REPORT

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April 11, 2016

FOUNDATION INVESTIGATION AND DESIGN REPORT

SWAMP CROSSINGS - PHASE 2
HIGHWAY 69 FOUR-LANING
FROM 1.0 KM NORTH OF THE NEW HIGHWAY 559 INTERCHANGE NORTHERLY TO 1.5 KM NORTH OF HIGHWAY 7182 (SHEBESHEKONG ROAD) FOR 17 KM
MINISTRY OF TRANSPORTATION, ONTARIO
G.W.P. 5111-07-00 (PHASE 2 OF G.W.P. 5402-05-00)

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Golder Associates

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FOUNDATION INVESTIGATION REPORT

SWAMP CROSSINGS – PHASE 2

HIGHWAY 69 FOUR-LANING

FROM 1.0 KM NORTH OF THE NEW HIGHWAY 559 INTERCHANGE NORTHERLY TO 1.5 KM NORTH OF HIGHWAY 7182 (SHEBESHEKONG ROAD) FOR 17 KM

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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by McCormick Rankin (MRC), a member of MMM Group Limited on behalf of Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for four (4) swamp crossings within the Phase 2 limits of the new Highway 69 alignment. The proposed work is part of the detail design for the four-laning of Highway 69 from 1.0 km north of the new Highway 559 Interchange northerly to 1.5 km north of Highway 7182 (Shebeshekong Road), which involves high fill embankments and embankments over swamps, the New Woods Road and Shebeshekong Road interchanges and structures, the Shawanaga River and Site 9 Road structures, the Shebeshekong Road Overpass structures, as well as culvert crossings. The Phase 2 limits of the project extend from 3 km north of the existing Woods Road to 6.1 km north of Highway 7182 (Shebeshekong Road). The general location of this section of the Highway 69 four-laning alignment is shown 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 January 2007. Golder's original proposal for foundation engineering services associated with the Phase 2 swamp crossings is contained in Section 6.8 of MRC's Technical Proposal for this assignment. Golder's additional scope of work for the crossings at Swamp 25 and Swamp 26 is contained in Addendum No. 7, dated February 14, 2013. The work has been carried out in accordance with Golder's Supplemental Specialty Quality Control Plan for foundation engineering services for this project, dated July 4, 2007. The General Arrangement (GA) drawing for the proposed new alignment of Highway 69 was provided to Golder by MRC on March 4, 2009 and May 15, 2015.

This report addresses the investigation carried out for the crossings at Swamp 23 to Swamp 26within the Phase 2 limits. A detailed list of the crossings at Swamp 23 to Swamp 26 Phase 2 is presented in Table 1. Separate reports address the foundation investigations for the Phase 1 swamp crossings and high fill areas, as well as for the culverts and the bridge structures for Phase 1 and 2 components of the project. It should be noted that the crossings at Swamp 18 to Swamp 22 within the Phase 2 limits have been report in the Swamp Crossings and High Fill Areas – Phase 1 report, Geocres No. 41H-73, dated November 2011.

The purpose of this investigation is to establish the subsurface conditions along the roadway alignment at the proposed Phase 2 swamp crossings by borehole drilling, rock coring, in situ testing and laboratory testing on selected samples. The swamp limits were located in the field by Callon Dietz Inc. (Callon Dietz), a professional surveying company retained by MRC. The investigation areas are shown in plan on Drawing 2.

2.0 SITE DESCRIPTION

The section of the new highway alignment being addressed by this report begins approximately 19 km northwest of Nobel, Ontario. Re-aligned and/or newly proposed highways and access / service roads associated with the four-laning of the new Highway 69 in this phase of the project include Shebeshekong Road, the adjoining ramps for the proposed Shebeshekong Road underpass (interchange) and overpass structures and Site No. 9 Road northerly from the interchange. The new four-lane Highway 69 alignment is oriented generally in a southeast-northwest direction with the Phase 2 project limits located within the Shawanaga Township.

In general, the topography in the area of the overall project limits consists of rolling terrain including densely treed areas and numerous bedrock outcrops separated by low-lying swamps containing areas of standing water and various vegetation types and organic soils. The ground surface within the investigated limits of the Phase 2 swamp crossings varies between about Elevation 201.7 m and 213.5 m, referenced to Geodetic datum, and is gently sloping downward from northeast to southwest towards Georgian Bay. A detailed description of each investigated swamp crossing is presented in Section 4.0. The locations of these areas are shown on Drawing 2.

3.0 INVESTIGATION PROCEDURES

3.1 Foundation Investigation

The field work for the Phase 2 swamp crossings investigation was carried out in two periods to cover the additional scope of work, between January 19 and March 22, 2009 and January 22 and February 5, 2015 during which time a total of sixty-two (62) boreholes and twenty-four (24) Dynamic Cone Penetration Tests (DCPTs) were advanced at the locations summarized in Table 1 and shown on Drawings A1 to D1 in Appendices A to D. In general, the boreholes and DCPTs were advanced along the centreline and the toes of the proposed embankment alignment (in accordance with the Terms of Reference).

The field investigation was carried out using a variety of drilling equipment as a result of the varying nature of the terrain within the Phase 2 project limits. The details of the drilling equipment and suppliers are listed below. Hand excavation methods were used as appropriate depending on the terrain.

Drilling Equipment	Supplied and Operated By
Track-mounted CME 55	Landcore Drilling of Sudbury, Ontario
Track-mounted CME 550	Landcore Drilling of Sudbury, Ontario
Track-mounted D-25	Walker Drilling Ltd. of Utopia, Ontario
Portable Equipment	Walker Drilling Ltd. of Utopia, Ontario Landcore Drilling of Sudbury, Ontario

The boreholes were advanced through the overburden using 108 mm inside diameter hollow-stem augers, 101 mm or 115 mm O.D. solid-stem augers, and 'HW', 'BW' or 'NW' casing. Soil samples were obtained continuously at some borehole locations but generally 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, performed in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586 Standard Test Method for Standard Penetration Test). Boreholes advanced by portable equipment employed full weight or half ($^1/_2$) weight hammers lifted manually. Where a half weight hammer was used, the hammer was dropped from the SPT height and the 'N'-values were corrected for the lower energy drive. Select samples of the cohesive soils were obtained using 50 mm or 76 mm O.D. thin-walled 'Shelby' tubes (ASTM D15878 Standard Practice for Thin-Walled Tube Sampling) for relatively undisturbed samples. Where BW casing was used to advance the boreholes, 48 mm O.D. Shelby tubes were used to obtain samples. Field vane shear tests were conducted in cohesive soils for determination of undrained shear strengths (ASTM D2573 Standard Test Method for Field Vane Shear Test) using the MTO Standard and 'N' size vanes, except where carried out in boreholes advanced by BW casing where a 'B' size vane was used. Samples of the bedrock were obtained using an 'HQ' size rock core barrel. All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903-Wells (as amended).

The boreholes and DCPTs were advanced to refusal to further auger, casing and/or split soon advancement, shovel penetration, or cone penetration. The boreholes and DCPT's were advanced to depths ranging from 0 m (bedrock outcrop) to 20 m below existing ground surface, including coring of bedrock for core lengths of 1.5 m and 1.6 m in three (3) boreholes. Refusal at locations where bedrock was not cored does not confirm bedrock surface elevations, but may be inferred to indicate potential proximity to the bedrock surface. At various borehole 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 in Appendices A to D. It should be noted that 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 on 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 and rock samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further detailed 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, organic content, Atterberg limits and grain size distribution) was carried out on selected samples. In addition, a one-dimensional consolidation (oedometer) test was carried out on a sample of the cohesive deposit and the summary of the consolidation test results is presented in Table 2. The results of the laboratory classification testing for the swamp crossings are included in Appendices A to D.

The proposed centreline of the highway was staked in the field by Callon Dietz prior to drilling. The borehole locations for the 2009 investigation were surveyed by a member of our technical staff in reference to the centreline stakes and the ground surface elevations at the stakes were provided by MRC (received on November 23, 2009). The boreholes for the 2015 investigation were staked in the field by Callon Dietz and the as-drilled borehole locations, in stations and offsets, and the ground surface elevation at the boreholes were measured in reference to the centreline alignment and were subsequently converted into MTM NAD 83 (Zone 10) coordinates in AutoCAD. The borehole locations shown on Drawings A1 to D1 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 Physiography of Southern Ontario[1] , this section of Highway 69 lies within the physiographic region known as the Georgian Bay Fringe, which extends along the east side of Georgian Bay through the Parry Sound and Muskoka areas, then eastward from Muskoka in patches into the area north of the Kawartha Lakes.

This part of the Georgian Bay Fringe physiographic region was never submerged during periods of glacial recession. As a result, the surficial soils in this area consist of very shallow deposits of sand, silt and clay underlain by metamorphic bedrock; numerous bare knobs and ridges of bedrock are present throughout the area. Localised low-lying swampy areas, containing peat and/or organic soils underlain by soft/loose native soils, are present in valleys between the bedrock knobs and ridges.

The bedrock in the area consists typically of gneisses of the Britt Domain of the Central Gneiss Belt, a subdivision of the Grenville Structural Province, as described in Geology of Ontario, OGS Special Volume 4[2]. Deposition of Paleozoic strata and later erosion during glaciation exposed these Precambrian rocks.

4.2 General Overview of Local Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes (including excavations by hand shovel) advanced during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are given on the attached Record of Borehole sheets in Appendices A to D. The detailed results of the laboratory testing are provided in Appendices A to D. The results of the in situ field tests (i.e. SPT

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

[2] Geology of Ontario, 1991. Ontario Geological Society, Special Volume 4, Part 2. Ministry of Northern Development and Mines, Ontario.

'N'-values) as presented on the Record of Borehole sheets and in Section 4.0 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 Standard Penetration Tests (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 the resistance to Dynamic Cone Penetration Test (DCPT) results are shown on the Record of Penetration Test sheets in Appendices A to D.

The inferred soil stratigraphy as encountered in the boreholes and DCPTs advanced for the proposed Phase 2 swamp crossings are shown on Drawings A1 to D1, inclusive. 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 (along the proposed Highway 69 alignment) and therefore may differ from that shown on the drawings which represents magnetic north.

In general, the stratigraphy encountered at the swamp areas investigated is similar, however, the thickness of the overburden (soil materials) is variable, ranging from no cover (i.e. bedrock outcrops present at ground surface) to about 20 m. The stratigraphy from ground surface to refusal or bedrock generally consists of:

- Surficial layers of peat, organic sand/silt/clayey silt, topsoil, sand and gravel fill and rock fill;
- Deposits of sandy silt to sand with interlayers of clayey silt to silty clay;
- Deposits of mixtures of clayey silt to clay interbedded with sand and silt layers and underlain by deposits of sand and silt, sand, and sand and gravel.

Detailed descriptions of the subsurface conditions at each investigated swamp crossing 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.

4.3 Highway 69 SBL – STA 15+690 to 15+720 (Swamp 23)

The plan and profiles along the centreline and toes of the embankment of the new Highway 69 SBL alignment showing the borehole locations and interpreted stratigraphy between about STA 15+690 and 15+720 are shown on Drawing A1 in Appendix A. The alignment extends across a swamp area and the proposed roadway embankment will be up to about 7 m above existing grade. A total of seven (7) boreholes (Boreholes S23-01 to S23-06, inclusive, and S23-03A), and four (4) Dynamic Cone Penetration Tests (DCPTs S23-DC01 to S23-DC03 and S23-DC07) were completed to investigate the subsurface conditions within this swamp area. The topography of this section of the proposed highway is relatively flat with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the swamp.

In general, the subsurface soils along the SBL alignment in this area consist of a surficial deposit of peat underlain by a deposit of sand which extends to the refusal depth. Resistance to dynamic cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at a greater depth at about STA 15+710. Bedrock outcrops are present along the southern limit of the swamp.

Snow / Ice / Water

Snow, ice and water to depths between 0.6 m and 0.9 m was encountered in all boreholes except at Boreholes S23-01 and S23-02.

Peat

A deposit of dark brown, wet, fibrous/amorphous peat containing roots and wood fragments was encountered underlying the ice/water cover in Boreholes S23-03, S23-03A, S23-04 and S23-05. The top of the peat deposit ranges from Elevation 208.8 m to 208.0 m and its thickness ranges from 0.1 m to 1.8 m.

The Standard Penetration Test (SPT) 'N'-values measured within the peat deposit range from 1 blow to 13 blows per 0.3 m of penetration, suggesting a very soft to stiff consistency.

The natural water content measured on two (2) samples of the peat is about 353 per cent and 357 per cent and the organic content measured on one (1) sample of the peat deposit is about 56 per cent.

Sand

A deposit of brown to grey sand, trace to some silt, trace to some gravel and trace clay was encountered underlying the peat deposit and snow cover or at ground surface in all boreholes except at Borehole S23-02. In Borehole S23-06, the deposit contains clay seams near the top between Elevation 207.8 m and 207.0 m. The top of this deposit ranges from Elevation 212.3 m to 206.2 m and its thickness ranges from 0.1 m to 6 m in Boreholes S23-01 to S23-06, including S23-03A and potentially up to about 7.5 m as inferred in DCPT S23-DC02. The bottom of this deposit was defined by refusal to further split-spoon and/or casing advancement, cone penetration or hand (shovel) excavation.

The SPT 'N'-values measured within this deposit range from 1 blow to 22 blows per 0.3 m of penetration, with values between 54 blows and 106 blows per 0.3 m of penetration and up to 68 blows per 0.15 m of penetration measured within the lower portion of the deposit, indicating a very loose to very dense relative density.

The natural water content measured on samples of this deposit ranges from about 14 per cent to 42 per cent but is typically less than 25 per cent. The upper portion of the sand deposit contains organics. Laboratory testing on two (2) samples of the deposit measured organic contents of about 2 per cent and 4 per cent.

The grain size distributions of six (6) samples of this deposit are shown on Figure A.S23-1 in Appendix A.

Bedrock / Refusal

Bedrock outcrops are present along the southern limit of the swamp and along the east toe of the proposed embankment. Bedrock is present below a thin cover of sandy soil on the centreline of the roadway at the south limit of the swamp (Boreholes S23-02 and S23-01, respectively). In Boreholes S23-03 to S23-06 and DCPTs S23-DC01 to S23-DC03 and S23-DC07, refusal to further split-spoon and/or casing advancement or cone penetration was encountered at depths between 1.4 m and 9.6 m below snow/ice or ground surface, corresponding to Elevation 207.5 m and 199.3 m. In general, refusal was encountered at greater depths towards the centre of the swamp between about STA 15+700 and 15+710.

Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet with free water noted in select sand samples. The water levels observed in the boreholes upon completion of drilling range from Elevation 209.4 m to 208.7 m, measured at the ice surface and up to a depth of about 0.6 m below the ice or snow surface.

4.4 Highway 69 NBL – STA 15+700 to 15+740 (Swamp 23)

The plan and profiles along the centreline and toes of the embankment of the new Highway 69 NBL alignment showing the borehole locations and interpreted stratigraphy between about STA 15+700 and 15+740 are shown on Drawings A1 and A2 in Appendix A. The alignment extends across a swamp area and the proposed roadway embankment will be up to about 7 m above existing grade. A total of five (5) boreholes (Boreholes S23-07 to S23-11, inclusive), and three (3) Dynamic Cone Penetration Tests (DCPTs S23-DC04 to S23-DC06) were completed to investigate the subsurface conditions within this swamp area. The topography of this section of the proposed highway is relatively flat with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the swamp.

In general, the subsurface soils along the NBL alignment in this area consist of a surficial deposit of peat underlain by a deposit of silty sand to sand which extends to refusal depth or is underlain by a deposit of gravelly sand in places. Resistance to dynamic cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greater depth at about STA 15+730. Bedrock outcrops are present along the southern limit of the swamp.

Ice / Water

Ice and water to depths between 0.7 m and 0.9 m was encountered in all boreholes except Borehole S23-11.

Peat

A 0.6 m and 0.8 m thick deposit of brown, wet, fibrous peat was encountered underlying the ice/water cover in Boreholes S23-07 and S23-08 at Elevation 208.1 m and 208.2 m, respectively.

The Standard Penetration Test (SPT) 'N'-values measured within the peat deposit are between 1 blow and 2 blows per 0.3 m of penetration, suggesting a very soft consistency.

The natural water content measured on a sample of the peat deposit is about 326 per cent and an organic content measured on this sample is about 64 per cent.

Silty Sand to Sand

A deposit of brown and grey silty sand containing trace to some gravel and clay seams to sand, trace to some silt, was encountered underlying the peat deposit and ice/water cover or at ground surface in all boreholes. The upper portion of the deposit contains a 0.7 m thick pocket of organic sand in Borehole S23-09. The top of this deposit ranges from Elevation 213.5 m to 207.5 m and its thickness ranges from about 4.3 m to 10.2 m as encountered in the boreholes and inferred in the DCPTs, except in Borehole S23-07 where the thickness is 0.7 m. Boreholes S23-08 to S23-10 were terminated within this deposit upon refusal to further split-spoon and/or casing advancement, while Borehole S23-11 was terminated within this deposit on a very dense material.

The SPT 'N'-values measured within this deposit range from 1 blow to 55 blows per 0.3 m of penetration, with values of 87 blows and 89 blows per 0.3 m of penetration measured within the lower portion of the deposit in Borehole S23-08, indicating a very loose to very dense relative density.

The natural water content measured on samples of this deposit ranges from about 9 per cent to 26 per cent. The upper portion of the sand deposit contains trace organics and laboratory testing on one (1) sample of the sand measured an organic content of about 1 per cent.

The grain size distributions of seven (7) samples of this deposit are shown on Figure A.S23-2 in Appendix A.

As noted above, a 0.7 m thick layer of brown and grey organic sand, trace to some silt and trace clay was encountered within the sand deposit in Borehole S23-09. A SPT 'N'-value measured within the layer is 6 blows per 0.3 m of penetration, indicating a loose relative density. The natural water content measured on a specimen of this layer is about 58 per cent.

Gravelly Sand

A deposit of brown gravelly sand some silt was encountered below the sand deposit in Borehole S23-07. The top of this deposit is at Elevation 206.8 and its thickness is 1.2 m. The bottom of this deposit was defined by refusal to further split-spoon and casing advancement.

The SPT 'N'-values measured within this deposit are 48 blows per 0.3 m of penetration and 109 blows per 0.2 m of penetration, indicating a dense to very dense relative density.

The natural water content measured on a sample of this deposit is about 11 per cent.

A grain size distribution of one (1) sample of this deposit is shown on Figure A.S23-3 in Appendix A.

Bedrock / Refusal

Bedrock outcrops are present along the southern limit of the swamp. In Boreholes S23-07 to S23-10 and DCPTs S23-DC04 to S23-DC06, refusal to further split-spoon and/or casing advancement or cone penetration was encountered at depths between 2.8 m and 11 m below ice or ground surface, corresponding to Elevation 209.1 m and 198.4 m. In general, refusal was encountered at greater depths towards the centre of the swamp between about STA 15+710 and 15+730.

Groundwater Conditions

In general, the samples taken in the boreholes were damp to wet with free water noted in select sand samples. Water levels observed in the boreholes upon completion of drilling range from Elevation 211.1 m to 208.4 m, measured at the ice surface or up to a depth of 2.4 m below the ice or ground surface.

4.5 Highway 69 SBL – STA 16+475 to 16+550 (Swamp 24)

The plan and profiles along the centreline and toes of the embankment of the new Highway 69 SBL alignment showing the borehole locations and interpreted stratigraphy between about STA 16+475 and 16+550 are shown on Drawing B1 in Appendix B. The alignment extends across a swamp area and the proposed roadway embankment will be up to about 9 m above existing grade. A total of eight (8) boreholes (Boreholes S24-01 to S24-07 and S24-09), and three (3) Dynamic Cone Penetration Test (DCPTs S24-DC01 to S24-DC03) were completed to investigate the subsurface conditions within this swamp area. The topography of this section of the proposed highway is relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the swamp.

In general, the subsurface soils along the SBL alignment in this area consist of a surficial deposit of root mat/peat underlain by a deposit of sand and silt to sand which in turn is underlain by a deposit of sand to sand and gravel in places. Resistance to dynamic cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greatest depth at about STA 16+525. Bedrock outcrops are present along the southern limit of the swamp.

Ice / Water

Ice and/or water to depths of 0.1 m and 0.2 m were encountered in Boreholes S24-01 and S24-06.

Root Mat / Peat

A deposit of dark brown, wet, root mat and/or amorphous peat was encountered either at the ground surface or below the ice/water cover in all boreholes advanced for this alignment. The top of the root mat/peat deposit ranges from Elevation 203.1 m to 202.5 m and its thickness ranges from 0.2 m to 0.7 m.

The Standard Penetration Test (SPT) 'N'-values measured within the root mat/peat range from 2 blows to 4 blows per 0.3 m of penetration, suggesting a very soft to soft consistency.

Sand and Silt to Sand

A deposit of non-cohesive soil comprised of brown to grey sand and silt to silty sand to sand some silt, was encountered below the peat deposit in all boreholes. The deposit generally contains trace clay, silt layers, pockets of silty clay and sand and gravel, and organics and rootlets near the surface. The top of this deposit ranges from Elevation 202.6 m to 201.9 m and its thickness ranges from about 2.8 m to 11.7 m and possibly up to 14.2 m. Boreholes S24-01, S24-02, S24-04, S24-06 and S24-09 were terminated within this deposit upon refusal to further split-spoon and/or casing/auger advancement.

The SPT 'N'-values measured within this deposit range from 2 blows to 23 blows per 0.3 m of penetration, but are typically greater than 5 blows per 0.3 m of penetration and a value of 100 blows per 0.25 m of penetration was measured at a location, indicating a generally loose to very dense relative density.

The natural water content measured on samples of this deposit typically ranges from about 19 per cent to 28 per cent and a water content of about 72 per cent was measured on a sample noted to contain organics. In general, the upper portion of this deposit contains trace organics and laboratory testing on specimens of the sand and silt deposit from Boreholes S24-05 and S24-06 measured organic contents of about 1 per cent.

The grain size distributions of eighteen (18) samples of three groupings of similar soil layers comprising this overall non-cohesive deposit are shown on Figures B.S24-1A to B.S24-1D in Appendix B for sand and silt to silty sand, sand and silt to sand, and silty sand to sand. Atterberg limits tests on two (2) specimens of the sand and silt deposit indicate this material to be non-plastic.

In Boreholes S24-03 and S24-04, a 0.1 m and 0.2 m thick layer of brown and grey silt, trace to some sand, trace gravel and trace clay containing slight organic and rootlets was encountered below the peat deposit that locally overlies the sand and silt to sand deposit. The SPT 'N'-values measured within the silt layer are 3 blows and 4 blows per 0.3 m of penetration, indicating very loose relative density.

As noted above, two approximately 0.1 m thick lenses of brown or grey silty clay were encountered in Borehole S24-01 and a 0.2 m thick layer of silty clay lens was encountered in Borehole S24-05 within or underlying the upper non-cohesive layer (zone) of sand and silt to silty sand. The natural water content measured on a specimen of the cohesive layer is about 70 per cent and the Atterberg limits test carried out on this specimen measured a liquid limit of about 46 per cent, a plastic limit of about 19 per cent and a plasticity index of about 27 per cent. The results of the Atterberg limits test are shown on the plasticity chart on Figure B.S24-2 in Appendix B and indicate the material to be silty clay of intermediate plasticity.

Sand to Sand and Gravel

A deposit comprised of grey to brown gravelly sand to sand and gravel, and underlying sand layer was encountered below the sand and silt to sand deposit in Boreholes S24-03, S24-05 and S24-07. The deposit generally contains trace to some silt and trace clay. The top of this deposit ranges from Elevation 196.4 m to 191.6 m and its thickness ranges from 1.6 m to 5.8 m. The bottom of this deposit was defined by refusal to further casing advancement or cone penetration as inferred in Borehole S24-07.

The SPT 'N'-values measured within the sand and gravel to sand deposit range from 15 blows to 33 blows per 0.3 m of penetration, indicating a compact to dense relative density.

The natural water content measured on samples of this deposit ranges from about 9 per cent to 21 per cent, generally greater than 20 per cent.

The grain size distributions of two (2) samples from the sand and gravel layer and one (1) sample from the underlying sand layer are shown on Figure B.S24-3A and B.S24-3B, respectively, in Appendix B.

Bedrock / Refusal

Bedrock outcrops are present along the southern limit of the swamp. In Boreholes S24-01 to S24-07 and S24-09, and DCPTs S24-DC01 to S24-DC03, refusal to further split-spoon, auger and/or casing advancement or cone penetration was encountered at depths between 3.1 m and 15.5 m below ice or ground surface, corresponding to Elevation 199.6 m and 187.3 m. In general, refusal was encountered at greater depths towards the northern limit of the swamp between about STA 16+525 and 16+550.

Groundwater Conditions

In general, the samples taken in the boreholes were wet. Water levels observed in the boreholes upon completion of drilling range from Elevation 202.8 m to 202.5 m, measured at the ice and ground surface or up to a depth of 0.3 m below the ground surface.

4.6 Highway 69 NBL – STA 16+450 to 16+550 (Swamp 24)

The plan and profiles along the centreline and toes of the embankment of the new Highway 69 NBL alignment showing the borehole locations and interpreted stratigraphy between about STA 16+450 and 16+550 are shown on Drawings B1 and B2 in Appendix B. The alignment extends across a swamp area and the proposed roadway embankment will be up to about 9.5 m above existing grade. A total of nine (9) boreholes (Boreholes S24-06 and S24-08 to S24-15, inclusive), and three (3) Dynamic Cone Penetration Tests (DCPTs S24-DC01, S24-DC02 and S24-DC04) were completed to investigate the subsurface conditions within this swamp area. The topography of this section of the proposed highway is relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the swamp.

In general, the subsurface soils along the NBL alignment in this area consist of a surficial deposit of root mat/peat underlain by a deposit of sandy silt to sand which in turn is underlain by a deposit of sand and gravel interlayered with sand and silt that extends to the refusal depth or by granite gneiss bedrock in places. Resistance to dynamic cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greatest depth at about STA 16+475. Bedrock outcrops are present along the southern limit of the swamp.

Ice / Water

Ice and/or water to depths between 0.1 m and 0.3 m were encountered in Boreholes S24-06, S24-10, S24-11, S24-13 and S24-14.

Root Mat / Peat

A deposit of dark brown and grey, wet, root mat and/or amorphous peat containing sand lenses and rootlets was encountered either at the ground surface or underlying the ice and/or water cover in all boreholes except in Borehole S24-08 where bedrock is exposed. The top of the root mat/peat deposit ranges from Elevation 202.8 m to 201.9 m and its thickness ranges from 0.1 m to 0.4 m across the site except in Borehole S24-11 where the thickness is 1.1 m.

The Standard Penetration Test (SPT) 'N'-values measured within the root mat/peat range from 1 blow to 3 blows per 0.3 m of penetration, with a value of 14 blows per 0.3 m of penetration measured in Boreholes S24-10 and S24-14 at the interface of this deposit with the underlying sand or silt deposit, generally suggesting a very soft to stiff consistency.

Silt

In Boreholes S24-10, S24-12 and S24-15, a 0.2 m and 0.3 m thick layer of brown and grey silt, trace to some sand and trace clay containing slight organic and rootlets was encountered below the peat deposit that is generally underlain by the sand to sandy silt deposit in the other boreholes. The top of the silt layer varies between Elevation 202.7 m and 202.2 m.

The SPT 'N'-values measured within this layer range between 5 blows and 14 blows per 0.3 m of penetration, indicating a loose to compact relative density.

Sandy Silt to Sand

A deposit comprised of brown to grey sandy silt to silt and sand to sand was encountered below the root mat/peat deposit in all boreholes except in Borehole S24-08 and inferred in all DCPTs based on resistance to cone penetration. The deposit generally contains trace gravel, trace clay, silty sand and silt layers, and organics and rootlets near the top surface. The top of this deposit ranges from Elevation 202.5 m to 200.8 m and its thickness ranges from 2.8 m to 11.7 m. Boreholes S24-06, S24-09, S24-11 and S24-14 were terminated within this deposit upon refusal to further split-spoon and/or auger/casing refusal. Borehole S24-15 was extended by a DCPT driven from the bottom of the borehole to refusal to further cone penetration.

The SPT 'N'-values measured within this deposit range from 2 blows to 49 blows per 0.3 m of penetration, and SPT 'N'-values up to 100 blows per 0.05 m of penetration were measured at the bottom of the deposit prior to split-spoon and casing refusal, generally indicating a very loose to very dense relative density.

The natural water content measured on samples of this deposit typically ranges from about 14 per cent to 30 per cent. Water content of about 72 per cent and 82 per cent were also measured within this deposit. The upper portion of this deposit contains organics and laboratory testing on specimens of this deposit measured organic contents up to about 1 per cent.

The grain size distributions of seventeen (17) samples from this deposit are shown on Figures B.S24-4A to B.S24-4C in Appendix B. An Atterberg limits test on one (1) specimen of the sand deposit indicates this material to be non-plastic.

Sand and Gravel

A deposit of grey sand and gravel trace silt containing cobbles and boulders at /near the base of the deposit was encountered below the sand to sand and silt deposit in Borehole S24-10. The sand and gravel deposit is intersected by a 3.2 m thick layer of sand and silt, which is intersected by a 0.6 m thick pocket of silt containing trace sand and trace clay. The top of the sand and gravel deposit is at Elevation 192.5 m and its thickness is 6.2 m. The top of the sand and silt layer within the sand and gravel deposit is at Elevation 191.1 m. The bottom of the lower portion of the sand and gravel deposit containing cobbles and boulders was defined by refusal to further split-spoon and casing advancement.

The SPT 'N'-values measured within the sand and gravel deposit range from 9 blows to 33 blows per 0.3 m of penetration, indicating a loose to dense relative density, with the lower 'N'-value measured at the interface between the sand and silt layer and the silt pocket.

The natural water content measured on a sample of the sand and silt portion of the deposit is about 46 per cent. The grain size distribution of one (1) sample from the sand and silt layer is shown on Figure B.S24-5 in Appendix B.

Bedrock / Refusal

Bedrock outcrops are present along the southern limit of the swamp and on the centreline of the proposed embankment at the location of Borehole S24-08 (at about STA 16+450) at Elevation 206.3 m. In Boreholes S24-06, S24-09 to S24-11, S24-14 and S24-15, and DCPTs S24-DC01, S24-DC02 and S24-DC04, refusal to further split-spoon and/or auger/casing advancement or cone penetration was encountered at depths between 3.1 m and 16.1 m below ice/water or ground surface, corresponding to Elevation 199.6 m and 186.3 m.

Bedrock was encountered and core samples were recovered from Boreholes S24-12 and S24-13. The depth to the surface of the bedrock is 5.1 m and 6.8 m corresponding to Elevation 197.5 m and 195.8 m, and the bedrock was cored for depths of about 1.5 m and 1.6 m. The bedrock generally consists of granite gneiss and the core samples are described as slightly weathered to fresh, fine to medium grained with feldspar banding, foliated, black, pink and grey. The Rock Quality Designation (RQD) measured on the core samples is 98 per cent and 100 per cent, indicating a rock mass of excellent quality. The Total Core Recovery (TCR) is 100 per cent in both boreholes, and the Solid Core Recovery (SCR) is 55 per cent and 98 per cent, in the respective boreholes.

Groundwater Conditions

In general, the samples taken in the boreholes were wet. The water levels observed in the boreholes upon completion of drilling range from Elevation 202.7 m to 202.2 m, measured at the ice or ground surface or at a depth of 0.2 m below the ground surface.

4.7 Highway 69 SBL – STA 17+230 to 17+350 (Swamp 25)

The plan and profiles along the centreline and toes of the embankment of the new Highway 69 SBL alignment showing the borehole locations and interpreted stratigraphy between about STA 17+230 and 17+350 are shown on Drawing C1 in Appendix C. The alignment extends across a swamp area and the proposed roadway embankment will be up to about 8.5 m high above existing grade. A total of eleven (11) boreholes (Boreholes S25-01 to S25-11, inclusive), and five (5) Dynamic Cone Penetration Tests (DCPTs S25-DC01 to S25-DC05, inclusive) were completed to investigate the subsurface conditions within this swamp area. The topography of this section of the proposed highway is relatively flat to low-lying consisting of bedrock knobs, grassy and heavily treed ground with areas of shallow open water. The swamp is bounded to the north by a valley slope and to the south by the existing Shebeshekong Road.

In general, the subsurface soils along the SBL alignment in this area consist of a deposit of fill associated with the embankment of the existing Shebeshekong Road and surficial deposit of peat/organic silty sand underlain by a deposit of sandy silt to sand, which in turn is underlain by a clayey silt to clay stratum in places containing pockets of silt or silty sand. The clayey silt to clay strata are underlain by a deposit of sandy silt to sand, underlain by a deposit of sand and gravel in places. Resistance to dynamic cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greatest depth between about STA 17+275 and 17+315. Bedrock outcrops are present along the northern limit of the swamp and to the south of the swamp beyond the adjacent existing Shebeshekong Road traversing the area.

Sand and Gravel Fill

A deposit of fill comprised of grey to brown sand and gravel was encountered at the ground surface in Borehole S25-01 advanced along the south toe of the existing Shebeshekong Road. The top of the granular fill is at Elevation 203.7 m and its thickness is 1.1 m.

A Standard Penetration Test (SPT) 'N'-value measured within this deposit is 8 blows per 0.3 m of penetration, indicating a loose relative density.

Ice / Water

Ice and water to depths between 0.6 m and 0.9 m was encountered in all boreholes and DCPTs except in Borehole S25-01, as noted above.

Peat / Organic Silty Sand to Sand

A deposit of black, wet, amorphous peat or dark brown, wet, organic silty sand to organic sand containing rootlets was encountered underlying the ice/water cover in Boreholes S25-03, S25-08 and S25-09. The top of the peat/organic silty sand to sand ranges from Elevations 202.0 m to 201.7 m and its thickness ranges from 0.2 m to 0.6 m.

The Standard Penetration Test (SPT) 'N'-values measured within the organic silty sand to sand deposit are 4 blows and 13 blows per 0.3 m of penetration, indicating a loose to compact relative density.

The natural water content measured on one (1) sample of the organic silty sand is about 80 per cent, and the organic content measured on this sample is about 11 per cent.

Sandy Silt to Sand

A deposit of non-cohesive soil comprised of dark brown to grey sandy silt, silty sand and sand trace to some silt was encountered underlying the ice/water cover and fill or peat/organic silty sand to organic sand deposit in all boreholes. The deposit generally contains trace to some gravel, trace to some clay, trace organics, wood fibres and rootlets near the top surface. The top of this deposit ranges from Elevations 202.6 m to 201.1 m and its thickness ranges from 1.1 m to 3.8 m. Boreholes S25-01 and S25-11 were terminated within this deposit upon refusal to further split-spoon and auger/casing refusal.

The SPT 'N'-values measured within this deposit range from 0 blows (weight of hammer) to 22 blows per 0.3 m of penetration, but are typically greater than 6 blows per 0.3 m of penetration, indicating a generally loose to compact relative density. SPT 'N'-values of 15 blows per 0.15 m of penetration and 6 blows per 0.1 m of penetration were measured prior to split-spoon and auger/casing refusal in Boreholes S25-01 and S25-11.

The natural water content measured on samples of this deposit ranges from about 15 per cent to 65 per cent, but are typically less than 29 per cent. The upper portion of this deposit was observed to have trace organics and laboratory testing on two (2) specimens of this deposit measured organic contents of about 4 per cent and 5 per cent.

A grain size distribution of one (1) sample of the silty sand deposit is shown on Figure C.S25-1 in Appendix C.

A 0.5 m and 0.9 m thick layer of brown and grey silt some sand, trace organics and containing rootlets was encountered below the peat deposit in Borehole S25-09 at Elevation 201.6 m and within the sand deposit in Borehole S25-11 at Elevation 201.5 m. The natural water content measured on a specimen of the silt layer is about 22 per cent. A grain size distribution of this specimen is shown on Figure C.S25-2 in Appendix C. An Atterberg limits test carried out on this specimen measured a liquid limit of about 18 per cent, a plastic limit of about 17 per cent and a plasticity index of about 1 per cent. The results of the Atterberg limits test are shown on the plasticity chart on Figure C.S25-3 in Appendix C and classified the material as silt of slight plasticity.

Clayey Silt to Clay

A stratum of grey to reddish brown clayey silt to clay, trace sand to clay containing silt seams was encountered below the sandy silt to sand deposit in all boreholes advanced for this alignment except in Boreholes S25-01 and S25-11. The top of this stratum ranges from Elevations 200.0 m to 199.3 m and its thickness ranges from 0.5 m to 2.6 m.

The SPT 'N'-values measured within the cohesive deposit range from 0 blows (weight of hammer) to 3 blows per 0.3 m of penetration. In situ field vane tests carried out within this stratum measured undrained shear strengths ranging from about 13 kPa to 35 kPa and the sensitivity is calculated to range from 1 to 7. The field vane tests results together with the SPT 'N'-values indicate that the clay to clayey silt stratum has a very soft to firm consistency.

The natural water content measured on samples of this stratum ranges from about 29 per cent to 71 per cent.

Atterberg limits tests were carried out on eight (8) specimens (including two Shelby tube samples) of the cohesive stratum and indicate liquid limits ranging from about 22 per cent to 56 per cent, plastic limits ranging from about 13 per cent to 22 per cent and plasticity indices ranging from about 9 per cent to 34 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figure C.S25-4 in Appendix C and indicate the material to be clayey silt of low plasticity to clay of high plasticity.

Borehole Sample No.	**Sample Depth / Elevation**	**σ'_{vo} (kPa)**	**σ'_{p} (kPa)**	**$\sigma'_{p} - \sigma'_{vo}$ (kPa)**	**OCR**	**C_c**	**C_r**	**e_o**	**c_v^* (cm^2/s)**
Borehole S25-08 Sample 4	3.3 m / 199.3 m	18	85	67	4.7	0.71	0.07	1.56	2.7×10^{-3}

Note: * For stress range of 20 kPa ≤ σ_v' ≤ 160 kPa

where:
- σ_{vo}' is the effective overburden stress in kPa
- σ_p' is the preconsolidation stress in kPa
- OCR is overconsolidation ratio
- e_o is 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

Silt

A pocket and a layer of grey silt, trace sand and trace clay was encountered within the clay stratum in Borehole S25-05 and underlying the clayey silt stratum in Borehole S25-07. The top of this stratum is at Elevation 198.9 m and 198.0 m and its thickness is 0.9 m and 2.7 m in the respective boreholes.

The SPT 'N'-values measured within the silt stratum are 3 blows per 0.3 m of penetration, indicating a very loose relative density.

The natural water content measured on two (2) samples of this stratum is about 23 per cent and 27 per cent.

A grain size distribution of one (1) sample of the silt stratum is shown on Figure C.S25-6 in Appendix C.

Sandy Silt to Sand

A deposit comprised of grey to brown sandy silt, sit and sand, silty sand and sand trace to some silt, and a pocket of silt was encountered underlying the clayey silt to clay stratum in all boreholes except in Boreholes S25-01 and S25-11. The deposit generally contains trace to some gravel and trace clay. The top of this deposit ranges from Elevation 199.1 m to 195.3 m and its thickness ranges from 2.3 m to 8.6 m. Boreholes S25-02 to S25-04, S25-06 and S25-08 to S25-10 were terminated within this deposit upon refusal to further split-spoon and/or casing refusal.

The SPT 'N'-values measured within this deposit range from 1 blow to 39 blows per 0.3 m of penetration, but are typically greater than 6 blows per 0.3 m of penetration, indicating a generally loose to dense relative density.

The natural water content measured on samples of this deposit ranges from about 12 per cent to 32 per cent.

The grain size distributions of five (5) samples of the silt and sand to sand deposit are shown on Figure C.S25-7 in Appendix C. An Atterberg limits test on one (1) sample of the sand and silt deposit indicate the material to be non-plastic.

As noted above, a 0.6 m thick pocket of grey silt trace sand was encountered within the silty sand to sand deposit in Boreholes S25-02 Elevation 198.0 m. The natural water content measured on a specimen of the silt pocket is about 29 per cent and an Atterberg limits test carried out on this specimen measured a liquid limit of about 19 per cent, a plastic limit of about 17 per cent and a plasticity index of about 2 per cent. The result of the Atterberg limits test is shown on the plasticity chart on Figure C.S25-8 in Appendix C and classifies the material as silt of slight plasticity.

Sand and Gravel

A deposit of grey sand and gravel was encountered below the sandy silt to sand deposit in Boreholes S25-05 and S25-07. The top of this deposit is at Elevation 190.9 m and 186.7 m and its thickness is 1.7 m and 0.5 m, at the respective boreholes. The bottom of this deposit is defined by refusal to further casing advancement.

A SPT 'N'-value measured within this deposit is 16 blows per 0.3 m of penetration, indicating a compact relative density.

Bedrock / Refusal

Bedrock outcrops are present to the north and to the south of the swamp beyond the adjacent existing Shebeshekong Road. In Boreholes S25-01 to S25-11, and DCPTs S25-DC01 to S25-DC05, refusal to further split-spoon and/or auger/casing advancement or cone penetration was encountered at depths between 4.7 m and 16.5 m below ice/water or ground surface, corresponding to between Elevations 197.9 m and 186.2 m. In general, refusal was encountered at greater depths towards the toe of the embankment in the centre of the swamp between about STA 17+275 and 17+315.

Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet with free water noted in some sand samples. A few boreholes encountered sand flow into the casing due to water pressure confined below cohesive deposits, which required water to be pumped into the borehole casing to maintain a constant head of water in order to allow for sampling by SPT and/or Shelby tube. Water levels observed in the boreholes upon completion of drilling range from Elevations 202.6 m to 202.1 m, measured at the ice surface or up to a depth of 1.6 m below the ice or ground surface.

4.8 Highway 69 NBL – STA 17+150 to 17+350 (Swamp 25)

The plan and profiles along the centreline and toes of the embankment of the new Highway 69 NBL alignment showing the borehole locations and interpreted stratigraphy between about STA 17+150 and 17+350 are shown on Drawings C1 and C2 in Appendix C. The alignment extends across a swamp area and the proposed roadway embankment will be up to about 9 m high above existing grade. A total of sixteen (16) boreholes (Boreholes S25-12 to S25-26, inclusive, and S25-17A), and five (5) Dynamic Cone Penetration Tests (DCPTs S25-DC06 to S25-DC10, inclusive) were completed to investigate the subsurface conditions within this swamp area. The topography of this section of the proposed highway is relatively flat to low-lying consisting of bedrock knobs, grassy and heavily treed ground with areas of shallow open water as well as an area of granular/rock fill. The existing Highway 69 is located about 80 m to the east of the proposed NBL alignment.

In general, the subsurface soils along the NBL alignment in this area consist of a deposit of fill associated with the Shawanaga First Nation gas station access road and platform as well as the embankment of the existing Shebeshekong Road and surficial deposit of peat/organic clayey silt/silt. The fill and organic deposits are underlain by a deposit of sandy silt to sand which in turn is underlain by a stratum of clayey silt to clay containing a pocket of silt and sand, or pockets. The clayey silt to clay stratum or silt layer(s) are underlain by a deposit of silt and sand to sand which is in turn underlain by a deposit of gravelly sand at to sand and gravel in places. Resistance to dynamic cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greatest depth between about STA 17+230 and 17+300. Bedrock outcrops are present along the northern limit of the swamp and to the south of the swamp beyond the adjacent existing Shebeshekong Road traversing the area.

Silty Sand to Sand and Gravel Fill and Rock Fill

A deposit of granular fill comprised of brown to grey silt and sand, silty sand, sand and sand and gravel was encountered at the ground surface in Boreholes S25-12 to S25-14, S25-17, S25-23, S25-25 and S25-26, and inferred as observed at ground surface in DCPT S25-DC07. The top of the granular fill ranges from Elevations 203.9 m to 202.7 m and the thickness of the fill ranges from 0.5 m to 2.2 m.

Rock fill was encountered in Boreholes S25-22 to S25-24 and S25-26 and was inferred at ground surface at DCPT S25-DC10. The top of the rock fill ranges from Elevation 202.8 m to 201.9 m and its thickness ranges from 0.6 m to 1.5 m.

The Standard Penetration Test (SPT) 'N'-values measured within the granular deposit range from 7 blows to 50 blows per 0.3 m of penetration, indicating a loose to dense to very dense relative density. The SPT 'N'-values measures within the rock fill range from 54 blows per 0.3 m of penetration to 122 blows per 0.15 m of penetration, indicating a very dense relative density.

The natural water content measured on one (1) sample of the sand and gravel fill is about 6 per cent.

Snow / Ice / Water

Snow, ice and water to depths between 0.2 m and 1.2 m was encountered in Boreholes S25-15, S25-16, S25-18, S25-19 and S25-21.

Peat / Organic Clayey Silt / Organic Silt

An organic deposit was encountered below the snow/ice/water in Boreholes S25-18, S25-19 and S25-21 and over and below the rock fill in Boreholes S25-22. A 0.6 m thick deposit of peat, organic clayey silt and organic silt was encountered in Boreholes S25-19, S25-18 and S25-21, respectively, between Elevations 202.2 m and 201.7 m. Two (2) layers of organic silt, each about 0.3 m thick, were encountered over and below the rock fill in Borehole B25-22 at Elevations 203.1 m and 201.9 m.

The Standard Penetration Test (SPT) 'N'-values measured within the organic deposits are 3 blows and 5 blows per 0.3 m of penetration, suggesting a soft to firm consistency/very loose relative density.

The natural water content measured on samples of the organic deposits is between about 38 per cent and 56 per cent, and the organic content measured on a sample of the organic clayey silt is about 6 per cent.

Sandy Silt to Sand (Upper Deposit)

A non-cohesive deposit comprised of brown to grey sandy silt, silt and sand, silty sand and sand was encountered underlying the ice/water cover and below the fill or peat/organic clayey silt/organic silt deposit in all boreholes, except in Borehole S25-20 which is located on a bedrock outcrop. The deposit generally contains trace gravel, trace clay, clayey silt and sand seams and sandy silt layers, organics and rootlets. The top of this deposit ranges from Elevations 202.4 m to 201.1 m and the thickness of the deposit ranges from 0.8 m to 4.1 m.

The SPT 'N'-values measured within this deposit range from 0 blows (weight of hammer) to 24 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on fifteen (15) samples of this deposit ranges from about 17 per cent to 35 per cent. The upper portion of this deposit was observed to contain trace organic and laboratory testing on one (1) specimen of the silty sand deposit measured an organic content of about 3 per cent.

The grain size distributions of six (6) samples of the silt and sand to sand portion of the deposit are shown on Figure C.S25-9 in Appendix C.

Clayey Silt to Clay

A stratum of grey and reddish brown clayey silt, silty clay and clay, containing trace to some sand and silt seams was encountered below the sandy silt to sand deposit in all boreholes, except in Boreholes S25-14, S25-20 and S25-21. The stratum was observed to contain a pocket of silt and sand in Borehole S25-15. The top of this stratum ranges from Elevation 200.8 m to 198.6 m and the thickness of the deposit ranges from 0.3 m to 4 m. Borehole S25-17A was terminated within this stratum, penetrating it for a depth of 0.6 m.

The SPT 'N'-values measured within the cohesive stratum range from 0 blows (weight of hammer) to 5 blows per 0.3 m of penetration with a SPT 'N'-value of 11 blows per 0.3 m of penetration measured at the interface with the underlying silt layer. In situ field vane tests carried out within this stratum measured undrained shear strengths ranging from about 15 kPa to 57 kPa and the sensitivity is calculated to be between 2 and 8. The field vane tests results together with the SPT 'N'-values indicate that the clayey silt to clay stratum has a very soft to stiff consistency.

The natural water content measured on thirteen (13) samples of this stratum ranges from about 22 per cent to 75 per cent.

Atterberg limits tests were carried out on twelve (12) specimens of the clayey silt to clay stratum and indicate liquid limits ranging from about 20 per cent to 61 per cent, plastic limits ranging from about 13 per cent to 24 per cent and plasticity indices ranging from about 7 per cent to 40 per cent. The results of the Atterberg limits tests are shown on the plasticity chart on Figures C.S25-10A and C.S25-10B in Appendix C and indicate the material to be clayey silt of low plasticity to clay of high plasticity.

Within the cohesive stratum in Borehole S25-15, a 0.6 m thick pocket of silt and sand trace clay was encountered at Elevation 198.6 m. A SPT 'N'-value measured in this layer is 6 blows per 0.3 m of penetration, indicating a loose relative density. The natural water content measured on the samples from this pocket is about 19 per cent.

Silt

Underlying the cohesive stratum in Boreholes S25-13, S25-17, S25-22, S25-25 and S25-26 is a stratum of grey silt, some sand and trace to some clay containing an estimated 0.4 m diameter boulder at the top of the deposit in Borehole S25-13. The top of this stratum is between Elevations 200.5 m and 197.3 m and the thickness of the layer ranges from 0.3 m to 2.3 m. Borehole S23-22 was terminated in this deposit due to refusal to further auger advancement.

The SPT 'N'-values measured within the silt stratum range between 4 blows and 8 blows per 0.3 m of penetration, indicating a loose relative density. A SPT 'N'-value of 29 blows per 0.2 m of penetration was measured in Borehole S25-22 at borehole termination on refusal.

The natural water content measured on five (5) samples of this stratum are between about 24 per cent and 31 per cent.

Grain size distributions of four (4) samples of the silt stratum are shown on Figure C.S25-11 in Appendix C.

Silt and Sand to Sand (Lower Deposit)

A deposit comprised of grey to brown silt and sand, silty sand and sand trace to some silt containing trace gravel and trace clay was encountered below the clayey silt to clay stratum or silt stratum in Boreholes S25-12, S25-13, S25-15 to S25-19 and S25-23 to S25-26, and underlying the upper sandy silt to sand deposit in Borehole S25-14. In Borehole S25-14, the deposit contains silty clay seams and a boulder at the bottom of the deposit, and in Borehole S25-17, the auger was noted to be grinding inferred on a boulder. The top of this deposit ranges from Elevations 199.1 m to 195.8 m and the thickness of the deposit ranges from 3 m to 10.3 m and may be up to about 12.2 m thick as inferred from the resistance to cone penetration for the DCPT driven from the bottom of Borehole S25-13. The bottom of this deposit is defined by refusal to further split-spoon, auger and/or casing advancement or cone penetration in all boreholes which the deposit was encountered except for S25-12, S25-24 and S25-25 where it is underlain by a gravelly sand to sand and gravel deposit.

The SPT 'N'-values measured within this deposit typically range from 0 blows (weight of sampler and rod) to 44 blows per 0.3 m of penetration, with occasional SPT 'N'-values between about 73 blows and 101 blows per 0.3 m of penetration, indicating very loose to very dense relative density.

The natural water content measured on twenty-four (24) samples of this deposit range from about 15 per cent to 30 per cent.

The grain size distributions of twelve (12) samples of this deposit are shown on Figures C.S25-12A and C.S25-12B in Appendix C.

Gravelly Sand and Sand and Gravel

A deposit of grey gravelly sand and sand and gravel, trace to some silt and trace clay 1.2 m to 2.2 m thick was encountered below the lower silt and sand to sand deposit in Boreholes S25-12, S25-24 and S25-25 at Elevations 185.7 m and 189.7 m, respectively. The boreholes were terminated in this deposit upon refusal to casing advancement.

A SPT 'N'-values measured within this deposit are 19 blows and 44 blows per 0.3 m of penetration, indicating a compact to dense relative density. A SPT 'N'-value of 23 blows per 0.15 m of penetration was measured in Borehole S25-24 on a silt and sand pocket.

The natural water content measured on three (3) samples of this deposit are about 11 per cent and 17 per cent. The grain size distribution of a sample of the gravelly sand portion of the deposit is shown on Figure C.S25-13A in Appendix C. The grain size distribution of the sample of the silt and sand pocket is shown on Figure C.S25-13B in Appendix C.

Bedrock / Refusal

Bedrock outcrops are present along the northern limit of the swamp at the location of Borehole S25-20 and DCPT S25-DC09 at Elevation 204.7 m and 203.9 m, respectively, and to the south of the swamp near the adjacent existing Shebeshekong Road at about STA 17+200. In Boreholes S25-12 to S25-19 and S25-21 to S25-26 and DCPTs S25-DC06 to S25-DC08 and S25-DC10 refusal to further split-spoon and/or auger/casing advancement or cone penetration was encountered at depths between 3.4 m and 20 m below ice/water or ground surface, corresponding to between Elevations 199.7 m and 183.9 m. In general, refusal was encountered at greater depths near the existing Shebeshekong Road between about STA 17+230 and 17+300.

Bedrock was encountered and core samples were recovered from Borehole S25-21. The depth to the surface of the bedrock is 1.7 m corresponding to Elevation 200.7 m, and the bedrock was cored for a depth of 1.6 m. The bedrock consists of granite gneiss and the core sample is described as slightly weathered, course grained with strong banding, foliated, pink, white and grey. The Rock Quality Designation (RQD) measured on the core samples is 100 per cent, indicating a rock mass of excellent quality (Table 3.10 of CFEM, 2006). The Total Core Recovery (TCR) is 100 per cent, and the Solid Core Recovery (SCR) is 90 per cent.

A point load strength index test (ASTM D5731 – Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications) was carried out on one sample of the bedrock core. The diametral point load test carried out on the sample of the bedrock core measured an Is_{50} strength index value of 13.7 MPa, as presented on the Record of Drillhole sheet in Appendix C. The point load strength index value suggests that the sample of gneiss is extremely strong (Table 3.5 of CFEM, 2006).

Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. A few boreholes encountered sand flow into the casing when the penetrating into non-cohesive deposits below cohesive deposits, requiring the casing to maintain a constant head of water in order to allow for sampling by SPT. The water level observed in the boreholes upon completion of drilling ranges from Elevation 202.6 m to 201.0 m, measured at the ice surface or up to a depth of 1.9 m below ground surface.

4.9 Site 9 Road – STA 10+225 to 10+300 (Swamp 26)

The plan and profiles along the centreline and toes of the embankment of the Site 9 Road alignment showing the borehole locations and interpreted stratigraphy between about STA 10+225 and 10+300 are shown on Drawing D1

in Appendix D. The alignment extends across a swamp area and the proposed roadway embankment will be up to about 9 m above existing grade. A total of eight (8) boreholes (Boreholes S26-01 to S26-08, inclusive), and three (3) Dynamic Cone Penetration Tests (DCPTs S26-DC01 to S26-DC03, inclusive) were completed to investigate the subsurface conditions within this swamp area. The topography of this section of the proposed Site 9 Road is relatively flat, with ground cover consisting of shrubs, sparse trees and wet grassy areas, located within the confines of a relatively higher ground and densely treed area and bounded to the east by the existing Highway 69. Bedrock outcrops are present along the southern limit of the swamp.

In general, the subsurface soils along the Site 9 Road alignment in this area consist of surficial deposits of topsoil, organic silt and clayey silt underlain by a deposit of silt to sandy sand which in turn is underlain by a gravelly sand to sand and gravel stratum in places. Resistance to dynamic cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at shallower depths at the southern limit of the swamp, at about STA 10+200. Bedrock outcrops are present along the southern limit of the swamp.

Topsoil / Organic Silt

A 0.2 m to 0.6 m thick deposit of topsoil, organic silt, some sand was encountered at ground surface in Boreholes S26-02 and S26-04 to S26-08. The top of the organic deposits was encountered between Elevations 212.9 m 210.7 m.

A Standard Penetration Test (SPT) 'N'-value measured within the organic silt is 3 blows per 0.3 m of penetration, indicating a very loose relative density.

The natural water content measured on three (3) samples of the organic silt are about 49 per cent and 188 per cent, and the organic content of two (2) sample of the organic silt are about 6 per cent and 25 per cent.

Clayey Silt

A 0.7 m thick deposit of clayey silt was encountered below the topsoil in Borehole S26-06 at a depth of 0.2 m below ground surface, corresponding to Elevation 211.5 m.

The Standard Penetration Test (SPT) 'N'-value measured within the clayey silt is 5 blows per 0.3 m of penetration, suggesting a firm consistency.

The natural water content measured on one (1) sample of the clayey silt is about 23 per cent. An Atterberg limits test carried out on this specimen measured a liquid limit of about 33 per cent, a plastic limit of about 14 per cent and a plasticity index of about 19 per cent. The results of the Atterberg limits test are shown on the plasticity chart on Figure D.S23-1 in Appendix D and indicate the material to be clayey silt of low plasticity.

Silt to Sand

A 2.3 m to 9.8 m thick non-cohesive deposit consisting of silt, sandy silt, silt and sand, silty sand and sand was encountered in all of the boreholes between Elevations 212.7 m and 210.4 m. The deposit was encountered at ground surface in Boreholes S26-01 and S26-03, below the organic silt in Borehole S26-02, S26-04, S26-05 and S26-07, below the clayey silt deposit in S26-06 and below the topsoil in S26-08. A 0.8 m thick pocket of clayey silt was encountered within the silt and sand/silty sand portion of the deposit in Borehole S26-05 at Elevation 209.4 m.

The Standard Penetration Test (SPT) 'N'-values measured within the silt to sand deposit range from 0 blows (weight of hammer) to 26 blows per 0.3 m of penetration, indicating a very loose to compact relative density. SPT

'N'-values of 66 blows per 0.13 m of penetration and 20 blows for 0 m of penetration were measured at the bottom of the deposit prior to split-spoon and casing refusal

The SPT 'N'-value measured within the clayey silt pocket is 3 blows per 0.3 m of penetration. Two (2) in situ field vane tests carried out within this pocket measured undrained shear strengths of about 46 kPa to 67 kPa and the sensitivity is calculated to be 7 and 5, respectively. The field vane test results indicate that the clayey silt pocket has a firm to stiff consistency.

The natural water content measured on thirty-five (35) samples of the silt to sand deposit range between about 14 per cent and 31 per cent and the organic content of one (1) sample of the silty sand portion of the deposit immediately underlying the organic silt deposit is about 1 per cent.

The natural water content measured on a sample of the clayey silt pocket is about 41 per cent, and the Atterberg limits test carried out on this specimen measured a liquid limit of about 30 per cent, a plastic limit of about 16 per cent and a plasticity index of about 14 per cent. The results of the Atterberg limits test are shown on the plasticity chart on Figure D.S23-1 in Appendix D and indicate the material to be clayey silt of low plasticity.

The grain size distributions of twelve (12) samples of the silt to sand deposit classified the selected samples as silt, sandy silt, silty sand and sand. The results are shown on Figures D.S26-2A and D.S26-2B in Appendix D. Atterberg limits tests carried out in two (2) samples of the sandy silt deposit indicates that this material in non-plastic.

Gravelly Sand / Sand and Gravel

A 0.1 m to 1.4 m deposit of gravelly sand to sand and gravel was encountered below the silt and sand deposit in Boreholes 26-01 and 26-05 at depths of 2.3 m and 7.2 m below ground surface, corresponding to Elevations 209.0 m and 203.7 m.

The Standard Penetration Test (SPT) 'N'-value measured within the gravelly sand/sand and gravel is 41 blows per 0.3 m of penetration and 20 blows per 0.15 m of penetration (measured at the bottom of the deposit prior to split-spoon and casing refusal), indicating a dense relative density

The natural water content measured on two (2) samples of the gravelly sand/sand and gravel deposit are about 11 per cent and 15 per cent.

The grain size distribution of one (1) sample of the gravelly sand portion of the deposit is shown on Figure D.S26-3 in Appendix D.

Bedrock / Refusal

Bedrock outcrops are present along the southern limit of the swamp. In Boreholes S26-01 to S26-08 and DCPTs S26-DC01 to S26-DC03, refusal to further split-spoon and/or auger advancement or cone penetration was encountered at depths ranging between 2.4 m and 10.1 m below ground surface, corresponding to between Elevations 208.9 m and 200.6 m. In general, refusal was encountered at shallower depths at the southern limit of the swamp, at about STA 10+200.

Groundwater Conditions

In general, the samples taken in the boreholes were wet. The water levels observed in the boreholes upon completion of drilling range from Elevation 212.0 m to 209.1 m, measured at the ground surface or at depths ranging from 0.2 m to 2.2 m below the ground surface.

5.0 CLOSURE

The field technicians directing the drilling program were Messrs. Indulis Dumpis, Mathew Riopelle and Matt Rhody. This report was prepared by Mmes Veronica T. Ayetan, P. Eng., and Madison C. Kennedy and was reviewed by Mr. Christopher Ng, P. Eng., a 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 a technical and an independent quality control review of the report.

