linear change (max)	1.5	ASTM D2126
Thermal Resistance	$m^2.^oC/W$ (min for 25 mm thickness)	0.7	ASTM C177 or C518
Flammability	Limiting Oxygen Index (min)	24	ASTM D2863
Water Absorption	% by Volume (max)	4	ASTM D2842

7.2.2.1 Geometry

The expanded polystyrene shall be supplied in the form of rectangular parallel blocks of minimum acceptable dimensions of 1200 mm x 600 mm x 300 mm .

The maximum deviation from the specified linear dimensions shall be ± 1%. The flatness of the block faces

shall be within ± 10 mm of a line formed by a 3 m straight edge.

The maximum difference in corner to corner dimensions (squareness) shall be 0.5%. The thickness shall be within –3 to +5 mm.

7.2.2.2 Compressive Strength

The minimum compressive strength, measured in accordance with ASTM D1621, Procedure A, shall be 115 kPa at a strain of not more than 5%. The maximum permissible permanent stress level should not exceed 30% of the compressive strength of the material at 5% strain.

7.2.2.3 Flexural Strength

The minimum flexural strength of the polystyrene shall be 240 kPa. The flexural strength shall be

determined in accordance to ASTM C203, method 1, Procedure B.2.7.4.

7.2.2.4 Dimensional Stability

Dimensional Stability shall be determined in accordance with ASTM D2126, Procedure G. A tolerance of 1.5% shall be satisfied.

7.2.2.5 Thermal Resistance

The thermal resistance shall be 0.7 $m^2.^oC/W$ for a 25 mm thickness using the following equation and using the average value from three specimens:

$$R_{25mm} = \frac{R_{measured}}{\text{thickness (mm)}} \quad x25$$

The thermal resistance shall be measured in accordance with ASTM C177 or C518.

7.2.2.6 Flammability

The expanded polystyrene shall be classified as to surface burning characteristics in accordance with CAN/ULC - 51022 having a flame spread rating less then 500. The expanded polystyrene shall have a minimum limiting oxygen index measured in accordance with ASTM D2863

7.2.2.7 Water Absorption

The water absorption as measured by ASTM D2842 shall be limited to 4% by volume.

7.2.2.8 Chemical Resistance

The expanded polystyrene shall be resistant to common inorganic acids and alkalies. A table identifying the chemical resistance as either resistant, limited, or not resistant shall be submitted.

7.2.2.9 Biological Resistance

The expanded polystyrene shall be resistant to biological degradation caused by organisms or enzymes.

7.2.2.10 Environmental

The expanded polystyrene shall be inert, non-nutritive and highly stable and shall not produce undesirable gases or leachate.

7.3 Polyethylene Sheeting

The plastic sheeting shall be 6 mil polyethylene sheeting or equivalent.

7.4 Concrete Top Slab

The concrete top slab shall consist of 30 MPa reinforced concrete as shown on the Contract Drawings.

8.0 DELIVERY, STORAGE AND HANDLING

The product shall be suitably marked to identify its type, number and the manufacturer's name or trademark.

The Contractor shall protect the expanded polystyrene from exposure to sunlight to avoid ultraviolet degradation as per manufacturer's recommendation.

Protection of materials and works from damage by weather, traffic, construction staging, fire or vandalism and other causes shall be the responsibility of the Contractor.

9.0 CONSTRUCTION

9.1 Foundation Excavation

Foundation excavation shall be carried out to the design elevations shown on the drawings as earth excavation or excavation for structure. Any softened, loosened or deleterious materials at the foundation footing elevation shall be subexcavated and replaced with Granular 'A' or Granular 'B' Type II material in accordance with OPSS 1010.

9.2 Leveling Pad

Place, level and compact a 100 mm thick layer of mortar sand material in accordance with OPSS 501 to within ± 30 mm of the design elevation. The leveling pad shall not deviate by more than 10 mm at any place on a 3 m straight edge over the limits of the bottom course of blocks. The leveling pad shall not be placed on frozen ground. The leveling pad must be placed in-the-dry.