Report Signature Page

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PART B

FOUNDATION DESIGN REPORT

SWAMP CROSSINGS – PHASE 2

HIGHWAY 69 FOUR-LANING

FROM 1.0 KM NORTH OF THE NEW HIGHWAY 559 INTERCHANGE NORTHERLY TO 1.5 KM NORTH OF HIGHWAY 7182 (SHEBESHEKONG ROAD) FOR 17 KM

MINISTRY OF TRANSPORTATION, ONTARIO

G.W.P. 5111-07-00 (PHASE 2 OF G.W.P. 5402-05-00)

April 11, 2016
Report No. 07-1111-0029-7

Golder Associates

6.0 DISCUSSION AND ENGINEERING RECOMMENDATIONS

This section of the report provides an interpretation of the geotechnical data obtained during the investigation and recommendations on the foundation aspects of 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) was retained by McCormick Rankin (MRC), a member of MMM Group Limited on behalf of Ministry of Transportation, Ontario (MTO) to provide recommendations on foundation aspects for the final design of embankment crossing four (4) swamps at locations along the proposed SBL and NBL Phase 2 Highway 69 alignment. The scope of work includes carrying out stability and settlement analyses, preliminary recommendations for stable embankment geometry, embankment fill materials and alternative ground improvement techniques that may be required as a means to minimize settlements and to improve stability (if necessary). The work also includes addressing specialized construction concerns and potential geotechnical problems associated with embankment construction, including sub-excavating soft / organic materials and placement of new fill materials.

The overall project involves the design of a 17 km section of the new Highway 69 four-laning alignment, including high fill embankments and embankments over swamps, the New Woods Road and Shebeshekong Road interchanges and structures, the Shawanaga River, Site 9 Road and existing Shebeshekong Road Overpass structures, as well as culvert crossings, north of Nobel, Ontario. As part of this work, foundation recommendations are required for areas of proposed swamp crossings (about 640 m in total length) between the new Shebeshekong Road interchange and the Shawanaga River (Phase 2 project limits). Table 1 summarizes the locations of the areas investigated within the Phase 2 project limits that require foundation design.

6.2 Embankments Over Swamps

Based on the profiles of the new alignments provided to us by MRC, including various revisions, between October 2007 and January 2009, it is our understanding that the new highway will require fill embankments ranging in height from about 1.5 m up to about 9.5 m.

Sections 6.2.2 and 6.2.3 of this report summarize the methods used for the analysis of stability and settlement for critical sections of swamp crossing embankments for the new Highway 69 four-laning and associated Site 9 Road. Section 6.3 presents a summary of the settlement performance criteria applicable to the highway embankment and Section 6.4 provides a general discussion and recommendations related to potential alternatives for mitigating stability and settlement-related design and construction issues. The results of the analyses and recommendations on mitigating stability and time-dependent settlements in relevant swamp crossings are presented for each individual area in Section 6.5.

6.2.1 Embankment Fill Types and Berm Requirements

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

It is understood that rock fill is the preferred embankment fill material for this project and as such, the stability and settlement analyses discussed in Section 6.5 have been carried out on the basis that the roadway embankments will be constructed of rock fill.

Rock Fill

The main advantage of constructing embankments using rock fill is the ability to achieve steeper side slopes (1.25H:1V), which is required in areas with limited right-of-way, for reducing the overall quantity of material required for the project and for placement of material in sub-excavated areas under water. Rock fill will also likely be available locally, either from excavations in deep cuts through existing bedrock outcrops within 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 high embankments is that some post-construction settlement of the embankment fill itself will occur, although mostly within about the first year of construction. 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 Rockfill 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, in general accordance with OPSD 202.010 (Slope Flattening). Given that the proposed new embankments in Phase 2 are less than 10 m high, 2 m wide berms are not required.

Granular Fill

The main advantage of using granular fill is 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 wider right-of-way because the side slopes of granular fill embankments (2H:1V) are flatter than those of rock fill. For this project, acceptable granular fill is considered to be well-graded, locally available and/or imported, granular material.

For granular fill embankments, 2 m wide berms should be incorporated into the side slope profiles for uninterrupted slopes greater than 8 m high in general accordance with OPSD 202.010.

6.2.2 Stability

The following sections outline the methodology used to evaluate embankment stability along the various swamp crossings. In addition, the parameters used in the analyses for each of the critical section(s) are also presented. The results of the analyses 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 swamp crossing. Critical sections correspond to the greatest new embankment height and/or the maximum thickness of soft, compressible cohesive soils. In areas where cohesive deposits were encountered in the founding soils, the stability of the proposed new embankment section(s) was analyzed using limit equilibrium methods. In areas where cohesive deposits were not encountered, the stability of the proposed embankment section was assessed based on engineering judgement and precedent experience in similar soil conditions.

All limit equilibrium slope stability analyses were performed using the commercially available program Slide (Version 6.0), produced by Rocscience Inc., employing the Morgenstern-Price method of analysis. For all analyses, the factor of safety of numerous potential failure surfaces was computed in order to establish the minimum factor of safety. The factor of safety is defined as the ratio of the forces tending to resist failure to the

driving forces tending to cause failure. A target minimum Factor of Safety of 1.3 is normally adopted for the design of embankment slopes under static conditions. This factor of safety 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 roadway. The stability analyses were carried out to check that the target minimum factor of safety was achieved for the various embankment heights and geometries.

The stability analyses assume that the organic soils encountered at/below ground surface, within the footprint of the embankment have been removed and replaced with granular or rock fill prior to construction of the new embankments and that rock fill will be used for replacement of sub-excavated material (as discussed in Section 6.6.1). The piezometric conditions required in the analyses were based on the groundwater levels observed during borehole drilling which were generally located at about the level of the natural ground surface at most locations.

6.2.2.2 Parameter Selection

The simplified stratigraphy together with the associated foundation engineering parameters employed for the different native soil types for the critical sections in each swamp crossing are summarized in Table 3. The rock fill modeled in the analyses is assumed to have a unit weight of 19 kN/m^3 and an effective friction angle of 40^o and the embankments constructed with 1.25H:1V side slopes.

The founding soils encountered in the various areas are composed of granular soils (silts, sands, sand, and gravel) or a combination of cohesive deposits (clayey silt, silty clay and clay) and granular soils. 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 granular soils were estimated from empirical correlations using the results of in situ Standard Penetration Tests (SPT), 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 (natural water content). 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 stress (kPa)

Where appropriate, Bjerrum's correction factor 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

When developing the area-specific correlations of engineering parameters based on laboratory or field test data, the results from all swamp crossings were combined to provide a larger set of parameters to evaluate. It was considered that all the swamp crossings exhibited sufficiently similar soil mineralogy and geology that correlations

based on all of the data would be justified. Having developed the area-specific correlations, the test results for each individual swamp area were examined and the design parameters developed accordingly.

6.2.3 Settlement

The following sections outline the methods used to conduct the settlement analyses at the various swamp crossings. In addition, the parameters used in the analyses for each of the critical section(s) are also presented. The results of the analyses are presented in Section 6.5.

6.2.3.1 Methodology

To estimate the magnitude of the expected settlements, analyses were carried out on the critical sections of the proposed fill embankments using the commercially available program Settle^{3D} (Version 3.0) 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. The rate of settlement/consolidation of the cohesive foundation soils was assessed using Terzaghi's one-dimensional consolidation theory.

The sources of settlement were considered to include:

- Primary time-dependent consolidation of the cohesive deposits;
- Secondary time-dependent (creep) consolidation of the cohesive deposits (long-term);
- Immediate settlement of the native granular soils; 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 alignments within each swamp crossing and as such the settlements along the length of a given alignment will similarly vary. Given that the analyses were carried out at the critical sections of each swamp crossing, the settlements estimated will generally represent the maximum value along a given alignment.

The settlement analyses assume that any surficial or near surface organic soils encountered at/below ground surface have been removed (as discussed in Section 6.6.1) and replaced with granular or rock fill prior to construction of the new embankments. For details on the thickness of organic deposits at each swamp crossing, refer to Section 4.0. The piezometric conditions required in the analyses was based on the groundwater levels noted during drilling which was essentially located at about the level of the natural ground surface at most locations.

6.2.3.2 Parameter Selection

The simplified stratigraphy along with the associated deformation and time-rate consolidation parameters employed for the different native soil types for the critical sections in each swamp crossing are given in Table 3.

The immediate compression of the very loose to very dense silt, sandy silt to silty sand, sand, and sand and gravel layers was modeled 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 the *Canadian Highway Bridge Design Code* (CHBDC, 2006) and adjusted, if necessary.

The consolidation settlement of the cohesive deposits was assessed using the results of the laboratory consolidation test and in situ field vane tests to estimate the stress history and deformation parameters for the

cohesive deposits. In addition, the results of consolidation tests were supplemented with estimates of 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 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 test for the cohesive soils at this site.

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

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

where : $s_{u(mob)} = \mu s_{u(FV)}$

σ'_p = preconsolidation stress (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 analysis was established using the results of the consolidation test and/or estimated from the U.S. Navy (1986) correlation with liquid limits assuming normally-consolidated soils.

In addition to primary consolidation within clays, 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 relationships have been employed for estimating the magnitude of creep settlement over the life of the embankment following the completion of primary settlement at each location.

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

$$C_{\alpha\varepsilon} \approx \frac{w_n}{10{,}000} \quad \text{(after Mesri, 1973)}$$

where :

S_c = secondary consolidation (creep) settlement (mm)
$C_{\alpha\varepsilon}$ = modified secondary compression index
H = initial thickness of compressible clay deposit (mm)
t = post-construction period of interest (10 years and 20 years for this project)
t_{EoP} = time to reach end of primary consolidation (years)
w_n = natural water content (%)

6.2.3.3 Settlement of Embankment Fill

Where rock fill is to be 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, dated September 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 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 (September 2010), as follows:

Total Height of Rock Fill, H	Short-Term Rock Fill Settlement (m)	
	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

It should be noted that approximately 90 per cent of the short-term rock fill 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 (September 2010), as follows:

Total Height of Rock Fill, H	Long-Term Rock Fill Settlement (m)	
	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 to over the design life of the embankment.

6.3 Settlement Performance Requirements

The following criterion was developed, in consultation with MTO and MRC, for the long-term performance of the embankments at these sites:

- Post-construction settlements of less than about 50 mm to 60 mm over a 10-year period following completion of construction.

This performance criterion forms part of the overall design performance for each swamp crossing and high fill area. In general, the recommended mitigation option for each site has been selected such that the remaining primary consolidation settlement, secondary consolidation (creep) settlement and the settlement due to compression of the rock fill under self-weight is limited to the criterion noted above

6.4 Stability and Settlement Mitigation Options

At each swamp crossing location, stability and settlement have been assessed based on existing subsurface conditions and proposed embankment fill heights. The presence of weak, 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 settlements and/or instability. A brief discussion on these alternatives is given below.

Details of the mitigation options for the swamp crossings requiring measures to mitigate stability/settlement issues of the foundation soils are provided in Section 6.5 and, where appropriate, the advantages, disadvantages, relative costs and risks/consequences are summarized in the Evaluation of Stability / Settlement Mitigation Options table in the respective appendices. In addition, a comparison of the estimated post-construction settlement over a 10-year period between the base case (i.e. no foundation mitigation carried out) and the various mitigation alternatives considered was carried out for each of the swamps. The results of the settlement analyses are summarized in Table 4.

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

It should be noted that in areas where the foundation soils consist of granular soils only, it is not anticipated that there will be embankment stability issues or significant settlement problems, provided all organic material are removed prior to construction and the requirements for mid-height berms are incorporated into the design, as necessary. As such, in these areas generally there is no need to implement any special construction procedures or schedule to maintain stability or to minimize long-term foundation settlements. However, in certain cases where the post-construction settlements of rock fill exceed the settlement performance criterion as a result of high embankments and/or relatively deep sub-excavations of peat/organic layers, the embankment will need to be preloaded.

6.4.1 Full Sub-Excavation

Sub-excavation of the weak and compressible soils 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 at this site. The removal of the soft, compressible cohesive soils would result in improved stability and reduced settlements within the areas underlain by cohesive deposits and/or where high embankment fills are proposed. It should be noted that despite the reduction in settlements, the post-construction settlement of rock fill may still exceed the settlement performance criterion. As such, the embankment would need to be preloaded to achieve acceptable post-construction settlements associated with long-term performance of the embankment. 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 this is the natural slope of rock fill and should not be affected by under-water placement. 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 will produce a large volume of spoil material for disposal and will require a large volume of rock fill replacement. The necessity to develop stable side slopes or back slopes within the excavation may result in slope geometries ranging from 1H:1V to as flat as 3H:1V, especially where excavations are carried out 'in-the-dry'. 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, the depth to the bottom of the soft, compressible soils within the swamp crossings ranges from about 2.5 m to 7.5 m below existing ground surface. In general, groundwater was encountered at or slightly below ground surface at all swamp locations. We understand that based on MTO field experience on similar highway 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 about 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 and replacement with rock fill is considered a generally feasible option for construction of the roadway embankments and would result in enhanced stability and reduced settlement of the embankments on this project.

This option is most suited for areas where there is a limited thickness of weak/soft, compressible soils underlying the proposed embankment, such that their removal is feasible where there are no requirements for setbacks and adequate right-of-way are 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;
- Reduced delay in construction (preloading may still be required at some locations to reduce rock fill settlements); and,
- Elimination of stabilizing toe berms.

The disadvantages of this option are:

- Generation of large volumes of excavation spoil requiring disposal/management;
- Increase post-construction settlement of rock fill, typically requiring a preload period in addition to the sub-excavation to satisfy the settlement performance criterion;
- May require a larger right-of-way corridor; and,
- Greater quantities of rock fill required.

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

As an alternative to sub-excavation and replacement of the weak/soft, compressible foundation soils, preloading may be considered for improving the stability and reducing post-construction settlements of the proposed embankments. Preloading refers to the placement of rock fill to the proposed height of embankment (in one or more stages) in advance of 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 embankment fill loads in advance of final grading of the embankment. It also increases the strength of any cohesive soils underlying the embankment footprint, thereby improving stability.

Preloading requires placement of embankment fill and, in some cases, monitoring of settlements, and possibly pore pressures, for a period of time corresponding to approximately the 'End of Primary' (EoP) consolidation of the cohesive soils. EoP consolidation times will vary depending on the properties and thicknesses of the cohesive deposits, and the height of the embankment. Once the estimated EoP consolidation has occurred, final grading for construction can proceed. Long-term secondary consolidation (creep) settlements will still continue to occur over the life of the embankment; however, such settlements would be less than the primary consolidation settlements. Where secondary consolidation (creep) settlements are considered to be large enough to affect the long-term performance of the roadway, these can be reduced by surcharging as discussed in Section 6.4.3.

In areas where cohesive deposits are thick and/or very soft, and where such conditions coincide with proposed high embankment fills, it may be necessary to construct stability berms along the embankment toes or to 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 phase 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 the existing organic material be sub-excavated prior to placement of any fill, because organic soils are highly compressible and experience significant secondary consolidation (creep) settlements.

This option is most suited for areas where removal of cohesive soils and their replacement with rock fill is not considered practical, where the thickness of the existing compressible soils is nominal (less than about 4 m) and where a delay in the construction schedule is acceptable or can be accommodated.

The advantages of this option are:

- Substantially reduced generation of excess excavation spoil compared with full sub-excavation;
- Will not require a larger right-of-way corridor, unless toe berms are required; and,
- The quantity of rock fill is limited to that required for sub-excavation and replacement of the near surface organics (if toe berms are not required), and to compensate for consolidation and foundation soil settlements.

The disadvantages of this option are:

- Construction is delayed to allow for primary consolidation to be completed and possibly for staged construction (if required);
- Increased quantity of rock fill if toe berms are required for stability;

- An instrumentation and monitoring program may be required to assess when EoP consolidation is reached (as discussed in Section 6.4.7); and,
- Re-grading is required to account for settlement prior to construction of the final pavement structure.

6.4.3 Surcharging (with 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). The difference between preloading and surcharging is the amount of fill placed and the time required for consolidation to be achieved. With surcharging, the preload is placed as described in Section 6.4.2, followed by the placement of 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 soils and increases the rate of primary consolidation over that achieved by preloading, resulting in over-consolidation of the underlying compressible foundations above 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 long-term, secondary consolidation (creep) settlements.

As with preloading, it may be necessary to construct toe berms or stage the placement of preload and surcharge fill to limit the potential for instability. Upon the completion of the surcharge period, the removed surcharge fill may be re-used on other parts of the site.

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 toe berms or staged construction, but where sufficient time for primary consolidation settlements to occur under preload fill loads alone is not available. Surcharging is also best suited for areas where large secondary consolidation (creep) settlements are expected.

The advantages of this option are:

- Reduced generation of excess excavation spoil over full sub-excavation;
- Reduction of secondary consolidation (creep) settlement;
- Will not require a larger right-of-way corridor, unless toe berms are required;
- The quantity of rock fill is limited to that required for sub-excavation and replacement of organics, 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;
- Larger quantity of rock fill if toe berms are required for stability as compared to preloading alone;
- An instrumentation and monitoring program may be required to assess when EoP consolidation is reached (as discussed in Section 6.4.7); and,
- Increased handling of the surcharge fill.

6.4.4 Wick Drains

Where sub-excavation is not practical (i.e. due to the thickness of or depth to the compressible soil deposits), but it is considered feasible to surcharge the foundation soils, consideration may be given to installing wick drains in conjunction with surcharging to further 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.

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 high proposed embankment fills and where primary consolidation times are large even under surcharge conditions.

It would still be necessary to sub-excavate and remove organics materials and place a granular drainage blanket at ground surface level prior to the installation of the wick drains.

The advantages of this option are:

- Substantially decreased consolidation time under surcharging; and,
- Increased 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 compact/very stiff near surface layer is present, incurring additional time and expense;
- Additional long-term settlements due to secondary consolidation (creep) settlement of the cohesive layer (if not compensated for by surcharging);
- An instrumentation and monitoring program is required to assess when EoP consolidation is reached (as discussed in Section 6.4.7); and,
- Re-grading is required to account for settlement prior to construction of the final pavement structure.

6.4.5 Lightweight Fill

Another 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 expanded polystyrene (EPS), 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 over large areas 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 subsoil conditions, where sub-excavation is not practical or feasible, and where there is no available time in the construction schedule for a preload or surcharge period.

The advantages of this option are:

- Improved stability;
- Reduced post-construction settlements;
- No significant delay in construction; and,

- Eliminate the need for stabilizing toe berms.

The disadvantages of this option are:

- Significant additional expense of lightweight fill (depending on the volume required);
- Not feasible to install in low height embankments (due to minimum conventional soil cover requirements over EPS); and,
- Requires embankments to be constructed with 2H:1V side slopes given the need for conventional soil cover of the side slopes.

6.4.6 Aggregate Piers

Aggregate piers can also be considered to improve embankment stability on, and reduce the long-term settlement of, weak/soft compressible foundation soils. The general installation process of aggregate piers involves either pre-drilling a hole through or inserting a hollow steel mandrel into the weak foundation soils followed by placement and ramming/compaction of successive lifts of stone/aggregate (introduced from the ground surface) to create a vertical column of stone/aggregate that typically penetrates the entire weak/soft soil deposit. The stone/aggregate is typically compacted to form a very dense soil reinforcing element.

The advantages of this option are:

- Improved stability of the soft/weak strata;
- Potentially accelerated rate of consolidation of clay strata and organic soils by providing vertical drainage paths for dissipation of excess pore pressures;
- Improved long-term settlement performance (reduced overall settlement); and,
- Generally shortened construction schedule.

The disadvantages of this option are:

- Significant additional expense to install the aggregate piers (depending on the length and spacing of the aggregate piers as well as the plan area to be treated);
- In some cases, a need for a temporary casing required to keep the hole open in caving soils during aggregate placement, or the use of alternative displacement-type construction; and,
- Requirement for the addition of cement grout to the aggregate in the pier, or the installation of a confinement sleeve in very soft/sensitive or organic soils to: stiffen the pier and bond the aggregate; provide higher strength to the column mass; and control lateral squeeze of the soft soil into the aggregate mass or bulging of the aggregate pier into the surrounding soil upon loading.

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 embankments over swamps 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 embankment and taking regular measurements/readings at given intervals of time during and after construction of the embankment for the duration of the preloading/surcharging period. In addition, standpipe piezometers (SPPs), or vibrating wire piezometers, may be required and are usually installed to provide background pore pressure readings for the vibrating wire

piezometers below the embankment. This monitoring instrumentation is particularly important where it is considered necessary to carefully monitor the stability of the subsoils during staged placement of 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 should be included as Special Provisions in the Contract Documents.

6.5 Results of Analysis

The results of the stability and settlement analyses for each swamp crossing are provided in the following sections. In addition, the options and recommendations for achieving the target factor of safety for the required embankment geometry and for minimizing the time dependent, post-construction settlements are also discussed. For swamp crossings that require stability and/or settlement mitigation, the advantages, disadvantages, relative costs, and risks / consequences for these areas are summarized and ranked in the Evaluation of Stability / Settlement Mitigation Options table in the respective appendices.

In areas where the foundation soils consist of non-cohesive deposits only, it is anticipated that there will not be any significant risk of instability of the embankments. Similarly, the settlement of the foundation soils in these areas is expected to occur during or shortly after construction, as a result of the estimated relatively high permeability of these soils. As such, in these areas there is typically no need to implement any special construction procedures or schedule to maintain stability or to mitigate settlement of the foundation soils.

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

For new embankments constructed with rock fill, 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 still 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 of the embankment.

6.5.1 Highway 69 SBL – STA 15+690 to 15+720 (Swamp 23)

The area extending from about STA 15+690 to 15+720 along the proposed Highway 69 Southbound lanes (SBL) alignment requires a new embankment up to about 7 m high to achieve the proposed vertical highway profile. The natural topography of this section of the proposed highway is relatively flat with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the swamp.

The subsoils in this area generally consist of an organic deposit (peat) about 0.1 m to 1.8 m thick underlain by a deposit of very loose to very dense sand about 6 m thick (potentially up to about 7.5 m thick).

Bedrock outcrops are present along the northern limit of the swamp. Refusal to auger advancement or dynamic cone penetration was encountered at depths between about 1.4 m and 9.6 m below ground surface. In general, refusal was encountered at greater depths between about STA 15+700 and 15+710.

Details of the subsurface conditions for this swamp crossing are presented in Section 4.3 and shown on Drawing A1 in Appendix A.

Given the absence of soft, compressible cohesive deposits in this area, stability issues are not anticipated for the proposed up to about 7 m high embankment, provided that all organic deposits are sub-excavated and replaced. Immediate settlement due to compression of the non-cohesive soil deposits is estimated to be about 60 mm. This settlement is expected to occur rapidly (i.e. during or shortly after completion of construction) in response to filling for embankment construction.

Based on a 7 m high embankment plus about 2 m of additional rock fill required after removal of the organic deposits, the short-term and long-term post-construction settlement of the rock fill is estimated to be about 70 mm and 10 mm, respectively, at the critical section(s).

To satisfy the long-term settlement performance criterion of the embankment, the rock fill embankment should be preloaded for a minimum period of 45 days. The magnitude of the remaining short-term and long-term post-construction settlement of the rock fill after the recommended preload period is estimated to be about 45 mm and 10 mm, respectively.

6.5.2 Highway 69 NBL – STA 15+700 to 15+740 (Swamp 23)

The area extending from about STA 15+700 to 15+740 along the proposed Highway 69 Northbound lanes (NBL) alignment requires a new embankment up to about 7 m high to achieve the proposed vertical highway profile. The natural topography of this section of the proposed highway is relatively flat with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the swamp.

The subsoils in this area generally consist of an organic deposit (peat) up to about 0.8 m thick underlain by a deposit of very loose to very dense sand to silty sand up to about 10.2 m thick. At one location, the sand deposit is underlain by a dense to very dense gravelly sand deposit about 1.2 m thick. At the time of the subsurface investigation the ground surface was covered by up to 9 m of ice/water.

Bedrock outcrops are present along the southern limit of the swamp. Refusal to auger advancement or dynamic cone penetration was encountered at depths between about 2.8 m and 11 m below ground surface. In general, refusal was encountered at greater depths between about STA 15+710 and 15+730.

Details of the subsurface conditions for this swamp crossing are presented in Section 4.4 and shown on Drawings A1 and A2 in Appendix A.

Given the absence of soft, compressible cohesive deposits in this area, stability issues are not anticipated for the proposed up to about 7 m high embankment, provided that all organic deposits are sub-excavated and replaced. Immediate settlement due to compression of the non-cohesive soil deposits is estimated to be up to about 65 mm. This settlement is expected to occur rapidly (i.e. during or shortly after completion of construction) in response to filling for embankment construction.

Based on a 7 m high embankment plus about 1 m of additional rock fill required after removal of the organic deposits, the short-term and long-term post-construction settlement of the rock fill is estimated to be about 60 mm and 10 mm, respectively, at the critical section(s).

To satisfy the long-term settlement performance criterion of the embankment, the rock fill embankment should be preloaded for a minimum period of 20 days. The magnitude of the remaining short-term and long-term post-construction settlement of the rock fill after the recommended preload period is estimated to be about 50 mm and 10 mm, respectively.

6.5.3 Highway 69 SBL – STA 16+475 to 16+550 (Swamp 24)

The area extending from about STA 16+475 to 16+550 along the proposed Highway 69 Southbound lanes (SBL) alignment requires a new embankment up to about 9 m high to achieve the proposed vertical highway profile. The

natural topography of this section of the proposed highway is relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the swamp.

The subsoils in this area generally consist of an organic deposit (root mat/peat) about 0.2 m to 0.7 m thick underlain by a deposit of loose to very dense sand to sand and silt about 11.7 m thick (possibly may be up to about 14.2 m thick). The sand to sand and silt deposit is in turn underlain in places by a deposit of generally compact to dense sand and gravel to sand up to about 5.8 m thick.

Bedrock outcrops are present along the southern limit of the swamp. Refusal to auger advancement or dynamic cone penetration was encountered at depths between about 3.1 m and 15.5 m below ground surface. In general, refusal was encountered at greater depths between about STA 16+525 and 16+550.

Details of the subsurface conditions for this swamp crossing are presented in Section 4.5 and shown on Drawing B1 in Appendix B.

Given the absence of soft, compressible cohesive deposits in this area, no stability issues are anticipated for the proposed up to about 9 m high embankment, provided that all organic deposits are sub-excavated and replaced. Immediate settlement due to compression of the non-cohesive soil deposits is estimated to be about 190 mm. This settlement is expected to occur rapidly (i.e. during or shortly after completion of construction) in response to filling for embankment construction.

Based on a 9 m high embankment plus about 0.5 m of additional rock fill backfill required after removal of the organic deposits, the short-term and long-term post-construction settlement of the rock fill is estimated to be about 75 mm and 10 mm, respectively, at the critical section(s).

To satisfy the long-term settlement performance criterion of the embankment, the rock fill embankment should be preloaded for a minimum period of 45 days. The magnitude of the remaining short-term and long-term post-construction settlement of the rock fill after the recommended preload period is estimated to be about 50 mm and 10 mm, respectively.

6.5.4 Highway 69 NBL – STA 16+450 to 16+550 (Swamp 24)

The area extending from about STA 16+450 to 16+550 along the proposed Highway 69 Northbound lanes (NBL) alignment requires a new embankment up to about 9.5 m high to achieve the proposed vertical highway profile. The natural topography of this section of the proposed highway is relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the swamp.

The subsoils in this area generally consist of an organic deposit (root mat/peat) about 0.1 m to 1.1 m thick, underlain by a deposit of loose to compact silt in places which in turn is underlain by a deposit of very loose to very dense sand to sandy silt up to about 11.7 m thick. Beneath the sand to sandy silt deposit at one location is a loose to dense sand and gravel deposit interlayered with a sand and silt deposit, up to about of about 6.2 m thick.

Bedrock outcrops are present along the southern limit of the swamp and along the centreline of the proposed embankment. Refusal to auger advancement or dynamic cone penetration and to the surface of the bedrock was encountered at depths between about 3.1 m and 16.1 m below ground surface. In general, refusal was encountered at a greater depth at about STA 16+475.

Details of the subsurface conditions for this swamp crossing are presented in Section 4.6 and shown on Drawings B1 and B2 in Appendix B.

Given the absence of soft, compressible cohesive deposits in this area, no stability issues are anticipated for the proposed up to about 9.5 m high embankment, provided that all organic deposits are sub-excavated and replaced.

Immediate settlement due to compression of the non-cohesive soil deposits is estimated to be up to about 190 mm. This settlement is expected to occur rapidly (i.e. during or shortly after completion of construction) in response to filling for embankment construction.

Based on a 9.5 m high embankment plus about 1 m of additional rock fill backfill required after removal of the organic deposits, the short-term and long-term post-construction settlement of the rock fill is estimated to be about 80 mm and 15 mm, respectively, at the critical section(s).

In order to satisfy the long-term settlement performance criterion of the embankment, the rock fill embankment should be preloaded for a minimum period of 55 days. The magnitude of the remaining short-term and long-term post-construction settlement of the rock fill after the recommended preload period is estimated to be about 45 mm and 15 mm, respectively.

6.5.5 Highway 69 SBL – STA 17+230 to 17+350 (Swamp 25)

The area extending from about STA 17+230 to 17+350 along the proposed Highway 69 Southbound lanes (SBL) alignment requires a new embankment up to about 8.5 m high to achieve the proposed vertical highway profile. The natural topography of this section of proposed highway is relatively flat to low-lying consisting of bedrock knobs, grassy and heavily treed ground with areas of shallow open water. The swamp is bounded to the north by a valley slope and to the south by the existing Shebeshekong Road.

The subsoils in this area generally consist of an up to about 1.1 m thick deposit of sand and gravel fill in places, and an about 0.2 m to 0.6 m thick organic deposits (peat and organic silty sand) underlain by an upper deposit of loose to compact sandy silt to sand up to about 3.8 m thick. The sandy silt to sand deposit is underlain by a deposit of very soft to firm clayey silt to clay. The thickness of the clayey silt to clay deposit is between about 0.5 m and 2.6 m, extending to a depth up to about 5.3 m below existing ground surface. At one location, the clayey silt to clay deposit is underlain by a stratum of very loose silt about 2.7 m thick. The clayey silt to clay stratum or the silt deposit is in turn underlain by a deposit of loose to dense sandy silt to sand up to about 8.6 m thick which is subsequently in places by a 0.5 m to 1.7 m thick deposit of compact sand and gravel in places.

Bedrock outcrops are present to the north and to the south of the swamp beyond the adjacent Shebeshekong Road. Refusal to auger advancement or dynamic cone penetration was encountered at depths ranging between about 4.7 m and 16.5 m below ground surface. In general, refusal was encountered at greater depths towards the toe of the embankment in the centre of the swamp between about STA 17+275 and 17+315.

Details of the subsurface conditions for this swamp crossing are presented in Section 4.7 and shown on Drawing C1 in Appendix C.

As noted in Section 6.2.1 on embankment fill types, the new embankment was analyzed assuming a rock fill composition and 1.25H:1V side slopes. The stability and settlement analysis assumes that the organic soils encountered at/below ground surface have been removed (to a geometry similar to OPSD 203.010 – Embankment Over Swamp) prior to construction of the new embankment. 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. The groundwater condition used for the analyses was based on the groundwater levels noted during drilling.

6.5.5.1 Stability

Due to the relatively short length (about 120 m) of embankment for this swamp crossing, the critical section (i.e. the greatest embankment height and/or maximum thickness of soft, compressible foundation soils) for this area encompasses the full length of the swamp, located between about STA 17+230 and 17+350. The stability analysis performed on the critical section(s) indicates that after the completion of construction (including removal and replacement of the very soft organic deposits), the embankment will have a Factor of Safety (FoS) less than 1.0

(i.e. slope failure) for a deep-seated, global failure surface that would impact the operation of the roadway. The stability analysis performed also indicates that a FoS equal to or greater than 1.3 or greater cannot be achieved by staged construction methods at this location.

To achieve a FoS equal to or greater than 1.3 for the proposed 8.5 m high embankment fill, it would be necessary to construct rock fill berms along the toes of the embankment. Stability analysis indicates that a 2.5 m high by 12 m wide rock fill berms at the level of the existing ground surface would be required along the outside embankment toe (i.e. west side of the SBL alignment) for the full length of the swamp crossing, as shown on Figure C1. The stability analysis indicates that the east side of the embankment (i.e. in the median between the NBL and SBL alignment) would have a FoS greater than 1.3 due to the proximity to the NBL embankment, as shown on Figure C2. It should be noted that the stability analysis assumes all organic material within the footprint of the berm and embankment are removed prior to the construction and that the construction of the NBL embankment will be concurrent with the construction of the SBL embankment.

The size of the toe berm required for the embankment stability at the critical section(s) is not considered to be practical and as such, other stability mitigation options should be considered, including full sub-excavation and removal of the weak/soft cohesive deposit or the use of lightweight fill to reduce the driving forces.

6.5.5.2 Settlement

To estimate the magnitude of the expected settlements due to new construction, analysis was carried out on the critical section(s) representative of the subsurface conditions within the swamp crossing area, located between about STA 17+265 and 17+325.

Based on the results of the settlement analysis, the settlement of the foundation soils at the critical section(s) is estimated to be about 435 mm, excluding the settlement of the embankment rock fill itself. This settlement is estimated to be comprised of about 240 mm of immediate settlement due to compression of the non-cohesive deposits and about 195 mm of primary consolidation within the cohesive deposit.

Based on an average coefficient of consolidation (c_v) of about 3.0 x 10^{-3} cm^2/s estimated for the cohesive deposit and the imposed loading conditions, and assuming two way drainage of the approximately 1.3 m thick cohesive deposit, it is estimated that about 90 per cent of the primary consolidation settlement will be completed in about 15 days.

The magnitude of secondary consolidation (creep) settlement for the cohesive deposit is expected to be about 15 mm per log-cycle of time for this area corresponding to about 40 mm over a 10-year period following completion of construction.

Based on a 8.5 m high embankment plus about 0.5 m of additional rock fill required after removal of the organic deposits, the short-term post-construction settlement of the rock fill is estimated to be about 70 mm at the critical section(s). In addition, the long-term post-construction settlement of the rock fill is estimated to be about 10 mm.

6.5.5.3 Mitigation of Stability Issues and/or Time Dependent Settlements

The presence of an up to 2.6 m thick clayey silt to clay deposit and the up to about 0.5 m thick organic deposit requiring sub-excavation and replacement influences both the stability and the settlement for the proposed 8.5 m high embankment. In order to construct the embankment to achieve a FoS equal to or greater than 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 C1 in Appendix C. Considering the relatively small area requiring foundation treatment, full sub-excavation with preloading of the rock fill for a duration of 120 days is ranked as the preferred option for this area, consistent with the preferred alternative for stability/settlement similar length section of the same swamp.

Full Sub-Excavation

The bottom of the cohesive deposit is up to about 5.5 m below existing ground surface within the proposed embankment footprint at this location. Full sub-excavation of the cohesive deposit to this depth in this area is considered feasible and would be the best technical solution in terms of the long-term performance of the roadway.

Since the groundwater table is located at or near the ground surface, the majority of the sub-excavation would have to be carried out 'in-the-wet' (i.e. below the water level). Excavation 'in-the-wet' results in less risk of instability and base heave than under dry conditions but will create more uncertainty regarding full removal of the cohesive deposits. Excavation 'in-the-wet' to remove the cohesive deposit in this area should be carried out with side slopes no steeper than 1H:1V to limit the risk of instability. Complete removal of the cohesive deposit should extend to a horizontal distance beyond the toe of the proposed embankment equal to the horizontal component of the side slope profile (i.e. 1.25 for rock fill) multiplied by the depth to the bottom of the cohesive deposit below the ground surface (in accordance to OPSD 203.010 – Embankment Over Swamp). Where there may be a restriction in space due to the proximity of the excavation to an existing roadway and depending on the sequence of construction of the adjacent new roadway alignment (i.e. the proposed Existing Shebeshekong Road overpass), a temporary support/protection system may be required to support the existing roadway adjacent to the excavation. Details regarding the recommendations for staged excavation of organics and weak/soft deposits and temporary shoring are provided in Section 6.6.2.

It should be noted, however, that full sub-excavation of the cohesive deposit would increase the effective thickness of the new embankment fill by up to about an additional 5 m (i.e. for a total below-grade rock fill thickness of about 5.5 m). The additional below-grade fill would need to be constructed with the same side slope profile as that used for the above-grade embankment (OPSD 203.010). Based on an 8.5 m high embankment plus about 5.5 m of additional rock fill required after full sub-excavation, the short-term and long-term post-construction settlement of the rock fill is estimated to be about 145 mm and 20 mm, respectively, at the critical section(s).

In order to satisfy the long-term settlement performance criterion of the embankment, the rock fill embankment should be preloaded for a minimum period of 120 days. The magnitude of the remaining short-term and long-term post-construction settlement of the rock fill after the recommended preload period is estimated to be about 40 mm and 20 mm, respectively.

Preloading with Toe Berms

Based on the estimated coefficient of consolidation (c_v about 3.0×10^{-3} cm^2/s) for the cohesive deposit, it is estimated that 90 per cent of primary consolidation settlement will be completed in about 15 days. However, if preloading is adopted as the foundation mitigation option at this location, to eliminate the need for instrumentation and settlement monitoring during and after the construction of the embankment and to meet the settlement performance criterion, it is recommended that a preload period of 90 days be included in the construction schedule. However, for this foundation alternative, a toe berm (2.5 m high by 12 m wide) at the level of the existing ground surface along the outside embankment toe (i.e. west side of the SBL alignment) would be required for the full length of the swamp crossing in order to maintain a Factor of Safety equal to or greater than 1.3. The stability analysis indicates that the west side of the (i.e. in the median between the NBL and SBL alignment) would have a FoS greater than 1.3 due to the proximity to NBL embankment. Details regarding the recommendations for staged excavation of organics and temporary shoring are provided in Section 6.6.2.

The magnitude of remaining primary consolidation settlement, secondary consolidation settlement and the settlement due to compression of the rock fill is estimated to be about 60 mm within the first 10 years following completion of construction.

Given the very large size of the toe berm required to maintain embankment stability on the outside embankment toe, preloading is not considered to be practical for this area.

Preloading with Staged Construction

Consideration was given to staged construction for the up to about 8.5 m high embankment. However, stability analyses indicate that there is insufficient strength gain in the cohesive deposit to maintain a FoS equal to or greater than 1.3 greater through the embankment construction period. As such, staged construction is not recommended for this area.

Surcharging with Toe Berms

Based on the estimated coefficient of consolidation (c_v about 3.0×10^{-3} cm^2/s) for the cohesive deposit and a surcharge fill 2 m high, it is estimated that 90 per cent of primary consolidation settlement will be completed in about 10 days. However, if surcharging is adopted as the foundation mitigation option at this location, to eliminate the need for instrumentation and settlement monitoring during and after the construction of the embankment plus surcharge as well as to meet the settlement performance criterion, it is recommended that a surcharge period of 50 days be included in the construction schedule. Based on the stability analysis with a 2 m high surcharge, a 2.5 m high by 14 m wide toe berm at the level of the existing ground surface along the outside embankment toe (i.e. west side of the SBL alignment) would be required for the full length of the swamp crossing to maintain a Factor of Safety equal to or greater than 1.3. In view of the short duration recommended for the full sub-excavation with preloading mitigation option (i.e. 120 days), the small amount of secondary (creep) settlement expected and the additional embankment fill required for the larger toe berm, surcharging is not considered to offer any significant advantage as a mitigation option for this area. Details regarding the recommendations for staged excavation of organics and temporary shoring are provided in Section 6.6.2.

The estimated post-construction settlement of the embankment, after surcharge removal, is 60 mm, comprised of 10 mm secondary consolidation settlement and 50 mm of rock fill settlement. Given the very large size of the toe berms required to maintain embankment stability on the outside embankment toe, surcharging is not considered to be practical for this area.

Wick Drains

Due to the limited thickness of the cohesive deposit (between about 0.5 m and 2.6 m), the use of wick drains to reduce the amount of time required for primary consolidation settlement is not considered to be practical for this area.

Lightweight Fill

In order to reduce the loads imposed by the 8.5 m high embankment on the compressible foundation soils, the use of lightweight fill (i.e. expanded polystyrene (EPS)) could be considered for this area. The use of this material for the embankment fill would eliminate the need for stabilizing toe berms and would result in very little long-term time-dependent (consolidation) settlement of the foundation soils. However, considering the volume of EPS fill required to construct the up to 8.5 m high by 120 m long embankment in this area, the cost will be an order of magnitude higher for this alternative than other mitigation options.

Aggregate Piers

Based on the results of limit equilibrium stability analysis, it is estimated that a high area replacement ratio (R_A – the ratio of the total area of aggregate pies to the area of the surrounding untreated soil in a unit area) would be required to achieve adequate stability at the critical section of Swamp 25. Given this and the associated high costs of achieving the required R_A in the field, the use of aggregate piers is not considered as a practical settlement or stability mitigation alternative for this area.

6.5.6 Highway 69 NBL – STA 17+150 to 17+350 (Swamp 25)

The area extending from about STA 17+150 to 17+350 along the proposed Highway 69 Northbound lanes (NBL) alignment requires a new embankment up to about 9 m high to achieve the proposed vertical highway profile. The natural topography of this section of proposed highway is relatively flat to low-lying consisting of bedrock knobs, grassy and heavily treed ground with areas of shallow open water. The swamp is bounded to the north by a valley slope and to the south by the existing Shebeshekong Road. The existing Highway 69 is located about 80 m to the east of the proposed NBL alignment.

The subsoils in this area generally consist of an up to about 2.2 m thick deposit silty sand to sand and gravel fill, up to 1.2 m thick layer of rock fill and about 0.6 m thick organic deposits (peat, organic clayey silt and organic silt) underlain by a deposit of very loose to compact sandy silt to sand up to about 4.1 m thick. The sandy silt to sand deposit is underlain by a deposit of very soft to stiff clayey silt to clay between about 0.3 m and 4 m thick, extending to a depth up to about 7.5 m below existing ground surface. At some location, the clayey silt to clay deposit is underlain by a stratum of loose silt up to about 2.3 m thick. The clayey silt to clay stratum or the silt deposit is underlain by a deposit of very loose to very dense silt and sand to sand up to about 12.2 m thick which is in turn underlain by a deposit of dense gravelly sand in places.

Bedrock outcrops are present along the northern limit of the swamp and to the south of the swamp near the existing Shebeshekong Road. Refusal to auger advancement or dynamic cone penetration was encountered at depths between about 3.4 m and 20 m below ground surface. In general, refusal was encountered at greater depths near the existing Shebeshekong Road between about STA 17+250 and 17+300.

Details of the subsurface conditions for this swamp crossing are presented in Section 4.8 and shown on Drawings C1 and C2 in Appendix C.

As noted in Section 6.2.1 on embankment fill types, the new embankment was analyzed assuming a rock fill composition and 1.25H:1V side slopes. The stability and settlement analysis assumes that the organic soils encountered at/below ground surface have been removed, (to a geometry similar to OPSD 203.010) prior to construction of the new embankment. 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. The groundwater condition used for the analyses was based on the groundwater levels noted during drilling.

6.5.6.1 Stability

Due to the relatively short length (about 200 m) of embankment for this swamp crossing, the critical section (i.e. the greatest embankment height and/or maximum thickness of soft, compressible foundation soils) for this area encompasses the full length of the swamp, between about STA 17+150 and 17+350. The stability analysis performed on the critical section(s) indicates that after the completion of construction (including removal and replacement of the very soft organic deposits), the embankment will have a Factor of Safety (FoS) less than 1.0 (i.e. slope failure) for a deep-seated, global failure surface that would impact the operation of the roadway. The stability analysis performed also indicates that a FoS equal to or greater than 1.3 cannot be achieved by staged construction methods at this location.

To achieve a FoS equal to or greater than 1.3 for the proposed 9 m high embankment fill, it would be necessary to construct rock fill berms along the toes of the embankment. Stability analysis indicates that a 2.5 m high by 22 m wide toe berm at the level of the existing ground surface would be required along the outside embankment toe (i.e. east side of the NBL alignment) for the full length of the swamp crossing, as shown on Figure C3. The stability analysis indicates that the west side of the embankment (i.e. in the median between the NBL and SBL alignment) would have a FoS greater than 1.3 due to the proximity to the SBL embankment, as shown on Figure C4. It should be noted that the stability analysis assumes all organic material within the footprint of the

berm and embankment are removed prior to the construction and that the construction of the NBL embankment will be concurrent with the construction of the NBL embankment.

The size of the toe berm required for the embankment stability at the critical section is not considered to be practical and as such, other stability mitigation options should be considered, including full sub-excavation and removal of the weak/soft cohesive deposit or the use of lightweight fill to reduce the driving forces.

6.5.6.2 Settlement

To estimate the magnitude of the expected settlements due to new construction, analysis was carried out on the critical section(s) representative of the subsurface conditions within the swamp crossing area, between about STA 17+265 and 17+325.

Based on the results of the settlement analysis, the settlement of the foundation soils at the critical section(s) is estimated to be about 720 mm, excluding the settlement of the embankment rock fill itself. This settlement is estimated to be comprised of about 85 mm of immediate settlement due to compression of the non-cohesive deposits and about 635 mm of primary consolidation within the cohesive deposit.

Based on an average coefficient of consolidation (c_v) of about 2.3 x 10^{-3} cm^2/s estimated for the cohesive deposit and the imposed loading conditions, and assuming two way drainage of the approximately 4 m thick cohesive deposit, it is estimated that about 90 per cent of the primary consolidation settlement will be completed in about 175 days.

The magnitude of secondary consolidation (creep) settlement for the cohesive deposit is expected to be about 20 mm per log-cycle of time for this area corresponding to about 30 mm over a 10-year period following completion of construction.

Based on a 9 m high embankment plus about 0.5 m of additional rock fill required after removal of the organic deposits, the short-term post-construction settlement of the rock fill is estimated to be about 75 mm at the critical section(s). In addition, the long-term post-construction settlement of the rock fill is estimated to be about 10 mm.

6.5.6.3 Mitigation of Stability Issues and/or Time Dependent Settlements

The presence of an up to 4 m thick clayey silt to clay deposit and the up to about 0.6 m thick organic deposit requiring sub-excavation and replacement influences both the stability and the settlement of the proposed 9 m high embankment. In order to construct the embankment to achieve a FoS equal to or greater than 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 C2 in Appendix C. Considering the relatively small area requiring foundation treatment, full sub-excavation with preloading of rock fill for a duration of 145 days is ranked as the preferred option for this area, consistent with the preferred alternative for stability/settlement mitigation of the SBL embankment.

Full Sub-Excavation

The bottom of the cohesive deposit is up to about 7.5 m below existing ground surface within the proposed embankment footprint at this location. Full sub-excavation of the cohesive deposit to this depth in this area is considered feasible and would be the best technical solution in terms of the long-term performance of the roadway.

Since the groundwater table is located at or near the ground surface, the majority of the sub-excavation would have to be carried out ‘in-the-wet’ (i.e. below the water level). Excavation ‘in-the-wet’ results in less risk of instability and base heave than under dry conditions but will create more uncertainty regarding full removal of the

cohesive deposits. Excavation 'in-the-wet' to remove the cohesive deposit in this area should be carried out with side slopes no steeper than 1H:1V to limit the risk of instability. Complete removal of the cohesive deposit should extend to a horizontal distance beyond the toe of the proposed embankment equal to the horizontal component of the side slope profile (i.e. 1.25 for rock fill) multiplied by the depth to the bottom of the cohesive deposit below the ground surface (in accordance to OPSD 203.010 – Embankment Over Swamp). Where there may be a restriction in space due to the proximity of the excavation to the existing roadway and depending on the sequence of construction of the adjacent new roadway alignment (i.e. the proposed Existing Shebeshekong Road overpass), a temporary support/protection system may be required to support the existing roadway adjacent to the excavation. Details regarding the recommendations for staged excavation of organics and weak/soft deposits and temporary shoring are provided in Section 6.6.2.

It should be noted, however, that full sub-excavation of the cohesive deposit would increase the effective thickness of the new embankment fill by up to about an additional 7 m (i.e. for a total below-grade rock fill thickness of about 7.5 m). The additional below-grade fill would need to be constructed with the same side slope profile as that used for the above-grade embankment (OPSD 203.010). Based on a 9 m high embankment plus about 7.5 m of additional rock fill required after full sub-excavation, the short-term and long-term post-construction settlement of the rock fill is estimated to be about 180 mm and 25 mm, respectively, at the critical section(s).

In order to satisfy the long-term settlement performance criterion of the embankment, the rock fill embankment should be preloaded for a minimum period of 145 days. The magnitude of the remaining short-term and long-term post-construction settlement of the rock fill after the recommended preload period is estimated to be about 30 mm and 25 mm, respectively.

Preloading with Toe Berms

Based on the estimated coefficient of consolidation (c_v about 2.3×10^{-3} cm^2/s) for the cohesive deposit, it is estimated that, if the cohesive deposit is left in place, 90 per cent of primary consolidation settlement will be completed in about 175 days. However, if preloading is adopted as the foundation mitigation option at this location, to eliminate the need for instrumentation and settlement monitoring during and after the construction of the embankment and to meet the settlement performance criterion it is recommended that a preload period of 260 days be included in the construction schedule. However, for this foundation alternative, a toe berm (2.5 m high by 22 m wide) at the level of the existing ground surface along the outside embankment toe (i.e. east side of the NBL alignment) would be required for the full length of the swamp crossing in order to maintain a Factor of Safety equal to or greater than 1.3. The stability analysis indicates that the west side of the embankment (i.e. in the median between the NBL and SBL alignment) would have a FoS greater than 1.3 due to the proximity to the SBL embankment. Details regarding the recommendations for staged excavation of organics and temporary shoring are provided in Section 6.6.2.

The magnitude of remaining primary consolidation settlement, secondary consolidation settlement and the settlement due to compression of the rock fill is estimated to be about 60 mm within the first 10 years following completion of construction.

Given the very large size of the toe berm required to maintain embankment stability on the outside embankment toe, preloading is not considered to be practical for this area.

Preloading with Staged Construction

Consideration was given to staged construction for the up to about 9 m high embankment. However, stability analyses indicate that there is insufficient strength gain in the cohesive deposit to maintain a FoS equal to or greater than 1.3 throughout the embankment construction period. As such, staged construction is not recommended for this area.

Surcharging with Toe Berms

Based on the estimated coefficient of consolidation (c_v about 2.3 x 10^{-3} cm^2/s) for the cohesive deposit and a surcharge fill 2 m high, it is estimated that 90 per cent of primary consolidation settlement will be completed in about 130 days. However, if surcharging is adopted as the foundation mitigation option at this location, to eliminate the need for instrumentation and settlement monitoring during and after the construction of the embankment plus surcharge as well as to meet the settlement performance criterion, it is recommended that a surcharge period of 190 days be included in the construction schedule.

Based on the stability analysis with a 2 m high surcharge, a 2.5 m high by 25 m wide toe berm at the level of the existing ground surface along the outside embankment toe (i.e. east side of the NBL alignment) would be required for the full length of the swamp crossing to maintain a Factor of Safety equal to or greater than 1.3. The stability analysis indicates that the west side of the embankment (i.e. in the median between the NBL and SBL alignment) would have a FoS above 1.3 due to the proximity to the SBL embankment. Details regarding the recommendations for staged excavation of organics and temporary shoring are provided in Section 6.6.2.

The estimated post-construction settlement of the embankment, after surcharge removal, is 50 mm comprised of 5 mm primary settlement and 15 mm rock fill settlement. Given the very large size of the toe berms required to maintain embankment stability on the outside embankment toe, surcharging is not considered to be practical for this area.

Wick Drains

Due to the limited thickness of the cohesive deposit (between about 0.6 m and 4 m) extending to a depth of up to about 7.5 m below ground surface and considering up to about 2 m thick compact non-cohesive deposit overlying the cohesive deposit, the use of wick drains to reduce the amount of time required for primary consolidation settlement is not considered to be practical and cost effective for this area.

Lightweight Fill

In order to reduce the loads imposed by the 9 m high embankment on the compressible foundation soils, the use of lightweight fill (i.e. expanded polystyrene (EPS)) could be considered for this area. The use of this material for the embankment fill would eliminate the need for stabilizing toe berms and would result in very little long-term time-dependent (consolidation) settlement of the foundation soils. However, considering the volume of EPS fill required to construct the up to 9 m high by 200 m long embankment in this area, the cost will be an order of magnitude higher for this alternative than other mitigation options.

Aggregate Piers

Based on the results of limit equilibrium stability analysis, it is estimated that a high area replacement ratio (R_A – the ratio of the total area of aggregate pies to the area of the surrounding untreated soil in a unit area) would be required to achieve adequate stability at the critical section of Swamp 25. Given this and the associated high costs of achieving the required R_A in the field, the use of aggregate piers is not considered as a practical settlement or stability mitigation alternative for this area.

6.5.7 Site 9 Road – STA 10+225 to 10+300 (Swamp 26)

The area extending from about STA 10+225 to 10+300 along the proposed Site 9 Road alignment requires a new embankment up to about 4.5 m high to achieve the proposed vertical road profile. The topography of this new section of Site 9 Road is relatively flat with ground cover consisting of shrubs, sparse trees and wet grassy areas,

located within the confines of a relatively higher densely treed area and bounded to the east by the existing Highway 69. Bedrock outcrops are present along the southern limit of the swamp.

The subsoils in this area generally consist of surficial organic and clayey silt deposit between about 0.2 m to 0.9 m thick, underlain by a deposit of very loose to compact silt to sand up to about 9.7 m thick. Beneath the silt to sand deposit at two (2) locations investigated is a dense to very dense gravelly sand to sand and gravel deposit up to about 1.4 m thick.

Bedrock outcrops are present along the southern limit of the swamp. Refusal to auger advancement or dynamic cone penetration and to the surface of the bedrock was encountered at depths between about 2.4 m and 10.1 m below ground surface. In general, refusal was encountered at shallower depths at the southern limit of the swamp, at about STA 10+200.

Details of the subsurface conditions for this swamp crossing are presented in Section 4.9 and shown on Drawing D1 in Appendix D.

Given the localized and pier ground surface pressure of the firm to stiff clayey silt in this area, stability issues are not anticipated for the proposed up to about 4.5 m high embankment, provided that all organic material and surficial clayey silt deposits are sub-excavated and replaced with granular material or rock fill. Based on the results of the settlement analysis, the settlement of the foundation soils at the critical section is estimated to be about 80 mm. This settlement is comprised of about 70 mm of immediate settlement due to compression of the non-cohesive deposits and about 10 mm of primary consolidation within the cohesive deposit. This settlement is expected to occur rapidly (i.e. during or shortly after completion of construction) in response to the filling for embankment construction.

Based on a 4.5 m high embankment plus about 0.9 m of additional rock fill required after removal of the organic and surficial clayey silt deposit, the short-term and long-term post-construction settlement of the rock fill is estimated to be about 35 mm and 5 mm, respectively, at the critical section(s).

6.6 Subgrade Preparation and Embankment Construction

As discussed in Section 6.1, the new Highway 69 four-laning for the section between Nobel and the Shawanaga River and development of the Shebeshekong Road interchange (including the associated ramps and Site 9 Road) will require the construction of numerous embankments over swamps and high fill embankments. The following sections discuss general aspects of subgrade preparation and embankment construction for the swamp crossings in Phase 2 project limits including: removal of surficial and near surface organic materials; excavation and replacement of soft subsoils; recommendations for temporary support/protection systems; staged excavation; groundwater control, where required; and embankment fill placement.

A summary of the recommended construction works for each swamp crossing is presented in Table 5. The summary contains: recommendations on embankment fill types and side slope profiles; estimated maximum depth of organics encountered; recommended preferred stability/settlement mitigation option; estimated settlement (during and post-construction) for the embankment materials and the subsoils; 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 Materials

Based on the information from the boreholes advanced during the field investigation, the thickness of organic deposits (i.e. topsoil, peat, and/or organic sand or silt) in the Phase 2 section of the proposed Highway 69 alignment generally ranges from about 0.1 m to 1.8 m. After clearing and grubbing of the swamp areas and prior to the placement of any fill for new construction, all surficial and near surface layers of topsoil and organic deposits within swamp areas should be stripped from the plan limits of the proposed works. The organics should be

removed using construction procedures in accordance with OPSS.PROV 209 (Embankments Over Swamps and Compressible Soils).

In areas where new embankments are being constructed away from existing highway embankments, the excavation limits should be carried out consistent with OPSD 203.010 (Embankments Over Swamp for New Construction) modified to remove the restrictions on the height of the embankment and the depth of excavation (i.e. Note A).

All excavations must be carried out in accordance with Ontario Regulation 213 Ontario Occupational Health and Safety Act for Construction Projects (as amended by Ontario Regulation 443). In addition, provisions for traffic control measures should be included in the Contract Documents to maintain the safe operation of Highway 69 and any associated side roads or detours during excavation operations.

6.6.2 Excavation of Soft Soils

In areas where stability and/or post-construction settlements require mitigation measures to enhance the performance of the roadway(s), excavation and replacement, either fully or partially, of soft subsoils is recommended. Excavation up to about 7.5 m below existing ground surface are anticipated in some areas of the Phase 2 section of the project where sub-excavation and replacement of soft materials is recommended as the preferred mitigation option. As such, conventional (or long-stick type) excavators should be suitable for all of the excavating operations through the swamp crossings. However, in some areas, staged excavation and/or temporary protection systems may be required to maintain stability and/or protect existing roadways. The soft subsoils should be removed using construction procedures in accordance with OPSS.PROV 209 (Embankments over Swamps and Compressible Soils).

All excavations must be carried out in accordance with Ontario Regulation 213 Ontario Occupational Health and Safety Act for Construction Projects (as amended by Ontario Regulation 443). In addition, provisions for traffic control measures should be included in the Contract Documents to maintain the safe operation of Highway 69 and any associated side roads or detours during excavation operations.

6.6.2.1 Temporary Protection Systems

Where there is restriction in space for open excavation due to the proximity to an existing roadway/open waterway, or property restrictions and depending on the sequence of construction of the adjacent new roadway alignment (i.e. proposed Existing Shebeshekong Road Overpass), a temporary support/protection system may be required to support the existing roadway adjacent to the excavation. Excavation works must be carried out in accordance with the guidelines outlined in the Occupational Health and safety Act and Regulations for Construction Projects. All temporary excavation support systems should be designed/constructed in accordance with OPSS.PROV 539 (Temporary Protection Systems). Temporary excavation support systems should be designed to Performance Level 2 for any excavation adjacent to existing roadways or Performance Level 3 for excavations in other areas remote from any roadways/utilities/structures.

6.6.3 Control of Groundwater and Surface Water

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

6.6.4 Backfilling

For replacement of the sub-excavated materials, it is assumed that rock fill will be used. Where sub-excavation of soft subsoils is being carried out as a foundation mitigation option, rock fill in should be placed accordance with OPSS.PROV 206 (Grading). The rock fill is anticipated to be end dumped (below the water table) as the excavation advances. Rock fill placement above the water level is to be carried out as per OPSS.PROV 206, compacted/chinked consistent with embankment fill placement requirement.

6.6.5 Embankment Fill Placement

Placement of rock fill material for embankment construction above the water table for construction of new embankments should be carried out in accordance with the requirements as outlined in OPSS.PROV 206. The rock 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.

6.6.6 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 settlement 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. It is understood that this directive applies to all rock fill embankments as well as for granular fill embankments where widening restrictions are present (i.e. due to space/property issues, presence of a sensitive body of water and so on). It is further understood that the minimum required platform widening on major highways (i.e. including Highway 69) 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. ramps and side roads) 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 long-term 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 crossings, the minimum platform widening is summarized in Table 5.

7.0 CLOSURE

This report was prepared by Miss Madison C. Kennedy, B.A.Sc., and Messrs. Tomasz Zalucki, P. Eng., Christopher Ng, P. Eng., and Alex Szot, B.A.Sc. The technical aspects were reviewed by Mr. Christopher Ng, P. Eng., a 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.

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n:\active\2007\1111\07-1111-0029 - mrc - hwy 69 four-laning -\report\final\7 - swamp crossings - phase 2\07-1111-0029-7 rpt 16apr11 highway 69 swamp crossings - phase 2.docx

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STANDARDS:

ASTM International:

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

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
ASTM D5731	Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications

Commercial Software:

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Ministry of Transportation Ontario:

MTO Guideline for Rock Fill Settlement and Rock Fill Quantity Estimates. September 2010.

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Ontario Regulation 213/91	Construction Projects
Ontario Regulation 443/09	Amendment to Ontario Regulation 213

Ontario Provincial Standard Drawing:

OPSD 202.010	Slope Flattening Using Surplus Excavated Material on Earth or Rock Embankments.
OPSD 203.010	Embankments Over Swamp – New Construction

Ontario Provincial Standard Specification:

OPSS.PROV 206	Construction Specification for Grading
OPSS.PROV 209	Construction Specification for Embankments Over Swamps and Compressible Soils
OPSS.PROV 539	Construction Specification for Temporary Protection Systems

Ontario Water Resources Act:

Ontario Regulation 372/97	Amendment to Ontario Regulation 903
Ontario Regulation 903/90	Wells

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 δ
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 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) or With (cohesive)	Sand and Gravel / Silty Clay with sand / Clayey Silt with sand

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, recovered at full diameter, measured relative to the length of the total core run. RQD varied from 0% for completely broken core to 100% for core in solid sticks.

DISCONTINUITY DATA

Fracture Index

A count of the number of discontinuities (physical separations) in the rock core, including both naturally occurring fractures and mechanically induced breaks caused by drilling.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes or mechanically induced features caused by drilling such as ground or shattered core and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

TABLES

TABLE 1 – SUMMARY OF SWAMP CROSSINGS
HIGHWAY 69 FOUR-LANING – PHASE 2

Highway	*Approx. Station*	*Designation*	*Proposed Embankment Height*[1]	*Boreholes/DCPT*
Highway 69 SBL	15+690 to 15+720	Swamp 23	2.5 m to 7 m	7 Boreholes (S23-01 to S23-06 and S23-03A) 4 DCPTs (S23-DC01 to S23-DC03 and S23-DC07)
Highway 69 NBL	15+700 to 15+740	Swamp 23	1.5 m to 7 m	5 Boreholes (S23-07 to S23-11) 3 DCPTs (S23-DC04 to S23-DC06)
Highway 69 SBL	16+475 to 16+550	Swamp 24	8 m to 9 m	8 Boreholes (S24-01 to S24-07 and S24-09) 3 DCPTs (S24-DC01 to S24-DC03)
Highway 69 NBL	16+450 to 16+550	Swamp 24	5.5 m to 9.5 m	9 Boreholes (S24-06 and S24-08 to S24-15) 3 DCPTs (S24-DC01, S24-DC02 and S24-DC04)
Highway 69 SBL	17+230 to 17+350	Swamp 25	7 m to 8.5 m	11 Boreholes (S25-01 to S25-11) 5 DCPTs (S25-DC01 to S25-DC05)
Highway 69 NBL	17+150 to 17+350	Swamp 25	7 m to 9 m	16 Boreholes (S25-12 to S25-26 and S25-17A) 5 DCPTs (S25-DC06 to S25-DC10)
Site 9 Road	10+225 to 10+300	Swamp 26	9 m	8 Boreholes (S26-01 to S26-08) 3 DCPTs (S26-DC01 to S26-DC03)_

Note: 1. Based on centreline of highway alignments and existing ground surface profiles provided by MRC on January 10, 2007.

Prepared By: VA/MCK

Reviewed By: CN/JMAC

TABLE 2 – SUMMARY OF CONSOLIDATION TEST PARAMETERS
HIGHWAY 69 FOUR-LANING – PHASE 2

Location	*Borehole and Sample No.*	*Elevation (m)*	*σ'_{vo} (kPa)*	*σ'_p (kPa)*	*σ'_{vo} - σ'_p (kPa)*	*OCR*	*C_c*	*C_r*	*e_o*	*c_v^* (cm^2/s)*
Highway 69 – Swamp 25	Borehole S25-08 Sample 4	199.3	18	85	67	4.7	0.71	0.07	1.56	2.7×10^{-3}

Note: *For stress range of $20 \leq \sigma_v' \leq 160$ kPa

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

Prepared By: VA

Reviewed By: CN/JMAC

TABLE 3 – SUMMARY OF FOUNDATION ENGINEERING PARAMETERS HIGHWAY 69 FOUR-LANING – PHASE 2

Swamp Crossing (Approx. Station)	*Stratigraphic Unit*	*Top Elevation (m)*	*Thickness (m)*	*γ' (kN/m^3)*	*ϕ' (°)*	*c' (kPa)*	*S_u (kPa)*	*σ'_p (kPa)*	*e_o*	*C_c*	*C_r*	*m_v (kPa^{-1})*	*E' (MPa)*	*c_v (cm^2/s)*
Highway 69 SBL - STA 15+690 to 15+720 (Swamp 23)	Peat	208.8 – 208.0	0.1 – 1.8	12	27	1	-	-	-	-	-	-	-	-
	Sand	212.3 – 206.2	0.1 – 7.5	19	32	0	-	-	-	-	-	-	10 – 25	-
Highway 69 NBL - STA 15+700 to 15+740 (Swamp 23)	Peat	208.2 – 208.1	0.6 – 0.8	12	27	1	-	-	-	-	-	-	-	-
	Sand	213.5 – 207.5	4.3 – 10.2	19	32	0	-	-	-	-	-	-	10 – 25	-
	Gravelly Sand	~ 206.8	~ 1.2	19	32	-	-	-	-	-	-	-	50	-
Highway 69 SBL – STA 16+475 to 16+550 (Swamp 24)	Peat	203.1 – 202.5	0.2 – 0.7	12	27	1	-	-	-	-	-	-	-	-
	Silt	202.7 – 202.4	0.2 – 0.3	18	26	0	-	-	-	-	-	-	4	-
	Silt and Sand to Sand	202.6 – 201.9	2.8 – 14.2	18.5	31	0	-	-	-	-	-	-	10	-
	Sand to Sand and Gravel	196.4 – 191.6	1.6 – 5.8	19	32	0	-	-	-	-	-	-	20	-
Highway 69 NBL – STA 16+450 to 16+550 (Swamp 24)	Peat	202.8 – 201.9	0.1 – 1.1	12	27	1	-	-	-	-	-	-	-	-
	Silt	202.7 – 202.2	0.2 – 0.3	18	26	0	-	-	-	-	-	-	4	-
	Sandy Silt to Sand	202.5 – 200.8	2.8 – 11.7	18.5	31	0	-	-	-	-	-	-	10	-
	Sand and Gravel	~ 192.5	~ 6.2	19	32	0	-	-	-	-	-	-	20	-

TABLE 3 – SUMMARY OF FOUNDATION ENGINEERING PARAMETERS HIGHWAY 69 FOUR-LANING – PHASE 2

Swamp Crossing (Approx. Station)	*Stratigraphic Unit*	*Top Elevation (m)*	*Thickness (m)*	*γ (kN/m^3)*	*ϕ' ($^\circ$)*	*c' (kPa)*	*S_u (kPa)*	*σ'_p (kPa)*	*e_o*	*C_c*	*C_r*	*m_v (kPa^{-1})*	*E' (MPa)*	*c_v (cm^2/s)*
Highway 69 SBL – STA 17+230 to 17+350 (Swamp 25)	Peat	~ 201.8	~ 0.2	12	27	1	-	-	-	-	-	-	-	-
	Organic Silty Sand to Sand	202.0 – 201.7	0.3 – 0.6	17	28	0	-	-	-	-	-	-	-	-
	Sandy Silt to Sand	202.6 – 201.1	1.1 – 3.8	18.5	28	0	-	-	-	-	-	-	20	-
	Clayey Silt to Clay	200.0 – 199.3	0.5 – 2.6	16.5	-	-	18	80	1.5	0.9	0.09	-	-	3×10^{-3}
	Silt	198.9 – 198.0	0.9 – 2.7	18	26	0	-	-	-	-	-	-	4	-
	Silty Sand to Sand	199.1 – 195.3	2.3 – 8.6	18.5	28	0	-	-	-	-	-	-	20	-
	Sand and Gravel	190.9 – 186.7	0.5 – 1.7	19	32	0	-	-	-	-	-	-	50	-
Highway 69 NBL – STA 17+150 to 17+350 (Swamp 25)	Peat	~ 201.7	~ 0.6	12	27	1	-	-	-	-	-	-	-	-
	Organic Clayey Silt	~ 201.7	~ 0.6	15	27	0	-	-	-	-	-	-	-	-
	Organic Silt	203.1 – 201.9	0.3 – 0.6	17	27	0	-	-	-	-	-	-	-	-
	Sandy Silt to Sand (Upper Deposit)	202.4 – 201.1	0.8 – 4.1	18.5	28	0	-	-	-	-	-	-	10	-
	Clay to Clayey Silt	200.8 – 198.6	0.3 – 4.0	16.5	-	-	18	80	1.5	0.9	0.09	-	-	2.3×10^{-3}
	Silt and Sand (Pocket)	~ 198.6	~ 0.6	18.5	28	0	--	-	-	-	-	-	10	-
	Silt	200.5 – 197.3	0.3 – 2.3	18	26	0	--	-	-	-	-	-	4	-
	Silt and Sand to Sand (Lower Deposit)	199.1 – 195.8	3.0 – 10.3	18.5	28	0	-	-	-	-	-	-	20	-
	Gravelly Sand and Sand and Gravel	189.7 to 185.7	1.2 – 2.2	19	32	0	-	-	-	-	-	-	50	-

TABLE 3 – SUMMARY OF FOUNDATION ENGINEERING PARAMETERS HIGHWAY 69 FOUR-LANING – PHASE 2

Swamp Crossing (Approx. Station)	*Stratigraphic Unit*	*Top Elevation (m)*	*Thickness (m)*	*γ (kN/m^3)*	*ϕ' ($^\circ$)*	*c' (kPa)*	*S_u (kPa)*	*σ'_p (kPa)*	*e_o*	*C_c*	*C_r*	*m_v (kPa^{-1})*	*E' (MPa)*	*c_v (cm^2/s)*
Site 9 Road – STA 10+225 to 10+300 (Swamp 26)	Organic Silt	212.9 – 210.7	0.2 – 0.6	17	27	0	-	-	-	-	-	-	-	-
	Clayey Silt	211.5	0.7	16.5	-	-	25	-	-	-	-	-	-	-
	Silt to Sand	212.7 – 210.4	2.3 – 9.8	18.5	28	0	-	-	-	-	-	-	7.5	-
	Clayey Silt (Pocket)	209.4	0.8	16.5	-	-	40	-	-	-	-	1x10^{-4}	-	-
	Gravelly Sand to Sand and Gravel	209.0 – 203.7	0.1 – 1.4	19	32	0	-	-	-	-	-	-	100	-

Prepared By: VA/MCK/AJS

Reviewed By: CN/JMAC

TABLE 4 – SUMMARY OF SETTLEMENT ANALYSES

Foundation Investigation Area	*Settlement (mm) / Delay Time[1] (days)*	*Estimated Post-Construction Settlement Over 10-Year Period at the Critical Section (mm)*						*Preferred Mitigation Option*
		No Foundation Mitigation	*Preloading[2]*	*Surcharging (2 m)[2]*	*Localized Sub-Excavation With Preloading[2]*	*Full Sub-Excavation*	*Full Sub-Excavation With Preloading of Rock Fill[2]*	
Highway 69 SBL STA 15+690 to 15+720 (Swamp 23)	$\delta_{primary}$ $\delta_{secondary}$ $\delta_{rock\ fill}$ **δ_{total}** t_{delay}	0 0 80 **80** 0 days	0 0 55 **55** 45 days	- - - - -	- - - - -	- - - - -	- - - - -	Preloading of Rock Fill Embankment (45 days)
Highway 69 NBL STA 15+700 to 15+740 (Swamp 23)	$\delta_{primary}$ $\delta_{secondary}$ $\delta_{rock\ fill}$ **δ_{total}** t_{delay}	0 0 70 **70** 0 days	0 0 60 **60** 20 days	- - - - -	- - - - -	- - - - -	- - - - -	Preloading of Rock Fill Embankment (20 days)
Highway 69 SBL STA 16+475 to 16+550 (Swamp 24)	$\delta_{primary}$ $\delta_{secondary}$ $\delta_{rock\ fill}$ **δ_{total}** t_{delay}	0 0 85 **85** 0 days	0 0 60 **60** 45 days	- - - - -	- - - - -	- - - - -	- - - - -	Preloading of Rock Fill Embankment (45 days)
Highway 69 NBL STA 16+450 to 16+550 (Swamp 24)	$\delta_{primary}$ $\delta_{secondary}$ $\delta_{rock\ fill}$ **δ_{total}** t_{delay}	0 0 95 **95** 0 days	0 0 60 **60** 55 days	- - - - -	- - - - -	- - - - -	- - - - -	Preloading of Rock Fill Embankment (55 days)
Highway 69 SBL STA 17+230 to 17+350 (Swamp 25)	$\delta_{primary}$ $\delta_{secondary}$ $\delta_{rock\ fill}$ **δ_{total}** t_{delay}	Not Feasible FoS < 1	~0 25 35 **60** 90 days	~0 10 50 **60** 50 days	- - - - -	0 0 165 **165** 0 days	0 0 60 **60** 120 days	Full Sub-Excavation of Cohesive Deposit (up to about 5.5 m) with Preloading of Rock Fill Embankment (120 days)
Highway 69 NBL STA 17+150 to 17+350 (Swamp 25)	$\delta_{primary}$ $\delta_{secondary}$ $\delta_{rock\ fill}$ **δ_{total}** t_{delay}	Not Feasible FoS < 1	25 25 10 **60** 260 days	5 30 15 **50** 190 days	- - - - -	0 0 205 **205** 0 days	0 0 55 **55** 145 days	Full Sub-Excavation of Cohesive Deposit (up to about 7.5 m) with Preloading of Rock Fill Embankment (145 days)

TABLE 4 – SUMMARY OF SETTLEMENT ANALYSES

Foundation Investigation Area	*Settlement (mm) / Delay Time[1] (days)*	*Estimated Post-Construction Settlement Over 10-Year Period at the Critical Section (mm)*						*Preferred Mitigation Option*
		No Foundation Mitigation	*Preloading[2]*	*Surcharging (2 m)[2]*	*Localized Sub-Excavation With Preloading[2]*	*Full Sub-Excavation*	*Full Sub-Excavation With Preloading of Rock Fill[2]*	
Site 9 Road – STA 10+225 to 10+300 (Swamp 26)	$\delta_{primary}$	0	-	-	-	-	-	No foundation mitigation measures required
	$\delta_{secondary}$	0	-	-	-	-	-	
	$\delta_{rock\ fill}$	40	-	-	-	-	-	
	δ_{total}	**40**	-	-	-	-	-	
	t_{delay}	0 days	-	-	-	-	-	

Note: [1] Delay time refers to the preload or surcharge time.

[2] Refer to Section 6.5 and Tables C1 and C2 for the recommended preload and surcharge durations and requirements for stability berms, where necessary.

Prepared By: TZ/VA/MCK/AJS

Reviewed By: CN/JMAC

TABLE 5 – SUMMARY OF PREFERRED FOUNDATION MITIGATION OPTIONS

Highway (Designation)	*Proposed Work (Maximum Fill Height)*	*Topography and Surface Conditions*	*Recommended Embankment Fill Type, Side Slope and Platform Widening*	*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 10-Year Period at the Critical Section*	*Standards for Swamp Excavation / Removal of Organics*
Highway 69 SBL STA 15+690 to 15+720 (Swamp 23)	Swamp Crossing (7 m)	Relatively flat with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the swamp. Bedrock outcrops are present along the southern limit of the swamp.	Rock Fill 1.25H : 1V 2 m per side	Peat up to about 1.8 m below ground surface.	Sub-Excavation of peat (up to about 1.8 m deep) Preloading of Rock Fill (45 days)	$\delta_{Primary}$ = 0 mm $\delta_{Immediate}$ = 60 mm $\delta_{Rock\ Fill}$ = 25 mm	$\delta_{Primary}$ = 0 mm $\delta_{Secondary}$ = 0 mm $\delta_{Rock\ Fill}$ = 55 mm	OPSD 203.010 OPSS.PROV 206 OPSS.PROV 209
Highway 69 NBL STA 15+700 to 15+740 (Swamp 23)	Swamp Crossing (7 m)	Relatively flat with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the swamp. Bedrock outcrops are present along the southern limit of the swamp.	Rock Fill 1.25H : 1V 2 m per side	Peat up to about 0.8 m below ground surface.	Sub-Excavation of peat (up to about 0.8 m deep) Preloading of Rock Fill (20 days)	$\delta_{Primary}$ = 0 mm $\delta_{Immediate}$ = 65 mm $\delta_{Rock\ Fill}$ = 25 mm	$\delta_{Primary}$ = 0 mm $\delta_{Secondary}$ = 0 mm $\delta_{Rock\ Fill}$ = 60 mm	OPSD 203.010 OPSS.PROV 206 OPSS.PROV 209
Highway 69 SBL STA 16+475 to 16+550 (Swamp 24)	Swamp Crossing (9 m)	Relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the swamp. Bedrock outcrops are present along the southern limit of the swamp.	Rock Fill 1.25H : 1V 2 m per side	Peat up to about 0.7 m below ground surface.	Sub-Excavation of peat (up to about 0.7 m deep) Preloading of Rock Fill (45 days)	$\delta_{Primary}$ = 0 mm $\delta_{Immediate}$ = 195 mm $\delta_{Rock\ Fill}$ = 25 mm	$\delta_{Primary}$ = 0 mm $\delta_{Secondary}$ = 0 mm $\delta_{Rock\ Fill}$ = 60 mm	OPSD 203.010 OPSS.PROV 206 OPSS.PROV 209

TABLE 5 – SUMMARY OF PREFERRED FOUNDATION MITIGATION OPTIONS

Highway (Designation)	*Proposed Work (Maximum Fill Height)*	*Topography and Surface Conditions*	*Recommended Embankment Fill Type, Side Slope and Platform Widening*	*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 10-Year Period at the Critical Section*	*Standards for Swamp Excavation / Removal of Organics*
Highway 69 NBL STA 16+450 to 16+550 (Swamp 24)	Swamp Crossing (9.5 m)	Relatively flat to low-lying with ground cover consisting of shrubs and wet grassy areas, located within the confines of tree covered valley slopes at the north and south limits of the swamp. Bedrock outcrops are present along the southern limit of the swamp.	Rock Fill 1.25H : 1V 2 m per side	Peat up to about 1.1 m below ground surface.	Sub-Excavation of peat (up to about 1.1 m deep) Preloading of Rock Fill (55 days)	$\delta_{Primary}$ = 0 mm $\delta_{Immediate}$ = 220 mm $\delta_{Rock\ Fill}$ = 35 mm	$\delta_{Primary}$ = 0 mm $\delta_{Secondary}$ = 0 mm $\delta_{Rock\ Fill}$ = 60 mm	OPSD 203.010 OPSS.PROV 206 OPSS.PROV 209
Highway 69 SBL STA 17+230 to 17+350 (Swamp 25)	Swamp Crossing (8.5 m)	Relatively flat to low-lying consisting of bedrock knobs, grassy and heavily treed ground with areas of shallow open water. The swamp is bounded to the north by a valley slope and to the south by the existing Shebeshekong Road. Bedrock outcrops are present to the north and south of the swamp.	Rock Fill 1.25H : 1V 2 m per side	Peat up to about 0.6 m below ground surface.	Full Sub-Excavation of clay to clayey silt deposit (up to about 5.5 m deep) Preloading of Rock Fill (120 days)	$\delta_{Primary}$ = 0 mm $\delta_{Immediate}$ = 280 mm $\delta_{Rock\ Fill}$ = 90 mm	$\delta_{Primary}$ = 0 mm $\delta_{Secondary}$ = 0 mm $\delta_{Rock\ Fill}$ = 60 mm	OPSD 203.010 OPSS.PROV 206 OPSS.PROV 209
Highway 69 NBL STA 17+150 to 17+350 (Swamp 25)	Swamp Crossing (9 m)	Relatively flat to low-lying consisting of bedrock knobs, grassy and heavily treed ground with areas of shallow open water. The swamp is bounded to the north by a valley slope and to the south by the existing Shebeshekong Road. Bedrock outcrops are present to the north and south of the swamp.	Rock Fill 1.25H : 1V 2 m per side	Peat and organic silt deposit 0.6 m thick; up to about 1.5 m below ground surface.	Full Sub-Excavation of clay to clayey silt deposit (up to about 7.5 m deep) Preloading of Rock Fill (145 days)	$\delta_{Primary}$ = 0 mm $\delta_{Immediate}$ = 85 mm $\delta_{Rock\ Fill}$ = 125 mm	$\delta_{Primary}$ = 0 mm $\delta_{Secondary}$ = 0 mm $\delta_{Rock\ Fill}$ = 55 mm	OPSD 203.010 OPSS.PROV 206 OPSS.PROV 209

TABLE 5 – SUMMARY OF PREFERRED FOUNDATION MITIGATION OPTIONS

Highway (Designation)	*Proposed Work (Maximum Fill Height)*	*Topography and Surface Conditions*	*Recommended Embankment Fill Type, Side Slope and Platform Widening*	*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 10-Year Period at the Critical Section*	*Standards for Swamp Excavation / Removal of Organics*
Site 9 Road – STA 10+225 to 10+300 (Swamp 26)	Swamp Crossing (4.5 m)	Relatively flat with ground cover consisting of shrubs, sparse trees and wet grassy areas, located within the confines of a relatively higher densely treed area and bounded to the east by the existing Highway 69. Bedrock outcrops are present along the southern limit of the swamp.	Rock Fill 1.25H : 1V 2 m per side	Topsoil and organic silt up to 0.6 m below ground surface.	Sub-Excavation of surficial topsoil, organic silt and clayey silt (up to about 0.9 m deep) No foundation mitigation options required	$\delta_{Primary}$ = 10 mm $\delta_{Immediate}$ = 70 mm $\delta_{Rock\ Fill}$ = 0 mm	$\delta_{Primary}$ = 0 mm $\delta_{Secondary}$ = 0 mm $\delta_{Rock\ Fill}$ = 40 mm	OPSD 203.010 OPSS.PROV 206 OPSS.PROV 209

Note: [1] Depths do not include any ponded water that may be present over the peat.
[2] In all swamp crossing, removal of organic deposits (i.e. topsoil, peat and/or organic silt/sand) is required prior to embankment construction.
[3] Full sub-excavation implies complete removal of soft, compressible cohesive deposits.

Prepared By: TZ/MCK/AJS

Reviewed By: CN/JMAC

DRAWINGS

MINISTRY OF TRANSPORTATION, ONTARIO

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

CONT No.
GWP No. 5111-07-00

SHEET

HIGHWAY 69
SITE LOCATION PLAN

Golder Associates

KEY PLAN
NOT TO SCALE

N 5050000
N 5040000
N 5030000
E 240000
E 250000
E 260000

SHAWANAGA RIVER BRIDGE NBL & SBL
(WP 5187-06-01 & 5188-06-01)
AND
SHAWANAGA RIVER SERVICE ROAD BRIDGE
(WP 5186-06-01)

SHEBESHEKONG ROAD
INTERCHANGE
SHEBESHEKONG ROAD UNDERPASS
(WP 5183-06-01)

NEW WOODS ROAD INTERCHANGE
NEW WOODS ROAD UNDERPASS
(WP 5180-06-01)

SNOWMOBILE CULVERT NBL & SBL
(WP 5180-06-01
& 5182-06-01)

GWP PHASE 2 5111-07-00
GWP PHASE 1 5402-05-00
HIGHWAY 69
SHAWANAGA RIVER
SHEBESHEKONG ROAD
SKERRYVORE ROAD
WOODS ROAD
HIGHWAY 559

SHAWANAGA FIRST NATION
THE ARCHIPELAGO SHAWANAGA FIRST NATION
THE ARCHIPELAGO SHAWANAGA
SHAWANAGA CARLING
THE ARCHIPELAGO CARLING
WHITESTONE THE ARCHIPELAGO
WHITESTONE SHAWANAGA
WHITESTONE MCDOUGALL
WHITESTONE CARLING
MCDOUGALL CARLING

GEORGIAN BAY
NOBEL
CARLING

PLAN
SCALE
1 0 1 2 km

REFERENCE
Base Data – MNR NRVIS, obtained 2004, CANMAP v2006.4
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, ©Queens Printer 2008
Datum : NAD 83 Projection : MTM Zone 10

NO.	DATE	BY	REVISION

Geocres No. 41H-161

HWY. 69		PROJECT NO. 07-1111-0029	DIST.
SUBM'D. VA	CHKD. VA/OK	DATE: May 2012	SITE:
DRAWN: JFC/CD	CHKD. CN	APPD. JPD/JMAC	DWG. 1

PLOT DATE: April 7, 2016
FILENAME: T:\Projects\2007\07-1111-0029 (MNC, Parry Sound)\-GC- Swamp Report - Phase 2 (5020) (5021)\07111102390C001.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

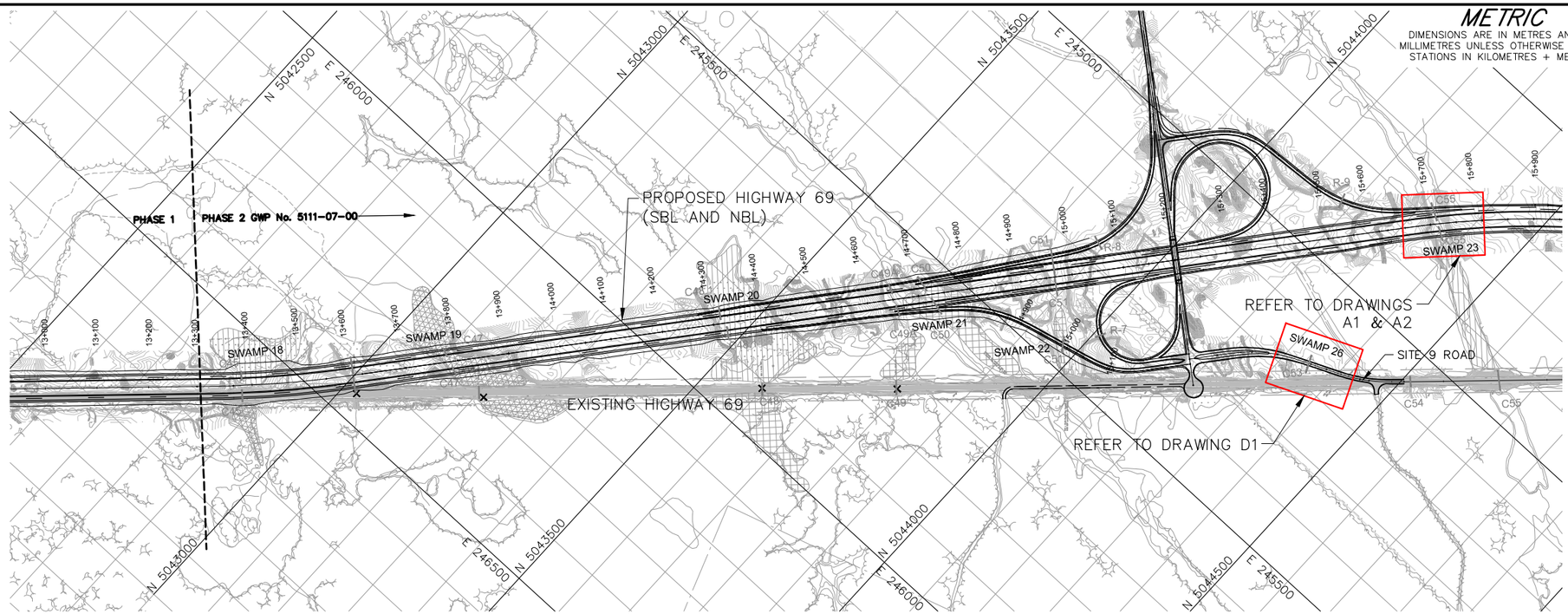
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5111-07-00

HIGHWAY 69
SWAMP CROSSINGS – PHASE 2
INDEX PLAN

SHEET

Golder Associates



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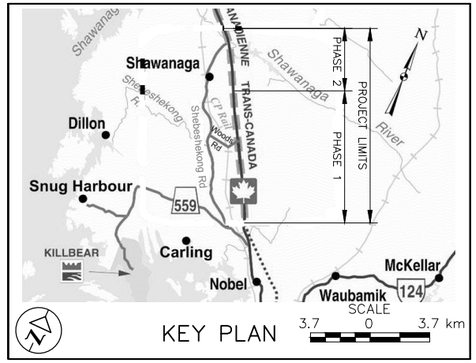

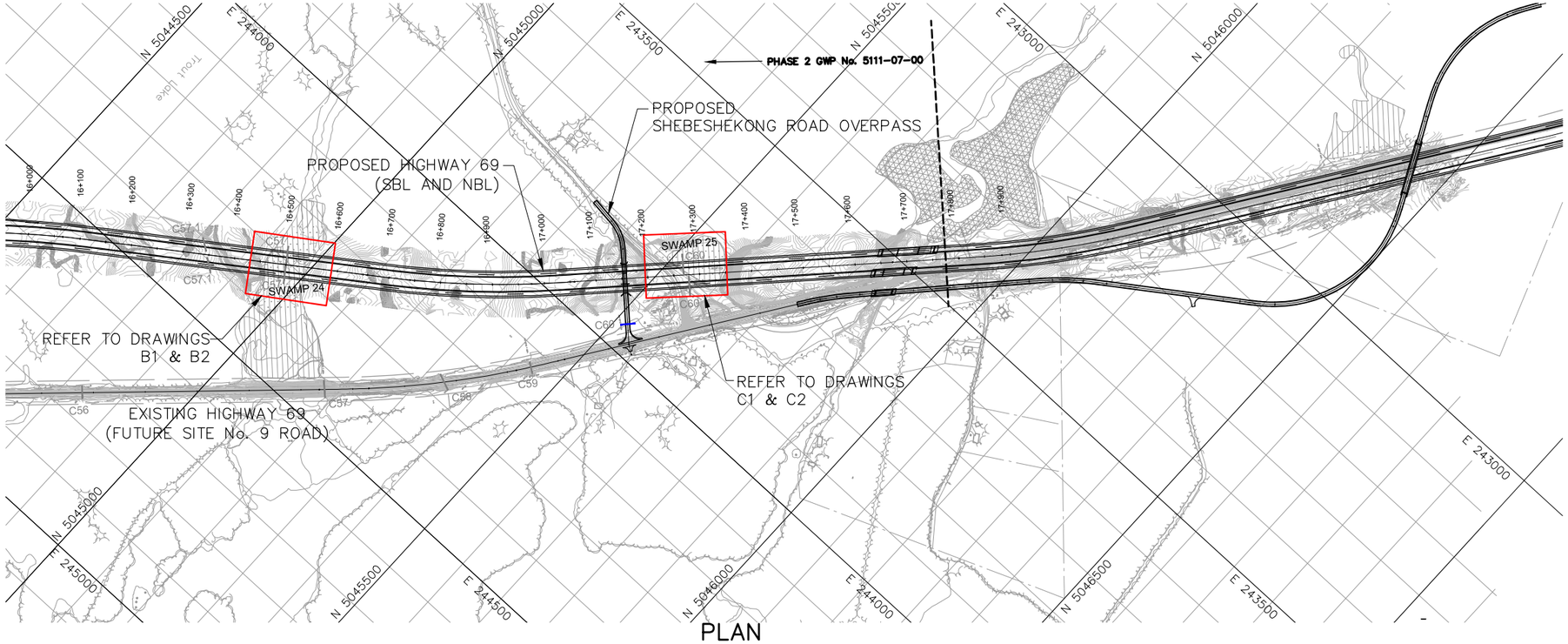

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NOTE

Crossing at Swamp 18 to Swamp 22 within the Phase 2 limits are reported in "Swamp Crossing and High Fill Areas – Phase 1" report Geocres No. 41H-73 dated November 2011, (Golder 2011).

REFERENCE

Base plans provided in digital format by MRC, drawing file 5271XB01.DWG, 5271-XPD-ARCHIPELAGO.dwg, 5271-XPD-Carling.dwg, 5271-XPD-SHAWANAGA.dwg, PR # 5377-02-00-PR-1.dwg, received October 1, 2007, and h6878_PHASE1_XA1, h6878_PHASE1_XN1.dwg, received January 21, 2009, h6878_PHASE2_XA1, h6878_PHASE2_XN1.dwg, received January 21, 2009.

NO.	DATE	BY	REVISION

Geocres No. 41H-161

HWY. 69	PROJECT NO. 07-1111-0029		DIST.
SUBM'D. VA	CHKD. VA/OK	DATE: Nov. 2009	SITE:
DRAWN: DD/RJ	CHKD. CN	APPD. JPD/JMAC	DWG. 2

PLOT DATE: April 12, 2016
FILENAME: T:\Projects\2007\07-1111-0029 (MRC, Parry Sound)\-00- Swamp Report - Phase 2 (5020) (5021)\071111002900202.dwg

APPENDIX A

Highway 69 SBL – STA 15+690 to 15+720 and Highway 69 NBL – STA 15+700 to 15+740 (Swamp 23)

MINISTRY OF TRANSPORTATION, ONTARIO

METRIC

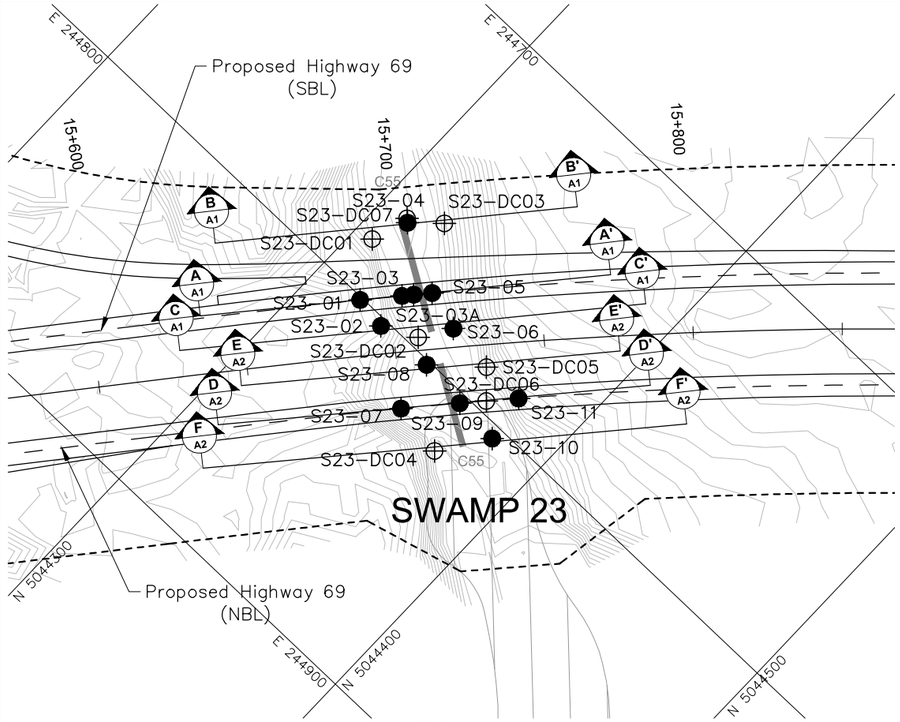
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5111-07-00

HIGHWAY 69 (SBL) STA 15+690 TO STA 15+720
HIGHWAY 69 (NBL) STA 15+700 TO STA 15+740
BOREHOLE LOCATIONS AND SOIL STRATA

SHEET

Golder Associates



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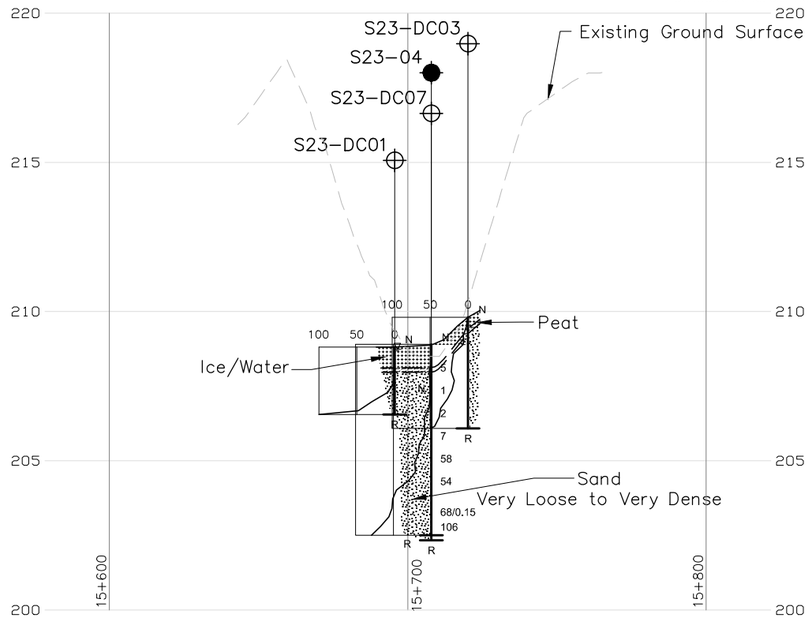

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HIGHWAY 69 (SBL)
HORIZONTAL SCALE
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VERTICAL SCALE
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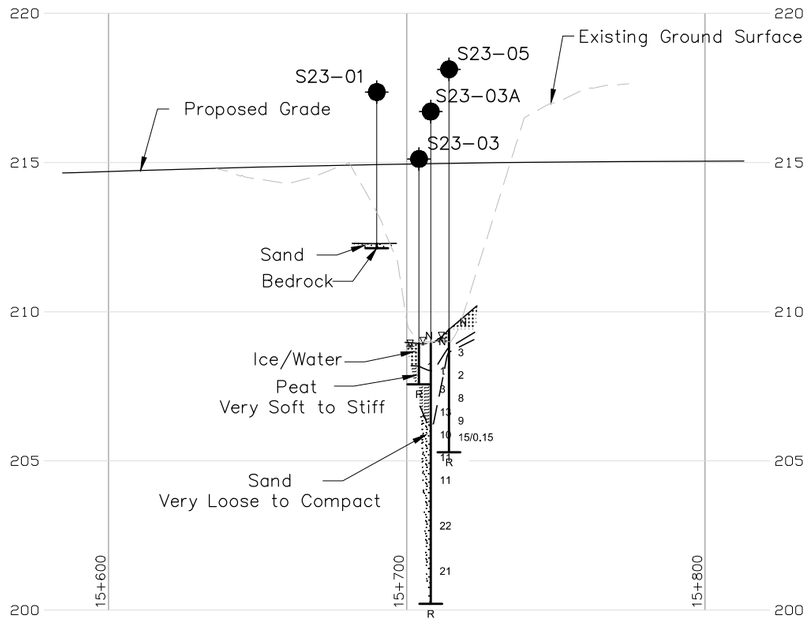

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HIGHWAY 69 (SBL)
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VERTICAL SCALE
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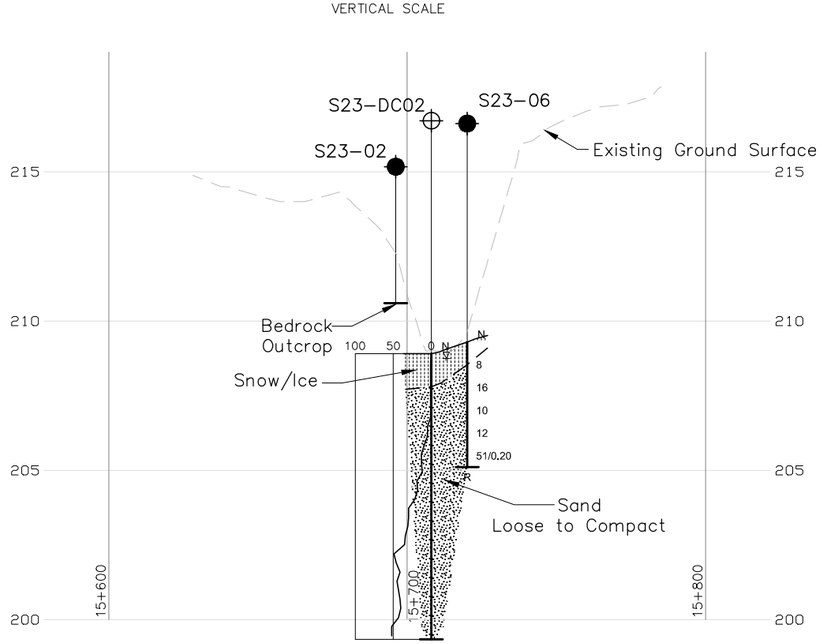

C-C' A1 EMBANKMENT TOE PROFILE
HIGHWAY 69 (SBL)
HORIZONTAL SCALE
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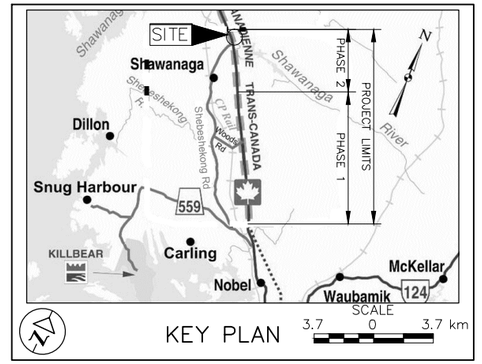
VERTICAL SCALE
2 0 2 4 m



KEY PLAN

LEGEND

- Borehole – Current Investigation
- 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
- R Refusal

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
S23-01	212.3	5044317.4	244800.9
S23-02	210.6	5044328.5	244802.4
S23-03	208.9	5044326.7	244790.2
S23-03A	208.9	5044329.2	244787.2
S23-04	208.9	5044311.1	244771.2
S23-05	209.4	5044333.3	244782.6
S23-06	209.3	5044346.7	244786.3
S23-07	209.0	5044352.4	244817.8
S23-08	208.9	5044348.5	244801.3
S23-09	208.9	5044365.5	244803.0
S23-10	209.4	5044381.5	244804.1
S23-11	213.5	5044378.7	244788.3
S23-DC01	208.8	5044306.3	244783.3
S23-DC02	208.9	5044340.2	244796.6
S23-DC03	209.8	5044320.2	244762.8
S23-DC04	208.8	5044370.3	244820.4
S23-DC05	211.9	5044363.7	244788.1
S23-DC06	209.5	5044371.4	244796.3
S23-DC07	208.9	5044310.0	244770.2

NOTES

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

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

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.

LICENSED PROFESSIONAL ENGINEER J. M. A. COSTA Apr. 06, 2016 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.P. DITTRICH Apr. 06, 2016 PROVINCE OF ONTARIO

REFERENCE

Base plans provided in digital format by MRC, drawing file 5271XB01.DWG, 5271-XPD-ARCHIPELAGO.dwg, 5271-XPD-Carling.dwg, 5271-XPD-SHAWANAGA.dwg, PR # 5377-02-00-PR-1.dwg, received October 1, 2007, and h6878_PHASE1_XA1, h6878_PHASE1_XN1.dwg, received January 21, 2009, h6878_PHASE2_XA1, h6878_PHASE2_XN1.dwg, received January 21, 2009.

NO.	DATE	BY	REVISION

Geocres No. 41H-161

HWY. 69	PROJECT NO. 07-1111-0029		DIST.
SUBM'D. VA	CHKD. VA/OK	DATE: Nov. 2009	SITE:
DRAWN: DD/RJ	CHKD. CN	APPD. JPD/JMAC	DWG. A1

PLOT DATE: April 6, 2016
FILENAME: I:\Projects\2007\07-1111-0029 (MRC, Parry Sound)\-GC- Swamp Report - Phase 2 (2920) (2021)\07111102920GA1.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

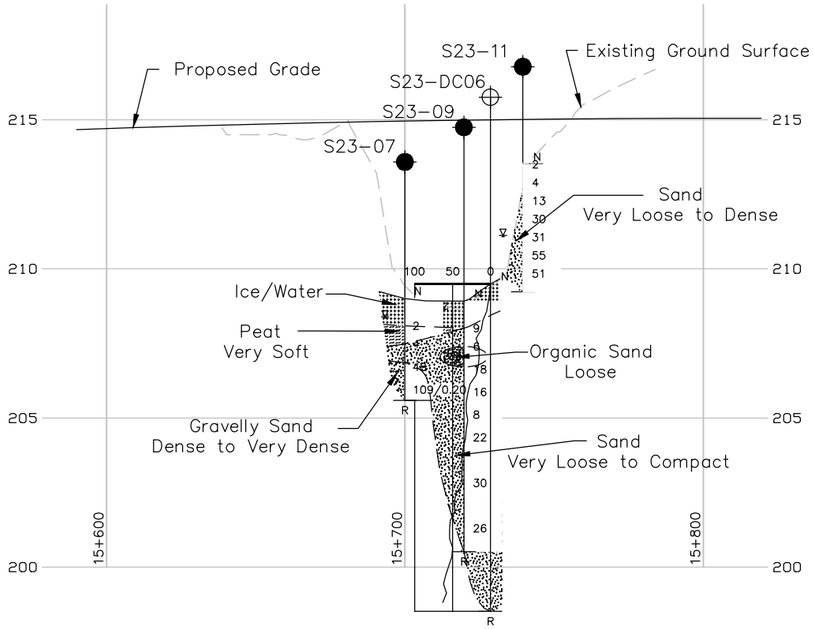
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5111-07-00

HIGHWAY 69 (NBL) STA 15+700 TO STA 15+740
SOIL STRATA

SHEET

Golder Associates



D-D' A1 CENTRELINE PROFILE
HIGHWAY 69 (NBL)
HORIZONTAL SCALE
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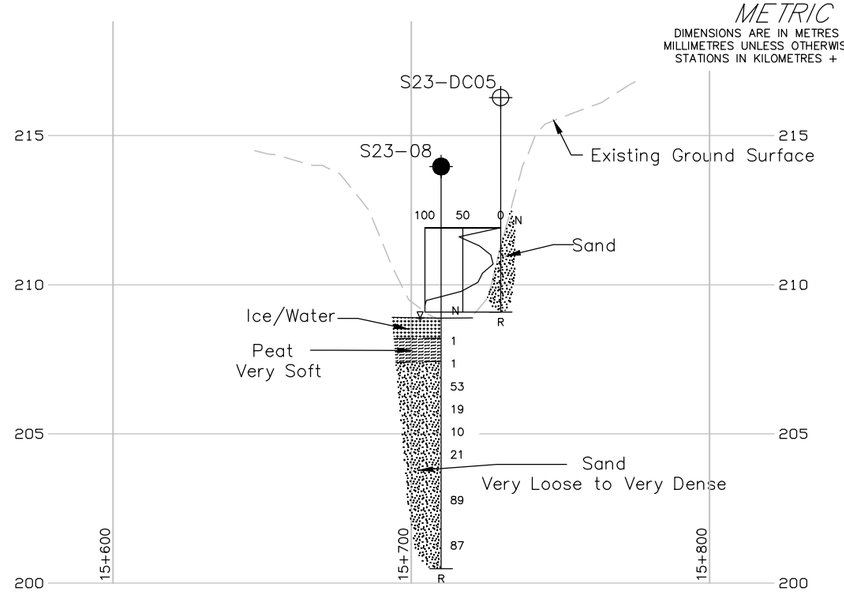
2 0 2 4 m
VERTICAL SCALE



E-E' A1 EMBANKMENT TOE PROFILE
HIGHWAY 69 (NBL)
HORIZONTAL SCALE
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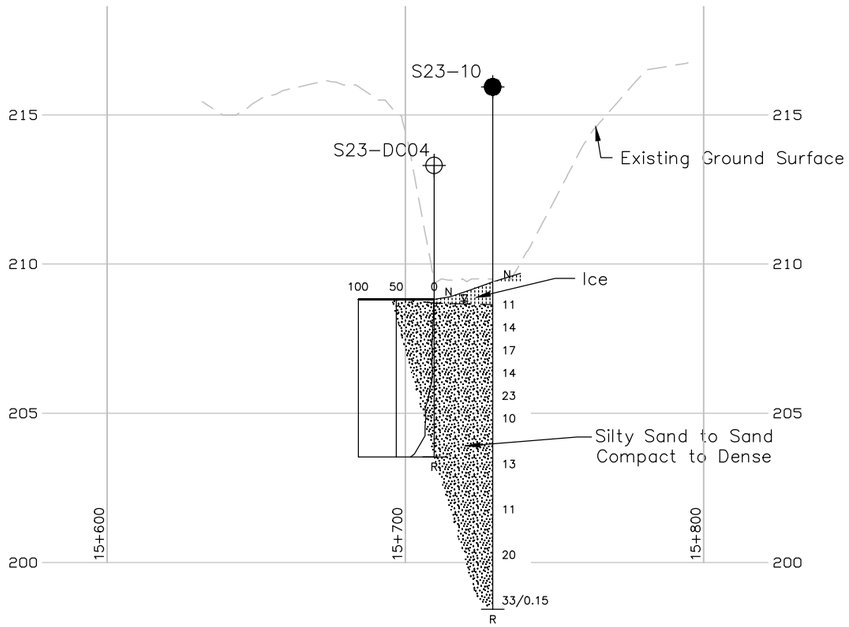
2 0 2 4 m
VERTICAL SCALE



F-F' A1 EMBANKMENT TOE PROFILE
HIGHWAY 69 (NBL)
HORIZONTAL SCALE
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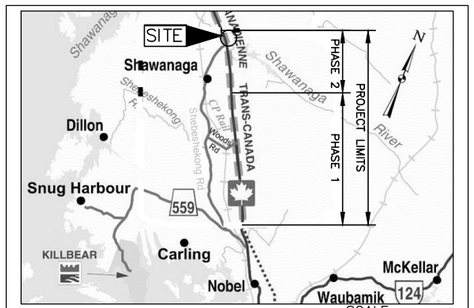
2 0 2 4 m
VERTICAL SCALE



KEY PLAN

LEGEND

- Borehole – Current Investigation
- 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
- R Refusal

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
S23-07	209.0	5044352.4	244817.8
S23-08	208.9	5044348.5	244801.3
S23-09	208.9	5044365.5	244803.0
S23-10	209.4	5044381.5	244804.1
S23-11	213.5	5044378.7	244788.3
S23-DC04	208.8	5044370.3	244820.4
S23-DC05	211.9	5044363.7	244788.1
S23-DC06	209.5	5044371.4	244796.3

NOTES

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

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

The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in 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 MRC, drawing file 5271XB01.DWG, 5271-XPD-ARCHIPELAGO.dwg, 5271-XPD-Carling.dwg, 5271-XPD-SHAWANAGA.dwg, PR # 5377-02-00-PR-1.dwg, received October 1, 2007, and h6878_PHASE1_XA1, h6878_PHASE1_XN1.dwg, received January 21, 2009, h6878_PHASE2_XA1, h6878_PHASE2_XN1.dwg, received January 21, 2009.

LICENSED PROFESSIONAL ENGINEER J. M. A. COSTA Apr. 06, 2016 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.P. DITTRICH Apr. 06, 2016 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41H-161

HWY. 69		PROJECT NO. 07-1111-0029	DIST.
SUBM'D. VA	CHKD. MCK	DATE: Nov. 2009	SITE:
DRAWN: DD/RJ	CHKD. CN	APPD. JPD/JMAC	DWG. A2

PLOT DATE: April 6, 2016
FILENAME: I:\Projects\2007\07-1111-0029 (MRC, Parry Sound)\-DC- Swamp Report - Phase 2 (2025) (2021)\07111100290C042.dwg

Golder Associates

RECORD OF BOREHOLE No S23-01

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5044317.4 ;E 244800.9 ORIGINATED BY MJR
DIST HWY 69 BOREHOLE TYPE Hand Excavation COMPILED BY PKS
DATUM Geodetic DATE February 20, 2009 CHECKED BY VA/OK

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
212.3	GROUND SURFACE										
0.0	SAND, trace silt, trace organics										
0.2	Brown Moist										
	END OF EXCAVATION BEDROCK										

NOTES:

1. Hand digging carried out at proposed borehole location to expose bedrock.

2. Water level in excavation not noted.

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

Golder Associates

RECORD OF BOREHOLE No S23-02

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044328.5 ;E 244802.4 ORIGINATED BY MJR

DIST HWY 69 BOREHOLE TYPE Hand Excavation COMPILED BY PKS

DATUM Geodetic DATE February 20, 2009 CHECKED BY VA/OK

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
210.6	GROUND SURFACE										
0.0	BEDROCK OUTCROP										

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

Golder Associates

RECORD OF BOREHOLE No S23-03

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
LOCATION N 5044326.7 ;E 244790.2
ORIGINATED BY ID
DIST HWY 69
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
COMPILED BY PKS
DATUM Geodetic
DATE February 18, 2009
CHECKED BY VA/OK

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
208.9	ICE SURFACE										
0.0	Ice										
208.3	Water										
0.8	PEAT (Fibrous) Very soft Dark brown Wet		1	SS	1		208				
207.6	SAND, trace to some silt, trace organics Brown Wet										
1.4	END OF BOREHOLE CASING REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 0.1 m below ice surface (Elev. 208.8 m) upon completion of drilling.

2. An additional borehole was drilled adjacent to Borehole S23-03; see Record of Borehole S23-03A for details.

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

Golder Associates

RECORD OF BOREHOLE No S23-03A

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044329.2 ;E 244787.2 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring COMPILED BY PKS

DATUM Geodetic DATE February 18, 2009 CHECKED BY VA/OK

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
208.9	ICE SURFACE										
0.0 208.5	Ice										
0.4 208.0	Water										
0.9	PEAT, trace roots and wood fragments (Amorphous) Very soft to stiff Dark brown Wet		1	SS	1		208				OC=55.5%
			2	SS	3		207		353		
206.2			3	SS	13						
2.7	SAND, trace to some silt, trace to some gravel Compact Brown Wet		4	SS	10		206		○		7 85 7 1
			5	SS	11		205				
			6	SS	11		204		○		
			7	SS	22		203		○		17 76 7 0
			8	SS	21		202 201				
200.2											
8.7	END OF BOREHOLE CASING AND SPOON REFUSAL (HAMMER BOUNCING)										

NOTES:

1. Water level in open borehole at ice surface (Elev. 208.9 m) upon completion of drilling

2. Borehole caved to a depth of 3.1 m below ice surface (Elev. 205.8 m) upon removal of casing.

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

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Golder Associates

RECORD OF BOREHOLE No S23-04

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044311.1 ;E 244771.2
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE February 17 and 18, 2009

ORIGINATED BY ID
COMPILED BY PKS
CHECKED BY VA/OK

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
208.9	ICE SURFACE										
0.0	Ice					▽					
208.4											
208.1	Water										
0.9	PEAT, trace roots and wood fragments (Amorphous) Dark brown Wet		1A 1B	SS	5		208		357.3		OC = 2.2%
	SAND, trace to some silt, trace clay, trace organics Very loose to loose Brown Wet		2	SS	1		207				OC = 3.8%
			3	SS	2						0 89 10 1
205.2			4	SS	7		206				
3.7	SAND, some gravel, trace to some silt, trace clay Very dense Brown to grey Wet		5	SS	58		205				
			6	SS	54		204				
			7	SS	68/0.15		203				15 76 8 1
	Grey below a depth of 6.1 m		8	SS	106						
202.4											
6.6	END OF BOREHOLE SPOON AND CASING REFUSAL										

NOTES:

1. Borehole advanced using portable drilling equipment with half-weight hammer to a depth of 5.9 . SPT 'N' values shown have been adjusted to reflect values that would be obtained using a standard weight hammer.

2. Water level in open borehole at a depth of 0.2 m below ice surface (Elev. 208.7 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No S23-05

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044333.3 ;E 244782.6
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE February 19, 2009

ORIGINATED BY ID
COMPILED BY PKS
CHECKED BY VA/OK

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
209.4	ICE SURFACE										
0.0 / 209.1	Ice										
208.8	Water										
0.8	PEAT, containing wood fragments (Fibrous) Dark brown Wet		1	SS	3		209				
	SAND, some gravel, trace to some silt Very loose to compact Brown Wet		2	SS	2		208		○		
			3	SS	8		207				
			4	SS	9		206		○		
205.3			5	SS	15/0.15				○		18 80 2 0
4.1	END OF BOREHOLE SPOON AND CASING REFUSAL										

NOTES:

1. Water level in open borehole at ice surface (Elev. 209.4 m) upon completion of drilling.

2. Borehole caved to a depth of 2.2 m below ice surface (Elev. 207.2 m) upon removal of casing.

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

Golder Associates

RECORD OF BOREHOLE No S23-06

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
LOCATION N 5044346.7 ;E 244786.3
ORIGINATED BY ID
DIST HWY 69
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
COMPILED BY PKS
DATUM Geodetic
DATE February 19, 2009
CHECKED BY VA/OK

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
209.3	ICE SURFACE										
0.0	Ice					▽	209				
208.5											
0.8	SAND, trace to some silt, trace gravel, trace clay, trace organics to a depth of 1.5 m, clay seams between depths of 1.5 m and 2.3 m Loose to compact Brown Wet		1	SS	8				○		
			2	SS	16		208		○		1 89 9 1
			3	SS	10		207				
			4	SS	12		206				
205.1			5	SS	51/0.20				○		
4.2	END OF BOREHOLE SPOON AND CASING REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 0.6 m below ice surface (Elev. 208.7 m) upon completion of drilling.

2. Borehole caved to a depth of 1.6 m below snow surface (Elev. 207.7 m) upon removal of casing.

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

Golder Associates

RECORD OF BOREHOLE No S23-07

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
LOCATION N 5044352.4 ;E 244817.8
ORIGINATED BY MJR
DIST HWY 69
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
COMPILED BY VA
DATUM Geodetic
DATE February 18, 2009
CHECKED BY VA/OK

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
209.0	ICE SURFACE										
0.0 208.1	Ice					▽					
0.9 207.5	PEAT (Fibrous) Very soft Brown Wet		1	SS	2		208				
1.5 206.8	SAND, trace gravel, trace organic Very loose Brown/grey Wet		2	SS	4		207		○		OC = 0.5%
2.2	Gravelly SAND, some silt Dense to very dense Brown Wet		3	SS	48				○		26 59 14 1
205.6			4	SS	109/0.20		206				
3.4	END OF BOREHOLE SPOON AND CASING REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 0.6 m below ice surface (Elev. 208.4 m) upon completion of drilling.

2. Borehole caved to a depth of 1.2 m below ice surface (Elev. 207.8 m) upon removal of casing.

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S23-08

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5044348.5 ;E 244801.3 ORIGINATED BY MJR
DIST HWY 69 BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring COMPILED BY VA
DATUM Geodetic DATE February 17, 2009 CHECKED BY VA/OK

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
208.9	ICE SURFACE										
0.0 / 208.6	Ice										
208.2	Water										
0.7 / 207.5	PEAT, trace wood fragments (Fibrous) Very soft Brown Wet		1	SS	1		208		326.3 ○		OC = 64.3%
1.5	SAND, trace gravel, trace silt Very loose to very dense Grey Wet		2	SS	1		207				
			3	SS	53				○		
			4	SS	19		206				
			5	SS	10		205		○		0 95 5 0
			6	SS	21		204				
							203				
			7	SS	89						
							202				
			8	SS	87		201		○		1 95 4 0
200.5											
8.4	END OF BOREHOLE CASING REFUSAL										

NOTES:

1. Water level in open borehole at ice surface (Elev. 208.9 m) upon completion of drilling.

2. Borehole caved to a depth of 1.5 m below ice surface (Elev. 207.4 m) upon removal of casing.

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

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Golder Associates

RECORD OF BOREHOLE No S23-09

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
LOCATION N 5044365.5 ;E 244803.0
ORIGINATED BY MJR
DIST HWY 69
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
COMPILED BY VA
DATUM Geodetic
DATE February 19, 2009
CHECKED BY VA/OK

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
208.9	ICE SURFACE							20 40 60 80 100	20 40 60		
0.0 / 208.3	Ice					▽	208				
208.0	Water										
0.9 / 207.4	SAND, trace gravel, trace silt, trace organics Loose Brown and grey Wet		1	SS	9				○		
1.5 / 206.7	Organic SAND, trace to some silt, trace clay Loose Dark brown/grey Wet		2	SS	6		207		○		
2.2	SAND, trace to some silt, trace gravel, trace clay Loose to compact Brown Wet		3	SS	18						
			4	SS	16		206		○		0 89 10 1
			5	SS	8		205				
			6	SS	22		204				
			7	SS	30		203		○		
							202				
			8	SS	26		201				
200.5											
8.4	END OF BOREHOLE CASING REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 0.3 m below ice surface (Elev. 208.6 m) upon completion of drilling.

2. Borehole caved to a depth of 1.4 m below ice surface (Elev. 207.5 m) upon removal of casing.

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S23-10

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST ____ HWY 69
DATUM Geodetic

LOCATION N 5044381.5 ;E 244804.1
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE February 19 and 20, 2009

ORIGINATED BY ID
COMPILED BY PKS
CHECKED BY VA/OK

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
209.4	ICE SURFACE										
0.0	Ice					▽	209				
208.6											
0.8	SAND, trace silt, trace organics Compact Brown		1	SS	11						
207.9	Wet						208				
1.5	Silty SAND, trace gravel, containing clay seams Compact Brown Wet		2	SS	14				○		
			3	SS	17		207				
			4	SS	14		206		○		0 75 24 1
			5	SS	23		205				
			6	SS	10				○		1 78 20 1
							204				
			7	SS	13		203				
							202				
			8	SS	11				○		
							201				
			9	SS	20		200				
199.2											
10.2	SAND, some gravel, trace silt Dense Brown						199				
198.4	Wet		10	SS	33/0.15				○		
11.0	END OF BOREHOLE SPOON AND CASING REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 0.6 m below ice surface (Elev. 208.8 m) upon completion of drilling.