9.3 Installation of Blocks

(1) The individually marked blocks shall be placed on the prepared leveling pad. The top surface of the first layer of blocks is to be set plane and level. Local trimming of the blocks may be necessary. Contractor shall ensure all trimmed material is disposed of in accordance with all applicable regulations and that no trimmed debris enters the watercourse.

(2) Subsequent successive layers shall be oriented with the long axis of blocks positioned at 90º to the previous layer in order to avoid continuous joints. Block joints shall be offset and staggered between layers except at the vertical construction joints.

(3) A continuous check shall be kept to ensure the evenness of the blocks is satisfactory in each layer. Blocks shall be laid with joints with maximum opening of 10 mm between blocks. Differences in heights between adjacent blocks in the same layer should not exceed 5 mm.

(4) Sloping end adjustments at the abutments shall be accomplished by leveling terraces in the subsoil in accordance with the block thickness.

(5) Temporary ballast shall be provided as necessary to prevent movement of expanded polystyrene both in storage and as placed due to windy conditions. Timber fasteners or equivalent shall be used as necessary.

(6) The expanded polystyrene embankment shall be protected from accidental ignition due to welding, smoking, grinding or cutting tools, etc. The Contractor shall take all necessary precautions to prevent ignition of the expanded polystyrene.

(7) The expanded polystyrene shall be protected from organic solvents and other aggressive, harmful chemicals during construction. The proposed method of protection during construction shall be submitted to the Contractor's Quality Verification Engineer for review and to the Contract Administrator for information purposes.

(8) Exposed blocks shall be covered immediately to avoid possible burrowing by animals.

(9) Individually marked blocks shall be fabricated and placed to ensure the top surface matches the elevation and crossfall shown on the drawings.

(10) The top surface and side surfaces of the expanded polystyrene shall be covered with 6 mil polyethylene sheeting extending onto adjacent work at the longitudinal ends of the embankment. All joints shall be lapped a minimum of 300 mm to provide a fully sealed enclosure.

9.4 Concrete Top Slab

The concrete top slab shall be poured after the polyethylene sheeting is fixed in place. Place 125 mm thick layer of concrete in accordance with OPSS 904 to within ± 30 mm of the design elevation.

9.5 Backfill

Backfill over the top of the concrete slab and on the sides of the embankment shall be as shown on the Contract Drawings.

10. EQUIPMENT

All cutting of polystyrene materials shall be by electric equipment or by hand.

Heavy equipment shall be limited in weight and size and restricted in operation to avoid damaging the expanded polystyrene as per the manufacturer's requirement.

11. QUALITY ASSURANCE

11.1 General

The Contract Administrator may undertake an independent testing program of the expanded polystyrene. Sampling and testing will be carried out in conformance with the relevant test procedure. The physical and thermal property testing identified in Table 1 will be conducted. The testing shall be conducted by a recognized testing laboratory accredited by the Standards Council of Canada.

11.2 Sampling Frequency

Sufficient sample material shall be obtained from blocks randomly selected by the Contract Administrator from each production lot as soon as the material arrives on site. At a minimum, three blocks shall be tested.

11.3 Acceptance/Rejection

Failure of any one of the sample blocks to comply with any requirements of this special provision shall be cause for rejection of the production lot from which it was taken. Replacement of the blocks shall be at the Contractor's expense.

12. MEASUREMENT FOR PAYMENT

12.1 Actual Measurement

Measurement will be by volume in cubic metres of rigid expanded polystyrene backfill material measured in its original position based on theoretical dimensions.

13. PAYMENT

13.1 Basis of Payment

Payment at the contract price for the above tender item shall be full compensation for all labour, materials and equipment to do the work as described above.

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Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Ltd.
1010 Lorne Street
Sudbury, Ontario, P3C 4R9
Canada
T: +1 (705) 524 6861

Golder Associates