2. Borehole caved to a depth of 2.1 m below ice surface (Elev. 207.3 m) upon removal of casing.

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

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

Golder Associates

RECORD OF BOREHOLE No S23-11

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5044378.7 ;E 244788.3 ORIGINATED BY MJR
DIST HWY 69 BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring COMPILED BY VA
DATUM Geodetic DATE February 20, 2009 CHECKED BY VA/OK

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
213.5	GROUND SURFACE										
0.0	SAND, trace to some silt, trace gravel, trace organics to a depth of 1.8 m Very loose to very dense Brown Damp to wet		1	SS	2		213		○		
			2	SS	4						
			3	SS	13		212		○		4 89 7 0
			4	SS	30	▽					
			5	SS	31		211		○		
			6	SS	55		210				
209.2			7	SS	51				○		1 85 14 0
4.3	END OF BOREHOLE NOTE: 1. Borehole advanced using portable drilling equipment with half-weight hammer. SPT N values shown have been adjusted to reflect values that would be obtained using a standard weight hammer. 2. Water level in open borehole at a depth of 2.4 m below ground surface (Elev. 211.1 m) upon completion of drilling.										

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

Golder Associates

RECORD OF DCPT No S23-DC01

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044306.3 ;E 244783.3 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE February 18, 2009 CHECKED BY VA/OK

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
208.8	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	Dynamic Cone Penetration Test (DCPT)						208				
206.5							207				
2.3	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 S23-DC02

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
LOCATION N 5044340.2 ;E 244796.6
ORIGINATED BY MJR
DIST HWY 69
BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test
COMPILED BY VA
DATUM Geodetic
DATE February 17, 2009
CHECKED BY VA/OK

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
208.9	GROUND SURFACE										
0.0	Dynamic Cone Penetration Test (DCPT)						208 207 206 205 204 203 202 201 200	150			
199.3											
9.6	END OF DCPT Refusal to Further Penetration (150 Blows / 0.1 m)										

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

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Golder Associates

RECORD OF DCPT No S23-DC03

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044320.2 ;E 244762.8 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE February 19, 2009 CHECKED BY VA/OK

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
209.8	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	Dynamic Cone Penetration Test (DCPT)						209				
							208				
							207				
206.1											
3.7	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 S23-DC04

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044370.3 ;E 244820.4 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE February 23, 2009 CHECKED BY VA/OK

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
208.8	GROUND SURFACE										
0.0	Dynamic Cone Penetration Test (DCPT)						208 207 206 205 204				
203.5											
5.3	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)										

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF DCPT No S23-DC05

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044363.7 ;E 244788.1 ORIGINATED BY MJR

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE February 17, 2009 CHECKED BY VA/OK

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
211.9	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	Dynamic Cone Penetration Test (DCPT)						211				
							210				
209.1								125			
2.8	END OF DCPT Refusal to Further Penetration (125 Blows / 0.1 m) NOTE: 1. DCPT advanced using portable drilling equipment with half weight hammer. Blows shown have been adjusted to reflect values that would be obtained using a standard weight hammer.										

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

Golder Associates

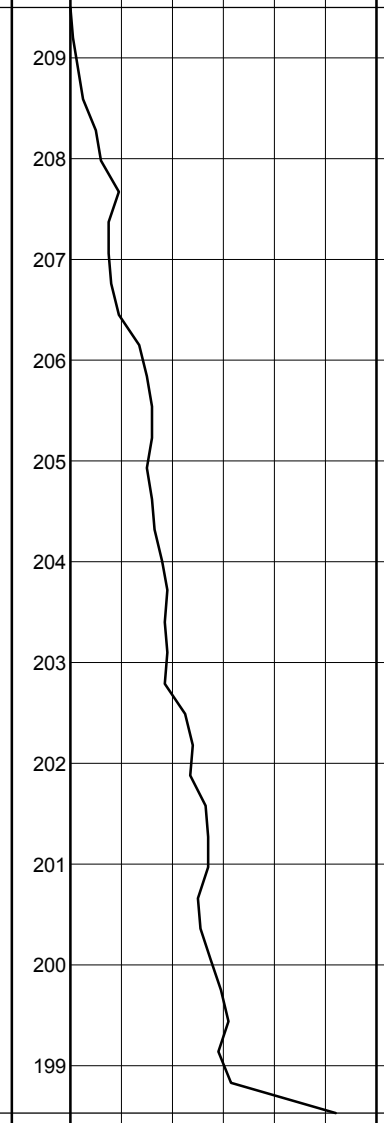
RECORD OF DCPT No S23-DC06

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
LOCATION N 5044371.4 ;E 244796.3
ORIGINATED BY ID
DIST HWY 69
BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test
COMPILED BY VA
DATUM Geodetic
DATE February 23, 2009
CHECKED BY VA/OK

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			
209.5	GROUND SURFACE							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	w_P w w_L	γ kN/m^3	GR SA SI CL
0.0	Dynamic Cone Penetration Test (DCPT)										
198.5											
11.0	END OF DCPT										



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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF DCPT No S23-DC07

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044310.0 ;E 244770.2 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE February 18, 2009 CHECKED BY VA/OK

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						
208.9	GROUND SURFACE										
0.0	Dynamic Cone Penetration Test (DCPT)						208 207 206 205 204 203				
202.5											
6.4	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)										

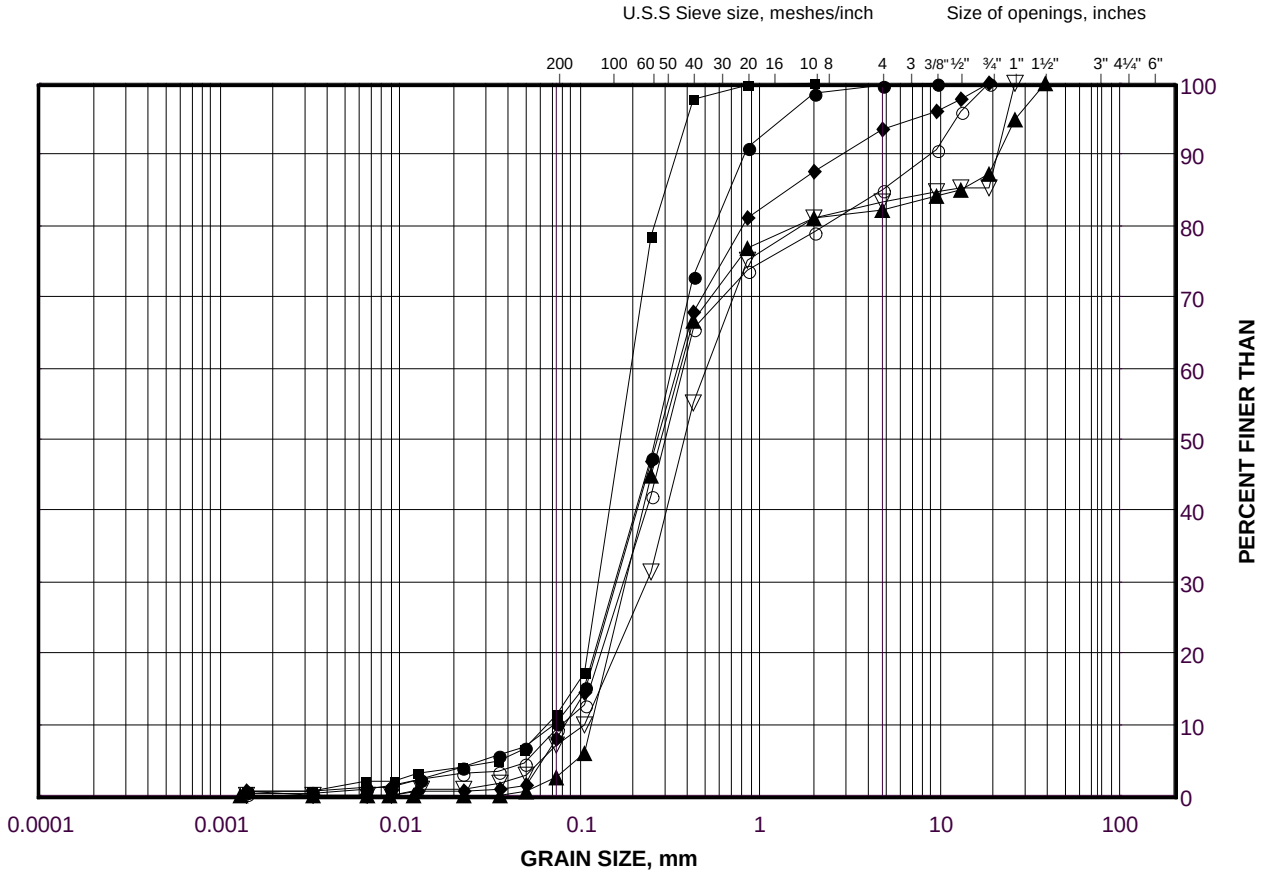
$+^3, \times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GRAIN SIZE DISTRIBUTION

Sand

Highway 69 (SBL) STA 15+690 to 15+720

FIGURE A.S23-1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S23-06	2	207.5
■	S23-04	3	206.3
◆	S23-03A	4	205.6
▲	S23-05	5	205.5
▽	S23-03A	7	202.5
❍	S23-04	7	203.1

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

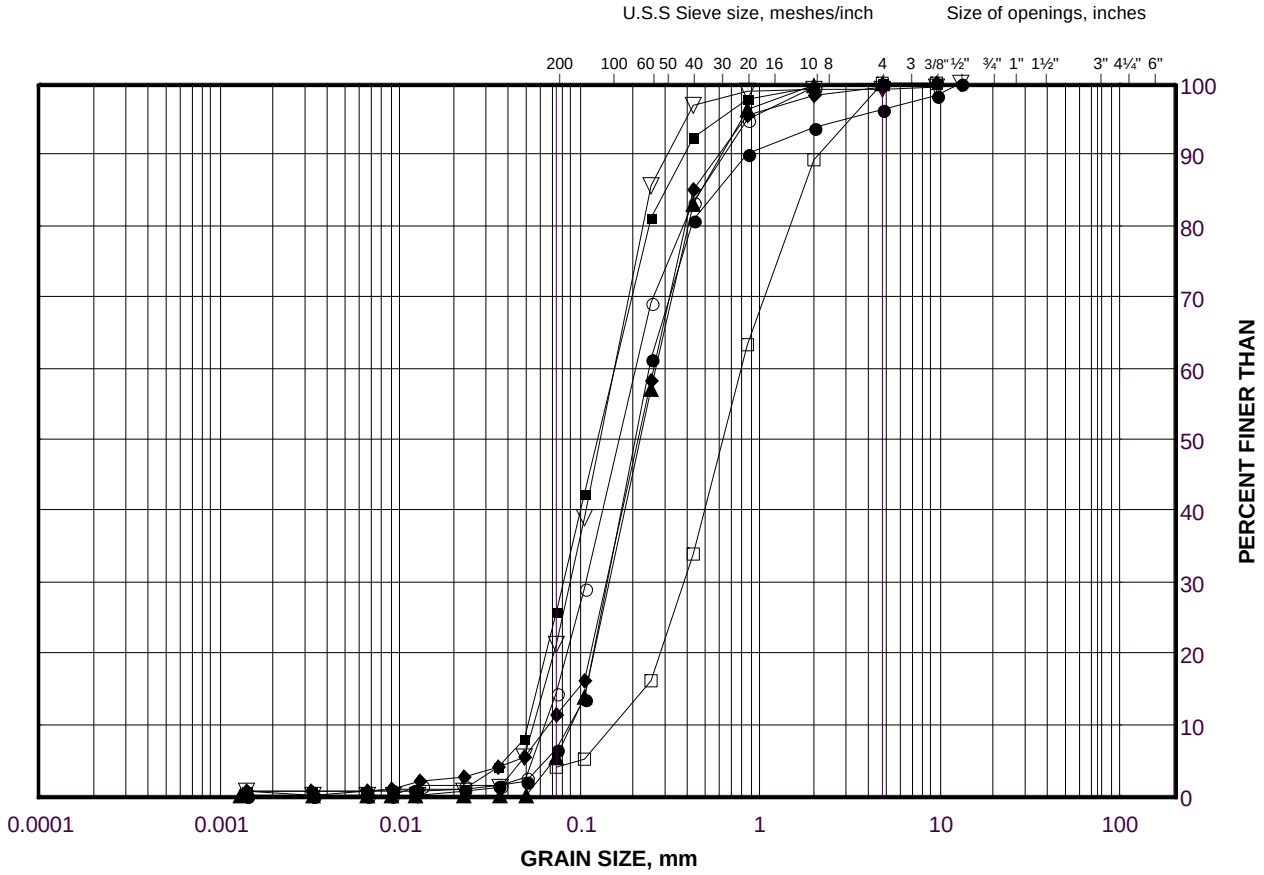
Date: 27-Nov-09

GRAIN SIZE DISTRIBUTION

Silty Sand to Sand

Highway 69 (NBL) STA 15+700 to 15+740

FIGURE A.S23-2



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S23-11	3	212.0
■	S23-10	4	206.1
◆	S23-09	4	205.5
▲	S23-08	5	204.8
▽	S23-10	6	204.5
❍	S23-11	7	209.5
□	S23-08	8	201.0

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

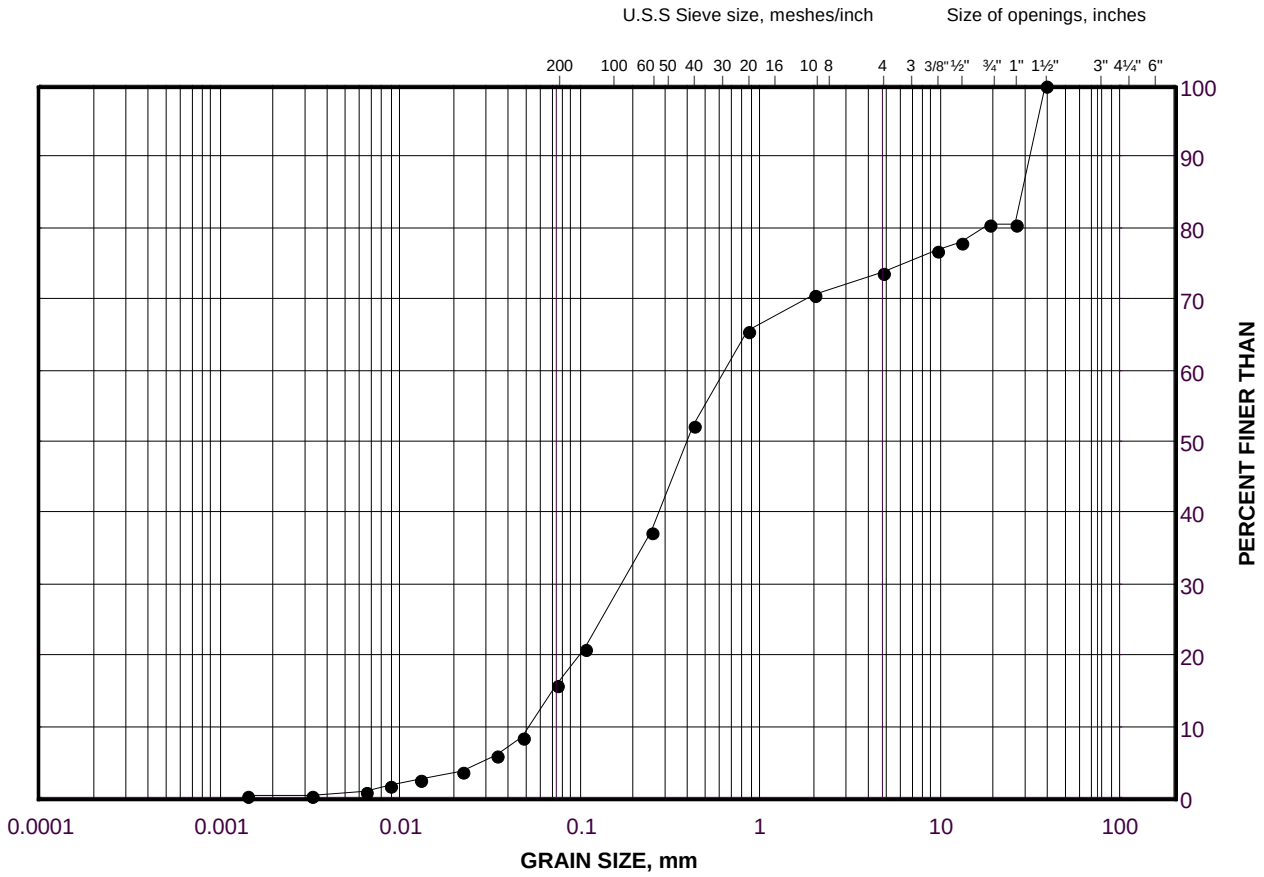
Date: 27-Nov-09

GRAIN SIZE DISTRIBUTION

Gravelly Sand

Highway 69 (NBL) STA 15+700 to 15+740

FIGURE A.S23-3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S23-07	3	206.4

Project Number: 07-1111-0029

Checked By: CN

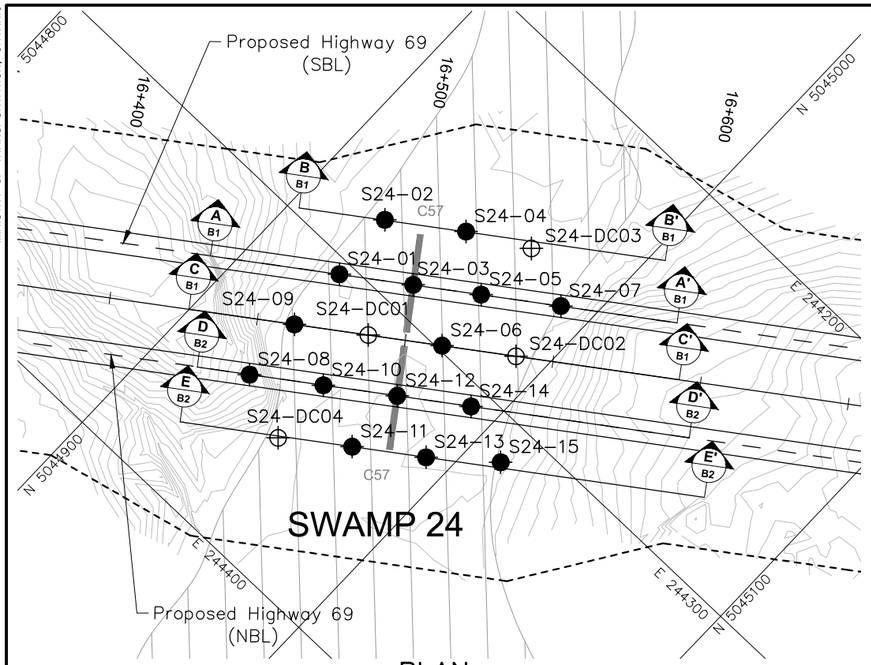
Golder Associates

Date: 27-Nov-09

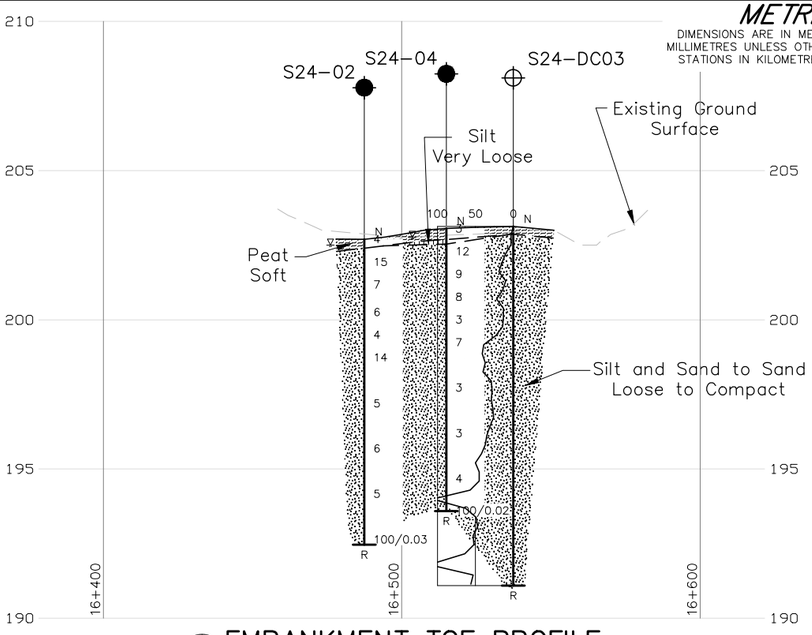
APPENDIX B

Highway 69 SBL – STA 16+475 to 16+550 and Highway 69 NBL – STA 16+450 to 16+550 (Swamp 24)

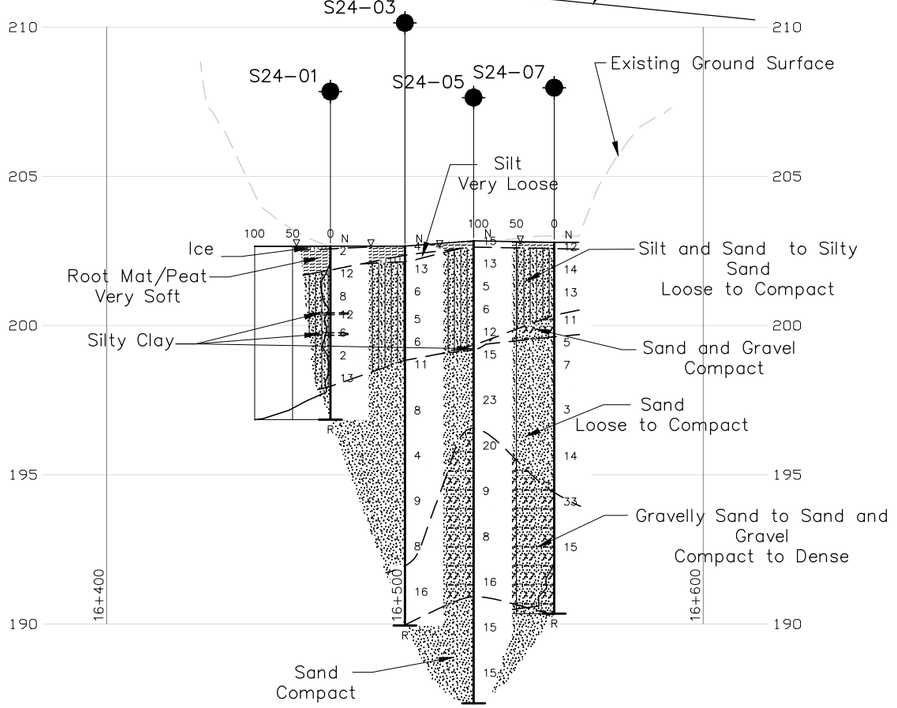
MINISTRY OF TRANSPORTATION, ONTARIO



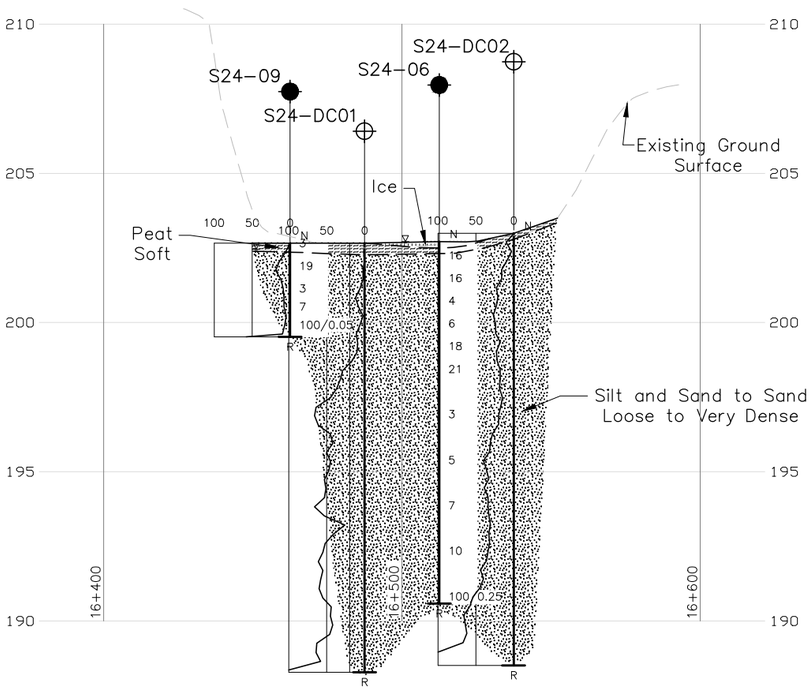
PLAN
SCALE
20 0 20 40 m



B-B' B1 EMBANKMENT TOE PROFILE
HIGHWAY 69 (SBL)
HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE



A-A' B1 CENTRELINE PROFILE
HIGHWAY 69 (SBL)
HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE



C-C' B1 EMBANKMENT TOE PROFILE
HIGHWAY 69 (MEDIAN)
HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE

J. M. A. COSTAER — LICENSED PROFESSIONAL ENGINEER — Apr. 06, 2016 — PROVINCE OF ONTARIO

J.P. DITTRICH — LICENSED PROFESSIONAL ENGINEER — Apr. 06, 2016 — PROVINCE OF ONTARIO

REFERENCE

Base plans provided in digital format by MRC, drawing file 5271XB01.DWG, 5271–XPD–ARCHIPELAGO.dwg, 5271–XPD–Carling.dwg, 5271–XPD–SHAWANAGA.dwg, PR # 5377–02–00–PR–1.dwg, received October 1, 2007, and h6878_PHASE1_XA1, h6878_PHASE1_XN1.dwg, received January 21, 2009, h6878_PHASE2_XA1, h6878_PHASE2_XN1.dwg, received January 21, 2009.

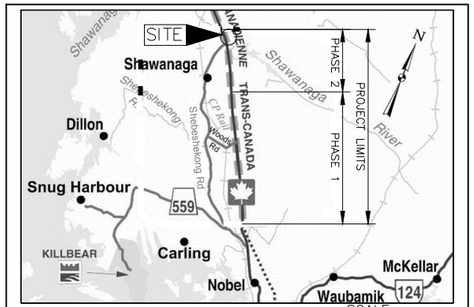
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN.
STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 5111–07–00

SHEET

HIGHWAY 69 (SBL) STA 16+475 TO STA 16+550
HIGHWAY 69 (NBL) STA 16+450 TO STA 16+550
BOREHOLE LOCATIONS
AND SOIL STRATA

Golder Associates



KEY PLAN

LEGEND

- Borehole – Current Investigation
- 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
- R Refusal

No.	ELEVATION	CO–ORDINATES	
		NORTHING	EASTING
S24–01	202.7	5044928.4	244304.7
S24–02	202.7	5044927.0	244281.0
S24–03	202.7	5044948.8	244290.3
S24–04	203.1	5044949.4	244265.1
S24–05	202.8	5044967.6	244277.0
S24–06	202.7	5044969.9	244298.4
S24–07	202.8	5044989.7	244261.4
S24–08	206.3	5044929.8	244349.9
S24–09	202.7	5044929.1	244327.3
S24–10	202.4	5044950.2	244335.4
S24–11	202.2	5044971.3	244343.7
S24–12	202.6	5044970.6	244321.0
S24–13	202.6	5044991.8	244329.3
S24–14	202.7	5044991.0	244306.5
S24–15	202.8	5045011.1	244313.3
S24–DC01	202.7	5044949.5	244312.9
S24–DC02	203.0	5044990.3	244284.0
S24–DC03	203.1	5044969.2	244254.2
S24–DC04	202.1	5044951.3	244358.6

NOTES

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

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.

NO.	DATE	BY	REVISION

Geocres No. 41H–161

HWY. 69	PROJECT NO. 07–1111–0029		DIST.
SUBM'D. VA	CHKD. VA/OK	DATE: Nov. 2009	SITE:
DRAWN: DD/RJ	CHKD. CN	APPD. JPD/JMAC	DWG. B1

PLOT DATE: April 11, 2016
FILENAME: f:\Projects\2007\07-1111-0029 (MRC, Parry Sound)\-DC- Swamp Report - Phase 2 (2020) (2021)\07111100290288.dwg

MINISTRY OF TRANSPORTATION, ONTARIO

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

CONT No.
GWP No. 5111-07-00

SHEET

HIGHWAY 69 (NBL) STA 16+450 TO STA 16+550

SOIL STRATA

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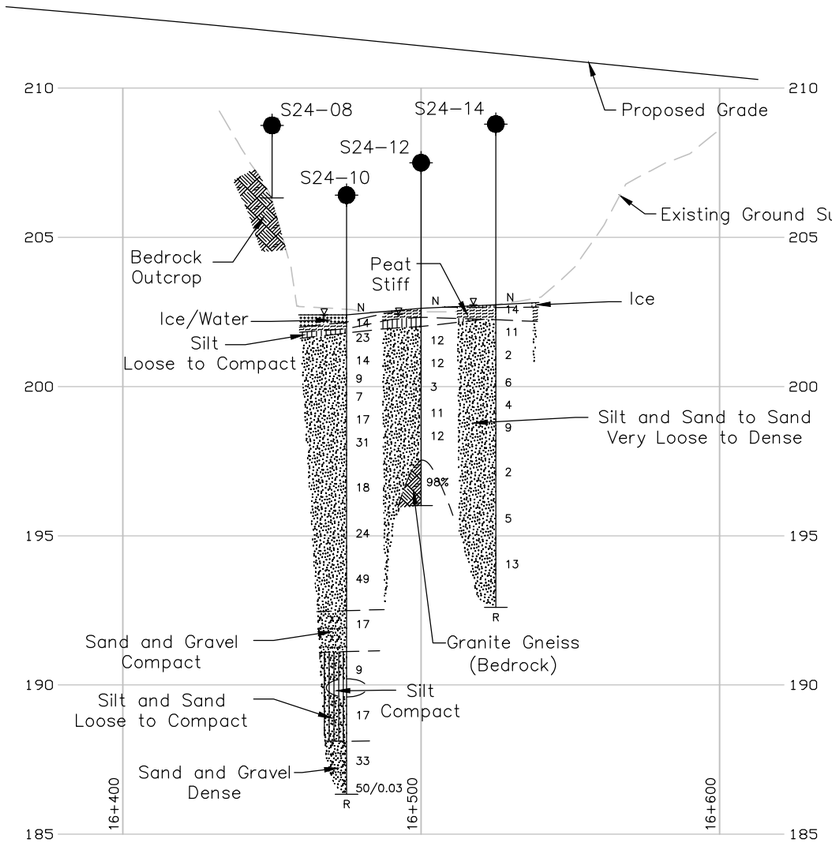
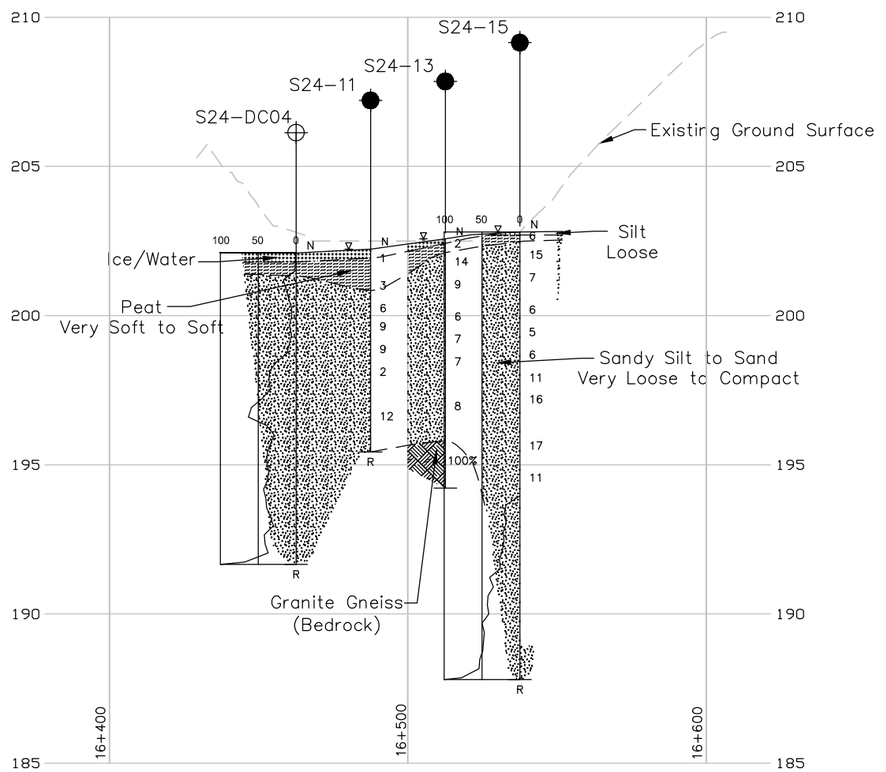
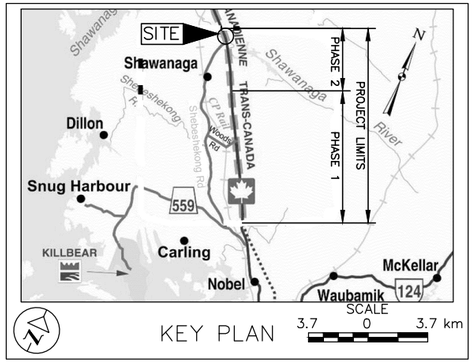


D-D' B1 CENTRELINE PROFILE
HIGHWAY 69 (NBL)
HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE



E-E' B1 EMBANKMENT TOE PROFILE
HIGHWAY 69 (NBL)
HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE



LEGEND

- Borehole – Current Investigation
- 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
- R — Refusal
- 100% — Rock Quality Designation (RQD)

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
S24-08	206.3	5044929.8	244349.9
S24-10	202.4	5044950.2	244335.4
S24-11	202.2	5044971.3	244343.7
S24-12	202.6	5044970.6	244321.0
S24-13	202.6	5044991.8	244329.3
S24-14	202.7	5044991.0	244306.5
S24-15	202.8	5045011.1	244313.3
S24-DC04	202.1	5044951.3	244358.6

NOTES

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

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 MRC, drawing file 5271XB01.DWG, 5271-XPD-ARCHIPELAGO.dwg, 5271-XPD-Carling.dwg, 5271-XPD-SHAWANAGA.dwg, PR # 5377-02-00-PR-1.dwg, received October 1, 2007, and h6878_PHASE1_XA1, h6878_PHASE1_XN1.dwg, received January 21, 2009, h6878_PHASE2_XA1, h6878_PHASE2_XN1.dwg, received January 21, 2009.

LICENSED PROFESSIONAL ENGINEER J. M. A. COSTA Apr. 06, 2016 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.P. DITTRICH Apr. 06, 2016 PROVINCE OF ONTARIO

NO.	DATE	BY	REVISION

Geocres No. 41H-161

HWY. 69	PROJECT NO. 07-1111-0029		DIST.
SUBM'D. VA	CHKD. VA/OK	DATE: Nov. 2009	SITE:
DRAWN: DD/RJ	CHKD. CN	APPD. JPD/JMAC	DWG. B2

PLOT DATE: April 6, 2016
FILENAME: T:\Projects\2007\07-1111-0029 (MRC, Parry Sound)\-DC- Swamp Report - Phase 2 (2020) (2021)\07111102920802.dwg

Golder Associates

RECORD OF BOREHOLE No S24-01

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044928.4 ;E 244304.7 ORIGINATED BY MR

DIST HWY 69 BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring COMPILED BY MWK

DATUM Geodetic DATE January 26, 2009 CHECKED BY VA/OK

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
202.7	ICE SURFACE										
0.0	Ice										
0.3	Root mat										
	PEAT, trace rootlets (Amorphous)		1	AS	2						
201.9	Very soft										
0.8	Dark brown										
	Wet										
	Silty SAND, trace clay		2	SS	12				○		0 77 21 2
	Loose to compact										
	Brown										
	Wet		3B	SS	8						
200.5											
2.3	SILTY CLAY, trace sand										
	Grey		4	SS	12				○		0 61 36 3
	Wet										
199.8	SILT and SAND, trace clay										
3.0	Compact		5A	SS	6				○		0 47 50 3
	Grey		5B								
	Wet										
	SILTY CLAY, trace sand										
	Brown		6	SS	2						
	Wet										
	SILT and SAND, trace clay, containing silt layers										
	Very loose to compact										
198.0	Grey		7A	SS	13				○		
4.7	Wet		7B								
197.5	SAND, trace silt										
5.2	Compact										
	Grey										
	Wet										
196.9	END OF BOREHOLE										
5.8	CASING REFUSAL										
	END OF DCPT										
	Refusal to Further Penetration (100 Blows / 0.03 m)										

NOTES:

1. Water level in open borehole at ice surface (Elev. 202.7 m) upon completion of drilling.

2. A Dynamic Cone Penetration Test was advanced 1.5 m west of Borehole S24-01, refusal encountered at a depth of 5.8 m below ice surface (Elev. 196.9 m).

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

Golder Associates

RECORD OF BOREHOLE No S24-02

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044927.0 ;E 244281.0
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring
DATE January 28, 2009

ORIGINATED BY MR
COMPILED BY MWK
CHECKED BY VA/OK

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
202.7	GROUND SURFACE										
0.0 / 202.4	PEAT (Amorphous) Soft Dark brown Wet		1	SS	4	▽	202				
202.0 / 0.7	SAND, some silt Loose Brown Wet		2	SS	15				○		0 58 40 2
	SILT and SAND, trace clay Loose to compact Grey Wet		3	SS	7		201				
200.4 / 2.3	SAND, some silt, trace gravel, trace clay Loose to compact Grey Wet		4	SS	6		200		○		
			5	SS	4		199				
			6	SS	14				○		1 83 12 4
197.5 / 5.2	Silty SAND, trace to some gravel below a depth of 9.5 m, trace clay Loose to dense Grey Wet		7	SS	5		198				
			8	SS	6		197		○		
			9	SS	5		196		○		0 78 21 1
192.5 / 10.2	END OF BOREHOLE SPOON AND CASING REFUSAL		10	SS	100/0.03		195				
	NOTE: 1. Water level in open borehole at a depth of 0.2 m below ground surface (Elev. 202.5 m) upon completion of drilling.						194				
							193				

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

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Golder Associates

RECORD OF BOREHOLE No S24-03

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044948.8 ;E 244290.3
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring
DATE January 26, 2009

ORIGINATED BY MR
COMPILED BY MWK
CHECKED BY VA/OK

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
202.7	GROUND SURFACE										
0.0 / 202.4	PEAT, trace rootlets (Amorphous) Soft Dark brown Wet		1	SS	4		202		○		
0.5	SILT, some sand, trace gravel, trace clay, trace organics and rootlets Very loose Grey Wet		2	SS	13						
	SILT and SAND, trace clay Loose to compact Grey Wet		3	SS	6		201		○		0 48 50 2 Non-Plastic
			4	SS	5		200		○		
198.8			5	SS	6		199				
3.9	SAND, some silt, trace clay Loose to compact Grey Wet		6	SS	11		198				
			7	SS	8		197		○		0 85 14 1
			8	SS	4		196				
			9	SS	9		195		○		
			10	SS	8		194		○		0 88 12 0
191.6							193				
11.1	SAND and GRAVEL, trace silt Compact Grey Wet		11	SS	16		192				
190.0							191				
12.7	END OF BOREHOLE CASING REFUSAL NOTE: 1. Water level in open borehole at ground surface (Elev. 202.7 m) upon completion of drilling.						190				

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

Golder Associates

RECORD OF BOREHOLE No S24-04

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044949.4 ;E 244265.1
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring
DATE January 28, 2009

ORIGINATED BY MR
COMPILED BY MWK
CHECKED BY VA/OK

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
203.1	GROUND SURFACE										
0.0 / 202.7	PEAT (Amorphous) Soft Dark brown Wet		1	SS	3	▽	203				
0.5	SILT, trace sand, trace clay, trace organics Brown and grey Wet		2	SS	12		202		○		0 82 17 1
201.3 / 1.8	SAND, some silt, trace clay Loose to compact Grey to brownish grey Wet		3A 3B	SS	9		201		○		
	SAND, trace silt, trace clay Very loose to loose Grey Wet		4	SS	8		200		○		
			5	SS	3				○		0 94 4 2
			6	SS	7		199				
							198				
			7	SS	3						
	Trace gravel below a depth of 6.4 m						197				
			8	SS	3		196		○		1 96 2 1
							195				
			9	SS	4				○		
193.6							194				
9.5	END OF BOREHOLE SPOON AND CASING REFUSAL		10	SS	100/0.02						

NOTE:

1. Water level in open borehole at a depth of 0.3 m below ground surface (Elev. 202.8 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No S24-05

SHEET 1 OF 2 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044967.6 ;E 244277.0
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring
DATE January 27, 2009

ORIGINATED BY MR
COMPILED BY MWK
CHECKED BY VA/OK

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
202.8	GROUND SURFACE										
0.0	Root mat										
0.2	SILT and SAND, trace clay, trace organics to a depth of 1.4 m Loose to compact Brown to grey Wet		1	SS	15	▽					OC=1.0%
			2	SS	13		202				
			3	SS	5		201				
	Silt layer between depths of 2.2 m and 3.5 m		4	SS	6		200				
199.3			5A 5B	SS	12						Non-Plastic
	SILTY CLAY, trace sand										
3.7	Very soft Brown Wet		6	SS	15		199				
	SAND, trace to some silt, trace clay Compact Grey Wet						198				
			7	SS	23		197				0 83 15 2
196.4											
6.4	Gravelly SAND, trace to some silt, trace clay Loose to compact Grey Wet		8	SS	20		196				20 73 7 2
							195				
			9	SS	9		194				
							193				
			10	SS	8						
191.8							192				
11.0	SAND and GRAVEL, trace silt Compact Grey Wet		11	SS	16		191				
190.6											
12.2	SAND, trace to some silt Compact Grey Wet						190				
			12	SS	15						0 90 10 0
							189				
			13	SS	15		188				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S24-05

SHEET 2 OF 2 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5044967.6 ;E 244277.0 ORIGINATED BY MR
DIST HWY 69 BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring COMPILED BY MWK
DATUM Geodetic DATE January 27, 2009 CHECKED BY VA/OK

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 ---										
187.3											
15.5	END OF BOREHOLE CASING REFUSAL NOTE: 1. Water level in open borehole at a depth of 0.2 m below ground surface (Elev. 202.6 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No S24-06

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044969.9 ;E 244298.4
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
DATE January 19, 2009

ORIGINATED BY MR
COMPILED BY MWK
CHECKED BY VA/OK

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
202.7	ICE SURFACE										
0.0	Ice										
	Water										
0.4	Root mat										
	SILT and SAND, trace clay, trace organics to a depth of 1.1 m, containing root mat and rootlets Loose to compact Brown and grey Wet		1	SS	16		202		○		OC=1.3%
			2	SS	16		201				
			3	SS	4				○		0 63 35 2
			4	SS	6		200				
199.3											
3.4	SAND, trace to some silt, trace clay Very loose to compact Grey Wet		5	SS	18		199		○		
			6	SS	21		198				
			7	SS	3		197		○		0 91 8 1
			8	SS	5		196				
			9	SS	7		195		○		
			10A 10B	SS	10		194				
							193				
							192		○		2 96 2 0
190.6			11	SS	100/0.25		191				
12.1	END OF BOREHOLE SPOON AND AUGER REFUSAL										

NOTE:

1. Water level in open borehole at ice surface (Elev. 202.7 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No S24-07

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044989.7 ;E 244261.4
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring
DATE January 27, 2009

ORIGINATED BY MR
COMPILED BY MWK
CHECKED BY VA/OK

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
202.8	GROUND SURFACE										
0.0	PEAT (Amorphous)										
0.2	SILT and SAND, trace clay, trace organics to a depth of 0.8 m and rootlets Compact Brown to grey Wet		1	SS	12		202				
			2	SS	14				○		
			3	SS	13		201				
200.4											
2.4	SAND and GRAVEL, trace silt Compact Grey Wet		4	SS	11		200				
199.5											
3.3	SAND, trace to some silt, trace gravel Very loose to compact Brown to brownish grey Wet		5	SS	5		199				
			6	SS	7				○		
			7	SS	3		198				
			8	SS	14		197		○		3 86 11 0
194.6							196				
8.2	SAND and GRAVEL, trace to some silt Compact to dense Brown to brownish grey Wet		9	SS	33		195				
							194		○		44 50 6 0
			10	SS	15		193				
192.0							192				
10.8	END OF BOREHOLE						191				
190.4											
12.4	END OF DCPT Refusal to Further Penetration (100 Blows / 0.23 m) NOTES: 1. Water level in open borehole at ground surface (Elev. 202.8 m) upon completion of drilling. 2. A Dynamic Cone Penetration Test was carried out below a depth of 10.8 m; refusal encountered at a depth of 12.4 m below ground surface (Elev. 190.4 m).										

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

Golder Associates

RECORD OF BOREHOLE No S24-08

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044929.8 ;E 244349.9 ORIGINATED BY MR

DIST HWY 69 BOREHOLE TYPE Hand Excavation COMPILED BY MWK

DATUM Geodetic DATE January 25, 2009 CHECKED BY VA/OK

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
206.3	GROUND SURFACE										
0.0	BEDROCK OUTCROP										

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

Golder Associates

RECORD OF BOREHOLE No S24-09

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044929.1 ;E 244327.3
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring
DATE January 25, 2009

ORIGINATED BY MR
COMPILED BY MWK
CHECKED BY VA/OK

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
202.7	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0 / 202.4	PEAT, trace rootlets (Amorphous) Soft Dark Brown Wet		1	SS	3	▽			○		
202.0 / 0.7	SAND, trace to some silt, trace organics Very loose Brown Wet		2	SS	19		202				
	SILT and SAND, trace clay, containing silty sand and silt layers Very loose to compact Brown to grey Wet		3	SS	3		201		○		0 63 33 4
			4	SS	7						
199.7			5	SS	100/0.05		200		○		
	END OF BOREHOLE SPOON AND CASING REFUSAL										
3.1	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)										

NOTES:

1. Water level in open borehole at a depth of 0.2 m below ground surface (Elev. 202.5 m) upon completion of drilling.

2. A Dynamic Cone Penetration Test was advanced 1.5 m west of Borehole S24-09, refusal encountered at a depth of 3.1 m below ground surface (Elev. 199.6 m).

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

Golder Associates

RECORD OF BOREHOLE No S24-10

SHEET 1 OF 2

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044950.2 ;E 244335.4
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring
DATE January 23, 2009

ORIGINATED BY MR
COMPILED BY MWK
CHECKED BY VA/OK

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
202.4	ICE SURFACE										
0.0	Ice Water PEAT (Amorphous) Stiff Dark brown Wet		1A 1B 1C	SS	14		202		○		
0.6	SILT, trace sand, trace clay, trace rootlets Compact Grey Wet		2	SS	23						
			3	SS	14		201		○		0 39 60 1
	SILT and SAND, trace clay, trace rootlets to a depth of 0.8 m Loose to compact Grey Wet		4	SS	9		200				
199.0			5	SS	7				○		
3.4	Silty SAND, trace clay Compact to dense Grey Wet		6	SS	17		199				
			7	SS	31		198		○		0 76 21 3
			8	SS	18		197				
			9	SS	24		196				
194.0							195		○		
8.4	SAND, some silt, trace gravel, trace clay Dense Grey Wet		10	SS	49		194				
192.5									○		3 80 15 2
9.9	SAND and GRAVEL, trace silt Compact Grey Wet		11	SS	17		193				
191.1							192				
11.3	SILT and SAND, trace clay Loose Grey Wet						191				
190.2			12	SS	9						
12.2	SILT, trace sand, trace clay Loose Grey Wet						190				
189.6											
12.8	SILT and SAND, trace clay, some cobbles and boulder Compact Grey Wet		13	SS	17		189		○		0 69 30 1
187.9							188				
14.5											

Continued Next Page

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

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

Golder Associates

RECORD OF BOREHOLE No S24-10

SHEET 2 OF 2 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5044950.2 ;E 244335.4 ORIGINATED BY MR
DIST HWY 69 BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring COMPILED BY MWK
DATUM Geodetic DATE January 23, 2009 CHECKED BY VA/OK

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
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND and GRAVEL, trace silt, containing cobbles and boulders between depths of 14.5 m and 14.8 m Dense Grey Wet		14	SS	33		187				
186.3			15	SS	50/0.03						
16.1	END OF BOREHOLE SPOON AND CASING REFUSAL NOTE: 1. Water level in open borehole at ice surface (Elev. 202.4 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No S24-11

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044971.3 ;E 244343.7
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring
DATE January 23, 2009

ORIGINATED BY MR
COMPILED BY MWK
CHECKED BY VA/OK

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
202.2	ICE SURFACE										
0.0	Ice						202				
	Water										
0.3	PEAT, trace sand layers (Amorphous) Very soft Dark brown Wet		1	SS	1						
200.8							201				
1.4	SILT and SAND, trace gravel, trace organics Very loose		2A 2B	SS	3						OC=0.4%
200.3											
1.9	Grey Wet Sandy SILT, trace clay Loose Grey Wet		3	SS	6		200		○		0 23 75 2
			4	SS	9						
198.9							199				
3.3	Silty SAND, trace clay Very loose to compact Grey Wet		5	SS	9				○		
			6	SS	2		198		○		0 77 22 1
							197				
			7	SS	12				○		
195.4							196				
6.8	END OF BOREHOLE CASING REFUSAL										

NOTES:

1. Water level in open borehole at ice surface (Elev. 202.2 m) upon completion of drilling.

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF BOREHOLE No S24-12

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044970.6 ;E 244321.0
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring
DATE January 24, 2009

ORIGINATED BY MR
COMPILED BY VA
CHECKED BY VA/OK

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
202.6	GROUND SURFACE										
0.0 / 202.3	PEAT (Amorphous) Dark brown Wet		1	AS	-	▽					
202.0	SILT, some sand, trace clay, trace organics and rootlets Loose Grey Wet		2A 2B	SS	5		202		○		OC=0.6%
201.6 / 1.0	SAND, some silt, trace clay, trace organics and rootlets Loose Grey Wet		3	SS	12		201		○		0 84 15 1
	SAND, trace to some silt Very loose to compact Grey Wet		4	SS	12				○		
			5	SS	3		200		○		
			6	SS	11		199				
			7	SS	12		198		○		0 84 15 1
197.5											
5.1	Granite Gneiss (BEDROCK) Bedrock cored from depths of 5.1 m to 6.6 m For bedrock coring details, refer to Record of Drillhole S24-12		1	RC	REC 100%		197				RQD = 98%
196.0							196				
6.6	END OF BOREHOLE NOTE: 1. Water level in open borehole at a depth of 0.2 m below ground surface (Elev. 202.4 m) upon completion of drilling.										

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

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: S24-12

SHEET 1 OF 1

LOCATION: N 5044970.6 ;E 244321.0

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling Ltd.

JN - Joint; FLT - Fault; SH - Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO - Foliation; CO - Contact; OR - Orthogonal; CL - Cleavage
PL - Planar; CU - Curved; UN - Undulating; ST - Stepped; IR - Irregular
PO - Polished; K - Slickensided; SM - Smooth; RO - Rough; VR - Very Rough
MB - Mechanical Break; BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES
		Continued from Record of Borehole S24-12		197.51																	
6	HQRC January 24, 2009	GRANITE GNEISS Slightly weathered to fresh, fine to medium grained with feldspar banding, foliated, black, pink and grey		5.09	1									JN,PL,Ro							
				195.99																	
		END OF DRILLHOLE		6.61																	
7																					
8																					
9																					
10																					
11																					
12																					
13																					
14																					
15																					

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: MR

CHECKED: VA/OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-MISS.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF BOREHOLE No S24-13

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044991.8 ;E 244329.3
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring
DATE January 22, 2009

ORIGINATED BY MR
COMPILED BY VA
CHECKED BY VA/OK

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
202.6	ICE SURFACE										
0.0	Ice										
202.1	PEAT (amorphous), containing rootlets		1	SS	2		202		○		
0.5	Soft Grey Wet										
	Silty SAND to SAND, trace gravel, trace organics and rootlets near surface of deposit Very loose to compact Grey Wet		2	SS	14						
			3	SS	9		201				
			4	SS	6		200		○		0 87 13 1
			5	SS	7		199				
			6	SS	7		198		○		
			7	SS	8		197		○		0 69 30 1
195.8											
6.8	Granite Gneiss (BEDROCK) Bedrock cored from depths of 6.8 m to 8.4 m For bedrock coring details, refer to Record of Drillhole S24-13		1	RC	REC 100%		196 195				RQD = 100%
194.3											
8.4	END OF BOREHOLE NOTE: 1. Water level in open borehole at ice surface (Elev. 202.6 m) upon completion of drilling.										

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: S24-13

SHEET 1 OF 1

LOCATION: N 5044991.8 ;E 244329.3

DRILLING DATE:

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling Ltd.

JN - Joint; FLT - Fault; SH - Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO - Foliation; CO - Contact; OR - Orthogonal; CL - Cleavage
PL - Planar; CU - Curved; UN - Undulating; ST - Stepped; IR - Irregular
PO - Polished; K - Slickensided; SM - Smooth; RO - Rough; VR - Very Rough
MB - Mechanical Break; BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	COLOUR / % RETURN	FLUSH	RECOVERY: TOTAL CORE %	RECOVERY: SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES
		Continued from Record of Borehole S24-13		195.83																	
7	HQRC January 22, 2009	GRANITE GNEISS Slightly weathered to fresh, fine to medium grained with feldspar banding, foliated, black, pink and grey		6.77	1							•		JN,UN,Ro							
8				194.25																	
		END OF DRILLHOLE		8.35																	
9																					
10																					
11																					
12																					
13																					
14																					
15																					
16																					

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: MR
CHECKED: VA/OK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-MISS.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF BOREHOLE No S24-14

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044991.0 ;E 244306.5
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and HW Casing, Wash Boring
DATE January 25, 2009

ORIGINATED BY MR
COMPILED BY MWK
CHECKED BY VA/OK

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
202.7	ICE SURFACE										
0.0	Ice										
0.1	PEAT, containing rootlets (Amorphous)		1	SS	14						
202.2	Stiff						202				
0.5	Dark brown Wet										
	SAND, trace to some silt, trace gravel, trace clay, trace organics to a depth of 0.8 m Very loose to compact Grey Wet		2	SS	11				○		1 87 11 1
			3	SS	2		201				
			4	SS	6		200		○		
			5	SS	4		199				
			6	SS	9				○		0 94 6 0
							198				
			7	SS	2		197				
							196				
			8	SS	5						
194.5							195				
8.2	SAND, trace silt, containing cobbles and boulders Compact Grey Wet		9	SS	13		194		○		
	Containing cobbles and boulder below a depth of 9.8 m						193				
192.6											
10.1	END OF BOREHOLE CASING REFUSAL										

NOTE:

1. Water level in open borehole at ice surface (Elev. 202.7 m) upon completion of drilling.

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

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PROJECT 07-1111-0029

RECORD OF BOREHOLE No S24-15

SHEET 1 OF 2

METRIC

W.P. 5111-07-00 LOCATION N 5045011.1 ;E 244313.3 ORIGINATED BY MR

DIST HWY 69 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers and HW Casing, Wash Boring COMPILED BY MWK

DATUM Geodetic DATE January 21, 2009 CHECKED BY VA/OK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES "N" VALUES	GROUND WATER CONDITIONS
202.8	GROUND SURFACE					
0.0	PEAT (Amorphous) Dark brown Wet		1	SS	6	
0.3	SILT, trace sand, trace clay, trace rootlets Loose Brown Wet		2	SS	15	
	SAND, trace to some silt, trace gravel, trace clay Loose to compact Grey to brownish grey Wet		3	SS	7	
			4	SS	6	
			5	SS	5	
			6	SS	6	
			7	SS	11	
			8	SS	16	
			9	SS	17	
194.0			10	SS	11	
8.8	END OF BOREHOLE					
187.8						

ELEVATION SCALE: 202, 201, 200, 199, 198, 197, 196, 195, 194, 193, 192, 191, 190, 189, 188

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

81.7

UNIT WEIGHT γ kN/m³

REMARKS & GRAIN SIZE DISTRIBUTION (%)

	GR	SA	SI	CL
Non-Plastic				
	0	97	3	0
	8	85	7	0

Continued Next Page

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

Golder Associates

PROJECT 07-1111-0029

RECORD OF BOREHOLE No S24-15

SHEET 2 OF 2

METRIC

W.P. 5111-07-00 LOCATION N 5045011.1 ;E 244313.3 ORIGINATED BY MR

DIST HWY 69 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers and HW Casing, Wash Boring COMPILED BY MWK

DATUM Geodetic DATE January 21, 2009 CHECKED BY VA/OK

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/m^3	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	--- CONTINUED FROM PREVIOUS PAGE ---										
15.0	END OF DCPT Refusal to Further Penetration (100 Blows / 0.1 m) NOTES: 1. Water level in open borehole at ground surface (Elev. 202.8 m) upon completion of drilling. 2. A Dynamic Cone Penetration Test was carried out below a depth of 8.8 m; refusal encountered at a depth of 15.0 m (Elev. 187.8 m) upon completion drilling.										

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

Golder Associates

RECORD OF DCPT No S24-DC-01

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044949.5 ;E 244312.9 ORIGINATED BY MR

DIST HWY 69 BOREHOLE TYPE D-25 Track Mount, Dynamic Cone Penetration Test COMPILED BY MWK

DATUM Geodetic DATE January 24, 2009 CHECKED BY VA/OK

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
202.7	GROUND SURFACE										
0.0	Dynamic Cone Penetration Test (DCPT)										
188.3											
14.4	END OF DCPT Refusal to Further Penetration (100 Blows / 0.03 m)										

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

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RECORD OF DCPT No S24-DC-02

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044990.3 ;E 244284.0 ORIGINATED BY MR

DIST HWY 69 BOREHOLE TYPE PENETRATION TEST COMPILED BY MWK

DATUM Geodetic DATE January 21, 2009 CHECKED BY VA/OK

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT / SHEAR STRENGTH kPa / 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 — PLASTIC LIMIT w_P NATURAL MOISTURE CONTENT w LIQUID LIMIT w_L — 20 40 60	γ kN/m³	GR SA SI CL
203.0	GROUND SURFACE									
0.0	Dynamic Cone Penetration Test (DCPT)						202 201 200 199 198 197 196 195 194 193 192 191 190 189	133		
188.5										
14.5	END OF DCPT Refusal to Further Penetration (100 Blows / 0.15 m)									

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

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RECORD OF DCPT No S24-DC-03

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044969.2 ;E 244254.2 ORIGINATED BY MR

DIST HWY 69 BOREHOLE TYPE PENETRATION TEST COMPILED BY MWK

DATUM Geodetic DATE January 22, 2009 CHECKED BY VA/OK

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						
203.1	GROUND SURFACE										
0.0	Dynamic Cone Penetration Test (DCPT)						203 202 201 200 199 198 197 196 195 194 193 192				
191.1											
12.0	END OF DCPT Refusal to Further Penetration (100 Blows / 0.15 m)										

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

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RECORD OF DCPT No S24-DC-04

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044951.3 ;E 244358.6 ORIGINATED BY MR

DIST HWY 69 BOREHOLE TYPE PENETRATION TEST COMPILED BY MWK

DATUM Geodetic DATE January 23, 2009 CHECKED BY VA/OK

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
202.1 GROUND SURFACE								20 40 60 80 100	20 40 60		
0.0	Dynamic Cone Penetration Test (DCPT)						202				
							201				
							200				
							199				
							198				
							197				
							196				
							195				
							194				
							193				
							192				
191.7											
10.4	END OF DCPT Refusal to Further Penetration (100 Blows / 0.08 m)										

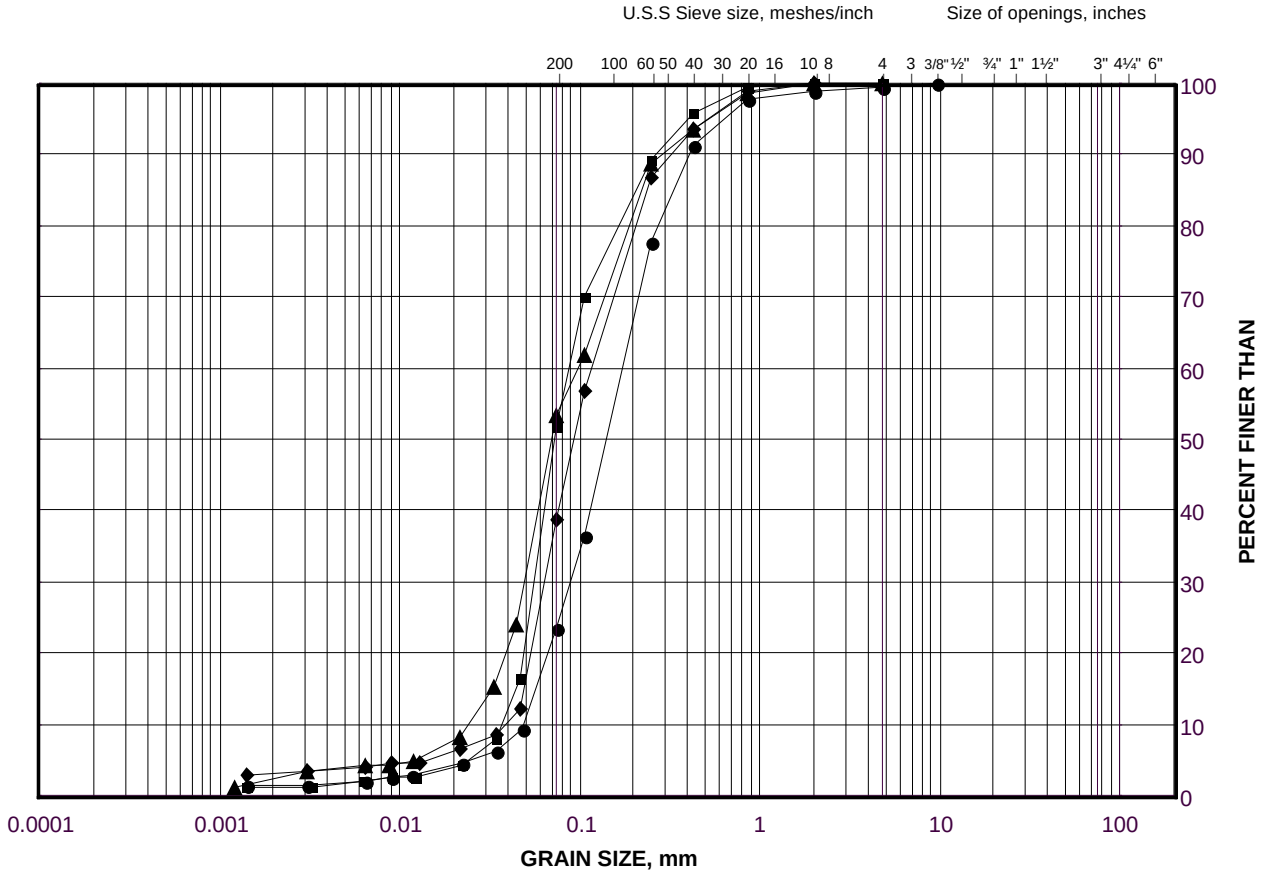
$+^3$, $\times^3$: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

GRAIN SIZE DISTRIBUTION

Silt and Sand to Silty Sand

Highway 69 (SBL) STA 16+475 to 16+550

FIGURE B.S24-1A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-01	2	201.4
■	S24-03	3	200.9
◆	S24-01	4	200.1
▲	S24-01	5B	199.5

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

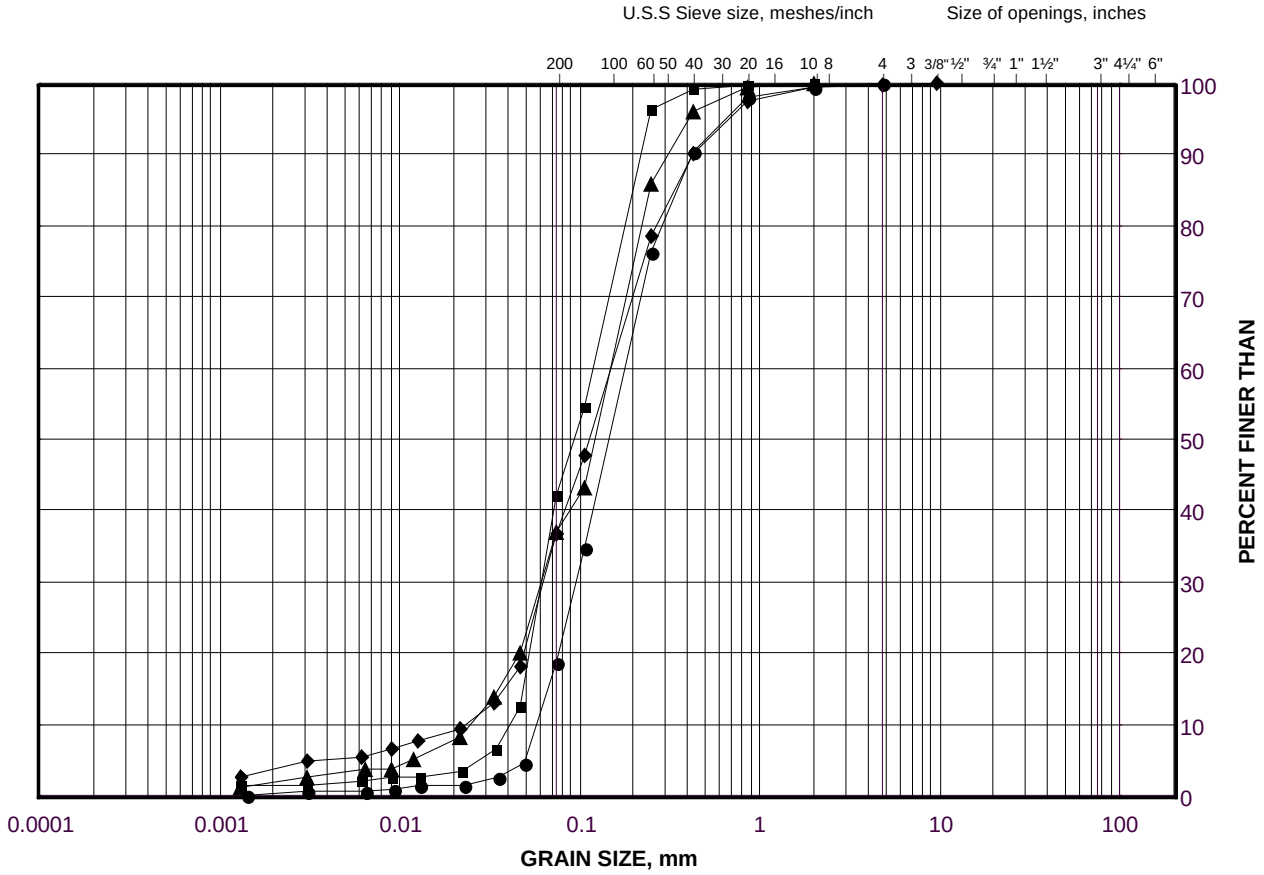
Date: 15-Dec-09

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand

Highway 69 (SBL) STA 16+475 to 16+550

FIGURE B.S24-1B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-04	2	202.0
■	S24-02	2	201.6
◆	S24-09	3	200.9
▲	S24-06	3	200.4

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

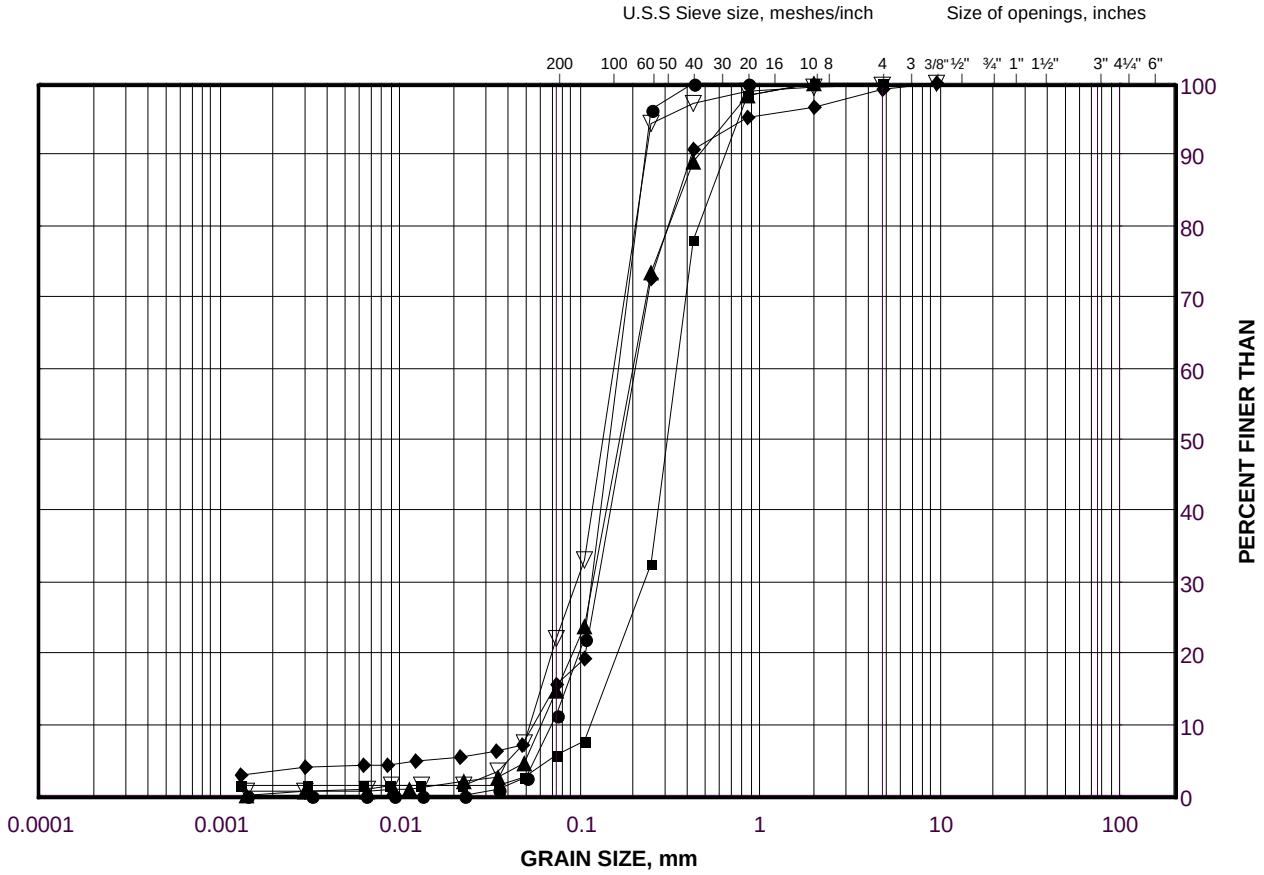
Date: 15-Dec-09

GRAIN SIZE DISTRIBUTION

Silty Sand to Sand

Highway 69 (SBL) STA 16+475 to 16+550

FIGURE B.S24-1C



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-03	10	192.3
■	S24-04	5	199.7
◆	S24-02	6	198.4
▲	S24-03	7	196.9
▽	S24-02	9	193.9

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

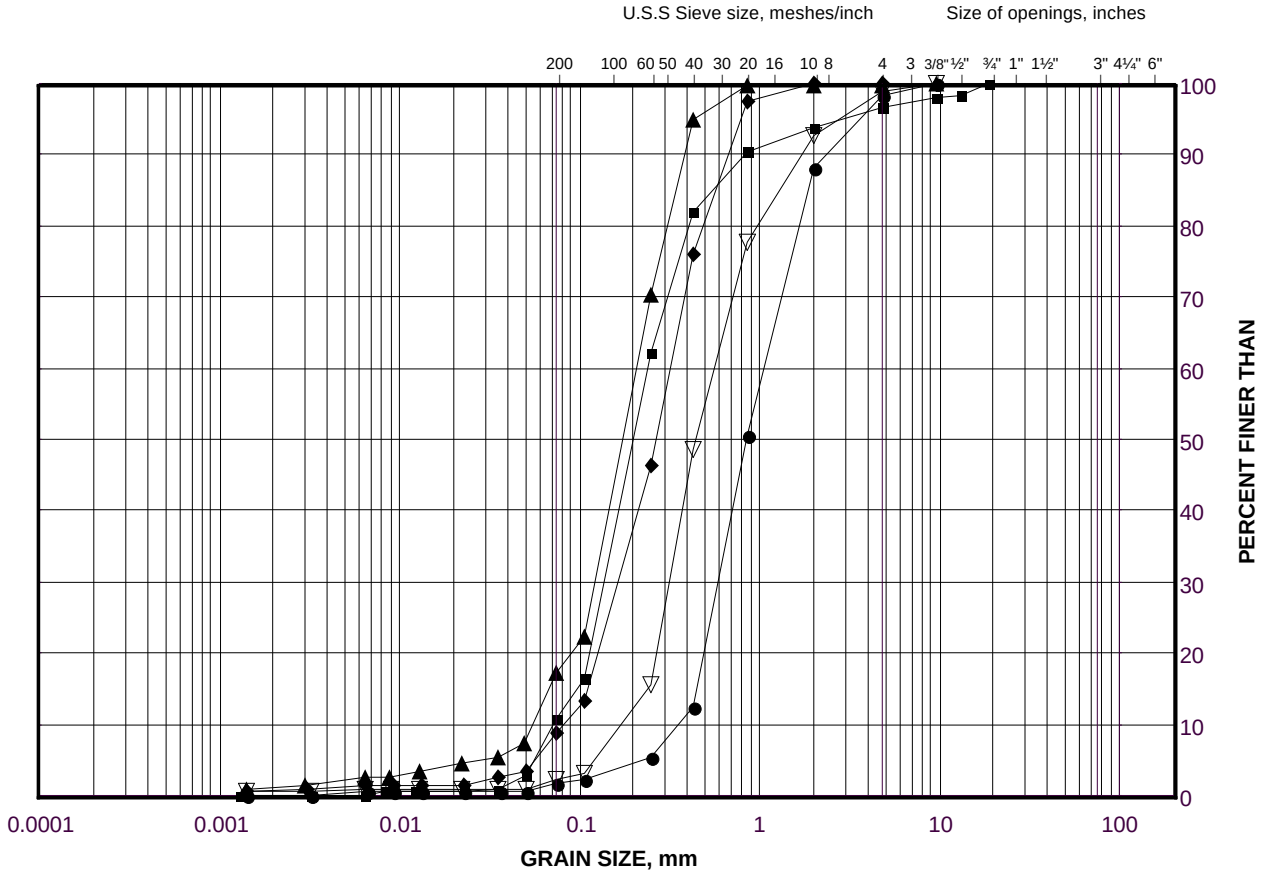
Date: 15-Dec-09

GRAIN SIZE DISTRIBUTION

Silty Sand to Sand

Highway 69 (SBL) STA 16+475 to 16+550

FIGURE B.S24-1D



LEGEND

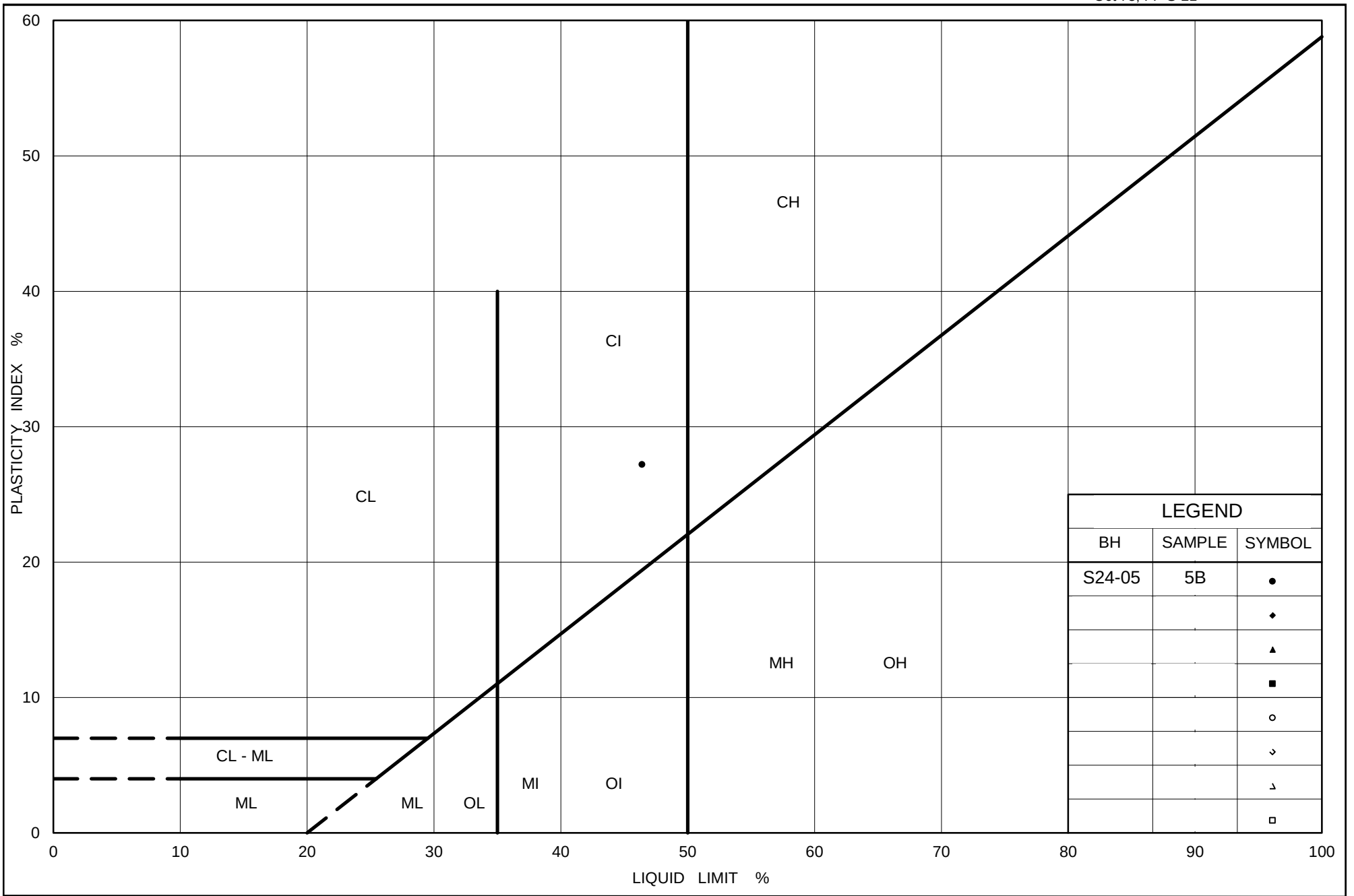
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-06	10A	192.1
■	S24-07	7	196.9
◆	S24-06	7	196.6
▲	S24-05	7	197.2
▽	S24-04	8	195.9

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

Date: 15-Dec-09



Ministry of Transportation

Ontario

PLASTICITY CHART
Silty Clay
Highway 69 (SBL) STA 16+475 to 16+550

Figure No. B.S24-2

Project No. 07-1111-0029

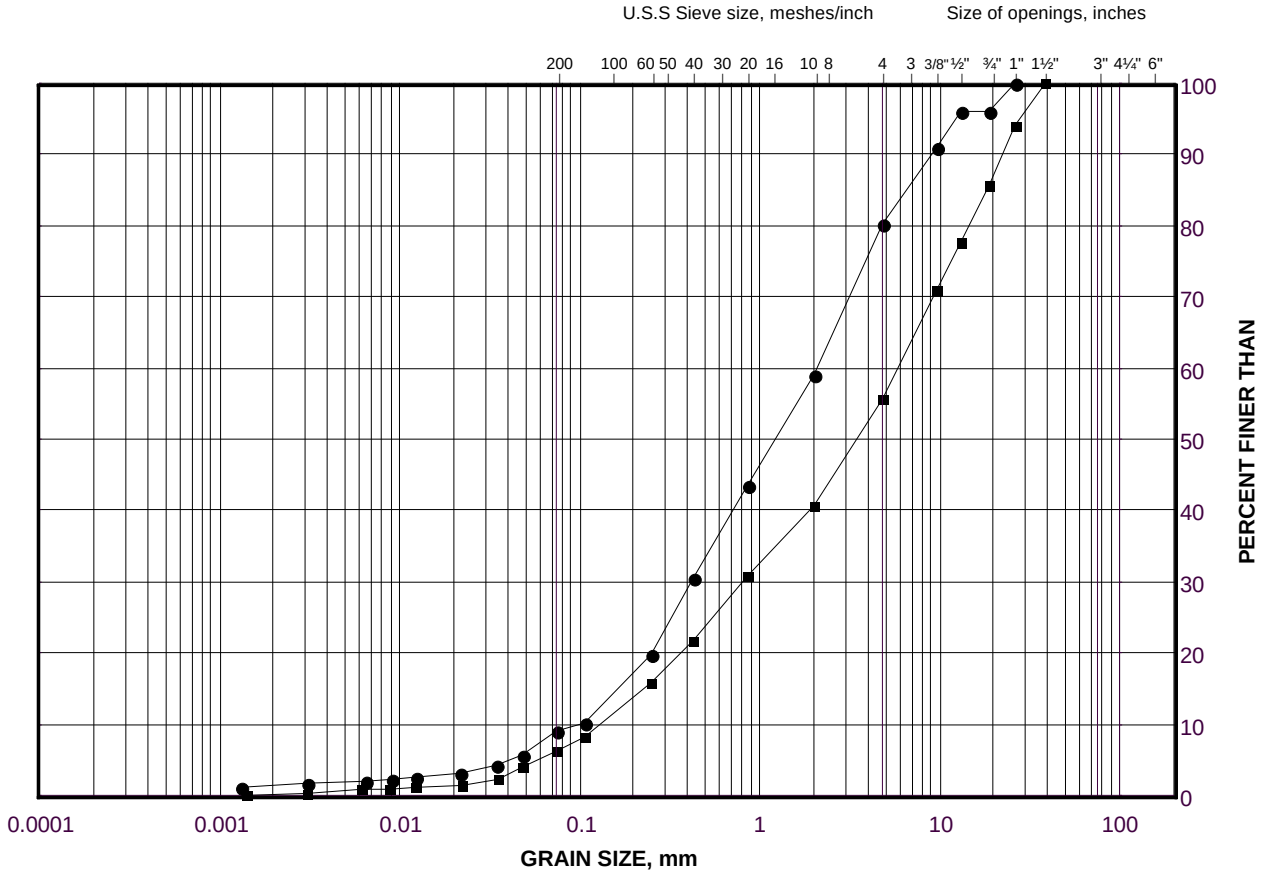
Checked By: CN

GRAIN SIZE DISTRIBUTION

Sand and Gravel

Highway 69 (SBL) STA 16+475 to 16+550

FIGURE B.S24-3A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-05	8	195.6
■	S24-07	9	193.8

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

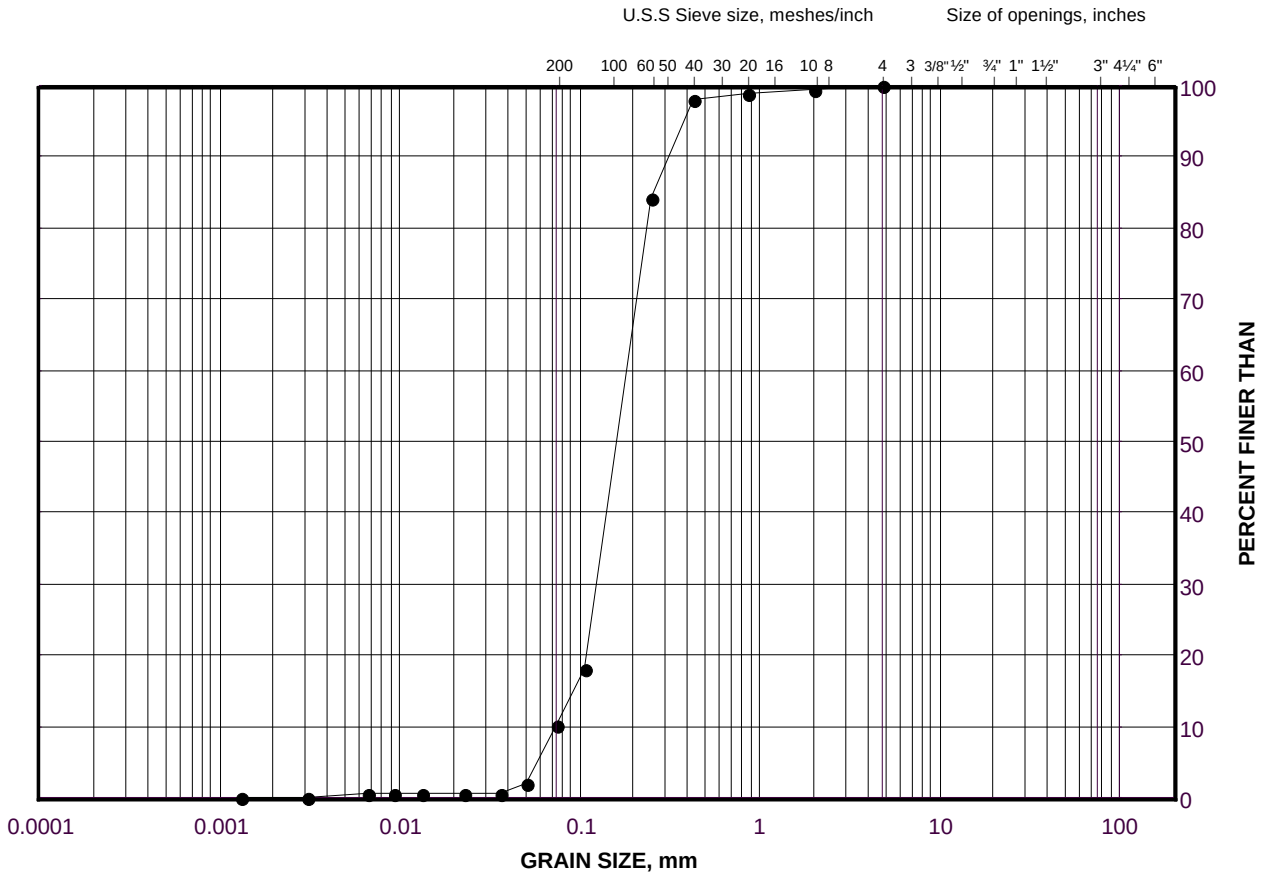
Date: 15-Dec-09

GRAIN SIZE DISTRIBUTION

Sand

Highway 69 (SBL) STA 16+475 to 16+550

FIGURE B.S24-3B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-05	12	189.6

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

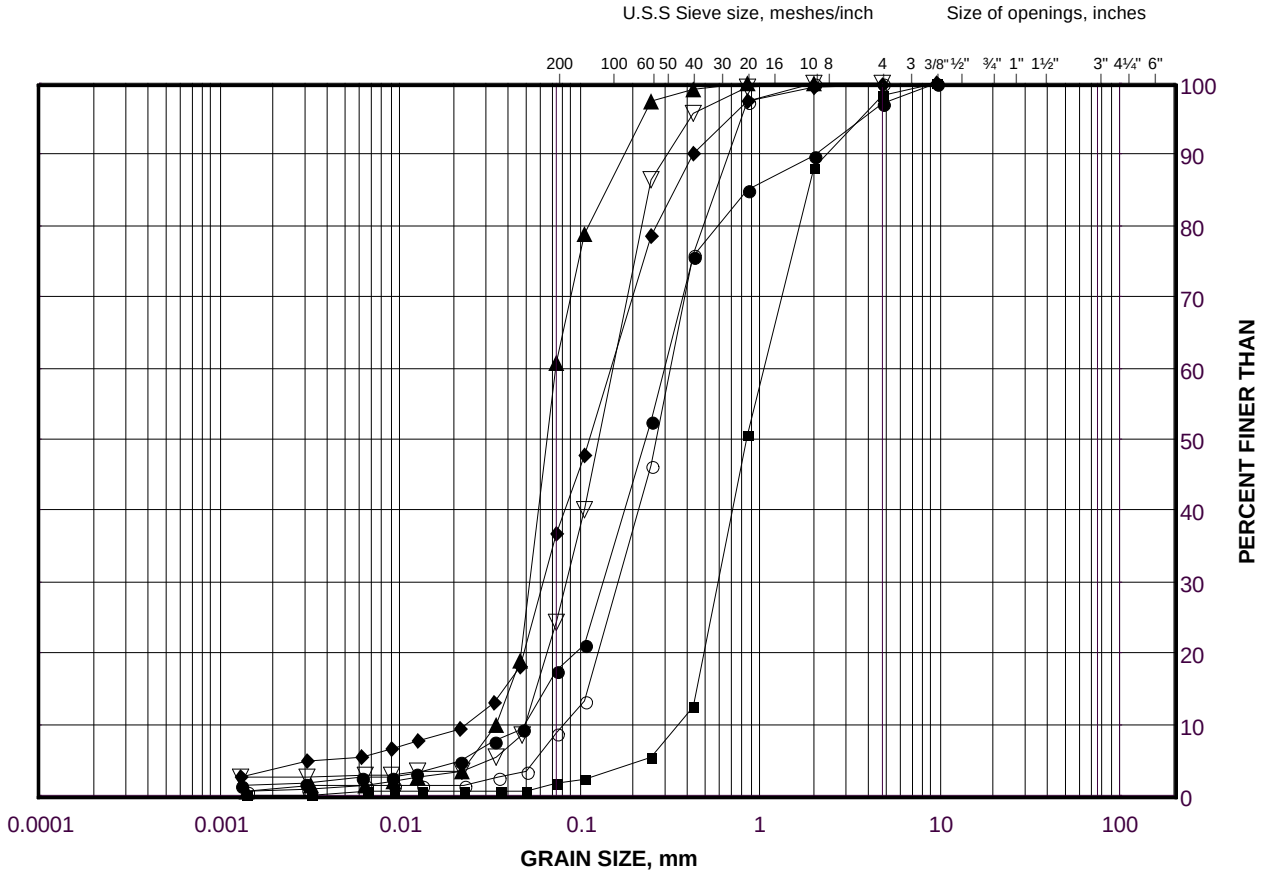
Date: 15-Dec-09

GRAIN SIZE DISTRIBUTION

Sandy Silt to Sand

Highway 69 (NBL) STA 16+450 to 16+550

FIGURE B.S24-4A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-10	10	193.3
■	S24-06	10A	192.1
◆	S24-09	3	200.8
▲	S24-10	3	200.6
▽	S24-10	7	197.8
❍	S24-06	7	196.6

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

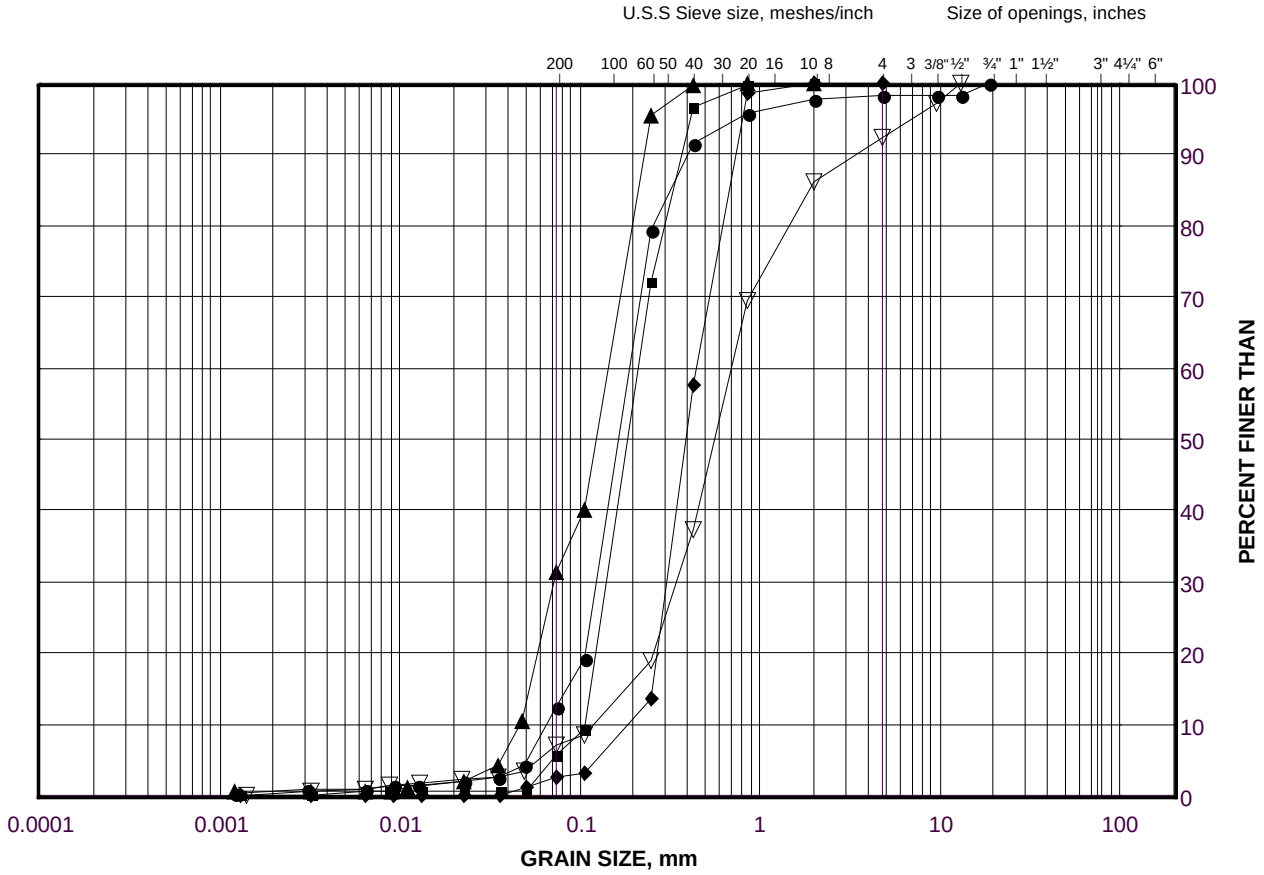
Date: 15-Dec-09

GRAIN SIZE DISTRIBUTION

Sandy Silt to Sand

Highway 69 (NBL) STA 16+450 to 16+550

FIGURE B.S24-4B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-14	2	201.5
■	S24-14	6	198.3
◆	S24-15	7	197.6
▲	S24-13	7	196.7
▽	S24-15	8	196.9

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

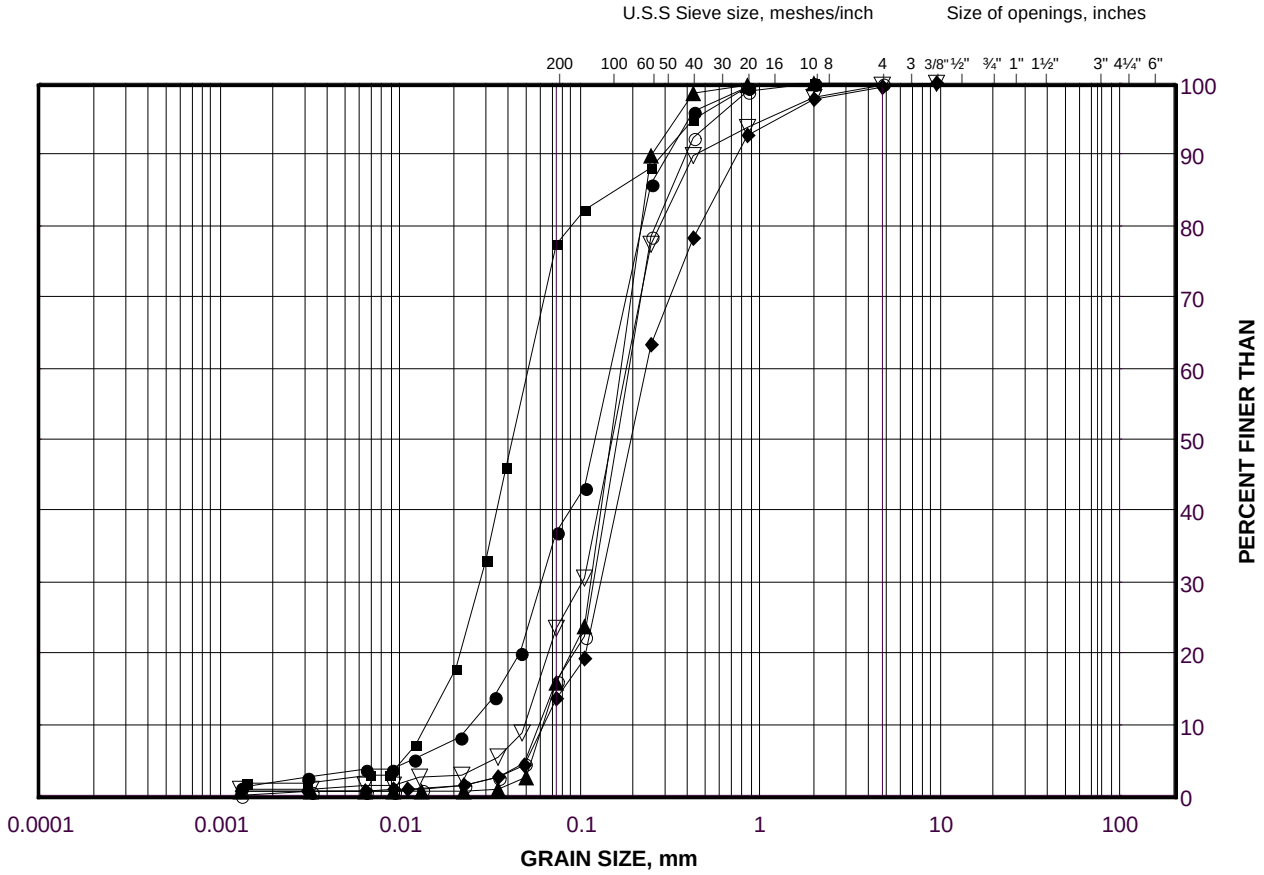
Date: 15-Dec-09

GRAIN SIZE DISTRIBUTION

Sandy Silt to Sand

Highway 69 (NBL) STA 16+450 to 16+550

FIGURE B.S24-4C



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-06	3	200.4
■	S24-11	3	199.9
◆	S24-13	4	199.7
▲	S24-12	4	200.5
▽	S24-11	6	197.8
❍	S24-12	7	198.0

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

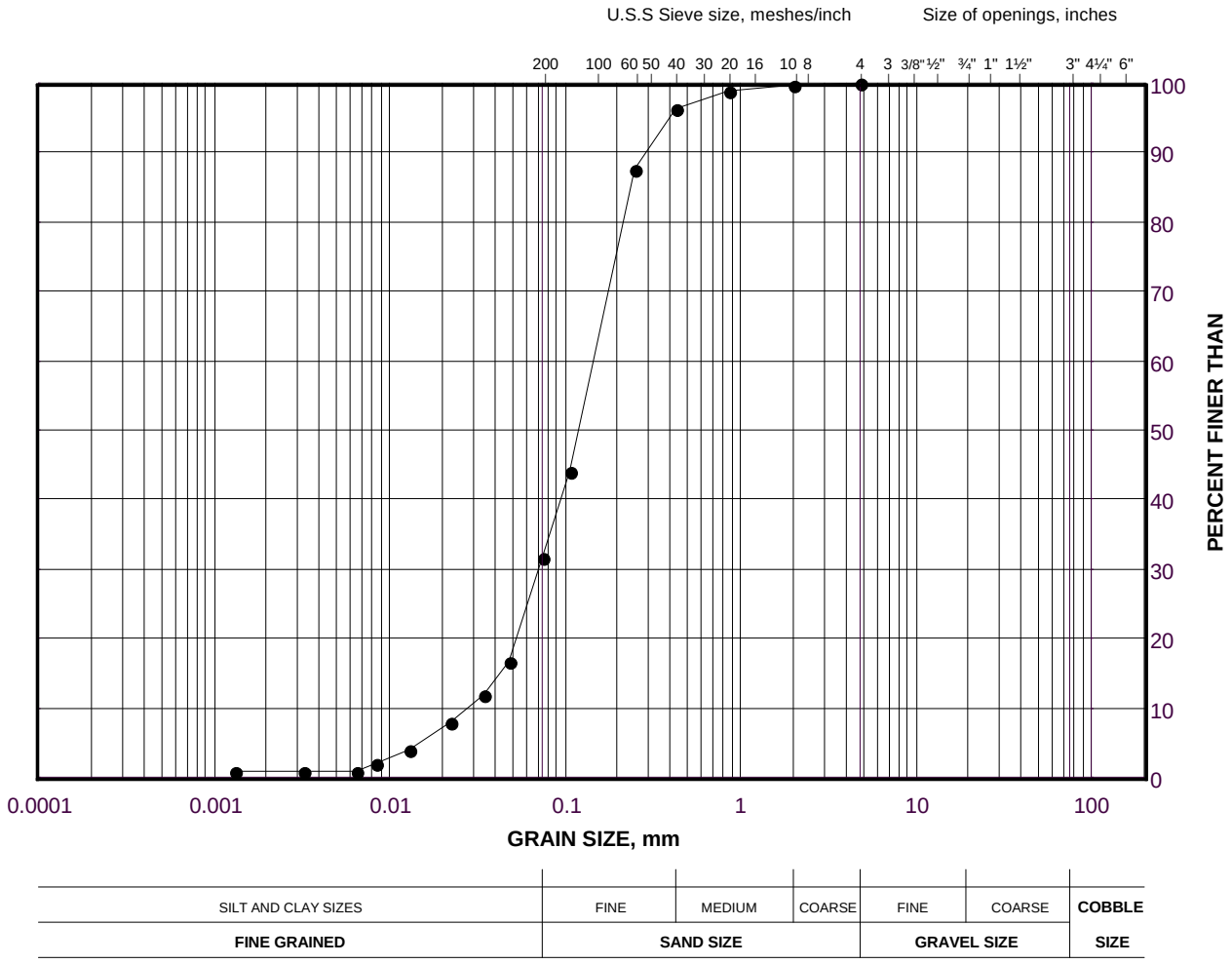
Date: 15-Dec-09

GRAIN SIZE DISTRIBUTION

Silt and Sand

Highway 69 (NBL) STA 16+450 to 16+550

FIGURE B.S24-5



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S24-10	13	188.7

Project Number: 07-1111-0029

Checked By: CN

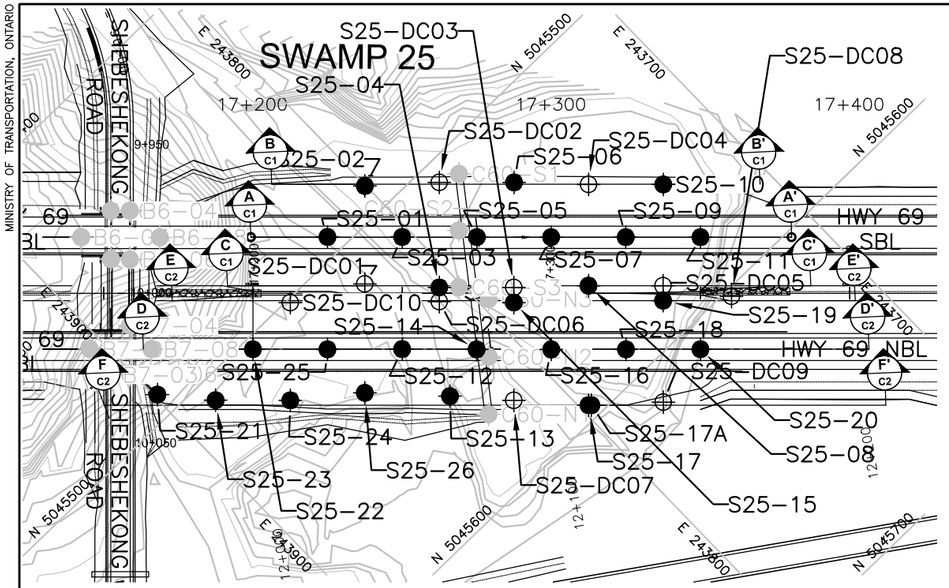
Golder Associates

Date: 15-Dec-09

APPENDIX C

Highway 69 SBL – STA 17+230 to 17+350 and Highway 69 NBL – STA 17+150 to 17+350 (Swamp 25)

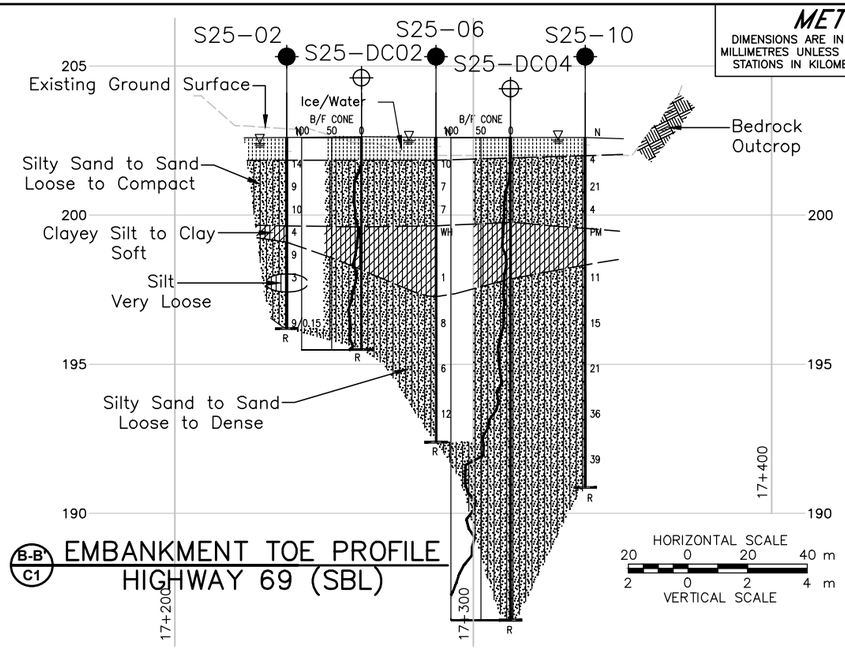
MINISTRY OF TRANSPORTATION, ONTARIO



PLAN

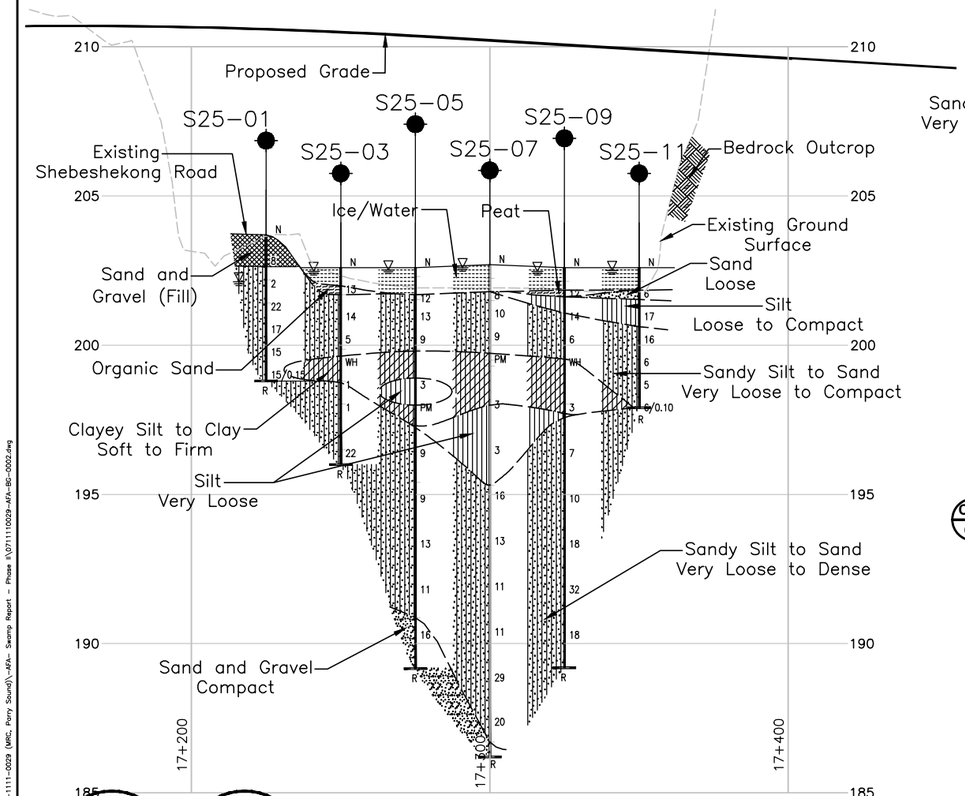
SCALE

20 0 20 40 m



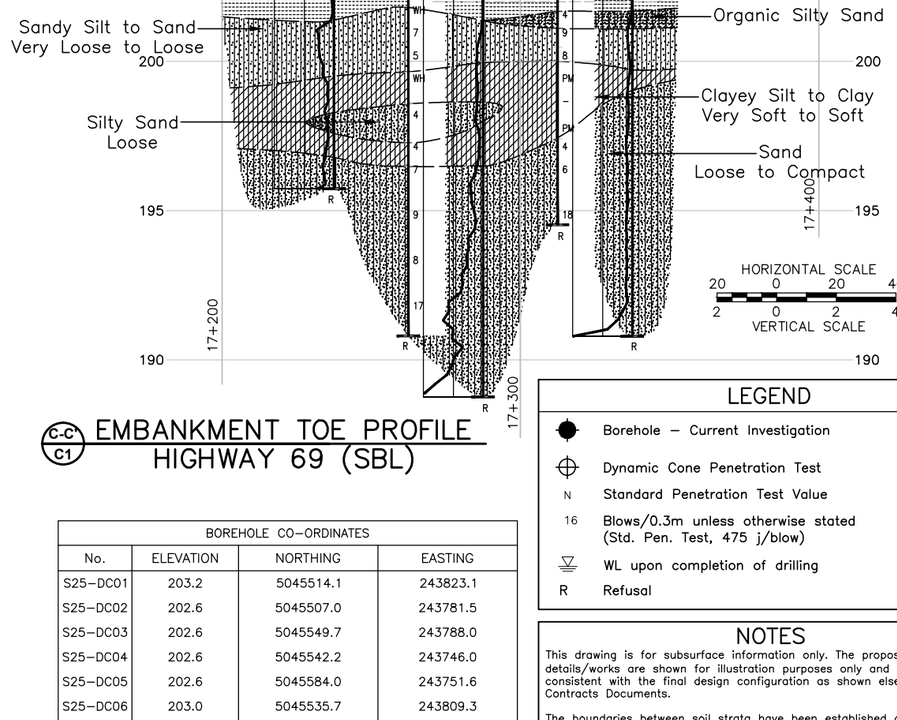
B-B' C1 EMBANKMENT TOE PROFILE
HIGHWAY 69 (SBL)

HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE



A-A' C1 CENTRELINE PROFILE
HIGHWAY 69 (SBL)

HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE



C-C C1 EMBANKMENT TOE PROFILE
HIGHWAY 69 (SBL)

HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
S25-DC01	203.2	5045514.1	243823.1
S25-DC02	202.6	5045507.0	243781.5
S25-DC03	202.6	5045549.7	243788.0
S25-DC04	202.6	5045542.2	243746.0
S25-DC05	202.6	5045584.0	243751.6
S25-DC06	203.0	5045535.7	243809.3
S25-DC07	202.2	5045576.9	243814.3
S25-DC08	202.6	5045602.5	243737.6
S25-DC09	203.9	5045612.1	243778.7
S25-DC10	202.9	5045501.2	243845.4

LEGEND

- Borehole – Current Investigation
- 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
- R — Refusal

NOTES

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

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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.

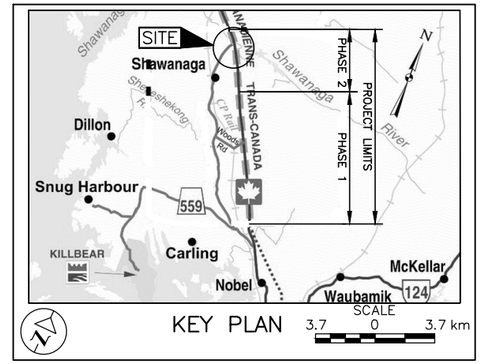
METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No. .
WP No. 5111-07-00

HIGHWAY 69 (SBL) STA 17+230 TO 17+350
HIGHWAY 69 (NBL) STA 17+150 TO 17+350
BOREHOLE LOCATIONS
AND SOIL STRATA

SHEET
.

Golder Associates



KEY PLAN

BOREHOLE CO-ORDINATES			
No.	ELEVATION	NORTHING	EASTING
S25-01	203.7	5045494.1	243821.2
S25-02	202.6	5045490.5	243800.3
S25-03	202.6	5045511.5	243803.2
S25-04	202.6	5045532.3	243806.0
S25-05	202.6	5045528.9	243785.2
S25-06	202.6	5045524.4	243763.5
S25-07	202.7	5045546.2	243767.3
S25-08	202.6	5045566.6	243769.6
S25-09	202.6	5045563.6	243749.3
S25-10	202.6	5045559.6	243728.0
S25-11	202.6	5045581.0	243731.3
S25-12	203.5	5045538.5	243829.3
S25-13	203.9	5045561.0	243828.7
S25-14	203.2	5045555.9	243811.4
S25-15	202.6	5045553.3	243791.5
S25-16	202.5	5045573.3	243793.4
S25-17	203.3	5045595.4	243797.4
S25-17A	203.3	5045596.1	243796.7
S25-18	202.6	5045590.7	243775.4
S25-19	202.6	5045587.6	243755.1
S25-20	204.7	5045608.0	243757.4
S25-21	202.4	5045492.5	243898.9
S25-22	203.1	5045503.8	243865.3
S25-23	202.9	5045507.4	243886.2
S25-24	203.0	5045524.8	243868.2
S25-25	203.0	5045521.2	243847.3
S25-26	202.7	5045540.4	243848.5

REFERENCE

Base plans contours and centreline profile provided in digital format by MMM, drawing file nos. S6878-330-001SGA.dwg, dated November 2013, s6878xb02 contours.dwg, h6878_PHASE2_XD1 grading.dwg and h6878_PHASE2_XN1.dwg, received November 10, 2014, 6878 jh Hwy 69 Profile Raise-July 23, 2013.dwg received May 14, 2015.

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 41H-161

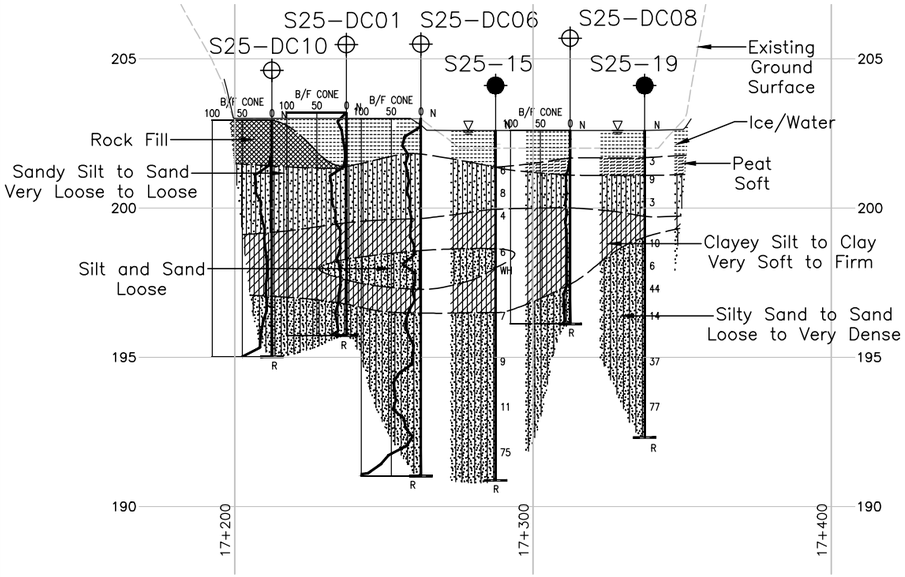
HWY. 69	PROJECT NO. 07-1111-0029		DIST. .
SUBM'D. CN/AJS	CHKD. CN	DATE: 5/20/2015	SITE: .
DRAWN: MR	CHKD. CN	APPD. JPD/JMAC	DWG. C1

LICENSED PROFESSIONAL ENGINEER J. M. A. COSTA Apr. 6, 2016 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.P. DITTRICH Apr. 6, 2016 PROVINCE OF ONTARIO

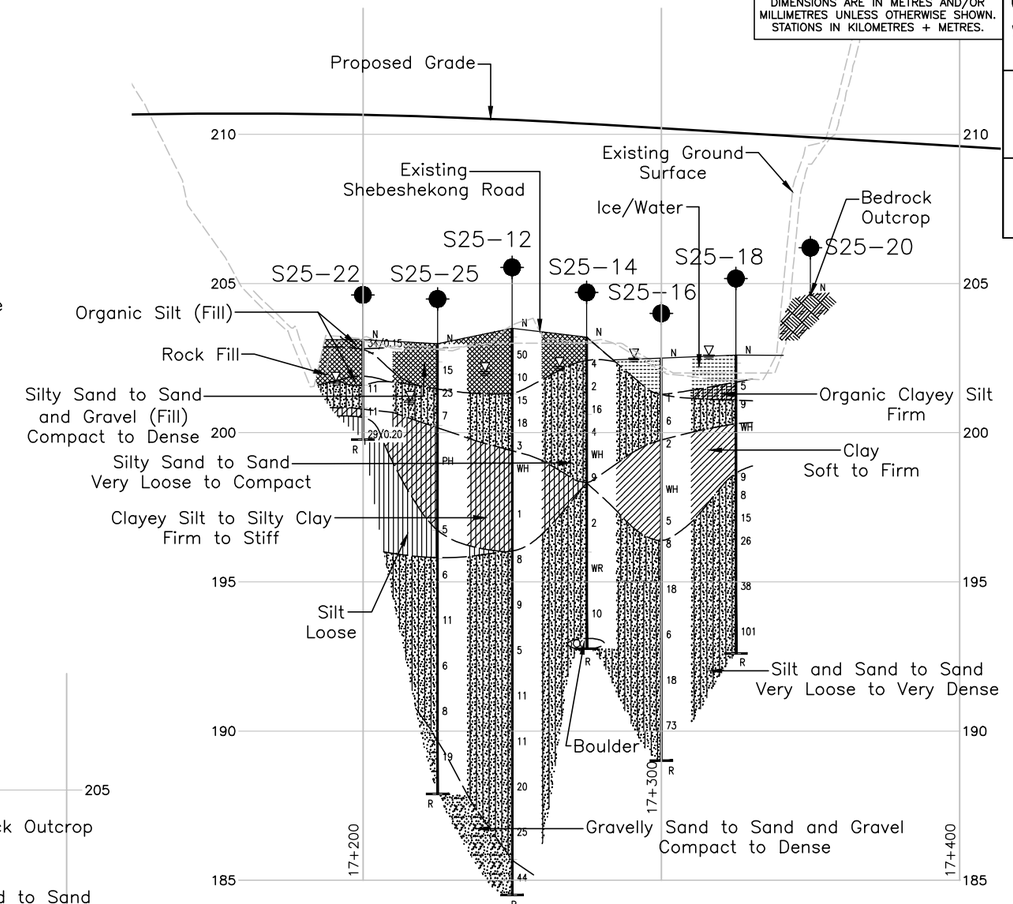
PLOT DATE: April 11, 2016
FILENAME: T:\Projects\2007\07-1111-0029 (MRC, Parry Sound)\-AFA- Swamp Report - Phase II\07111029-AFA-BC-0002.dwg

MINISTRY OF TRANSPORTATION, ONTARIO



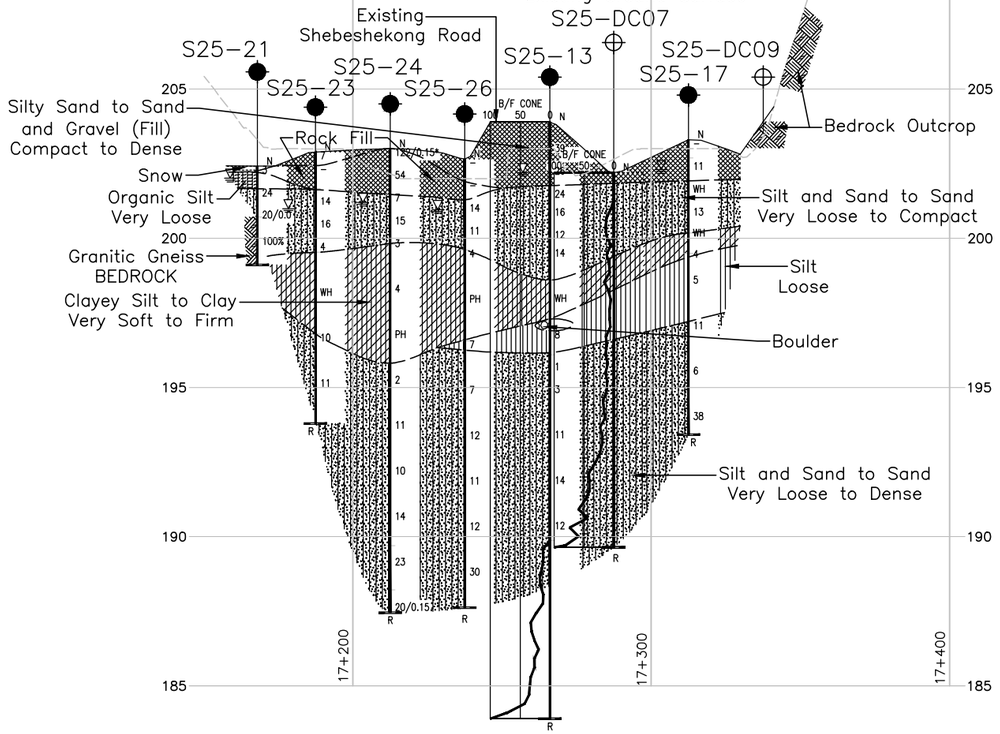
E-E' C2 EMBANKMENT TOE PROFILE
HIGHWAY 69 (NBL)

HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE



D-D' C2 CENTRELINE PROFILE
HIGHWAY 69 (NBL)

HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE



F-F' C2 EMBANKMENT TOE PROFILE
HIGHWAY 69 (NBL)

HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE

METRIC

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

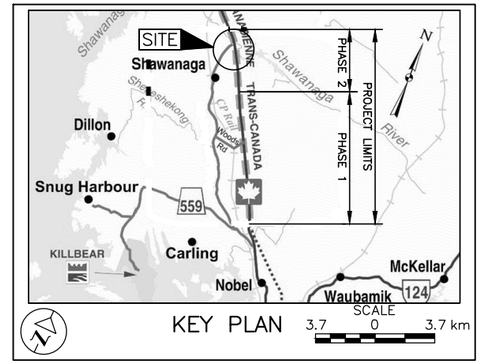
CONT No.
WP No. 5111-07-00

HIGHWAY 69 (NBL) STA 17+150 TO 17+350

SOIL STRATA

SHEET

Golder Associates



BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
S25-12	203.5	5045538.5	243829.3
S25-13	203.9	5045561.0	243828.7
S25-14	203.2	5045555.9	243811.4
S25-15	202.6	5045553.3	243791.5
S25-16	202.5	5045573.3	243793.4
S25-17	203.3	5045595.4	243797.4
S25-18	202.6	5045590.7	243775.4
S25-19	202.6	5045587.6	243755.1
S25-20	204.7	5045608.0	243757.4
S25-21	202.4	5045492.5	243898.9
S25-22	203.1	5045503.8	243865.3
S25-23	202.9	5045507.4	243886.2
S25-24	203.0	5045524.8	243868.2
S25-25	203.0	5045521.2	243847.3
S25-26	202.7	5045540.4	243848.5
S25-DC01	203.2	5045514.1	243823.1
S25-DC06	203.0	5045535.7	243809.3
S25-DC07	202.2	5045576.9	243814.3
S25-DC08	202.6	5045570.2	243773.1
S25-DC09	203.9	5045612.1	243778.7
S25-DC10	202.9	5045501.2	243845.4

LEGEND

- Borehole – Current Investigation
- Dynamic Cone Penetration Test
- N — Standard Penetration Test Value
- 16 — Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- 100% — Rock Quality Designation (RQD)
- WL upon completion of drilling
- R — Refusal

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.

LICENSED PROFESSIONAL ENGINEER J. M. A. COSTA Apr. 6, 2016 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.P. DITTRICH Apr. 6, 2016 PROVINCE OF ONTARIO

REFERENCE

Base plans contours and centreline profile provided in digital format by MMM, drawing file nos. S6878-330-001SGA.dwg, dated November 2013, s6878xb02 contours.dwg, h6878_PHASE2_XD1 grading.dwg and h6878_PHASE2_XN1.dwg, received November 10, 2014, 6878 jh Hwy 69 Profile Raise-July 23, 2013.dwg received May 14, 2015.

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 41H-161

HWY. 69	PROJECT NO. 07-1111-0029		DIST. .
SUBM'D. CN/AJS	CHKD. CN	DATE: 5/20/2015	SITE: .
DRAWN: MR	CHKD. CN	APPD. JPD/JMAC	DWG. C2

PLOT DATE: April 11, 2016
FILENAME: T:\Projects\2007\07-1111-0029 (MRC, Parry Sound)\-AFA- Seamp Report - Phase II\07111029-AFA-BS-0003.dwg

Golder Associates

RECORD OF BOREHOLE No S25-01

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045494.1 ;E 243821.2
BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers
DATE March 21, 2009

ORIGINATED BY ID
COMPILED BY TZ
CHECKED BY VA/OK

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
203.7	GROUND SURFACE										
0.0	Sand and gravel (FILL) Grey to brown Moist to wet Loose										
202.6			1	SS	8		203				
1.1	SAND, some gravel Loose Brown Moist										
202.2			2	SS	2	▽	202		○		0 70 30 0 OC=4.8%
1.5	Silty SAND, trace organics, trace wood fibres Very loose										
201.4			3	SS	22		201				
2.3	Grey Wet SAND, trace silt Compact Brown to grey Wet		4	SS	17				○		
			5	SS	15		200				
198.8			6	SS	15/0.15		199		○		
4.9	Some gravel below a depth of 4.7 m END OF BOREHOLE SPOON AND AUGER REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 1.6 m below ground surface (Elev. 202.1 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No S25-02

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045490.5 ;E 243800.3
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE February 25, 2009

ORIGINATED BY ID
COMPILED BY TZ
CHECKED BY VA/OK

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
202.6	ICE SURFACE										
0.0 / 202.1	Ice					▽					
201.8	Water						202				
0.8	SAND, trace organics to a depth of 1.4 m Loose to compact Brown to grey Wet		1	SS	14						
			2	SS	9		201				
199.6			3	SS	10		200				
3.0 / 199.1	CLAY, trace sand Soft Grey Wet		4	SS	4			+ 4 4			
3.5	Silty SAND, trace clay Loose Grey Wet		5	SS	9		199				
198.0											
4.6 / 197.4	SILT, trace sand Very loose Grey Wet		6	SS	3		198				
5.2	SAND, trace silt Compact Grey Wet						197				
196.2			7	SS	9/0.15						
6.4	END OF BOREHOLE SPOON AND CASING REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 0.2 m below ice surface (Elev. 202.4 m) upon completion of drilling.

2. An additional borehole was drilled 1.5 m east of Borehole S25-02 to carry out in situ vane testing at depths of 3.4 m and 3.7 m below ice surface (Elev. 199.2 m and 198.9 m).

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S25-03

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045511.5 ;E 243803.2
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE February 26, 2009

ORIGINATED BY ID
COMPILED BY TZ
CHECKED BY VA/OK

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
202.6	ICE SURFACE										
0.0 / 202.3	Ice										
202.0	Water										
201.7 / 0.9	Organic SAND Dark brown Wet		1	SS	13		202				
	SAND, trace silt Loose to compact Brown Wet		2	SS	14		201				
199.9			3	SS	5		200	5 4			
3.0	Sandy SILT Loose Grey Wet		4	SS	WH						
198.8 / 3.8	SILTY CLAY Soft Grey Wet		5	SS	1		199				
198.0 / 4.6	Sandy SILT Very loose Grey Wet		6	SS	1		198				0 61 36 3 Non-Plastic
	SILT and SAND, trace clay Very loose Grey Wet						197				
196.5 / 6.1	SAND, trace gravel Compact Grey Wet		7	SS	22		196				
196.0 / 6.6	END OF BOREHOLE SPOON AND CASING REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 0.1 m below ice surface (Elev. 202.5 m) upon completion of drilling.

2. Two additional boreholes were drilled 1.5 m north and 1.5 m north-east of Borehole S25-03 to obtain a Shelby tube sample between depths of 2.9 m and 3.3 m below ice surface (Elev. 199.7 m and 199.2 m), and to carry out in situ vane testing at depths of 3.0 m and 3.4 m below ice surface (Elev. 199.6 m and 199.2 m).

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S25-04

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5045532.3 ;E 243806.0 ORIGINATED BY MJR
DIST HWY 69 BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring COMPILED BY TZ
DATUM Geodetic DATE March 4, 2009 CHECKED BY VA/OK

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
202.6	ICE SURFACE							20 40 60 80 100	20 40 60		
0.0 / 202.3	Ice						202				
0.3 / 201.8	Water										
0.8	Silty SAND, trace gravel, trace organics to a depth of 2.1 m Very loose to loose Dark brown Wet		1	SS	WH						
			2	SS	7		201		○		
			3	SS	5		200				
199.6											
3.0	CLAYEY SILT Very soft Grey Wet		4	SS	WH				⊢○		
198.6							199	2			
4.0	Silty SAND, trace clay Loose Grey Wet		5	SS	4		198		○		
197.3											
5.3	SILTY CLAY Soft Reddish brown Wet		6	SS	4		197				
196.5											
6.1	SAND, trace to some silt Loose to compact Grey Wet		7	SS	7		196		○		
			8	SS	9		195				
			9	SS	8		194		○		
			10	SS	17		193				
190.8							192				
							191				
11.8	END OF BOREHOLE CASING REFUSAL										

NOTES:

1. Water level in open borehole at ice surface (Elev. 202.6 m) upon completion of drilling.

2. Borehole caved to a depth of 6.2 m below ice surface (Elev. 196.4 m) upon removal of casing.

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF BOREHOLE No S25-05

SHEET 1 OF 2

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045528.9 ;E 243785.2
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE February 26, 2009

ORIGINATED BY ID
COMPILED BY TZ
CHECKED BY VA/OK

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
202.6	ICE SURFACE										
0.0 / 202.3	Ice										
0.3 / 201.7	Water						202				
1.1	SAND, trace organics Loose Dark brown Wet		1	SS	12						
	SAND, trace silt Loose to compact Brown Wet		2	SS	13		201		○		
199.9			3	SS	9		200	6 5			
2.7 / 198.9	CLAY Soft Grey and brown Wet						199				
3.7 / 198.0	SILT, trace sand, trace clay Very loose Grey Wet		4	SS	3				○		
4.6 / 197.3	CLAY Grey and brown Wet		5	TO	PM		198		⊢—○		
5.3	Silty SAND Loose Grey Wet		6	SS	9		197		○		0 78 22 0
195.4							196				
7.2	SAND, trace gravel, trace silt Loose to compact Grey Wet		7	SS	9		195				
			8	SS	13		194				
			9	SS	11		193		○		
190.9							192				
11.7	SAND and GRAVEL Compact Grey Wet		10	SS	16		191				
189.2							190				
13.4	END OF BOREHOLE CASING REFUSAL										

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S25-05

SHEET 2 OF 2 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5045528.9 ;E 243785.2 ORIGINATED BY ID
DIST HWY 69 BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring COMPILED BY TZ
DATUM Geodetic DATE February 26, 2009 CHECKED BY VA/OK

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		
	NOTES: 1. Water level in open borehole at a depth of 0.1 m below ice surface (Elev. 202.5 m) upon completion of drilling. 2. Borehole caved to a depth of 2.5 m below ice surface (Elev. 200.1 m) upon removal of casing.										

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

Golder Associates

RECORD OF BOREHOLE No S25-06

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045524.4 ;E 243763.5
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE February 25, 2009

ORIGINATED BY ID
COMPILED BY TZ
CHECKED BY VA/OK

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
202.6	ICE SURFACE										
0.0 / 202.3	Ice										
0.3 / 201.8	Water										
0.8	SAND, trace organics to a depth of 0.9 m Loose Brown and grey Wet		1	SS	10		202				
			2	SS	7		201		○		
200.3											
2.3 / 199.6	Silty SAND Loose Grey Wet		3	SS	7		200		○		
3.0	CLAYEY SILT, some silt seams Soft Grey Wet		4	SS	WH		199	5 5	⊢ ○		
197.3			5	SS	1		198				
5.3	SAND, trace gravel, trace silt Loose to compact Grey Wet		6	SS	8		197				
							196				
			7	SS	6		195		○		
							194				
			8	SS	12		193				
192.4											
10.2	END OF BOREHOLE SPOON AND CASING REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 0.1 m below ice surface (Elev. 202.5 m) upon completion of drilling.

2. Borehole caved to a depth of 2.2 m below ice surface (Elev. 200.4 m) upon removal of casing.

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S25-07

SHEET 1 OF 2

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045546.2 ;E 243767.3
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE March 2, 2009

ORIGINATED BY ID
COMPILED BY TZ
CHECKED BY VA/OK

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
202.7	ICE SURFACE										
0.0 / 202.2	Ice										
0.5 / 201.8	Water						202				
201.5 / 1.2	SAND, trace organics Loose Dark brown Wet		1	SS	8						
	SAND, trace to some silt Loose to compact Brown to grey Wet		2	SS	10		201		○		
			3	SS	9		200				
199.5											
3.4	Sandy SILT, trace to some clay Grey Wet		4	TO	PM				⊢○		
	CLAYEY SILT, trace sand Firm Grey Wet						199	+ 5 + 5			
198.0											
4.7	SILT, trace sand, trace clay Very loose Grey Wet		5	SS	3		198				
			6	SS	3		197		○		0 4 91 5
195.3							196				
7.4	SAND, trace to some silt, trace gravel Compact Grey Moist		7	SS	16		195		○		
			8	SS	13		194				
			9	SS	11		193				
			10	SS	11		192		○		
			11	SS	29		191				
							190				
							189		○		
							188				

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S25-07

SHEET 2 OF 2 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5045546.2 ;E 243767.3 ORIGINATED BY ID
DIST HWY 69 BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring COMPILED BY TZ
DATUM Geodetic DATE March 2, 2009 CHECKED BY VA/OK

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
	--- CONTINUED FROM PREVIOUS PAGE ---										
	SAND, trace to some silt, trace gravel Compact Grey Moist		12	SS	20		187				
186.7											
16.0	SAND and GRAVEL Grey Wet										
186.2											
16.5	END OF BOREHOLE CASING REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 0.1 m below ice surface (Elev. 202.6 m) upon completion of drilling.

2. Borehole caved to a depth of 2.5 m below ice surface (Elev. 200.2 m) upon removal of casing.

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

Golder Associates

RECORD OF BOREHOLE No S25-08

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045566.6 ;E 243769.6
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE February 25, 2009

ORIGINATED BY MJR
COMPILED BY TZ
CHECKED BY VA/OK

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
202.6	ICE SURFACE										
0.0 / 202.3	Ice										
0.3 / 201.7	Water						202				
0.9 / 201.1	Organic Silty SAND, trace rootlets Loose Dark brown Wet		1	SS	4				80.4		OC=11.4 %
1.5 / 200.5	SAND, trace to some silt, trace gravel Loose		2	SS	9		201				
2.1 / 200.0	Grey Wet		3A 3B	SS	8						
2.6	Sandy SILT, trace to some clay Loose Grey Wet						200				
	SILTY CLAY, trace sand Soft Grey and reddish brown Wet		4	TO	PM			1, 2		16.5	
			5	WS	-		199	3, 3, 3, 2			
197.4			6	TO	PM		198				
5.2	SAND, some silt, trace clay Loose to compact Grey to brown Wet		7	SS	4		197				
			8	SS	6						0 82 18 0
							196				
194.5			9	SS	18		195				
8.1	END OF BOREHOLE SPOON AND CASING REFUSAL										

NOTES:

1. Water level in open borehole at ice surface (Elev. 202.6 m) upon completion of drilling.

2. An additional borehole was drilled 1.0 m west of Borehole S25-08 to carry out in situ vane testing between depths of 3.0 m and 4.9 m below ice surface (Elev. 199.6 m and 197.7 m).

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF BOREHOLE No S25-09

SHEET 1 OF 2

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045563.6 ;E 243749.3
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE March 3, 2009

ORIGINATED BY ID
COMPILED BY TZ
CHECKED BY VA/OK

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
202.6	ICE SURFACE										
0.0	Ice										
202.1											
201.8	Water										
	PEAT (Amorphous)										
1.0	Black Wet		1	SS	12						
201.1	SILT										
1.5	Compact Grey Wet		2	SS	14						
	SAND, trace to some silt Loose to compact Brown and grey Wet		3	SS	6						
199.6											
3.1	CLAY, trace sand Soft to firm Grey Wet		4	SS	WH						
198.0											
197.7	CLAYEY SILT Firm		5	SS	3						
4.9	Grey and brown Wet										
	SAND, trace gravel, trace silt Loose to dense Grey to brown Wet		6	SS	7						
			7	SS	10						
			8	SS	18						
			9	SS	32						1 97 2 0
			10	SS	18						
189.2											
13.4	END OF BOREHOLE CASING REFUSAL										

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S25-09

SHEET 2 OF 2 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
LOCATION N 5045563.6 ;E 243749.3
ORIGINATED BY ID
DIST HWY 69
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
COMPILED BY TZ
DATUM Geodetic
DATE March 3, 2009
CHECKED BY VA/OK

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 ---											
	NOTES: 1. Water level in open borehole at a depth of 0.1 m below ice surface (Elev. 202.5 m) upon completion of drilling. 2. An additional borehole was drilled 1.5 m north of Borehole S25-09 to carry out in situ vane testing at depths of 3.2 m and 3.5 m below ice surface (Elev. 199.4 m and 199.1 m) and at depth of 4.6 m below ice surface (Elev. 198.0 m).										

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

Golder Associates

RECORD OF BOREHOLE No S25-10

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045559.6 ;E 243728.0
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE February 24, 2009

ORIGINATED BY ID
COMPILED BY TZ
CHECKED BY VA/OK

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
202.6	ICE SURFACE										
0.0	Ice										
202.0	Water										
0.6	SAND, trace to some silt, trace gravel, trace organics and rootlets to a depth of 0.9 m Loose to compact Brown Wet		1A 1B	SS	4		202		○		OC = 3.9%
			2	SS	21		201		○		
			3	SS	4		200				
199.5											
3.1	CLAY Soft Grey Wet		4	TO	PM		199	+5			
198.3											
4.3	SAND, trace to some gravel, trace to some silt Compact to dense Brown Wet		5	SS	11		198				
			6	SS	15		197		○		8 81 11 0
			7	SS	21		196		○		
			8	SS	36		195				
			9	SS	39		194		○		
190.9							193				
11.7	END OF BOREHOLE CASING REFUSAL						192				
	NOTES: 1. Water level in open borehole at a depth of 0.1 m below ice surface (Elev. 202.5 m) upon completion of drilling.						191				

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

Golder Associates

RECORD OF BOREHOLE No S25-11

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5045581.0 ;E 243731.3 ORIGINATED BY ID
DIST HWY 69 BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring COMPILED BY TZ
DATUM Geodetic DATE March 3, 2009 CHECKED BY VA/OK

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
202.6	ICE SURFACE										
0.0	Ice					▽					
202.1											
201.8	Water						202				
201.5	SAND, trace organics, trace rootlets		1	SS	6						
1.1	Loose Dark brown Wet										
	SILT, some sand, containing organics to a depth of 1.4 m		2	SS	17		201				0 17 72 11
200.6											
2.0	Loose to compact Grey to brown Wet										
	SAND, trace gravel		3	SS	16		200				
	Loose to compact Brown Wet										
			4	SS	6						
							199				
			5	SS	5						
197.9			6	SS	6/0.10		198				
4.7	END OF BOREHOLE SPOON AND CASING REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 0.1 m below ice surface (Elev. 202.5 m) upon completion of drilling.

2. Borehole caved to a depth of 2.7 m below ice surface (Elev. 199.9 m) upon removal of casing.

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

Golder Associates

RECORD OF BOREHOLE No S25-12

SHEET 1 OF 2

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045538.5 ;E 243829.3
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring
DATE March 21, 2009

ORIGINATED BY ID
COMPILED BY TZ
CHECKED BY VA/OK

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
203.5	GROUND SURFACE										
0.0 / 203.2	Sand and gravel (FILL) Grey						203				
0.3	Dry Sand (FILL) Dense Brown Wet		1	SS	50	▽					
202.0	Frozen to a depth of 1.1 m						202				
1.5	Sand and gravel (FILL) Compact Brown		2	SS	10						
201.3	Wet						201				
2.2	SAND, trace to some silt, trace organics to a depth of 3.1 m Very loose to compact Brown Wet		3	SS	15						
			4	SS	18		200				
199.4			5	SS	3						
4.1	SILTY CLAY, trace sand Firm to stiff Brown Wet		6	TO	WH		199	3 3			
			7	SS	1		198				
	Silt seams below a depth of 7.0 m						197	2 2			
196.0											
7.5	Silty SAND, trace gravel Loose to compact Grey to brown Wet		8	SS	8		196				
			9	SS	9		195				
			10	SS	5		194				
			11	SS	11		193				0 78 22 0
			12	SS	11		192				
							191				
							190				
							189				

Continued Next Page

+ 3 , × 3 : Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S25-12

SHEET 2 OF 2 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045538.5 ;E 243829.3
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring
DATE March 21, 2009

ORIGINATED BY ID
COMPILED BY TZ
CHECKED BY VA/OK

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 ---										
			13	SS	20		188		○		
							187				
			14	SS	25						
185.7							186				
17.8	Gravelly SAND, trace to some silt, trace clay Dense Grey Wet		15	SS	44		185		○		26 67 6 1
184.5											
19.0	END OF BOREHOLE CASING REFUSAL NOTE: 1. Water level in open borehole at a depth of 1.5 m below ground surface (Elev. 202.0 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No S25-13

SHEET 1 OF 2

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045561.0 ;E 243828.7
BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring
DATE March 22, 2009

ORIGINATED BY MR
COMPILED BY TZ
CHECKED BY VA/OK

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) / WATER CONTENT (%) (PLASTIC LIMIT w_P, NATURAL MOISTURE CONTENT w, LIQUID LIMIT w_L)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
203.9	GROUND SURFACE									
0.0	Sand and gravel, trace silt (FILL) Compact to dense Grey Moist to wet									
			1	SS	39		203			
201.8			2	SS	26	▽	202			
2.1	SAND, some silt, trace gravel Compact Brown Wet		3	SS	24		201			
			4	SS	16					
			5	SS	12		200			1 82 17 0
198.6			6	SS	14		199			
5.3	CLAY, trace sand Firm Brown Wet		7	SS	WH		198	3, 3		
197.3										
6.6	SILT, some sand, trace clay, boulder between depths of 6.6 m and 7.0 m Loose Grey Wet		8	SS	8		197			
196.1										
7.8	SILT and SAND, trace gravel, trace silt Very loose to compact Grey to brown Wet		9	SS	1		196			
			10	SS	3		195			
	Becoming brown below a depth of 10.4 m		11	SS	11		194			
			12	SS	14		193			1 65 33 1
189.9			13	SS	12		192			
14.0	END OF BOREHOLE						191			
							190			
							189			

Continued Next Page

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S25-13

SHEET 2 OF 2 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5045561.0 ;E 243828.7 ORIGINATED BY MR
DIST HWY 69 BOREHOLE TYPE 115 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring COMPILED BY TZ
DATUM Geodetic DATE March 22, 2009 CHECKED BY VA/OK

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		
							188				
							187				
							186				
							185				
183.9							184				
20.0	END OF DCPT Refusal to Further Penetration (100 Blows / 0.18 m)										

NOTES:

1. Water level in open borehole at a depth of 1.7 m below ground surface (Elev. 202.2 m) upon completion of drilling.

2. An additional borehole was drilled 1.0 m west of Borehole S25-13 to carry out in situ vane testing at depths of 5.9 m and 6.2 m below ground surface (Elev. 198.0 m and 197.7 m).

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

Golder Associates

RECORD OF BOREHOLE No S25-14

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045555.9 ;E 243811.4
BOREHOLE TYPE 101 mm O.D. Continuous Flight Solid Stem Augers and NW Casing, Wash Boring
DATE March 5, 2009

ORIGINATED BY EHS
COMPILED BY TZ
CHECKED BY VA/OK

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
203.2	GROUND SURFACE						203				
0.0 / 202.4	Sand, trace gravel, trace silt, trace rootlets (FILL) Light brown Moist										
0.8	Frozen to a depth of 0.3 m		1	SS	4	▽					
	Silty SAND, trace clay, trace organics Very loose to loose Brown to grey Moist to wet		2	SS	2		202		○		OC = 3.0%
200.6			3	SS	16		201				
2.6	SAND, trace to some silt, clayey silt seams and sandy silt layers throughout Very loose to compact Light grey Wet		4	SS	4		200		○		
			5	SS	WH		199				
198.3			6A 6B	SS	9				○		0 57 40 3
4.9	SILT and SAND, trace clay, silty clay seams Very loose to loose Grey and reddish brown Wet						198				
			7	SS	2		197		○		
196.0							196				
7.2	SAND, trace to some silt Very loose to compact Grey Wet		8	SS	WR						
			9	SS	10		194		○		
192.8	Boulder encountered at depth of 10.1 m						193				
10.4	END OF BOREHOLE CASING REFUSAL										

NOTE:

1. Water level in open borehole at a depth of 1.0 m below ground surface (Elev. 202.2 m) upon completion of drilling.

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF BOREHOLE No S25-15

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045553.3 ;E 243791.5
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE March 3, 2009

ORIGINATED BY MJR
COMPILED BY TZ
CHECKED BY VA/OK

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
202.6	ICE SURFACE										
0.0 / 202.1	Ice										
0.5 / 201.4	Water						202				
1.2	SAND, trace to some silt, trace organics Loose Brown to grey Wet		1	SS	6						
200.0			2	SS	8		201		○		
2.6	CLAYEY SILT, trace to some sand Firm Grey Wet		3	SS	4		200		H ○		
198.6							199	+ 2			
4.0 / 198.0	SILT and SAND, trace clay Loose Grey Wet		4	SS	6				○		
4.6	CLAY, trace silt, trace sand Soft Grey and reddish brown Wet		5	SS	WH		198		H ○		
196.5							197	+ 2 + 2			
6.1	Silty SAND, trace gravel Loose to very dense Grey to brown Wet		6	SS	7		196				
			7	SS	9		195				
			8	SS	11		194		○		0 77 23 0
			9	SS	75		193				
190.9							192				
11.7	END OF BOREHOLE CASING REFUSAL						191				

NOTES:

1. Water level in open borehole at ice surface (Elev. 202.6 m) upon completion of drilling.

2. Borehole caved to a depth of 6.4 m below ice surface (Elev. 196.2 m) upon removal of casing.

+ ³, × ³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S25-16

SHEET 1 OF 2

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
LOCATION N 5045573.3 ;E 243793.4
ORIGINATED BY MJR
DIST HWY 69
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
COMPILED BY TZ
DATUM Geodetic
DATE March 2, 2009
CHECKED BY VA/OK

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
202.5	ICE SURFACE							20 40 60 80 100	20 40 60		
0.0 / 202.0	Ice						202				
0.5 / 201.3	Water										
1.2	SAND, trace silt, trace organics, trace rootlets Very loose to loose Brown Wet		1	SS	1		201				
			2	SS	6				○		
199.8							200				
2.7	CLAY, trace silt, trace sand Soft Grey and reddish brown Wet		3	SS	2				○		
							199	+ 2			
			4	SS	WH		198		○		
								+ 2			
	Sand seams below a depth of 5.3 m		5	SS	5		197				
196.4											
6.1	SAND, trace gravel, trace silt Loose to very dense Grey Wet		6	SS	8		196				
			7	SS	18		195		○		
			8	SS	6		193				
			9	SS	18		192		○		0 97 3 0
			10	SS	73		190				
189.0											
13.5	END OF BOREHOLE CASING REFUSAL										

Continued Next Page

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S25-16

SHEET 2 OF 2

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
LOCATION N 5045573.3 ;E 243793.4
ORIGINATED BY MJR
DIST HWY 69
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
COMPILED BY TZ
DATUM Geodetic
DATE March 2, 2009
CHECKED BY VA/OK

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		
	NOTES: 1. Water level in open borehole at ice surface (Elev. 202.5 m) upon completion of drilling. 2. Borehole caved to a depth of 3.2 m below ice surface (Elev. 199.3 m) upon removal of casing.										

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

Golder Associates

RECORD OF BOREHOLE No S25-17

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045595.4 ;E 243797.4
BOREHOLE TYPE 101 mm O.D. Continuous Flight Solid Stem Augers
DATE March 5, 2009

ORIGINATED BY EHS
COMPILED BY TZ
CHECKED BY VA/OK

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
203.3	GROUND SURFACE										
0.0 / 202.7	Sand, trace gravel, trace silt, trace rootlets (FILL) Brown		1	AS	-		203				
0.6	Frozen to moist										
201.9	Silty sand and cobbles, trace to some gravel (FILL) Compact Brown		2	SS	11	▽	202				
1.4	Moist to wet										
	SILT and SAND, trace clay, trace organics Very loose to compact Brownish grey Wet		3	SS	WH						
			4	SS	13		201		○		0 67 30 3
200.2											
3.1 / 199.5	SILTY CLAY, trace to some sand Very soft to soft Brown Wet		5	SS	1		200				
3.8	SILT, some sand, trace to some clay Loose Brown Wet		6	SS	4				○		0 16 74 10
			7	SS	5		199				
197.2							198				
6.1	SAND, trace gravel, trace silt Loose to dense Grey Wet Auger grinding between depths of 6.6 m and 7.0 m		8	SS	11		197				
			9	SS	6		196		○		
			10	SS	38		195				
193.4							194				
9.9	END OF BOREHOLE AUGER REFUSAL										

NOTES:

1. Water level in open borehole at a depth of 1.0 m below ground surface (Elev. 202.3 m) upon completion of drilling.

2. Borehole caved to a depth of 1.4 m below ground surface (Elev. 201.9 m) upon removal of casing.

3. An additional borehole was drilled 1.0 m up-chainage in order to confirm soil samples between depths of 1.5 m and 3.7 m below ground surface (Elev. 201.8 m and 199.6 m); see Record of Borehole S25-17A for details.

+ 3, × 3: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S25-17A

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5045596.1 ;E 243796.7 ORIGINATED BY EHS
DIST HWY 69 BOREHOLE TYPE 101 mm O.D. Continuous Flight Solid Stem Augers COMPILED BY TZ
DATUM Geodetic DATE March 4 & 5, 2009 CHECKED BY VA/OK

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
203.3	GROUND SURFACE										
0.0	See Record of Borehole S25-17 for subsurface conditions within these elevations.						203				
201.8							202				
1.5	Silty SAND, trace gravel, trace clay, trace organics, some sand seams Very loose to compact Brownish grey Wet		1	SS	WH						
			2	SS	15		201		○		
200.2											
3.1	CLAY, trace sand Soft		3A 3B	SS	1		200				
199.6	Reddish brown Wet										
3.7	END OF BOREHOLE										

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

Golder Associates

RECORD OF BOREHOLE No S25-18

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045590.7 ;E 243775.4
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE February 26, 2009

ORIGINATED BY MJR
COMPILED BY TZ
CHECKED BY VA/OK

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
202.6	ICE SURFACE										
0.0 / 202.3	Ice										
0.3 / 201.7	Water						202				
0.9 / 201.1	Organic CLAYEY SILT, trace rootlets Firm Dark brown and grey Wet		1	SS	5						OC = 5.5%
1.5 / 200.3	SAND, trace to some silt, trace clay Loose Brown to grey Wet		2	SS	9		201				
2.3 / 198.6	CLAY, trace silt Soft to firm Grey to reddish brown Wet		3	SS	WH		200	3 3			
4.0 / 192.6	SAND, trace gravel, trace silt Loose to very dense Grey Wet		4	SS	9		199				
			5	SS	8		198				
			6	SS	15		197				
			7	SS	26		196				
			8	SS	38		195				0 99 1 0
			9	SS	101		194				
10.0	END OF BOREHOLE CASING REFUSAL NOTES: 1. Water level in open borehole at ice surface (Elev. 202.6 m) upon completion of drilling. 2. Borehole caved to a depth of 2.0 m below ice surface (Elev. 200.6 m) upon removal of casing.						193				

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

Golder Associates

RECORD OF BOREHOLE No S25-19

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045587.6 ;E 243755.1
BOREHOLE TYPE Portable Equipment, BW Casing, Wash Boring
DATE February 24, 2009

ORIGINATED BY MJR
COMPILED BY TZ
CHECKED BY VA/OK

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
202.6	ICE SURFACE										
0.0	Ice										
0.2	Water										
201.7											
0.9	PEAT (Amorphous), some wood fragments Soft Dark brown Wet		1	SS	3				○		
201.1											
1.5	SAND, trace to some silt Loose Grey Wet		2	SS	9						
200.3											
2.3	Sandy SILT Very loose Grey Wet		3	SS	3				○		
199.7											
2.9	SILTY CLAY Soft Grey Wet							2			
199.1											
3.5	SAND, trace gravel, trace silt Loose to very dense Grey Wet		4	SS	10						
			5	SS	6				○		2 96 2 0
			6	SS	44						
			7	SS	14				○		
			8	SS	37						
			9	SS	77				○		
192.3											
10.3	END OF BOREHOLE CASING REFUSAL										

NOTES:

1. Water level in open borehole at ice surface (Elev. 202.6 m) upon completion of drilling.

2. Borehole caved to a depth of 1.7 m below ground surface (Elev. 200.9 m) upon removal of casing.

+³, ×³: Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE

Golder Associates

RECORD OF BOREHOLE No S25-20

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5045608.0 ;E 243757.4 ORIGINATED BY MJR

DIST HWY 69 BOREHOLE TYPE Hand Excavation COMPILED BY TZ

DATUM Geodetic DATE February 24, 2009 CHECKED BY VA/OK

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						
204.7	GROUND SURFACE										
0.0	BEDROCK OUTCROP										

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

Golder Associates

RECORD OF BOREHOLE No S25-21

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045492.5 ;E 243898.9
BOREHOLE TYPE 108 mm I.D. Continous Flight Hollow Stem Augers, NW Casing, Wash Boring
DATE January 22, 2015

ORIGINATED BY ID
COMPILED BY KD
CHECKED BY AJS/MCK

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
202.4	GROUND SURFACE										
0.0	SNOW		1A								
0.2	ORGANIC SILT Very loose		1B	SS	3	▽	202		○		
201.6											
0.8	SILT and SAND, trace to some clay, trace gravel Compact Brown Wet		2	SS	24						
200.7			3	SS	20/0.0		201		○		1 35 59 5
1.7	Granite Gneiss (BEDROCK) Bedrock cored from depths of 1.7 m to 3.3 m. For bedrock coring details refer to Record of Drillhole S25-21.		1	RC	REC 100%		200				RQD = 100%
199.1											
3.3	END OF BOREHOLE NOTE: 1. Water level in open borehole measured at a depth of 0.4 m below ground surface (Elev. 202.0 m) upon completion of drilling.										

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

PROJECT: 07-1111-0029

RECORD OF DRILLHOLE: S25-21

SHEET 1 OF 1

LOCATION: N 5045492.5 ;E 243898.9

DRILLING DATE: January 22, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: C.M.E 550

DRILLING CONTRACTOR: Landcore Drilling Inc.

JN - Joint; FLT - Fault; SH - Shear; VN - Vein; CJ - Conjugate
BD - Bedding; FO - Foliation; CO - Contact; OR - Orthogonal; CL - Cleavage
PL - Planar; CU - Curved; UN - Undulating; ST - Stepped; IR - Irregular
PO - Polished; K - Slickensided; SM - Smooth; RO - Rough; VR - Very Rough
MB - Mechanical Break; BR - Broken Rock
NOTE: For additional abbreviations refer to list of abbreviations & symbols.

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	FLUSH	COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.25 m	DISCONTINUITY DATA: B Angle	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC -Q' AVG.	NOTES
		Continued from Record of Borehole S25-21		200.73																	
2	NW Casing	Slightly weathered, foliated, pink, white and grey coarse grained, non-porous, strong banded GRANITE GNEISS		1.68	1			80 60 20	80 60 40 20	80 60 20	5 10 15 20	0 90 180 270	0 30 60 90	FO,CU,RO,Fe		4			2 4 6		13.7 MPa
3	NQRC January 22, 2015													FO,UN,RO,Fe							
				199.11																	
		END OF DRILLHOLE		3.30																	
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: ID

CHECKED: AJS/MCK

GTA-RCK 018 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-MISS.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF BOREHOLE No S25-22

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045503.8 ;E 243865.3
BOREHOLE TYPE 108 mm I.D. Continous Flight Hollow Stem Augers, NW Casing, Wash Boring
DATE January 23, 2015

ORIGINATED BY ID
COMPILED BY KD
CHECKED BY AJS/MCK

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
203.1	GROUND SURFACE						203				
0.0 / 202.8	Organic silt, some sand (FILL) Dark grey to grey Moist		1A	SS	34/0.15						
0.3 / 201.9	Rock fill (FILL)		1B	RC	-		202				
201.6	ORGANIC SILT					▽					
1.5 / 200.8	Sandy SILT, trace organics Compact Grey to brown Wet		2	SS	11				○		
200.5	SILTY CLAY Stiff		3A	SS	11		201		⊢○⊣		
2.6	Brown to grey Moist		3B								
199.7	SILT, some sand, some clay Compact Brown to grey Wet		4	SS	29/0.20		200		○		0 12 75 13
3.4	SPOON AND AUGER REFUSAL END OF BOREHOLE										

NOTE:

1. Water level in open borehole measured at a depth of 1.4 m below ground surface (Elev. 201.7 m) upon completion of drilling.

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF BOREHOLE No S25-23

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045507.4 ;E 243886.2
BOREHOLE TYPE 108 mm I.D. Continous Flight Hollow Stem Augers, NW Casing, Wash Boring
DATE January 22, 2015

ORIGINATED BY ID
COMPILED BY KD
CHECKED BY AJS/MCK

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
202.9	GROUND SURFACE										
0.0 / 202.4	Silt and sand, some gravel, trace organics (FILL) Loose Dark grey Moist		1A	SS	7						
0.5 / 201.7	Rock fill (FILL)		1B	RC	-		202				
1.2	SILT and SAND, trace gravel, trace organics Compact Brown Wet		2	SS	14	▽	201				
			3	SS	16						0 65 33 2
199.5			4A 4B	SS	4		200				
3.4	SILTY CLAY to CLAY Firm to stiff Grey Moist to wet						199	5, 8			
			5	SS	WH		198	5, 7			
196.8							197				
6.1	SAND, trace silt Loose to compact Grey Wet		6	SS	10		196				
			7	SS	11		195				0 96 4 0
193.8							194				
9.1	CASING REFUSAL END OF BOREHOLE										

NOTE:

1. Water level in open borehole measured at a depth of 1.9 m below ground surface (Elev. 201.0 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No S25-24

SHEET 1 OF 2

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045524.8 ;E 243868.2
BOREHOLE TYPE NW Casing, Wash Boring
DATE January 23, 2015

ORIGINATED BY ID
COMPILED BY KD
CHECKED BY AJS/MCK

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
203.0	GROUND SURFACE								
0.0	Rock fill (FILL) Very dense Grey		1	SS	122/0.15				
			2	SS	54		202		
201.5									
1.5	Silty SAND, trace organics Loose to compact Dark brown to brown Wet		3	SS	7	▽	201		0 72 24 4
			4	SS	15		200		
199.8									
3.2	CLAY Soft to firm Brown to grey Wet		5A 5B	SS	3		199		
			6	SS	4		198		
	Sand seams at a depth of 6.1 m		7	TO	PH		197		
195.8							196		
7.2	SAND, trace to some silt Very loose to compact Brown to grey Wet		8	SS	2		195		
			9	SS	11		194		
			10	SS	10		193 192		0 92 8 0
			11	SS	14		191		
189.7							190		
13.3	SILT and SAND, some gravel, some silt, containing silt pockets Compact Grey Wet		12	SS	23		189		13 54 32 1
	Auger grinding below a depth of 14.6 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

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S25-24

SHEET 2 OF 2 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5045524.8 ;E 243868.2 ORIGINATED BY ID
DIST HWY 69 BOREHOLE TYPE NW Casing, Wash Boring COMPILED BY KD
DATUM Geodetic DATE January 23, 2015 CHECKED BY AJS/MCK

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* ---										
187.5	SILT and SAND, some gravel, containing silt pockets Compact Grey Wet		13	SS	20/0.15				○		
15.5	SPOON AND CASING REFUSAL END OF BOREHOLE										

NOTES:

1. Water level in open borehole measured at a depth of 1.8 m below ground surface (Elev. 201.2 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No S25-25

SHEET 1 OF 2

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045521.2 ;E 243847.3
BOREHOLE TYPE 108 mm I.D. Continous Flight Hollow Stem Augers, NW Casing, Wash Boring
DATE January 27, 2015

ORIGINATED BY ID
COMPILED BY KD
CHECKED BY AJS/MCK

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
203.0	GROUND SURFACE										
0.0 / 202.4	Silty sand, some gravel (FILL) Dark grey Moist		1	AS	-		202				
0.6 / 201.5	Sand and gravel, some silt to silty (FILL) Compact Brown Wet		2	SS	15				○		
1.5 / 200.3	SILT and SAND, trace clay Loose to compact Grey Wet		3	SS	23	▽	201		○		0 67 32 1
			4A 4B	SS	7						
2.7 / 196.8	CLAYEY SILT, trace sand Firm Grey Wet		5	TO	PH		200	+3 +2			
							199				
							198	+3 +5			
							197		⊢○⊣		
6.2 / 195.8	SILT, some sand, trace to some clay Loose Grey Wet		6A 6B	SS	5				○		0 17 76 7
7.2	SAND, some silt Loose to compact Grey Wet		7	SS	6		196				
							195				
			8	SS	11		194		○		
							193				
			9	SS	6		192				
							191				
189.7			10	SS	8				○		0 88 12 0
13.3	SAND and GRAVEL Compact Grey Wet						190				
			11	SS	19		189				

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S25-25

SHEET 2 OF 2 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5045521.2 ;E 243847.3 ORIGINATED BY ID
DIST HWY 69 BOREHOLE TYPE 108 mm I.D. Continous Flight Hollow Stem Augers, NW Casing, Wash Boring COMPILED BY KD
DATUM Geodetic DATE January 27, 2015 CHECKED BY AJS/MCK

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
	--- *CONTINUED FROM PREVIOUS PAGE* ---										
187.9 / 15.1	CASING REFUSAL END OF BOREHOLE NOTE: 1. Water level in open borehole measured at a depth of 1.9 m below ground surface (Elev. 201.1 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No S25-26

SHEET 1 OF 2

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045540.4 ;E 243848.5
BOREHOLE TYPE 108 mm I.D. Continous Flight Hollow Stem Augers, NW Casing, Wash Boring
DATE January 28, 2015

ORIGINATED BY ID
COMPILED BY KD
CHECKED BY AJS/MCK

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS
202.7	GROUND SURFACE					
0.0 / 201.9	Silty sand, some gravel (FILL) Dark grey Wet		1A	AS	-	
0.8 / 201.3	Rock fill (FILL)		1B	RC	-	
1.4	Silty SAND, some gravel, trace clay, trace organics Compact Dark brown Wet		2	SS	14	▽
199.7			3	SS	11	
3.0	CLAYEY SILT, some sand Firm Brown to grey Wet		4	SS	4	
196.6			5	TO	PH	
196.3 / 6.4	SILT, some sand, trace to some clay Loose Grey Wet		6A 6B	SS	7	
	SAND, trace to some silt Loose to compact Brown to grey Wet		7	SS	7	
			8	SS	12	
			9	SS	11	
			10	SS	12	
			11	SS	30	
187.7						

ELEVATION SCALE: 202, 201, 200, 199, 198, 197, 196, 195, 194, 193, 192, 191, 190, 189, 188

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
6A 6B	0	14	81	5
7	0	92	8	0
10	0	87	12	1

Continued Next Page

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

Golder Associates

RECORD OF BOREHOLE No S25-26

SHEET 2 OF 2

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5045540.4 ;E 243848.5
BOREHOLE TYPE 108 mm I.D. Continous Flight Hollow Stem Augers, NW Casing, Wash Boring
DATE January 28, 2015

ORIGINATED BY ID
COMPILED BY KD
CHECKED BY AJS/MCK

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 ---										
15.0	CASING REFUSAL END OF BOREHOLE NOTE: 1. Water level in open borehole measured at a depth of 1.7 m below ground surface (Elev. 201.0 m) upon completion of drilling.										

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

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

Golder Associates

RECORD OF DCPT No S25-DC01

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
LOCATION N 5045514.1 ;E 243823.1
ORIGINATED BY ID
DIST HWY 69
BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test
COMPILED BY VA
DATUM Geodetic
DATE March 21, 2009
CHECKED BY VA/OK

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
203.2 GROUND SURFACE							203	20 40 60 80 100	20 40 60		
0.0	Dynamic Cone Penetration Test (DCPT)						202				
							201				
							200				
							199				
							198				
							197				
195.7							196				
7.5	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)										

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

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

Golder Associates

RECORD OF DCPT No S25-DC02

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5045507.0 ;E 243781.5 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE February 26, 2009 CHECKED BY VA/OK

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
202.6	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	Dynamic Cone Penetration Test (DCPT)						202 201 200 199 198 197 196				
195.5											
7.1	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 S25-DC03

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5045549.7 ;E 243788.0 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE March 3, 2009 CHECKED BY VA/OK

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
202.6	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	Dynamic Cone Penetration Test (DCPT)						202				
							201				
							200				
							199				
							198				
							197				
							196				
							195				
							194				
							193				
							192				
							191				
							190				
188.8							189	140			
13.8	END OF DCPT Refusal to Further Penetration										

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF DCPT No S25-DC04

SHEET 1 OF 2

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5045542.2 ;E 243746.0 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE February 25, 2009 CHECKED BY VA/OK

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	20 40 60	γ kN/m^3	GR SA SI CL
202.6	GROUND SURFACE							○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED	w_P w w_L		
0.0	Dynamic Cone Penetration Test (DCPT)										

Continued Next Page

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

Golder Associates

PROJECT 07-1111-0029

RECORD OF DCPT No S25-DC04 SHEET 2 OF 2 METRIC

W.P. 5111-07-00 LOCATION N 5045542.2 ;E 243746.0 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE February 25, 2009 CHECKED BY VA/OK

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 ---										
	Dynamic Cone Penetration Test (DCPT)						187	125			
186.4 16.2	END OF DCPT Refusal to Further Penetration										

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

Golder Associates

RECORD OF DCPT No S25-DC05

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5045584.0 ;E 243751.6 ORIGINATED BY MJR

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE February 23, 2009 CHECKED BY VA/OK

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						
202.6	GROUND SURFACE										
0.0	Dynamic Cone Penetration Test (DCPT)						202 201 200 199 198 197 196 195 194 193 192 191				
190.8											
11.8	END OF DCPT Refusal to Further Penetration										

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

Golder Associates

RECORD OF DCPT No S25-DC06

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5045535.7 ;E 243809.3 ORIGINATED BY MJR

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE March 4, 2009 CHECKED BY VA/OK

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
203.0	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	Dynamic Cone Penetration Test (DCPT)						202				
							201				
							200				
							199				
							198				
							197				
							196				
							195				
							194				
							193				
							192				
191.0								122			
12.0	END OF DCPT Refusal to Further Penetration										

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF DCPT No S25-DC07

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5045576.9 ;E 243814.3 ORIGINATED BY MJR

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE March 5, 2009 CHECKED BY VA/OK

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 (%)
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES						GR SA SI CL
202.2	GROUND SURFACE										
0.0	Dynamic Cone Penetration Test (DCPT)						202 201 200 199 198 197 196 195 194 193 192 191 190				
189.6 12.6	END OF DCPT Refusal to Further Penetration										

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

Golder Associates

RECORD OF DCPT No S25-DC08

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5045570.2 ;E 243773.1 ORIGINATED BY MJR

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE February 25, 2009 CHECKED BY VA/OK

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
202.6 GROUND SURFACE								20 40 60 80 100	20 40 60		
0.0	Dynamic Cone Penetration Test (DCPT)						202				
							201				
							200				
							199				
							198				
							197				
196.1											
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 S25-DC09

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5045612.1 ;E 243778.7 ORIGINATED BY MJR

DIST HWY 69 BOREHOLE TYPE Portable Equipment, Dynamic Cone Penetration Test COMPILED BY VA

DATUM Geodetic DATE February 25, 2009 CHECKED BY VA/OK

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						
203.9	GROUND SURFACE										
0.0	BEDROCK OUTCROP										

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

Golder Associates

RECORD OF DCPT No S25-DC10

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
LOCATION N 5045501.2 ;E 243845.4
ORIGINATED BY ID
DIST HWY 69
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY MR
DATUM Geodetic
DATE January 27, 2015
CHECKED BY AJS/MCK

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						
202.9	GROUND SURFACE										
0.0	AUGERED THROUGH ROCK FILL										
201.7											
1.2	Dynamic Cone Penetration Test (DCPT)										
195.0											
7.9	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)										

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
ELEVATION SCALE: 202 201 200 199 198 197 196
UNIT WEIGHT γ kN/m^3
REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL

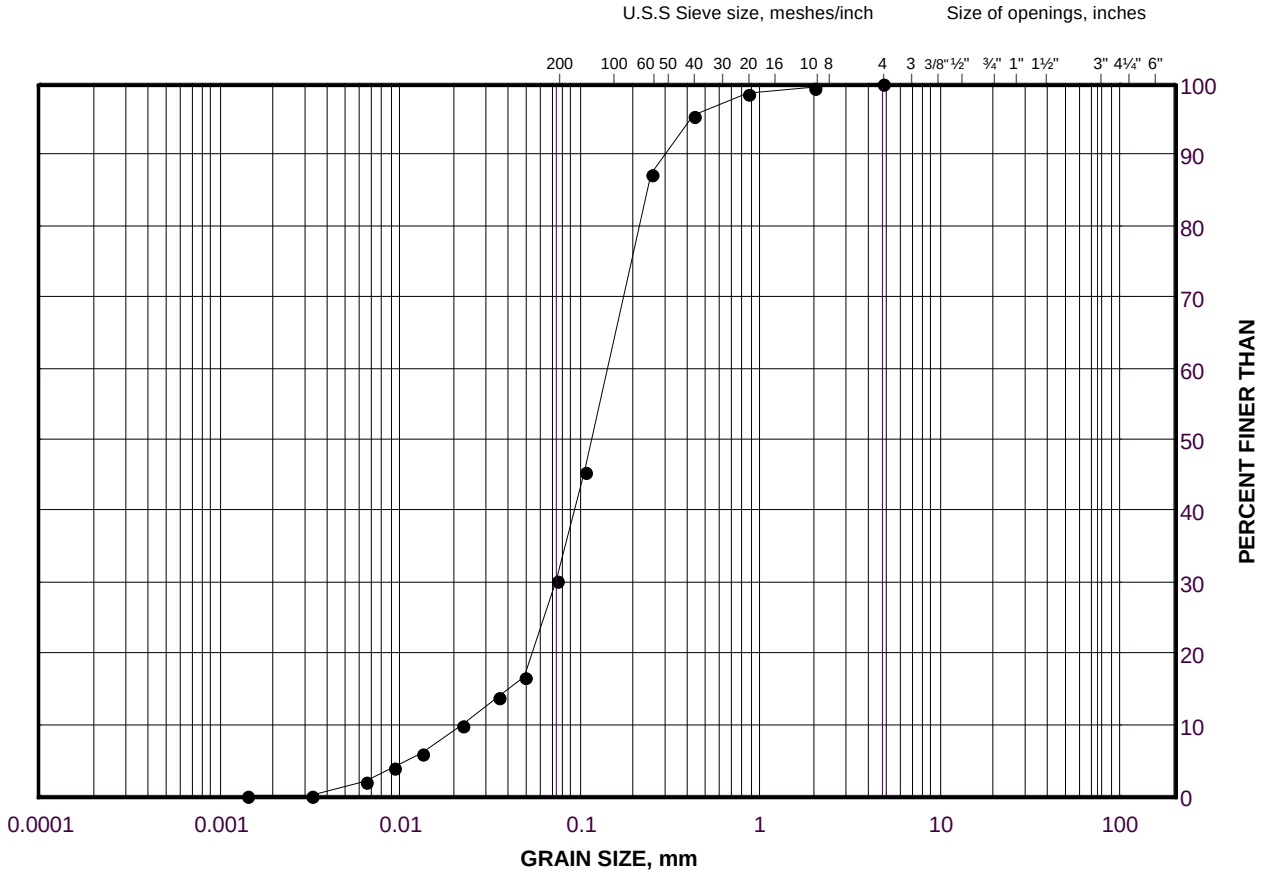
$+^3, \times^3$: Numbers refer to Sensitivity
$\circ^{3\%}$ STRAIN AT FAILURE

GRAIN SIZE DISTRIBUTION

Silty Sand

Highway 69 (SBL) STA 17+230 to 17+350

FIGURE C.S25-1



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S25-01	2	201.9

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

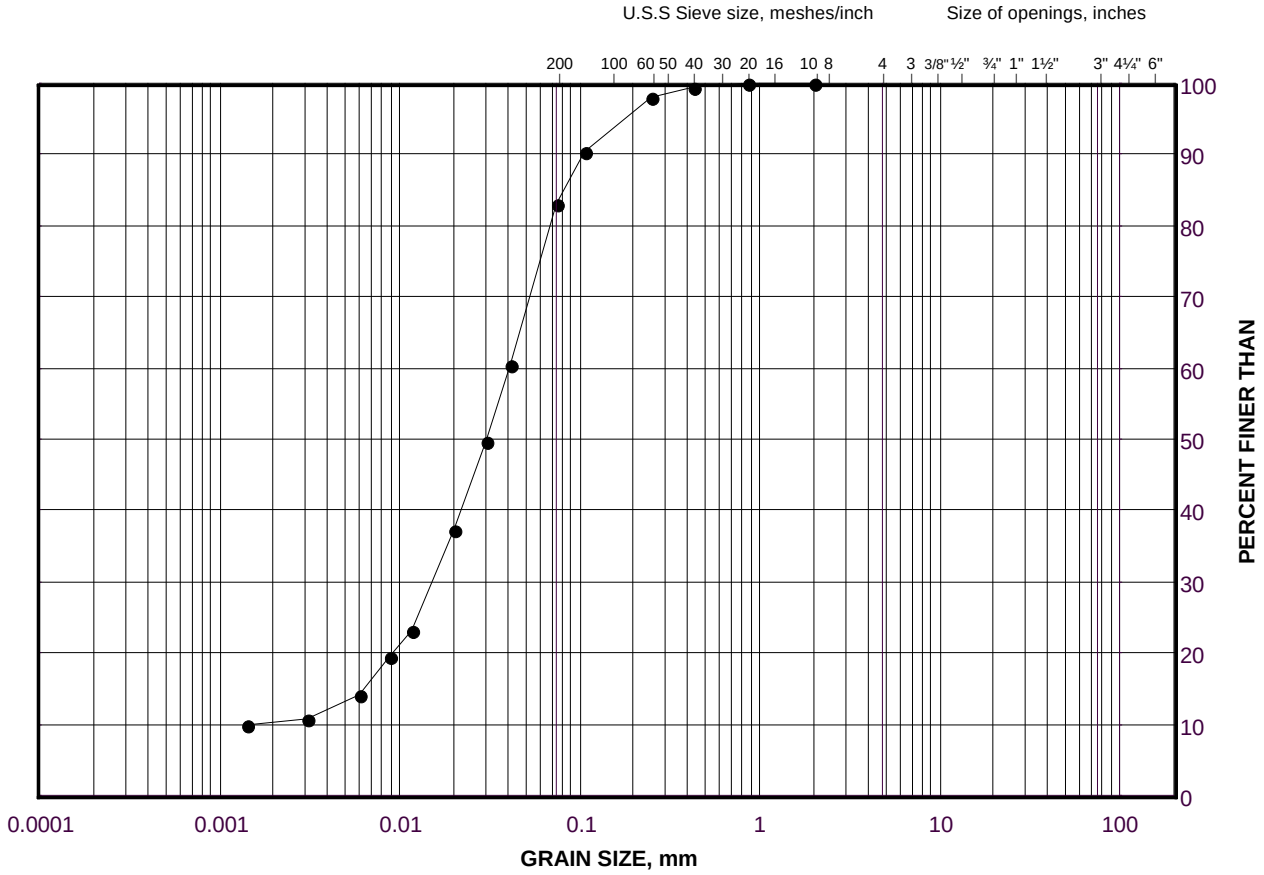
Date: 27-Nov-09

GRAIN SIZE DISTRIBUTION

Silt

Highway 69 (SBL) STA 17+230 to 17+350

FIGURE C.S25-2



LEGEND

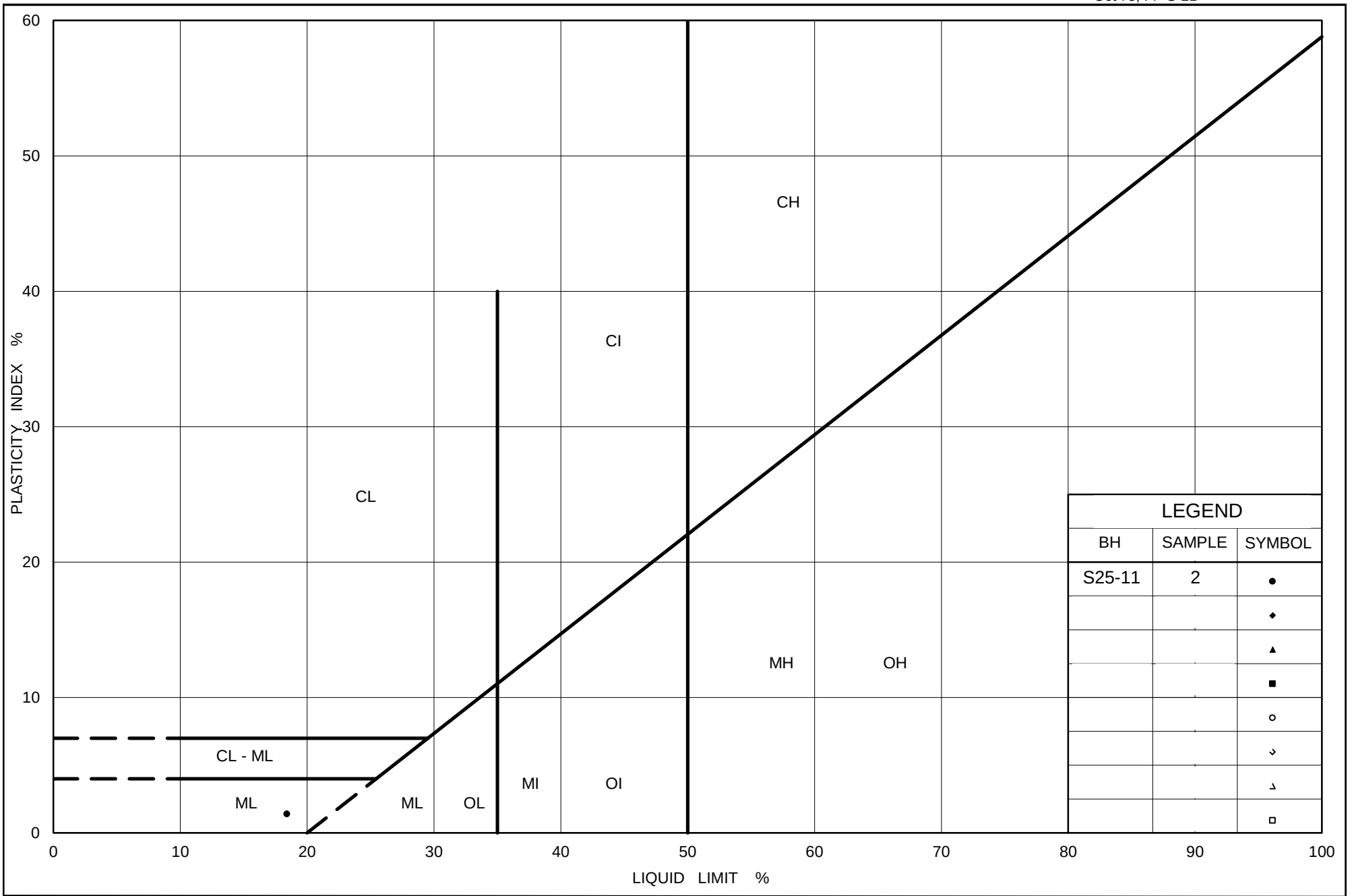
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S25-11	2	200.8

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

Date: 27-Nov-09



Ministry of Transportation

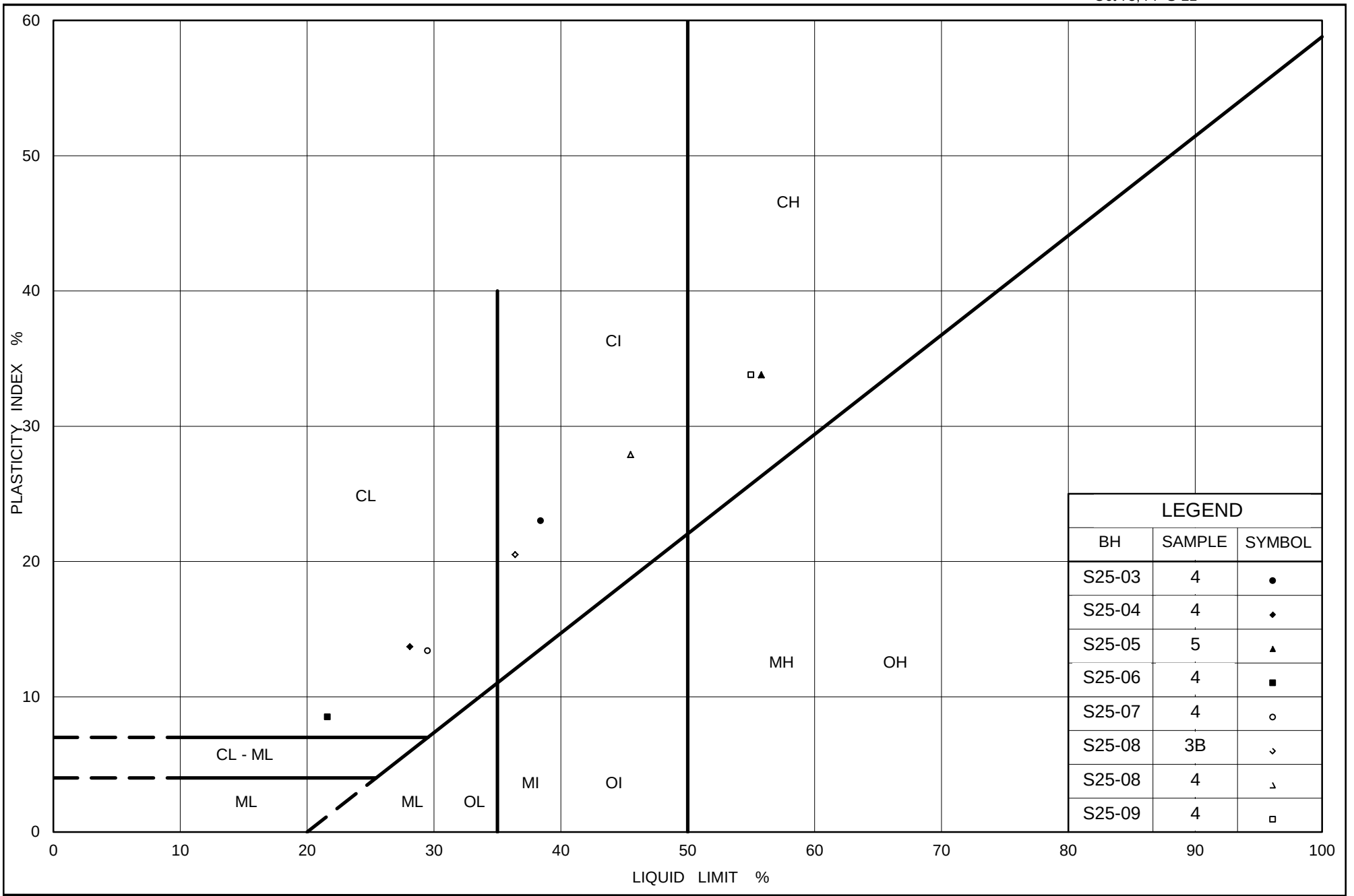
Ontario

PLASTICITY CHART
Silt
Highway 69 (SBL) STA 17+230 to 350

Figure No. C.S25-3

Project No. 07-1111-0029

Checked By: CN



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt to Clay
Highway 69 (SBL) STA 17+230 to 17+350

Figure No. C.S25-4

Project No. 07-1111-0029

Checked By: CN

OEDOMETER CONSOLIDATION SUMMARY

FIGURE C.S25-5
Sheet 1 of 4

SAMPLE IDENTIFICATION

Project Number	07-1111-0029	Sample Number	4
Borehole Number	S25-08	Sample Depth, m	3.0-3.7

TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	8		
Date Started	10/2/2009		
Date Completed	10/24/2009		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.25	Unit Weight, kN/m^3	16.52
Sample Diameter, cm	4.97	Dry Unit Weight, kN/m^3	10.58
Area, cm^2	19.40	Specific Gravity, measured	2.76
Volume, cm^3	24.31	Solids Height, cm	0.490
Water Content, %	56.12	Volume of Solids, cm^3	9.50
Wet Mass, g	40.95	Volume of Voids, cm^3	14.80
Dry Mass, g	26.23	Degree of Saturation, %	99.4

TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t_{90} sec	cv. cm^2/s	mv m^2/kN	k cm/s
0.00	1.253	1.558	1.253				
5.00	1.243	1.537	1.248	12	2.75E-02	1.61E-03	4.35E-06
10.00	1.231	1.513	1.237	43	7.54E-03	1.88E-03	1.39E-06
20.00	1.212	1.474	1.222	94	3.37E-03	1.52E-03	5.00E-07
40.00	1.184	1.418	1.198	86	3.54E-03	1.11E-03	3.85E-07
80.00	1.140	1.327	1.162	140	2.05E-03	8.84E-04	1.77E-07
160.00	1.074	1.192	1.107	158	1.64E-03	6.59E-04	1.06E-07
320.00	0.984	1.008	1.029	206	1.09E-03	4.49E-04	4.79E-08
640.00	0.895	0.826	0.939	171	1.09E-03	2.23E-04	2.39E-08
1280.00	0.819	0.671	0.857	135	1.15E-03	9.45E-05	1.07E-08
2560.00	0.753	0.537	0.786	124	1.06E-03	4.12E-05	4.26E-09
1280.00	0.767	0.566	0.760				
320.00	0.775	0.582	0.771				
80.00	0.804	0.642	0.790				
20.00	0.837	0.709	0.821				
5.00	0.852	0.738	0.844				

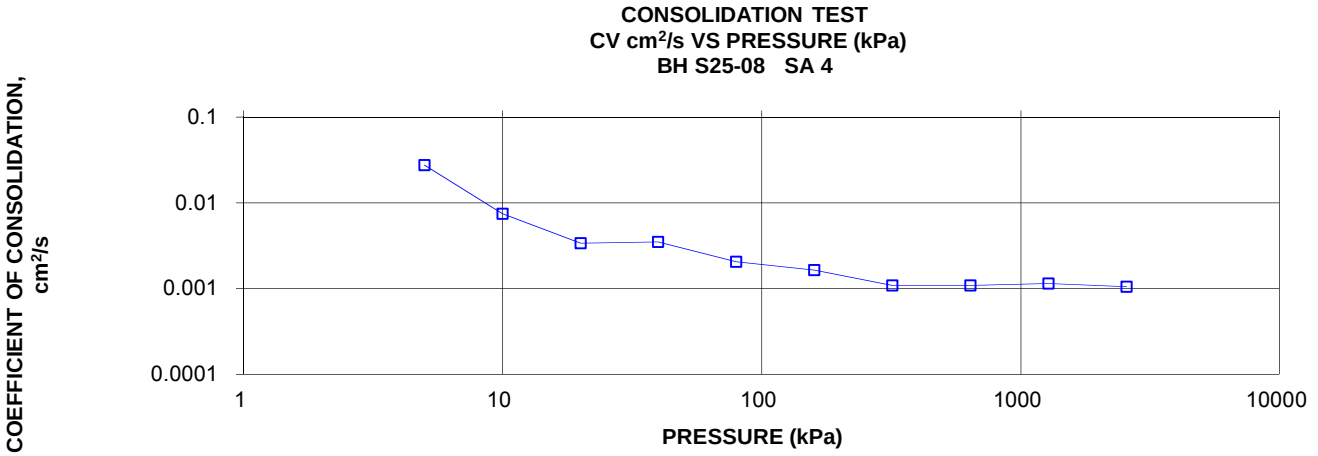
Note:
k calculated using cv based on t_{90} values.

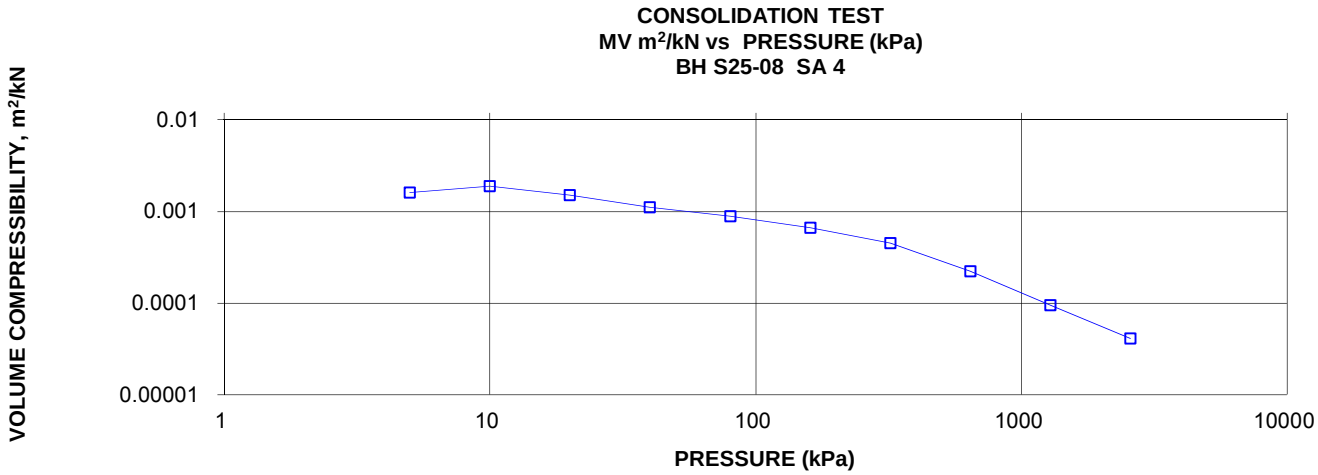
SAMPLE DIMENSIONS AND PROPERTIES - FINAL

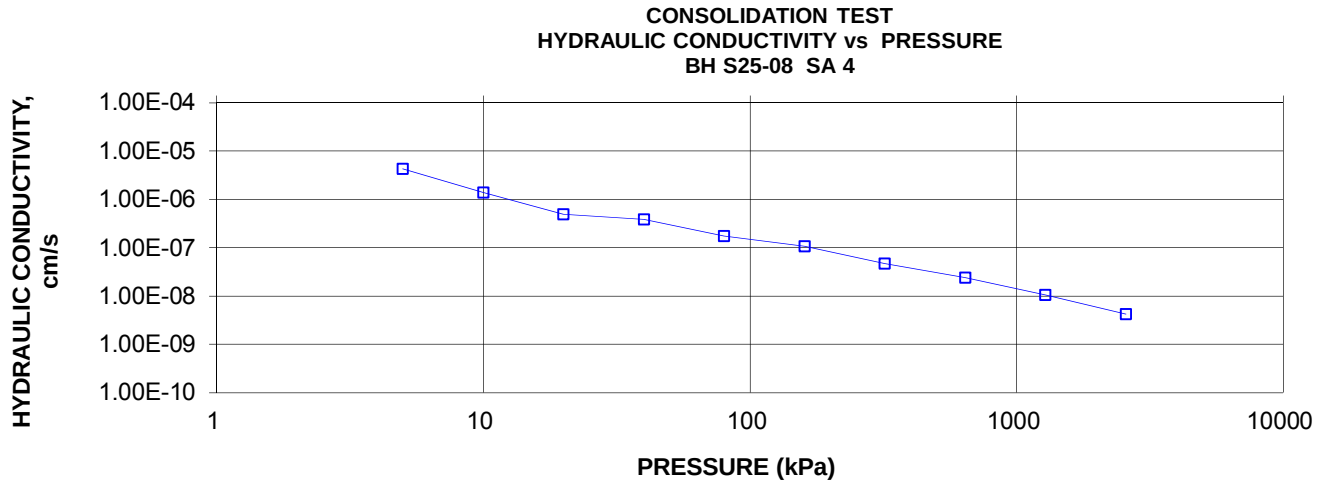
Sample Height, cm	0.85	Unit Weight, kN/m^3	20.23
Sample Diameter, cm	4.97	Dry Unit Weight, kN/m^3	15.57
Area, cm^2	19.40	Specific Gravity, measured	2.76
Volume, cm^3	16.52	Solids Height, cm	0.490
Water Content, %	29.89	Volume of Solids, cm^3	9.50
Wet Mass, g	34.07	Volume of Voids, cm^3	7.02
Dry Mass, g	26.23		

OEDOMETER CONSOLIDATION

FIGURE C.S25-5
Sheet 2 of 4





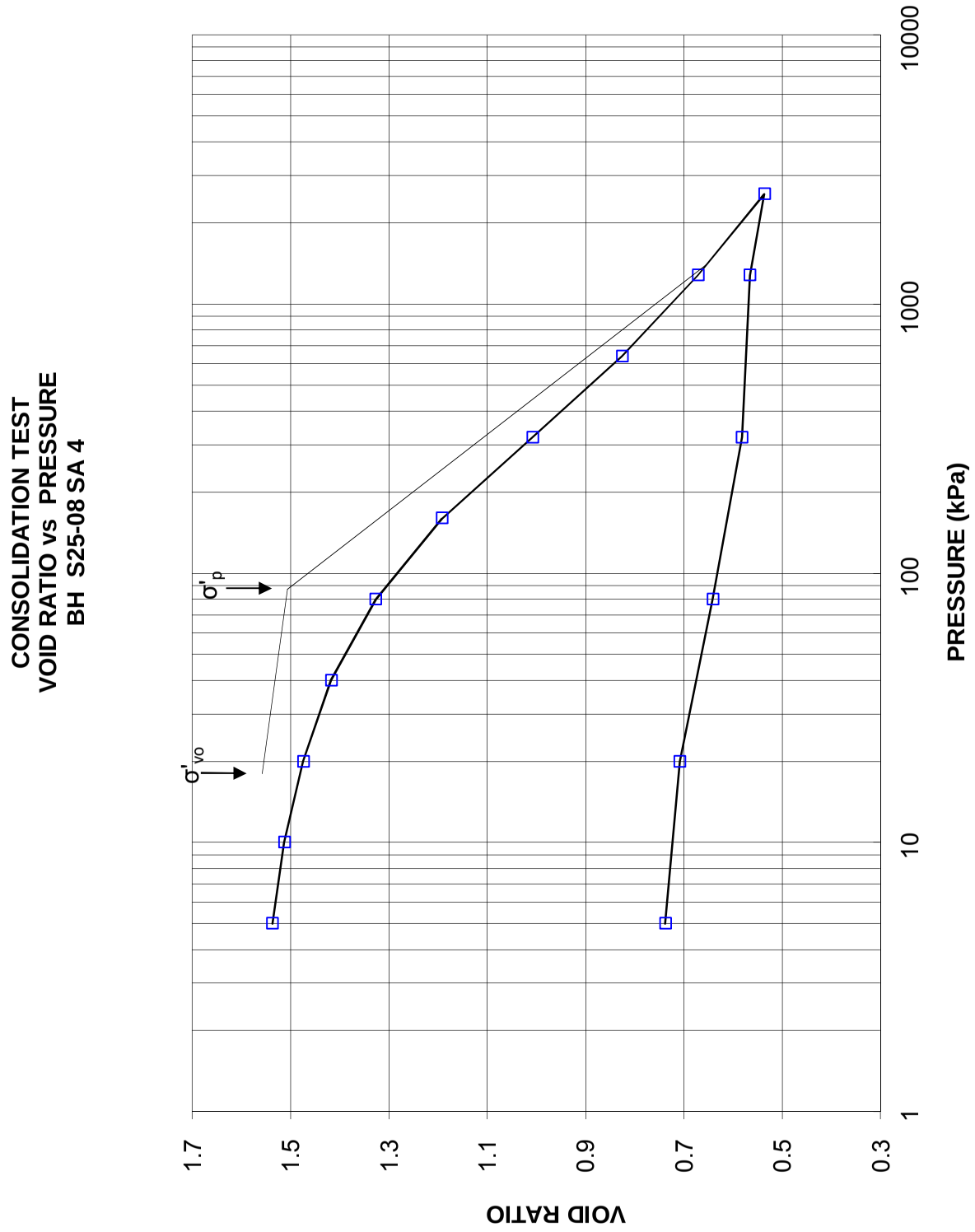


Project No. 07-1111-0029
Prepared By: LFG

Golder Associates

Checked By: CN

CONSOLIDATION TEST SUMMARY VOID RATIO VS. LOG PRESSURE	FIGURE C.S25-5 Sheet 3 of 4



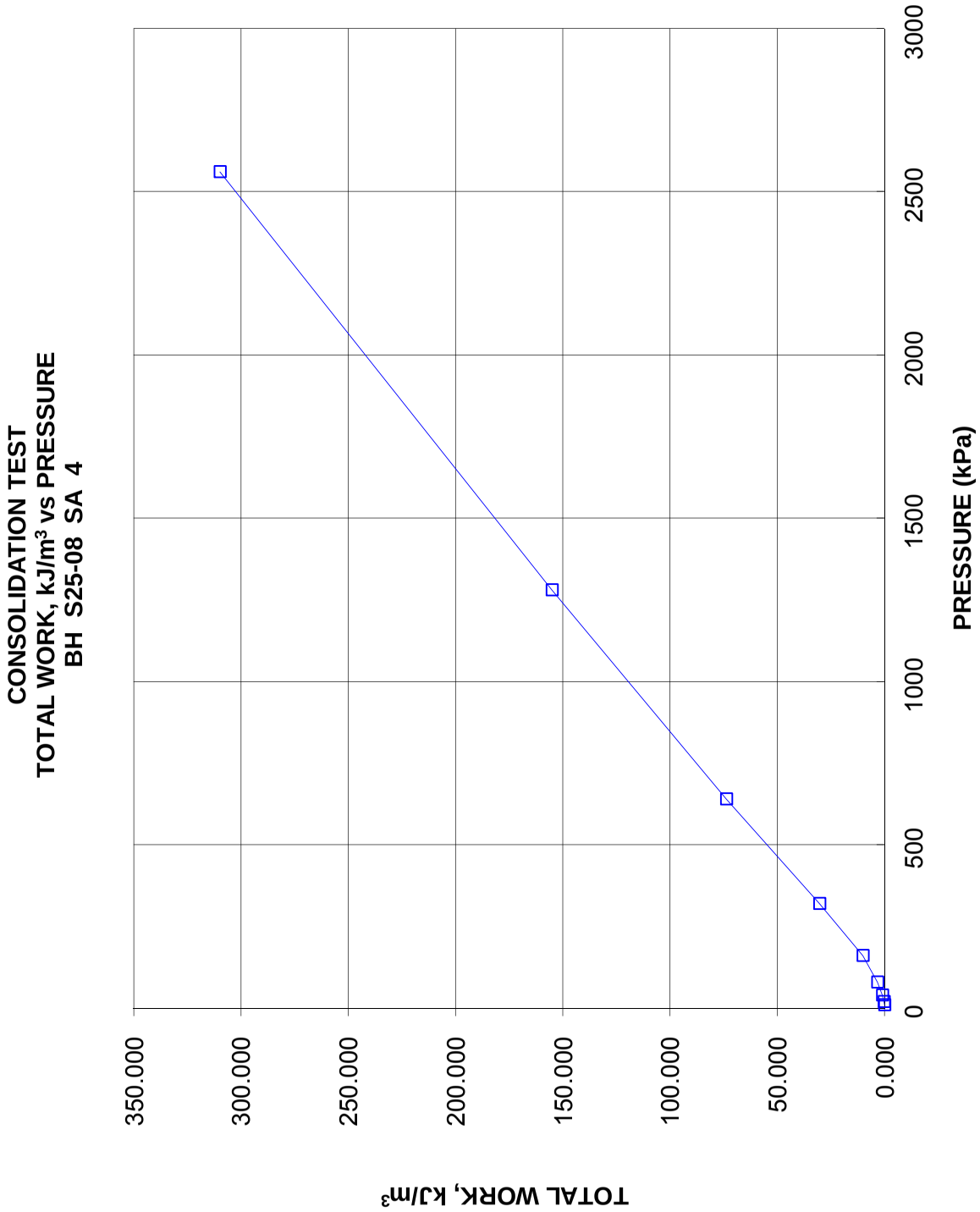
Project No. 07-1111-0029

Prepared By: LFG

Golder Associates

Checked By: CN

CONSOLIDATION TEST TOTAL WORK VS PRESSURE	FIGURE C.S25-5 Sheet 4 of 4



Project No. 07-1111-0029

Prepared By: LFG

Golder Associates

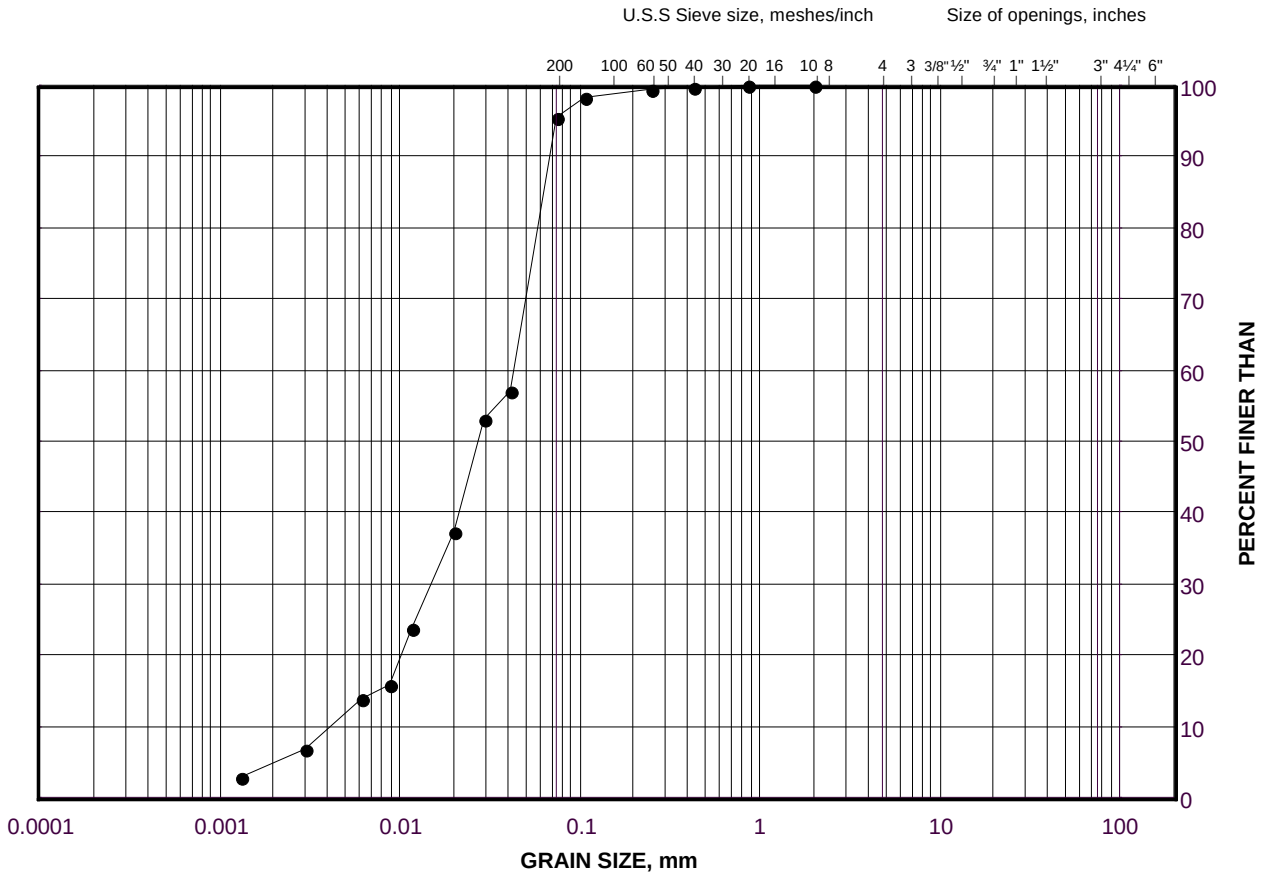
Checked By: CN

GRAIN SIZE DISTRIBUTION

Silt

Highway 69 (SBL) STA 17+230 to 17+350

FIGURE C.S25-6



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S25-07	6	196.3

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

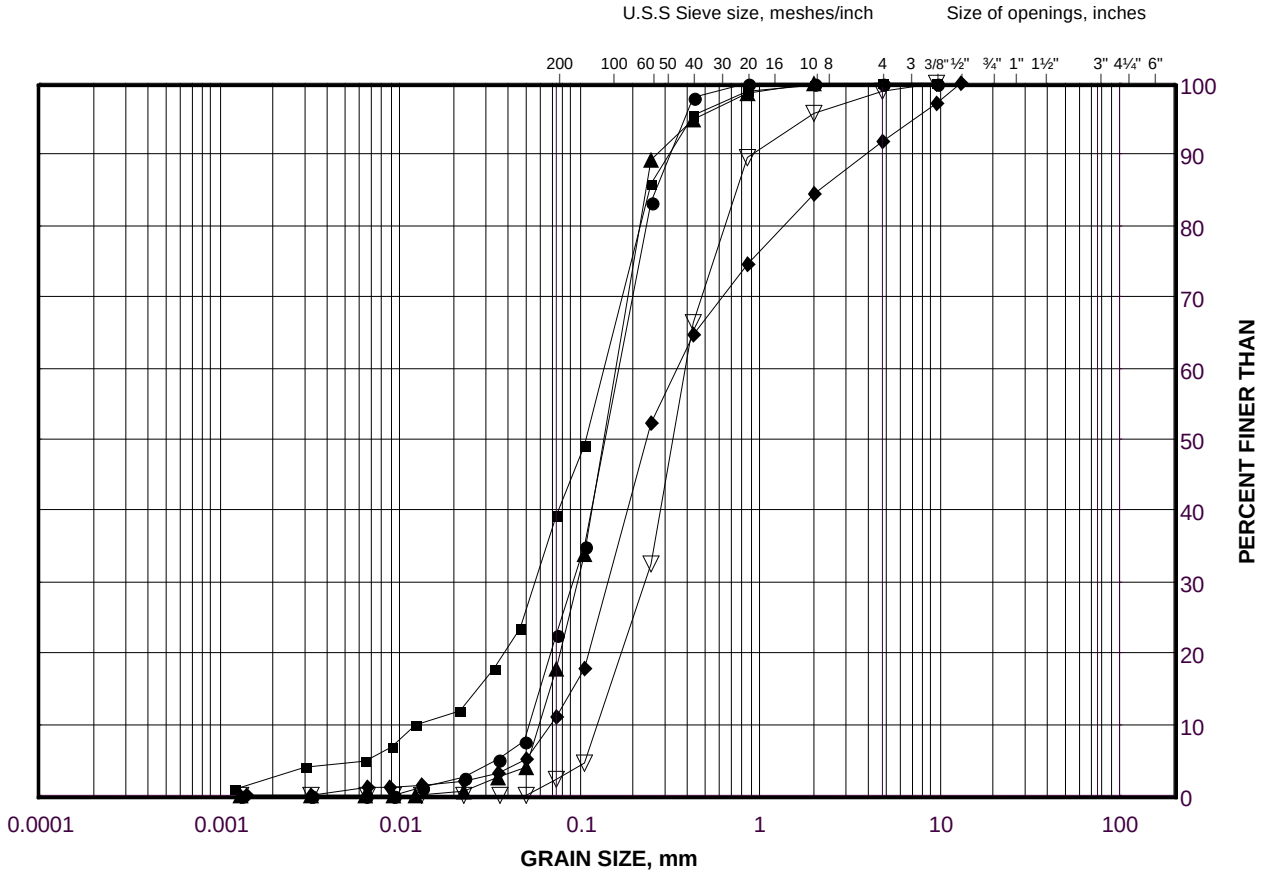
Date: 27-Nov-09

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand

Highway 69 (SBL) STA 17+230 to 17+350

FIGURE C.S25-7



LEGEND

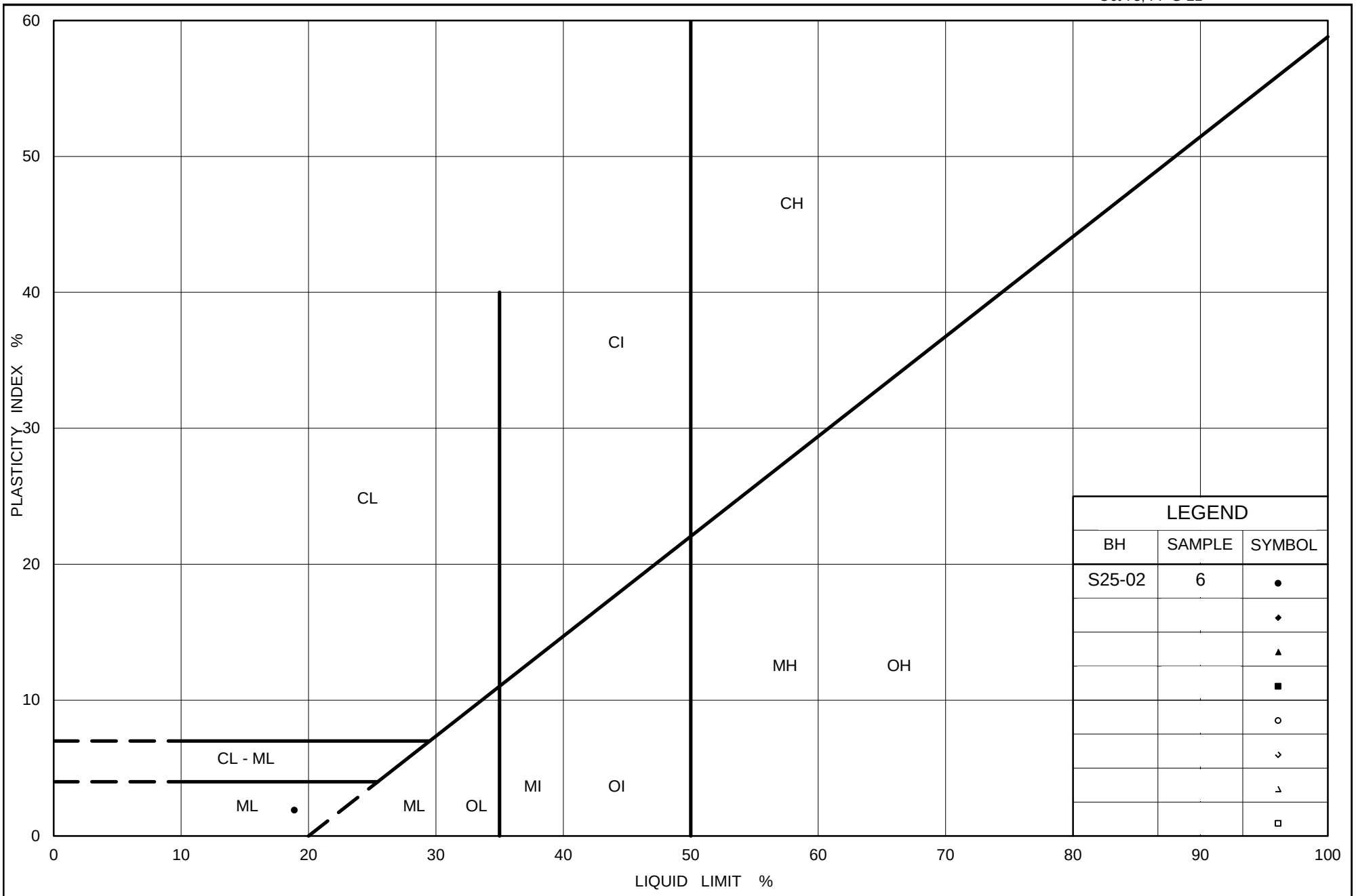
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S25-05	6	196.2
■	S25-03	6	197.7
◆	S25-10	6	196.2
▲	S25-08	8	196.2
▽	S25-09	9	191.6

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

Date: 15-Dec-09



Ministry of Transportation

Ontario

PLASTICITY CHART
Silt
Highway 69 (SBL) STA 17+230 to 17+350

Figure No. C.S25-8

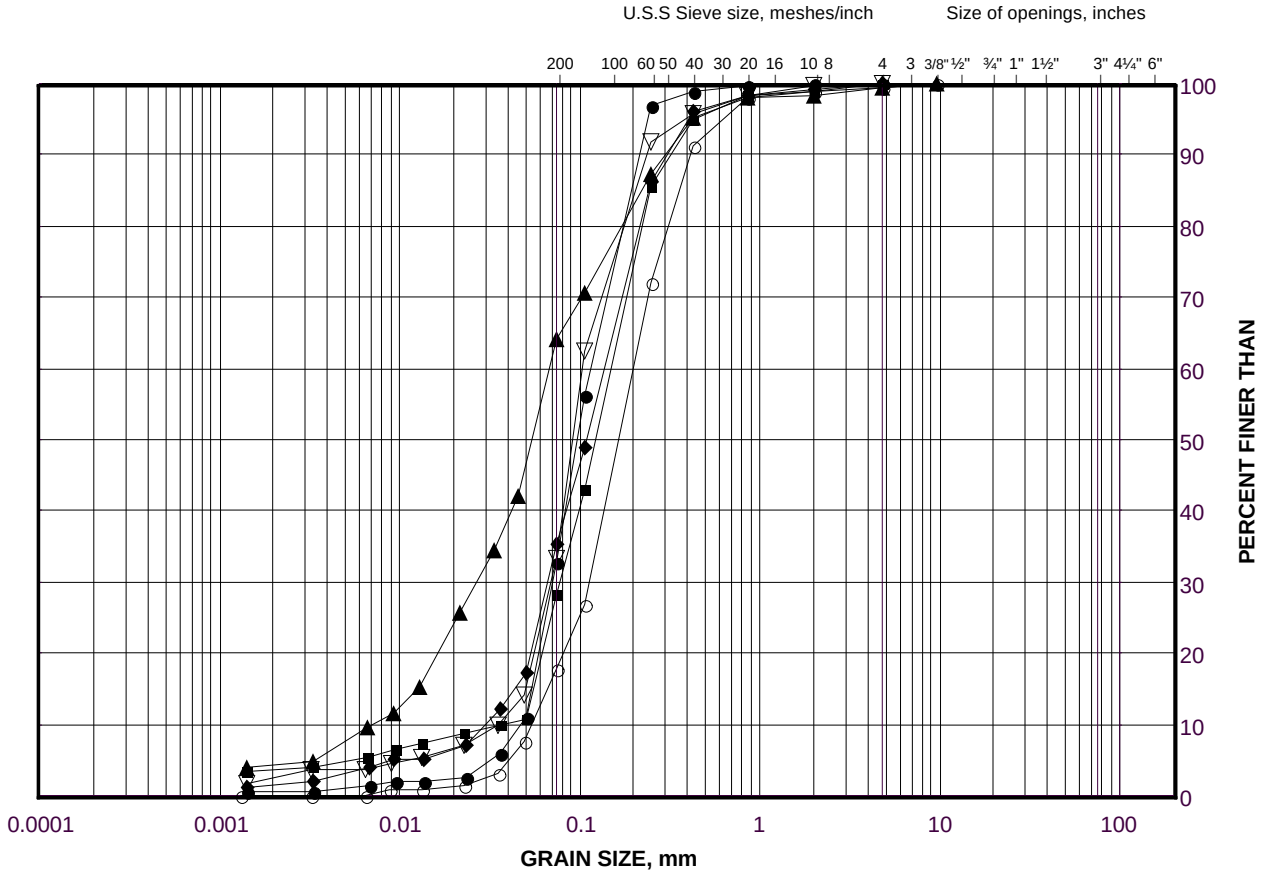
Project No. 07-1111-0029

Checked By: CN

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand (Upper Deposit)
Highway 69 (NBL) STA 17+150 to 17+350

FIGURE C.S25-9



LEGEND

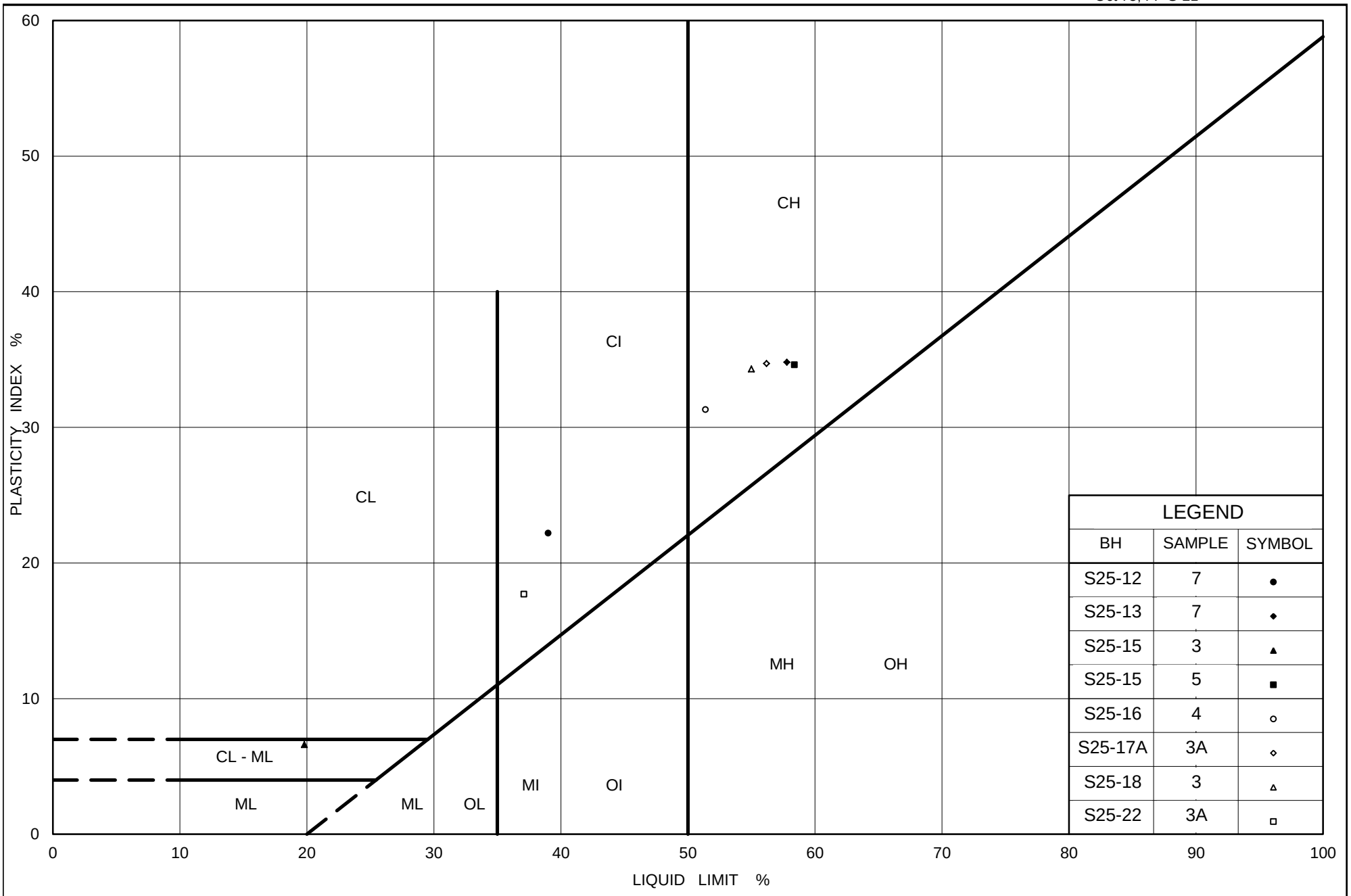
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S25-25	3	201.2
■	S25-24	3	201.2
◆	S25-23	3	200.3
▲	S25-21	3	200.6
▽	S25-17	4	200.9
❍	S25-13	5	199.9

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

Date: 22-May-15



Ministry of Transportation

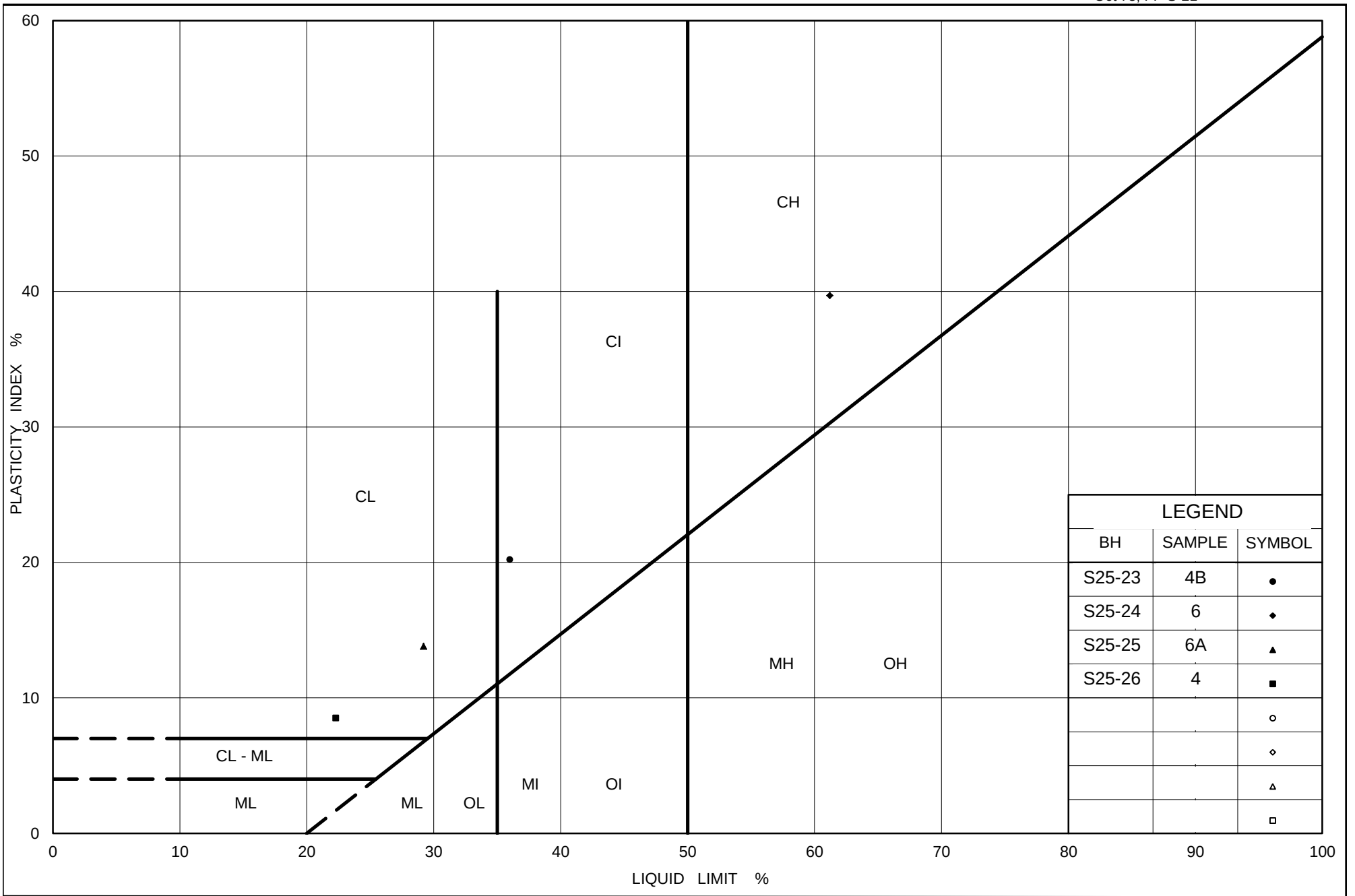
Ontario

PLASTICITY CHART
Clayey Silt to Clay
Highway 69 (NBL) STA 17+150 to 17+350

Figure No. C.S25-10A

Project No. 07-1111-0029

Checked By: CN



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt to Clay
Highway 69 (NBL) STA 17+150 to 17+350

Figure No. C.S25-10B

Project No. 07-1111-0029

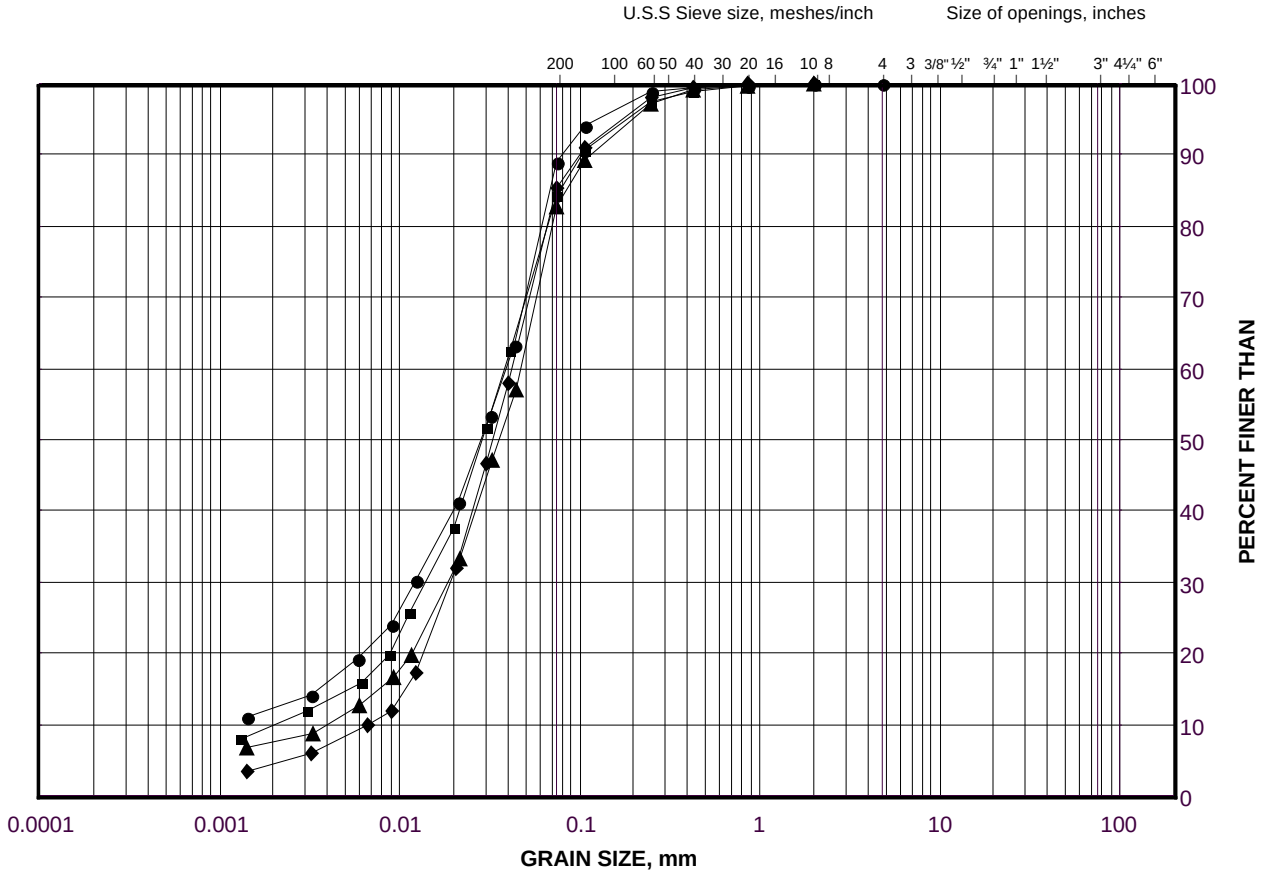
Checked By: CN

GRAIN SIZE DISTRIBUTION

Silt

Highway 69 (NBL) STA 17+150 to 17+350

FIGURE C.S25-11



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S25-22	4	199.8
■	S25-17	6	199.2
◆	S25-26	6A	196.5
▲	S25-25	6B	196.5

Project Number: 07-1111-0029

Checked By: CN

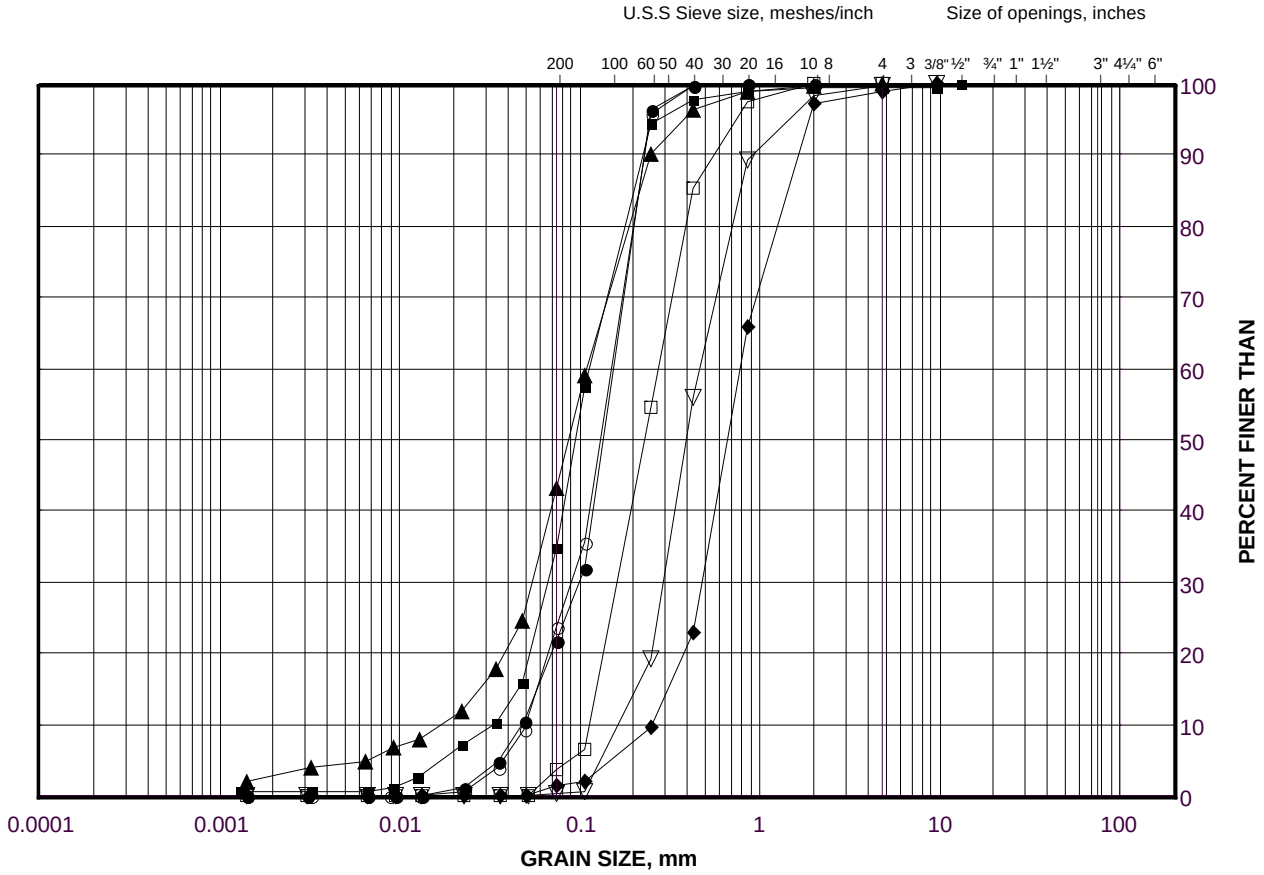
Golder Associates

Date: 31-Jul-15

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand (Lower Deposit)
Highway 69 (NBL) STA 17+150 to 17+350

FIGURE C.S25-12A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S25-12	11	191.0
■	S25-13	12	191.7
◆	S25-19	5	197.9
▲	S25-14	6B	198.3
▽	S25-18	8	194.7
❍	S25-15	8	193.2
□	S25-16	9	191.5

Project Number: 07-1111-0029

Checked By: CN

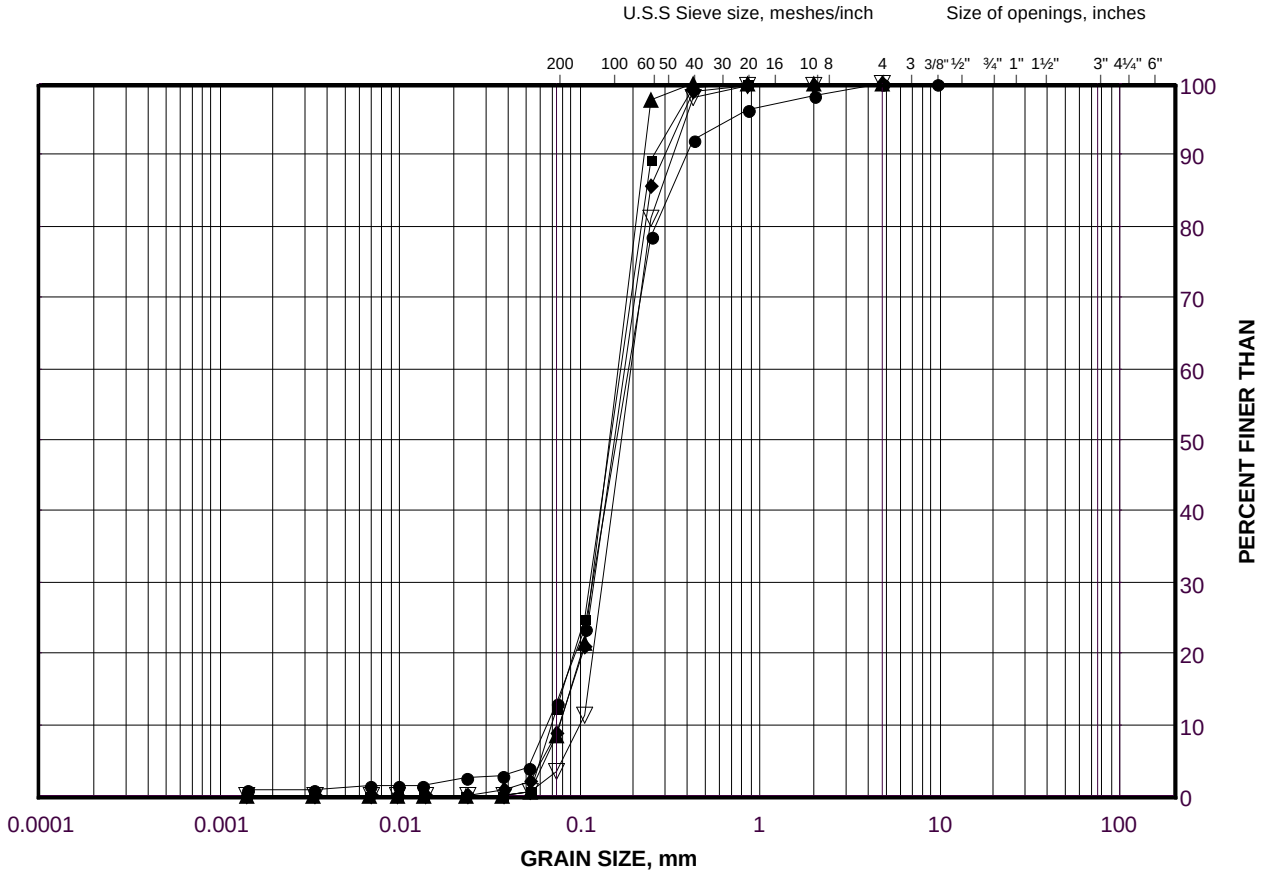
Golder Associates

Date: 22-May-15

GRAIN SIZE DISTRIBUTION

Silt and Sand to Sand (Lower Deposit)
Highway 69 (NBL) STA 17+150 to 17+350

FIGURE C.S25-12B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S25-26	10	190.2
■	S25-25	10	190.5
◆	S25-24	10	192.0
▲	S25-26	7	194.8
▽	S25-23	7	195.0

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

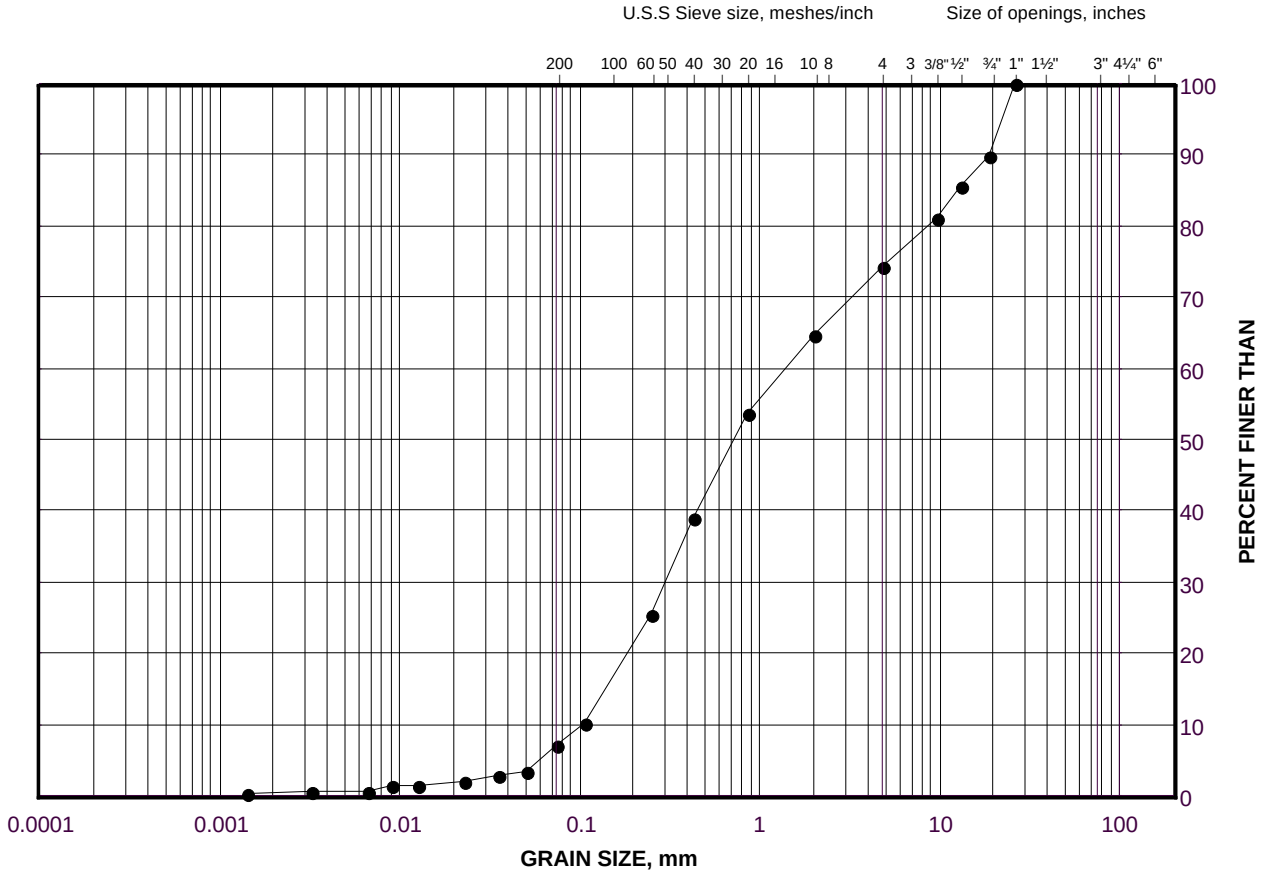
Date: 31-Jul-15

GRAIN SIZE DISTRIBUTION

Gravelly Sand

Highway 69 (NBL) STA 17+150 to 17+350

FIGURE C.S25-13A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S25-12	15	184.9

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

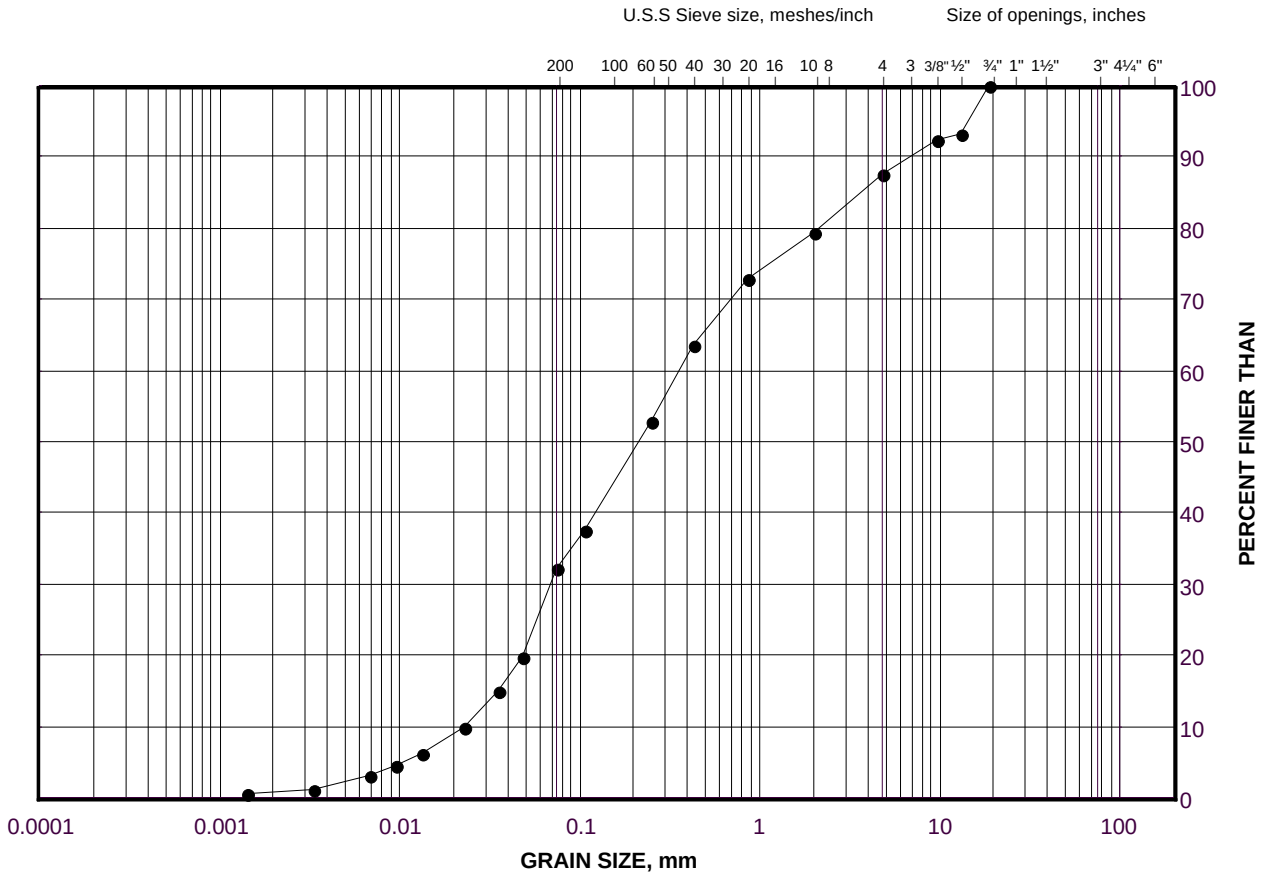
Date: 27-Nov-09

GRAIN SIZE DISTRIBUTION

Silt and Sand (Pocket)

Highway 69 (NBL) STA 17+150 to 17+350

FIGURE C.S25-13B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S25-24	12	189.0

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

Date: 31-Jul-15

TABLE C1
EVALUATION OF STABILITY / SETTLEMENT MITIGATION OPTIONS
HIGHWAY 69 SBL – STA 17+230 TO 17+350 (SWAMP 25)

Stability / Settlement Mitigation Option	***Rank***	***Advantages***	***Disadvantages***	***Relative Costs***	***Risks / Consequences***
Full Sub-Excavation (up to about 5.5 m deep) with Preloading of Rock Fill (120 days)	1	• Improved stability. • Reduced total settlement. • No delay in construction. • Toe berms are not required.	• Additional effort required for sub-excavation and replacement. • Additional post-construction settlement of rock fill itself; requires preloading to reduce rock fill settlement to acceptable criterion • Generation of large volume of excess excavation spoil. • Greater quantities of rock fill required.	• Additional costs associated with sub-excavation, disposal and replacement of weak and soft, compressible deposits.	• Medium risk with respect to maintaining stability of existing roadway embankment during sub-excavation. • Staged excavation in strips of limited width may be required. • Consider “preloading” rock fill embankment for up to 120 days to reduce post-construction settlement.
Preloading (90 days) with Large Toe Berms (no instrumentation and monitoring)	Not practical	• Standard construction operation.	• Delay in construction to allow for at least 90 % primary consolidation to be completed. • Re-grading is required to account for settlement prior to final pavement structure construction. • Large outside toe berm up to 2.5 m high by 12 m wide required for stability.	• Reduced cost for smaller quantity of embankment fill material as compared with full sub-excavation or surcharge options (including toe berms). • Reduced costs for disposal / management of excavation spoil as compared with full sub-excavation option.	• Some secondary consolidation (creep) may occur. • Preload time could be reduced by instrumenting embankment and monitoring actual rate of settlement. • Some risk with respect to maintaining stability of fill on weak foundation soils. • May need to acquire additional right-of-way due to the 12 m wide outside toe berms required for stability.
Surcharging (50 days) with Large Toe Berms (no instrumentation and monitoring)	Not practical	• Standard construction operation. • Reduced time to reach at least 90% primary consolidation as compared with preloading. • Reduced secondary (creep) consolidation settlement.	• Some delay in construction to allow for at least 90% primary consolidation to be completed. • Increased handling of rock fill (or Granular ‘B’) to remove surcharge. • Large outside toe berm up to 2.5 m high by 14 m wide is required to maintain stability of higher embankment.	• Increased costs associated with construction and materials for 2 m high surcharge and larger toe berms as compared with preload option. • Reduced costs for disposal / management of excavation spoil as compared with full sub-excavation option.	• Some risk with respect to maintaining stability of higher (surcharged) fills on weak foundation soils. • May need to acquire additional right-of-way due to the 14 m wide outside toe berms required for stability.

TABLE C1
EVALUATION OF STABILITY / SETTLEMENT MITIGATION OPTIONS
HIGHWAY 69 SBL – STA 17+230 TO 17+350 (SWAMP 25)

Stability / Settlement Mitigation Option	***Rank***	***Advantages***	***Disadvantages***	***Relative Costs***	***Risks / Consequences***
Wick Drains (with or without surcharge)	Not practical	• Decreased time for primary consolidation.	• Limited thickness (about 0.5 m to 2.6 m) of the cohesive deposit. • Increased time for installation of wick drains. • Instrumentation and monitoring program required to monitor staged construction and to assess when end of primary consolidation is reached. • Toe berms may be required whether surcharge is applied immediately or staged construction is employed.	• Additional costs associated with wick drain design, toe berms, installation and instrumentation and monitoring program.	• Secondary consolidation (creep) will occur if surcharge is not applied. • May need to acquire additional right-of-way if toe berms are required.
Lightweight Fill (EPS)	2	• Improved stability. • Reduce post-construction settlements. • No delay in construction. • Toe berms are not required.	• High cost of construction materials. • Restricted use within the embankment cross-section to above water table.	• Reduced costs for disposal / management of excavation spoil as compared with full sub-excavation option. • Relative cost of EPS fill is at least an order of magnitude higher than fill required for the other options. • Additional cost for embankment design.	• Very low risk with respect to stability and long-term settlement of foundation soils.

TABLE C1
EVALUATION OF STABILITY / SETTLEMENT MITIGATION OPTIONS
HIGHWAY 69 SBL – STA 17+230 TO 17+350 (SWAMP 25)

Stability / Settlement Mitigation Option	***Rank***	***Advantages***	***Disadvantages***	***Relative Costs***	***Risks / Consequences***
Aggregate Piers	Not Practical	• Reduces total settlement. • Potentially increase rate of consolidation settlement • Improved stability. • Toe berms not required.	• High area replacement ratio (R_a) required to satisfy stability. • Post-construction settlement of the rock fill embankment would still require preloading to reduce rock fill settlement to acceptable criterion.	• Additional costs associated with mobilization of specialized equipment and design / installation of piers. • Reduced costs for disposal / management of excavation spoil as compared with full sub-excavation option. • Additional cost for embankment design.	• High area replacement ratio required to obtain stability is not economical. • Low risk with respect to stability and long-term settlement of foundation soils.

n:\active\2007\1111\07-1111-0029 - mrc - hwy 69 four-laning -\report\final\7 - swamp crossings - phase 2\appendix c - table and figure files\07-1111-0029-7 tbl c1 evaluation of mitigation options-s25.docx

Prepared By: AJS/MCK

Reviewed By: CN/JMAC

TABLE C2
EVALUATION OF STABILITY / SETTLEMENT MITIGATION OPTIONS
HIGHWAY 69 NBL – STA 17+150 TO 17+350 (SWAMP 25)

Stability / Settlement Mitigation Option	***Rank***	***Advantages***	***Disadvantages***	***Relative Costs***	***Risks / Consequences***
Full Sub-Excavation (up to about 7.5 m deep) with Preloading of Rock Fill (145 days)	1	• Improved stability. • Reduced total settlement. • No delay in construction. • Toe berms are not required.	• Additional effort required for sub-excavation and replacement. • Additional post-construction settlement of rock fill itself; requires preloading to reduce rock fill settlement to acceptable criterion. • Generation of large volume of excess excavation spoil. • Greater quantities of rock fill required.	• Additional costs associated with sub-excavation, disposal and replacement of weak and soft, compressible deposits.	• Medium risk with respect to maintaining stability of existing roadway embankment during sub-excavation. • Staged excavation in strips of limited width may be required. • Consider “preloading” rock fill embankment for up to 145 days to reduce post-construction settlement.
Preloading (260 days) with Large Toe Berms (no instrumentation and monitoring)	Not practical	• Standard construction operation.	• Delay in construction to allow for at least 90 % primary consolidation to be completed. • Re-grading is required to account for settlement prior to final pavement structure construction. • Very large outside toe berm up to 2.5 m high by 22 m wide required for stability.	• Reduced cost for smaller quantity of embankment fill material as compared with full sub-excavation or surcharge options (including toe berms). • Reduced costs for disposal / management of excavation spoil as compared with full sub-excavation option.	• Some secondary consolidation (creep) may occur. • Preload time could be reduced by instrumenting embankment and monitoring actual rate of settlement. • Some risk with respect to maintaining stability of fill on weak foundation soils. • May need to acquire additional right-of-way due to the 22 m wide outside toe berm required for stability.
Surcharging (190 days) with Large Toe Berms (No instrumentation and monitoring)	Not practical	• Standard construction operation. • Reduced time to reach at least 90% primary consolidation as compared with preloading. • Reduced secondary (creep) consolidation settlement.	• Some delay in construction to allow for at least 90% primary consolidation to be completed. • Increased handling of rock fill (or Granular ‘B’) to remove surcharge. • Very large outside toe berm up to 2.5 m high by 25 m wide is required to maintain stability of higher embankment	• Increased costs associated with construction and materials for 2 m high surcharge and larger toe berms as compared with preload option. • Reduced costs for disposal / management of excavation spoil as compared with full sub-excavation option.	• Some risk with respect to maintaining stability of higher (surcharged) fills on weak foundation soils. • Toe berms are required for stability. • May need to acquire additional right-of-way due to the 25 m wide outside toe berm required for stability.

TABLE C2
EVALUATION OF STABILITY / SETTLEMENT MITIGATION OPTIONS
HIGHWAY 69 NBL – STA 17+150 TO 17+350 (SWAMP 25)

Stability / Settlement Mitigation Option	*Rank*	*Advantages*	*Disadvantages*	*Relative Costs*	*Risks / Consequences*
Wick Drains (with or without surcharge)	Not practical	• Decreased time for primary consolidation.	• Limited thickness (about 0.6 m to 4.0 m) of the cohesive deposit. • Increased time for installation of wick drains. • Instrumentation and monitoring program required to monitor staged construction and to assess when end of primary consolidation is reached. • Toe berms may be required whether surcharge is applied immediately or staged construction is employed.	• Additional costs associated with wick drain design, toe berms, installation and instrumentation and monitoring program.	• Secondary consolidation (creep) will occur if surcharge is not applied. • May need to acquire additional right-of-way if toe berms are required.
Lightweight Fill (EPS)	2	• Improved stability. • Reduce post-construction settlements. • No delay in construction. • Toe berms are not required.	• High cost of construction materials. • Restricted use within the embankment cross-section to above water table.	• Reduced costs for disposal / management of excavation spoil as compared with full sub-excavation option. • Relative cost of EPS fill is at least an order of magnitude higher than fill required for the other options. • Additional cost for embankment design.	• Very low risk with respect to stability and long-term settlement of foundation soils.
Aggregate Piers	Not Practical	• Reduces total settlement. • Potentially increased rate of consolidation settlement. • Improved stability. • Toe berms not required.	• High area replacement ratio (R_A) required to satisfy stability. • Post-construction settlement of the rock fill embankment would still require preloading to reduce rock fill settlement to acceptable criterion.	• Additional costs associated with mobilization of specialized equipment and design / installation of piers. • Reduced costs for disposal / management of excavation spoil as compared with full sub-excavation option. • Additional cost for embankment design.	• High area replacement ratio required to obtain stability is not economical. • Low risk with respect to stability and long-term settlement of foundation soils.

n:\active\2007\1111\07-1111-0029 - mrc - hwy 69 four-laning -\report\final\7 - swamp crossings - phase 2\appendix c - table and figure files\07-1111-0029-7 tbl c2 evaluation of mitigation options-s25.docx

Prepared By: AJS/MCK **Reviewed By:** CN/JMAC

Highway 69 SBL – STA 17+230 to 17+350 (Swamp 25)
Slope Stability (SBL Outside Toe Berm)

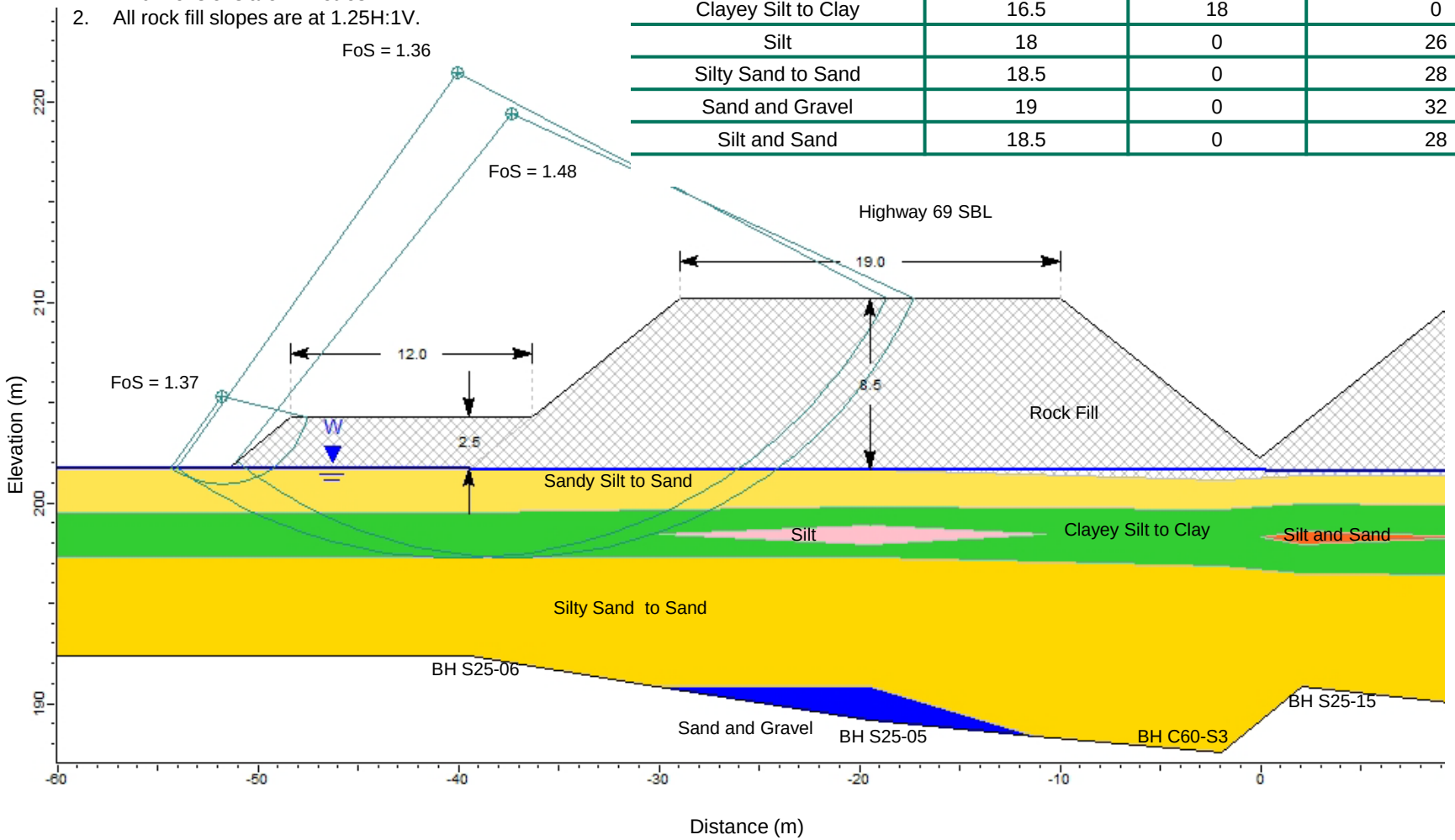
Figure C1

STA 17+300

NOTES:

1. All dimensions are in metres.
2. All rock fill slopes are at 1.25H:1V.

Material Name	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (degrees)
Rock Fill	19	0	40
Sandy Silt to Sand	18.5	0	28
Clayey Silt to Clay	16.5	18	0
Silt	18	0	26
Silty Sand to Sand	18.5	0	28
Sand and Gravel	19	0	32
Silt and Sand	18.5	0	28



Date: April 11, 2016
Project No: 07-1111-0029-7

Analysis By: AJS **Reviewed By:** CN

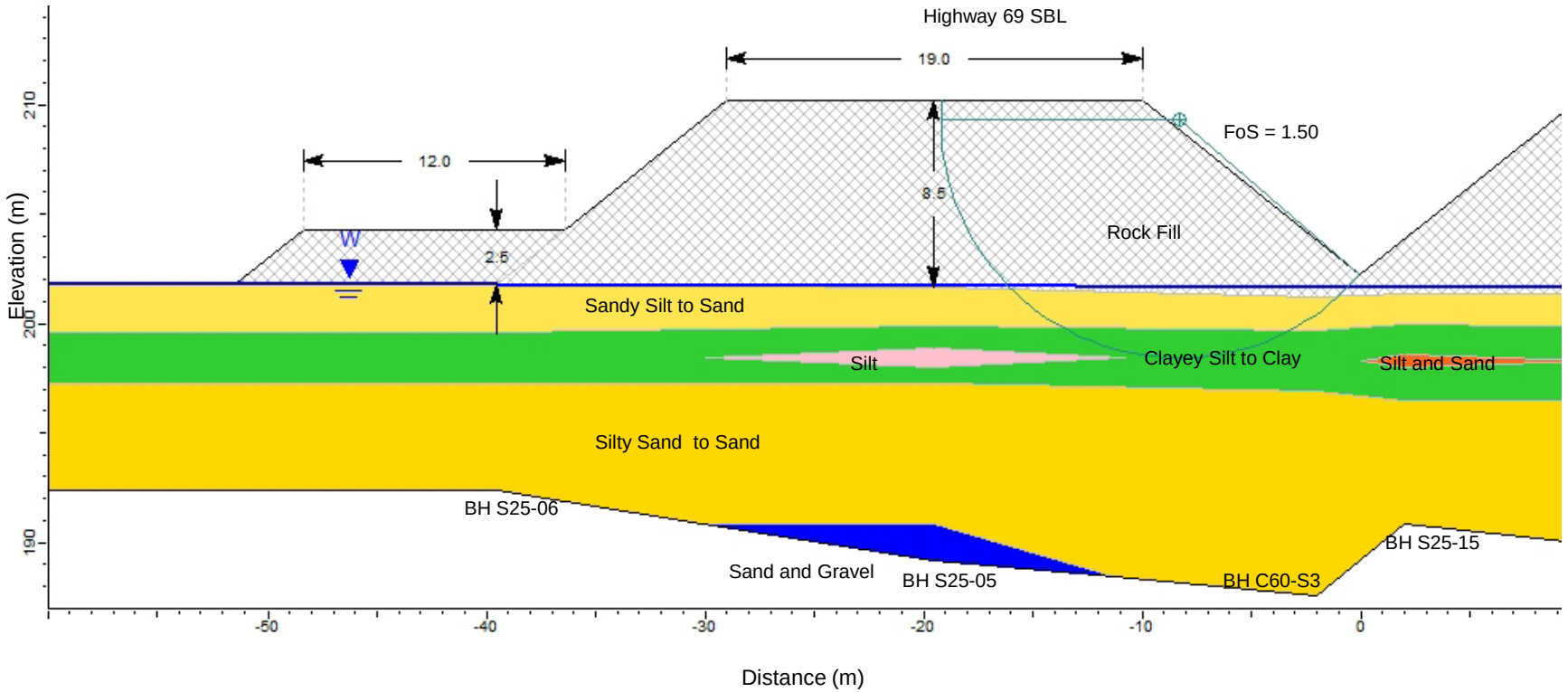
Golder Associates

STA 17+300

NOTES:

1. All dimensions are in metres.
2. All rock fill slopes are at 1.25H:1V.

Material Name	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (degrees)
Rock Fill	19	0	40
Sandy Silt to Sand	18.5	0	28
Clayey Silt to Clay	16.5	18	0
Silt	18	0	26
Silty Sand to Sand	18.5	0	28
Sand and Gravel	19	0	32
Silt and Sand	18.5	0	28



Date: April 11, 2016
Project No: 07-1111-0029-7

Analysis By: AJS **Reviewed By:** CN

Golder Associates

Highway 69 NBL – STA 17+150 to 17+350 (Swamp 25)
Slope Stability (NBL Outside Toe Berm)

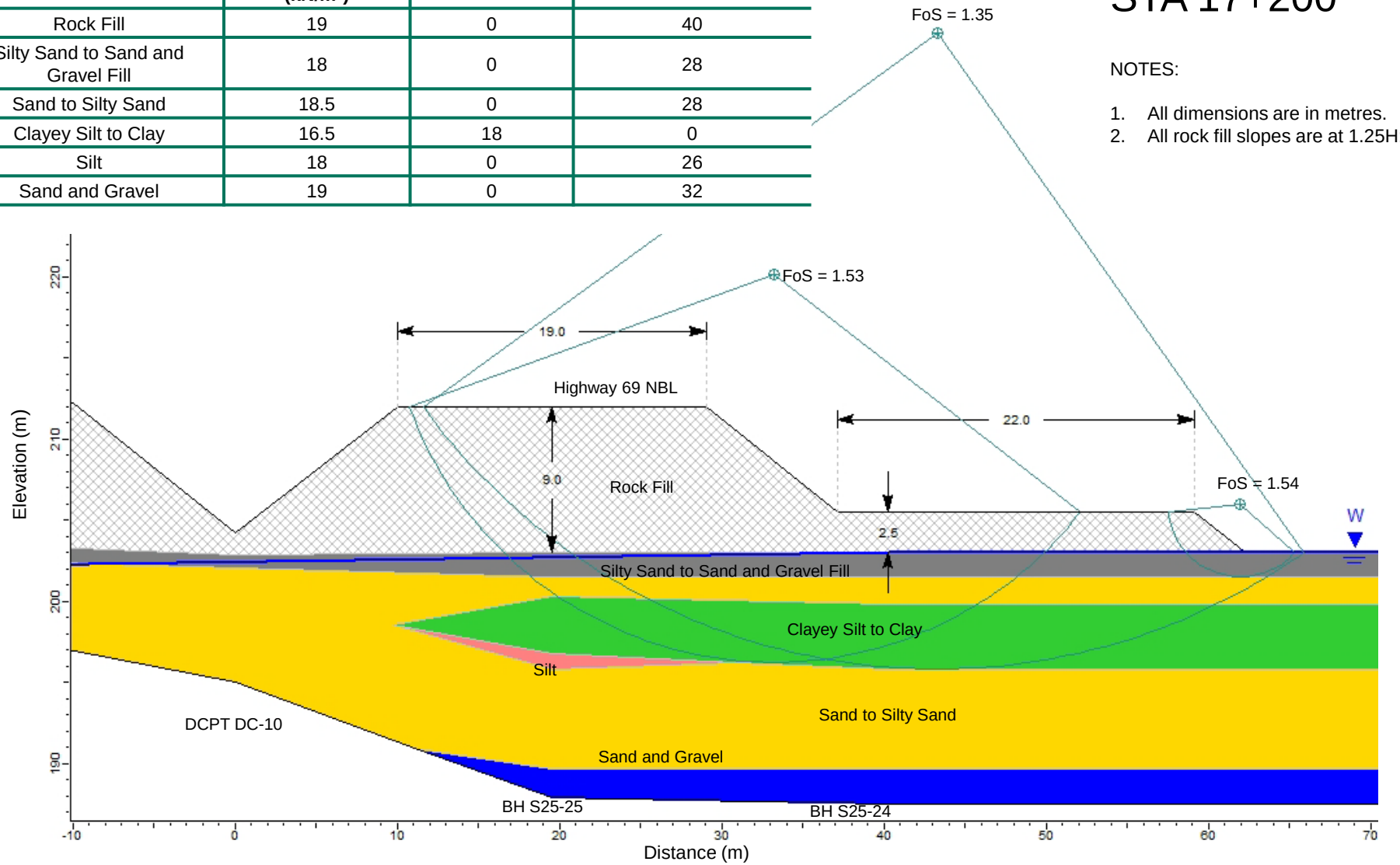
Figure C3

Material Name	Unit Weight (kN/m³)	Cohesion (kPa)	Friction Angle (degrees)
Rock Fill	19	0	40
Silty Sand to Sand and Gravel Fill	18	0	28
Sand to Silty Sand	18.5	0	28
Clayey Silt to Clay	16.5	18	0
Silt	18	0	26
Sand and Gravel	19	0	32

STA 17+200

NOTES:

1. All dimensions are in metres.
2. All rock fill slopes are at 1.25H:1V.



Date: April 11, 2016
Project No: 07-1111-0029-7

Analysis By: AJS **Reviewed By:** CN

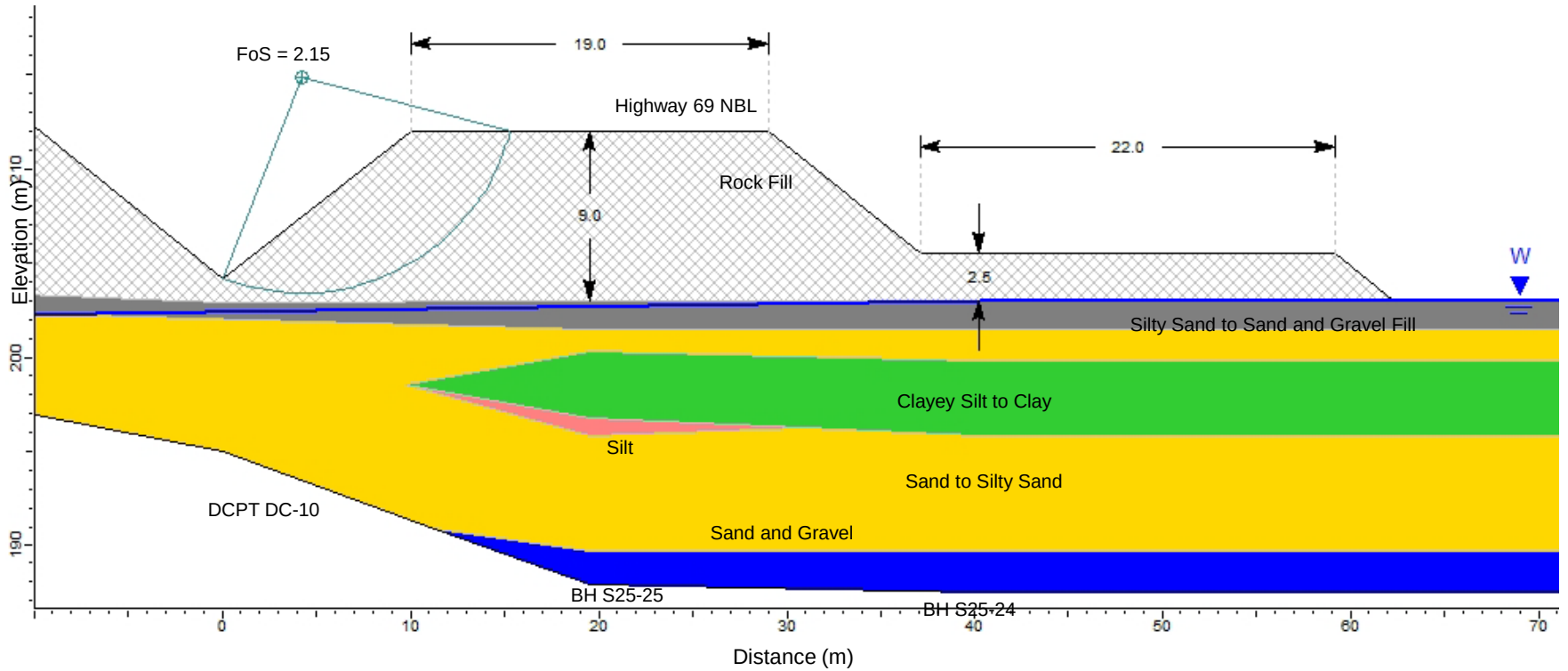
Golder Associates

Material Name	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (degrees)
Rock Fill	19	0	40
Silty Sand to Sand and Gravel Fill	18	0	28
Sand to Silty Sand	18.5	0	28
Clayey Silt to Clay	16.5	18	0
Silt	18	0	26
Sand and Gravel	19	0	32

STA 17+200

NOTES:

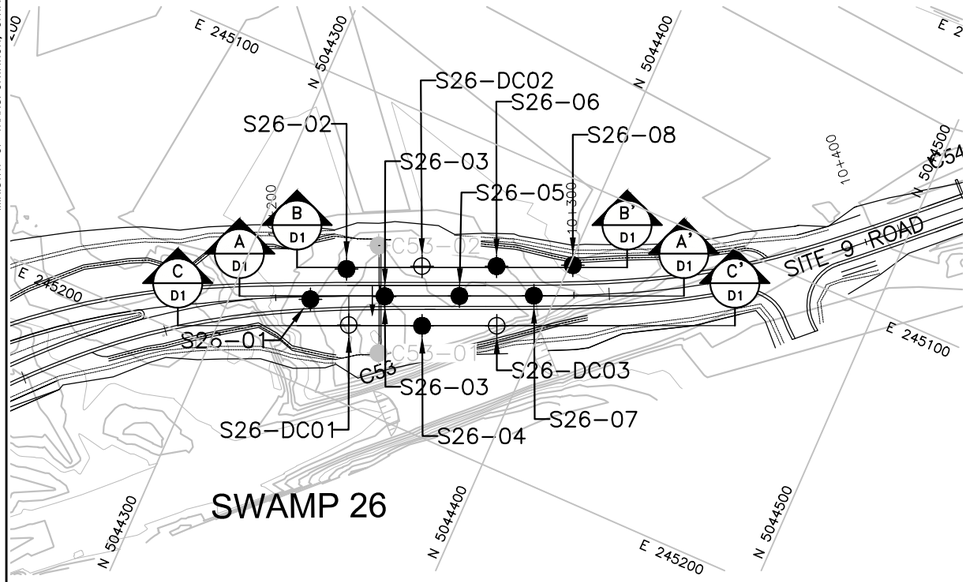
1. All dimensions are in metres.
2. All rock fill slopes are at 1.25H:1V.



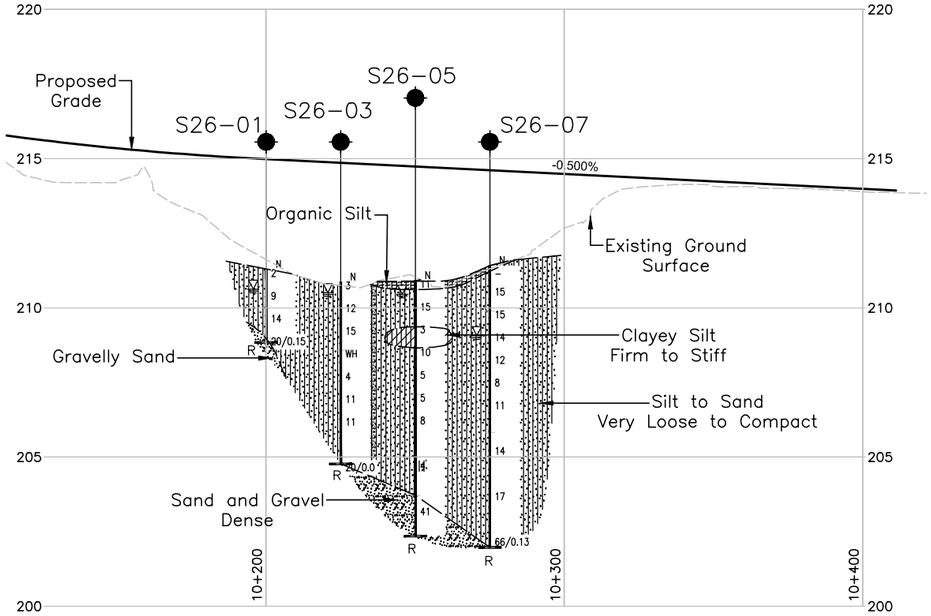
APPENDIX D

Site 9 Road – STA 10+225 to 10+300 (Swamp 26)

MINISTRY OF TRANSPORTATION, ONTARIO

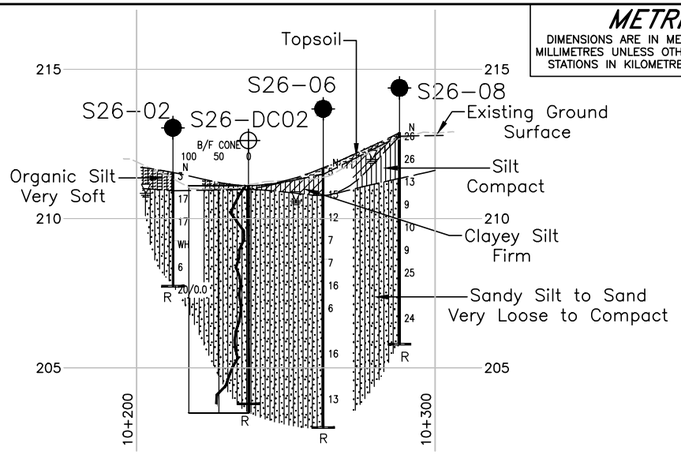


PLAN
SCALE
20 0 20 40 m



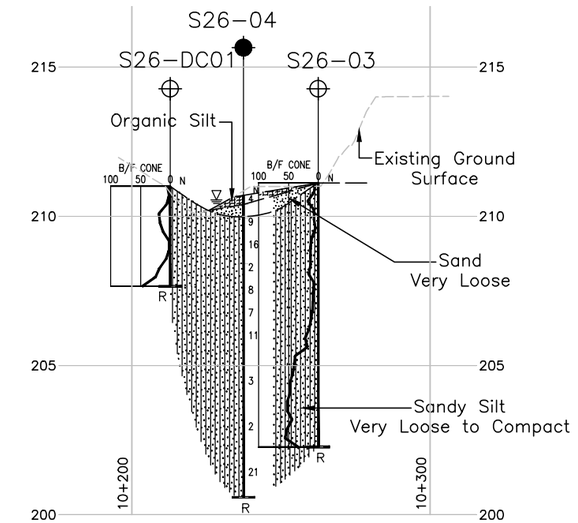
A-A' D1 CENTRELINE PROFILE
SITE 9 ROAD

HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE



B-B' D1 EMBANKMENT TOE PROFILE
SITE 9 ROAD

HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE



C-C' D1 EMBANKMENT TOE PROFILE
SITE 9 ROAD

HORIZONTAL SCALE
20 0 20 40 m
2 0 2 4 m
VERTICAL SCALE

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

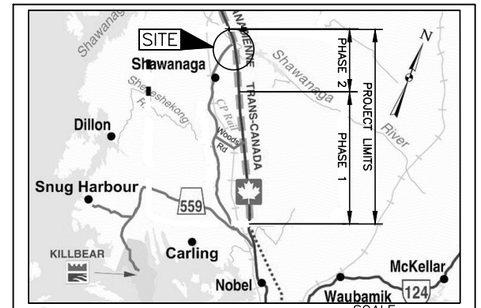
CONT No. .
WP No. 5111-07-00

SHEET .

SITE 9 ROAD STA 10+225 TO 10+300

BOREHOLE LOCATIONS AND SOIL STRATA

Golder Associates



KEY PLAN

LEGEND

- Borehole – Current Investigation
- 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
- R Refusal

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
S26-01	211.3	5044325.0	245172.5
S26-02	211.5	5044332.1	245158.3
S26-03	210.9	5044347.5	245161.6
S26-03	211.7	5044347.5	245161.6
S26-04	210.7	5044362.9	245165.6
S26-05	210.9	5044370.4	245151.4
S26-06	211.7	5044377.8	245137.3
S26-07	211.4	5044393.2	245141.3
S26-08	212.9	5044401.1	245126.7
S26-DC01	211.0	5044340.3	245175.2
S26-DC02	211.1	5044354.9	245147.3
S26-DC03	211.1	5044385.9	245155.5

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

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

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

LICENSED PROFESSIONAL ENGINEER J. M. A. COSTA Apr. 6, 2016 PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER J.P. DITTRICH Apr. 6, 2016 PROVINCE OF ONTARIO

REFERENCE
Base plans contours and centreline profile provided in digital format by MMM, drawing file nos. S6878-330-001SGA.dwg, dated November 2013, s6878xb02 contours.dwg, h6878_PHASE2_XD1 grading.dwg and h6878_PHASE2_XN1.dwg, received November 10, 2014, 6878 jh Sheb Tie In at IC Profile-May 14, 2015.dwg received May 14, 2015.

NO.	DATE	BY	REVISION
.	.	.	.

Geocres No. 41H-161

HWY. 69	PROJECT NO. 07-1111-0029		DIST. .
SUBM'D. AJS	CHKD. CN	DATE: 5/21/2015	SITE: .
DRAWN: MR	CHKD. CN	APPD. JPD/JMAC	DWG. D1

PLOT DATE: April 11, 2016
FILENAME: T:\Projects\2007\07-1111-0029 (MRC, Parry Sound)\-AFA- Swamp Report - Phase II\0711110029-AFA-BC-0004.dwg

Golder Associates

RECORD OF BOREHOLE No S26-01

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044325.0 ;E 245172.5
BOREHOLE TYPE Continous Flight 108 mm I.D. Hollow Stem Augers
DATE January 29, 2015

ORIGINATED BY ID
COMPILED BY KD/MR
CHECKED BY AJS/MCK

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
211.3	GROUND SURFACE										
0.0	SILT and SAND, some gravel, trace clay, clayey silt seam at 1.5 m depth Very loose to compact Brown to grey Wet		1	SS	2	▽	211				
			2	SS	9		210		○		
			3	SS	14						
209.0											
2.4	Gravelly SAND, some silt, trace clay Grey Wet	° °	4	SS	20/0.15		209		○		24 52 20 4
	SPOON AND AUGER REFUSAL END OF BOREHOLE										

NOTE:

1. Water level in open borehole measured at a depth of 0.6 m below ground surface (Elev. 210.7 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No S26-02

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5044332.1 ;E 245158.3 ORIGINATED BY ID
DIST HWY 69 BOREHOLE TYPE Continous Flight 108 mm I.D. Hollow Stem Augers COMPILED BY KD/MR
DATUM Geodetic DATE January 30, 2015 CHECKED BY AJS/MCK

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
211.5	GROUND SURFACE										
0.0 / 210.9	ORGANIC SILT, some sand Very soft Dark brown Wet		1	SS	3	▽	211	○ at 3	○ at 40		OC = 6.1%
0.6 / 209.2	SAND, some silt, trace organics Compact Brown to grey Moist to wet		2	SS	17						
			3	SS	17		210		○ at 20		
2.3 / 207.7	Sandy SILT, trace clay, trace organics, trace wood fragments Very loose to loose Brown to grey Wet		4	SS	WH		209		○ at 20		
			5	SS	6		208		○ at 10		0 25 71 4 Non-Plastic
3.8	SPOON AND AUGER REFUSAL END OF BOREHOLE NOTE: 1. Water level in open borehole measured at a depth of 0.7 m below ground surface (Elev. 210.8 m) upon completion of drilling.		6	SS	20/0.0						

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

Golder Associates

RECORD OF BOREHOLE No S26-03

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5044347.5 ;E 245161.6 ORIGINATED BY ID
DIST HWY 69 BOREHOLE TYPE Continous Flight 108 mm I.D. Hollow Stem Augers COMPILED BY KD/MR
DATUM Geodetic DATE January 30, 2015 CHECKED BY AJS/MCK

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
210.9	GROUND SURFACE							20 40 60 80 100	20 40 60		
0.0	Silty SAND, trace clay, trace organics to a depth of 0.8 m Very loose to compact Brown to grey Wet		1	SS	3	▽	210				
			2	SS	12			○	○		
			3	SS	15		209	○	○		0 69 28 3
208.6											
2.3	Sandy SILT, trace clay Very loose to compact Brown to grey Wet		4	SS	WH		208				
			5	SS	4						
			6	SS	11		207	○	○		0 22 75 3
			7	SS	11		206	○	○		
204.8			8	SS	20/0.0		205				
6.1	SPOON AND AUGER REFUSAL END OF BOREHOLE NOTE: 1. Water level in open borehole measured at a depth of 0.3 m below ground surface (Elev. 210.6 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No S26-04

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5044362.9 ;E 245165.6 ORIGINATED BY ID
DIST HWY 69 BOREHOLE TYPE Continous Flight 108 mm I.D. Hollow Stem Augers COMPILED BY KD/MR
DATUM Geodetic DATE February 2, 2015 CHECKED BY AJS/MCK

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
210.7	GROUND SURFACE										
0.0 / 210.4	ORGANIC SILT		1A	SS	4	▽	210				
0.3 / 209.9	SAND, trace organics Very loose Brown Wet		1B								
0.8	Silty SAND Loose to compact Brown to grey Wet		2	SS	9						
208.4			3	SS	16		209				
2.3	Sandy SILT, trace to some gravel, trace clay Very loose to compact Grey Wet		4	SS	2		208				0 27 69 4 Non-Plastic
			5	SS	8						
			6	SS	7		207				
			7	SS	11		206				20 22 54 4
			8	SS	3		205				
			9	SS	2		204				
			10	SS	21		203				
200.6							202				
10.1	AUGER REFUSAL END OF BOREHOLE NOTE: 1. Water level in open borehole measured at a depth of 0.2 m below ground surface (Elev. 210.5 m) upon completion of drilling.						201				

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

Golder Associates

PROJECT 07-1111-0029

RECORD OF BOREHOLE No S26-05

SHEET 1 OF 1

METRIC

W.P. 5111-07-00 LOCATION N 5044370.4 ;E 245151.4 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Continous Flight 108 mm I.D. Hollow Stem Augers COMPILED BY KD/MR

DATUM Geodetic DATE February 3, 2015 CHECKED BY AJS/MCK

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
210.9	GROUND SURFACE										
0.0 / 210.6	ORGANIC SILT		1A	SS	11	▽			188		
0.3	Silty SAND, trace organics Compact Brown to grey Moist to wet		1B								OC = 0.8%
209.4			2	SS	15		210				
1.5	CLAYEY SILT, trace sand Firm to stiff Grey Moist		3	SS	3		209	7, 5			
208.6											
2.3	SILT and SAND Loose to compact Brown Wet		4	SS	10		208				
207.1			5	SS	5						
3.8	SAND, trace to some gravel, trace silt Loose Brown to grey Wet		6	SS	5		207				8 88 4 0
			7	SS	8		206				
							205				
			8	SS	4						
203.7							204				
7.2	SAND and GRAVEL, trace silt Compact Dense Brown to grey Wet		9	SS	41		203				
202.3											
8.6	AUGER REFUSAL END OF BOREHOLE										

NOTES:

1. An additional borehole advanced 1.1 m south of Borehole S26-05 to carry out in situ field vanes at depths of 1.7 m and 2.0 m.

2. Water level in open borehole measured at a depth of 0.4 m below ground surface (Elev. 210.5 m) upon completion of drilling.

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

Golder Associates

RECORD OF BOREHOLE No S26-06

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00
DIST HWY 69
DATUM Geodetic

LOCATION N 5044377.8 ;E 245137.3
BOREHOLE TYPE Continous Flight 108 mm I.D. Hollow Stem Augers
DATE February 4, 2015

ORIGINATED BY ID
COMPILED BY KD/MR
CHECKED BY AJS/MCK

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
211.7	GROUND SURFACE										
0.0	TOPSOIL		1A	SS	5						
0.2	CLAYEY SILT Firm Brown to grey		1B				211				
210.8	Moist		2A	SS	15	▽					
0.9	Sandy SILT, trace clay Loose to compact Brown to grey Wet		2B								
			3	SS	12		210				0 26 70 4
			4	SS	7		209				
208.7											
3.0	Silty SAND Loose to compact Brown to grey Moist to wet		5	SS	7		208				
			6	SS	16						
			7	SS	6		207				
			8	SS	16		206				1 76 23 0
							205				
			9	SS	13		204				
203.0											
8.7	AUGER REFUSAL END OF BOREHOLE										

NOTE:

1. Water level in open borehole measured at a depth of 1.1 m below ground surface (Elev. 210.6 m) upon completion of drilling.

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF BOREHOLE No S26-07

SHEET 1 OF 1 **METRIC**

PROJECT 07-1111-0029
W.P. 5111-07-00 LOCATION N 5044393.2 ;E 245141.3 ORIGINATED BY ID
DIST HWY 69 BOREHOLE TYPE Continous Flight 108 mm I.D. Hollow Stem Augers COMPILED BY KD/MR
DATUM Geodetic DATE February 5, 2015 CHECKED BY AJS/MCK

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
211.4	GROUND SURFACE										
0.0	ORGANIC SILT		1A	AS	-		211		163.2		OC = 24.6%
0.2	SILT, some sand Compact Brown, becoming grey at a depth of 0.8 m Moist to wet		1B								
			2	SS	15				○		
209.9							210				
1.5	SAND, trace to some silt, trace clay, trace gravel Loose to compact Brown to grey Wet		3	SS	15	▽			○		0 82 17 1
			4	SS	14		209		○		
			5	SS	12		208		○		
			6	SS	8		207				
			7	SS	11				○		1 98 1 0
205.8							206				
5.6	Silty SAND, some gravel Compact Brown to grey Wet		8	SS	14		205		○		
			9	SS	17		204				
							203				
202.0			10	SS	66/0.13		202		○		
9.4	SPOON AND AUGER REFUSAL END OF BOREHOLE NOTE: 1. Water level in open borehole measured at a depth of 2.3 m below ground surface (Elev. 209.1 m) upon completion of drilling.										

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

Golder Associates

RECORD OF BOREHOLE No S26-08

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
LOCATION N 5044401.1 ;E 245126.7
ORIGINATED BY ID
DIST HWY 69
BOREHOLE TYPE Continous Flight 108 mm I.D. Hollow Stem Augers
COMPILED BY KD/MR
DATUM Geodetic
DATE February 5, 2015
CHECKED BY AJS/MCK

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
212.9	GROUND SURFACE										
0.0	TOPSOIL		1A								
0.2	SILT, some sand Compact Light brown with reddish pockets Wet		1B	SS	26				○		0 14 82 4
			2	SS	26	▽	212				
211.4											
1.5	SAND, some silt, trace gravel Loose to compact Brown to grey Wet		3	SS	13		211				
			4	SS	9		210				
			5	SS	10				○		
			6	SS	9		209		○		1 80 19 0
			7	SS	25		208				
							207				
			8	SS	24				○		
205.8							206				
7.1	AUGER REFUSAL END OF BOREHOLE NOTE: 1. Water level in open borehole measured at a depth of 0.9 m below ground surface (Elev. 212.0 m) upon completion of drilling.										

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

GTA-MTO 001 T:\PROJECTS\2007\07-1111-0029 (MRC, PARRY SOUND)\LOG\07-1111-0029-SWAMP-PHASE II.GPJ GAL-GTA.GDT 03/25/16 DD/SAC

Golder Associates

RECORD OF DCPT No S26-DC01

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044340.3 ;E 245175.2 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY KD/MR

DATUM Geodetic DATE January 25, 2015 CHECKED BY AJS/MCK

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
211.0	GROUND SURFACE										
0.0	Dynamic Cone Penetration Test (DCPT)						210 209 208				
207.4											
3.6	END OF DCPT Refusal to Further Penetration										

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

Golder Associates

RECORD OF DCPT No S26-DC02

SHEET 1 OF 1

METRIC

PROJECT 07-1111-0029

W.P. 5111-07-00 LOCATION N 5044354.9 ;E 245147.3 ORIGINATED BY ID

DIST HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY KD/MR

DATUM Geodetic DATE January 29, 2015 CHECKED BY AJS/MCK

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
211.1	GROUND SURFACE										
0.0	Dynamic Cone Penetration Test (DCPT)						211 210 209 208 207 206 205 204				
203.5											
7.6	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)										

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

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RECORD OF DCPT No S26-DC03

SHEET 1 OF 1

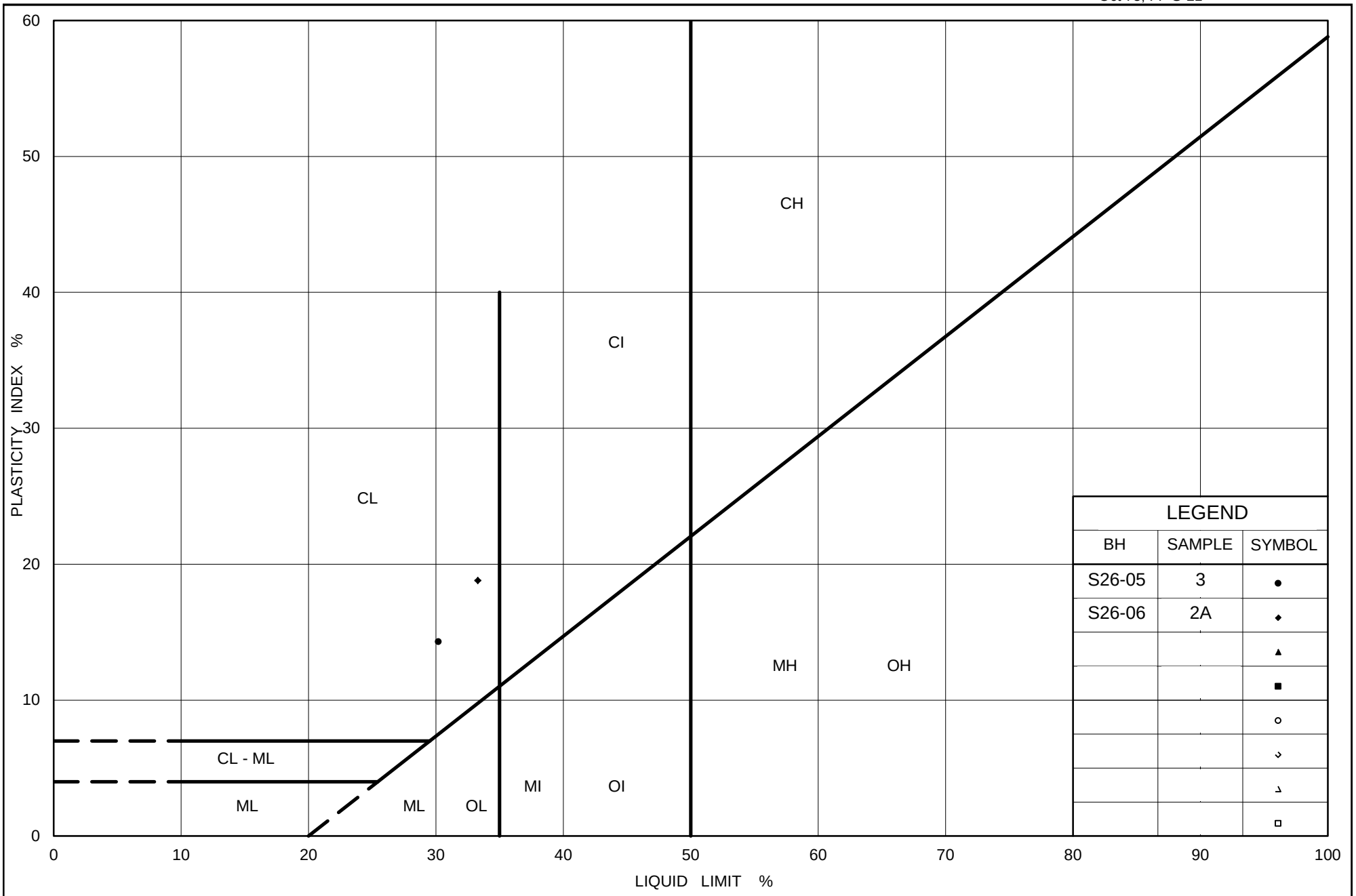
METRIC

PROJECT 07-1111-0029
W.P. 5111-07-00
LOCATION N 5044385.9 ;E 245155.5
ORIGINATED BY ID
DIST HWY 69
BOREHOLE TYPE Dynamic Cone Penetration Test
COMPILED BY KD/MR
DATUM Geodetic
DATE January 29, 2015
CHECKED BY AJS/MCK

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
211.1	GROUND SURFACE						211	20 40 60 80 100	20 40 60		
0.0	Dynamic Cone Penetration Test (DCPT)						210				
							209				
							208				
							207				
							206				
							205				
							204				
							203				
201.8							202				
9.3	END OF DCPT Refusal to Further Penetration (Hammer Bouncing)										

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

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



Ministry of Transportation

Ontario

PLASTICITY CHART
Clayey Silt
Site 9 Road STA 10+225 to 10+300

Figure No. D.S26-1

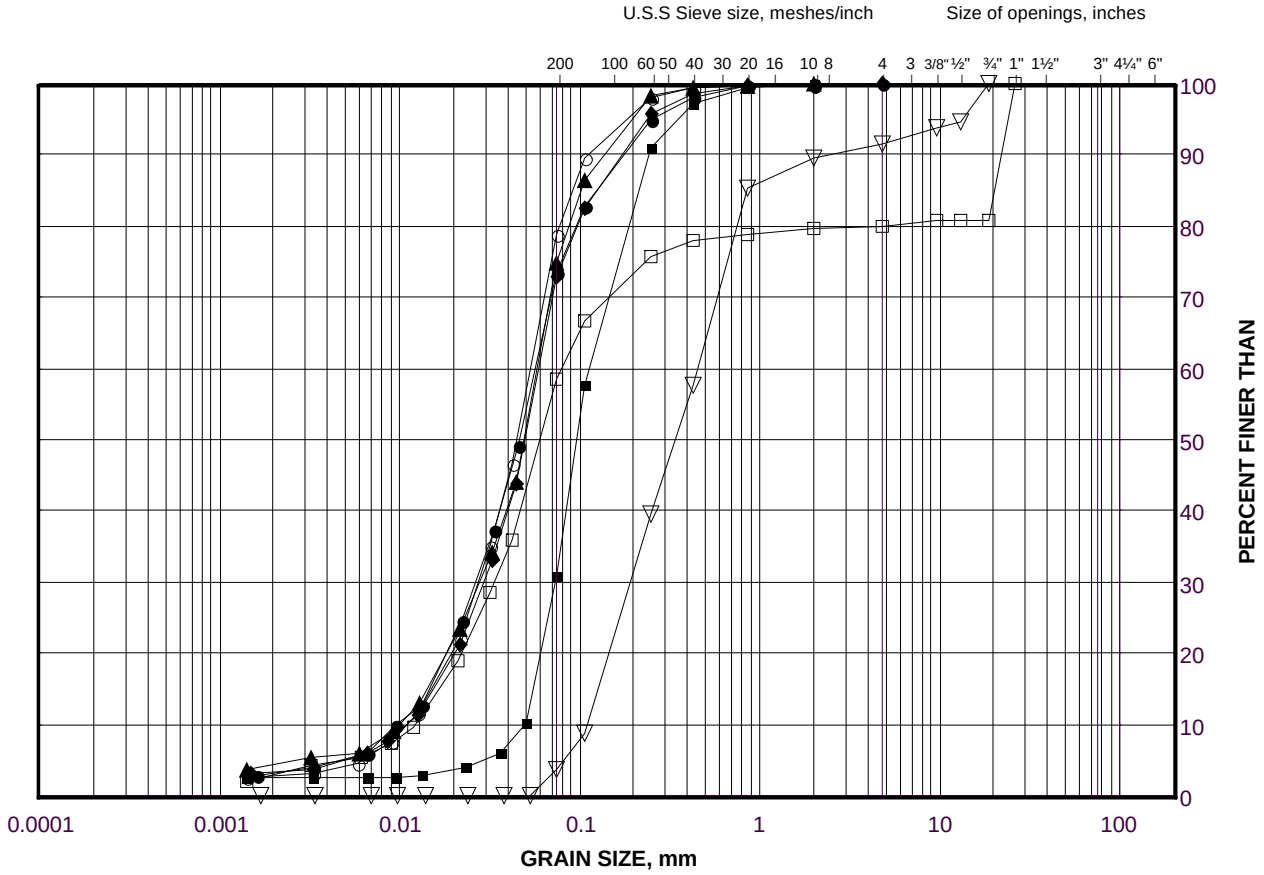
Project No. 07-1111-0029

Checked By: CN

GRAIN SIZE DISTRIBUTION

Sandy Silt to Sand
Site 9 Road STA 10+225 to 10+300

FIGURE D.S26-2A



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S26-06	3	209.9
■	S26-03	3	209.1
◆	S26-04	4	208.1
▲	S26-02	5	208.2
▽	S26-05	6	206.8
❍	S26-03	6	206.8
□	S26-04	7	205.9

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

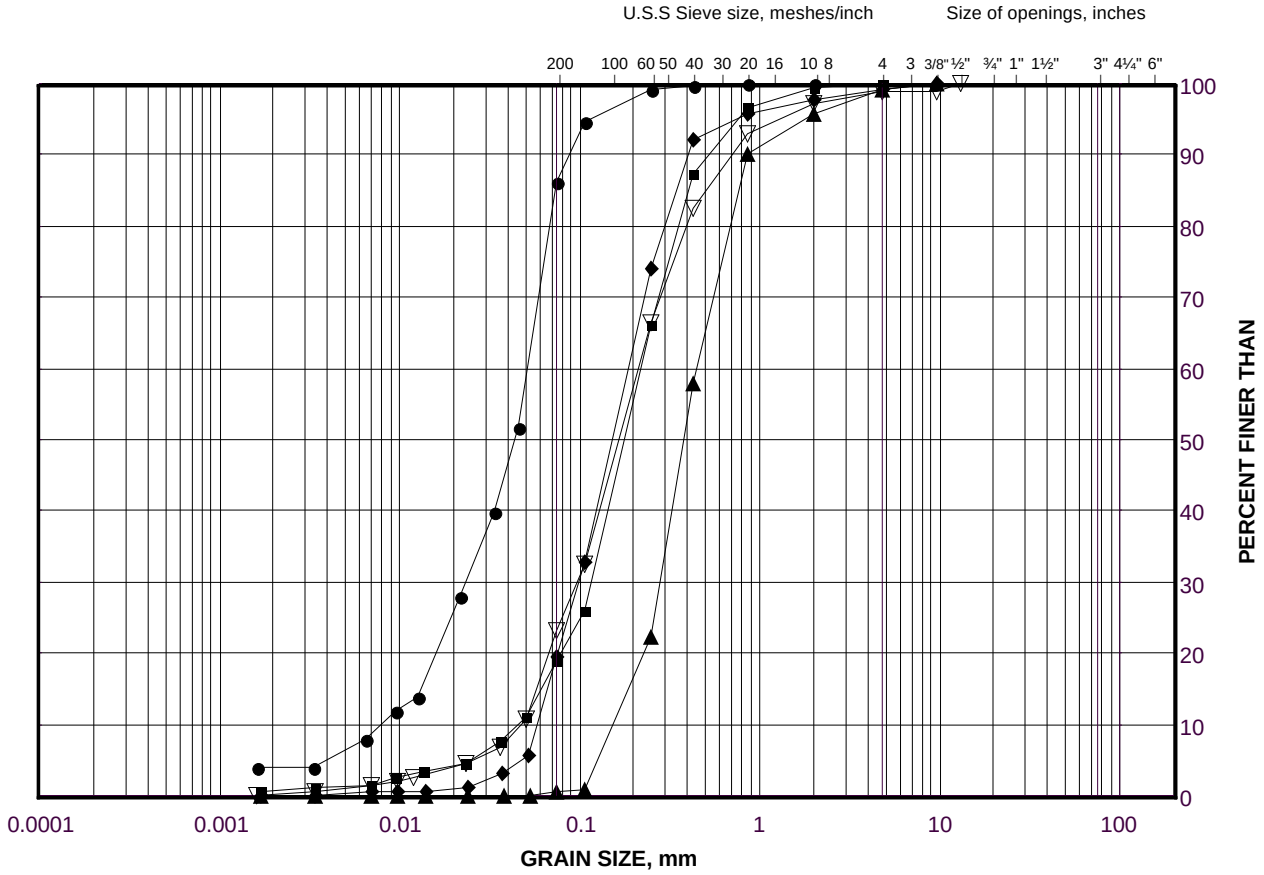
Date: 22-May-15

GRAIN SIZE DISTRIBUTION

Silt to Sand

Site 9 Road STA 10+225 to 10+300

FIGURE D.S26-2B



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S26-08	1B	212.4
■	S26-07	3	209.6
◆	S26-08	6	208.8
▲	S26-07	7	206.5
▽	S26-06	8	205.3

Project Number: 07-1111-0029

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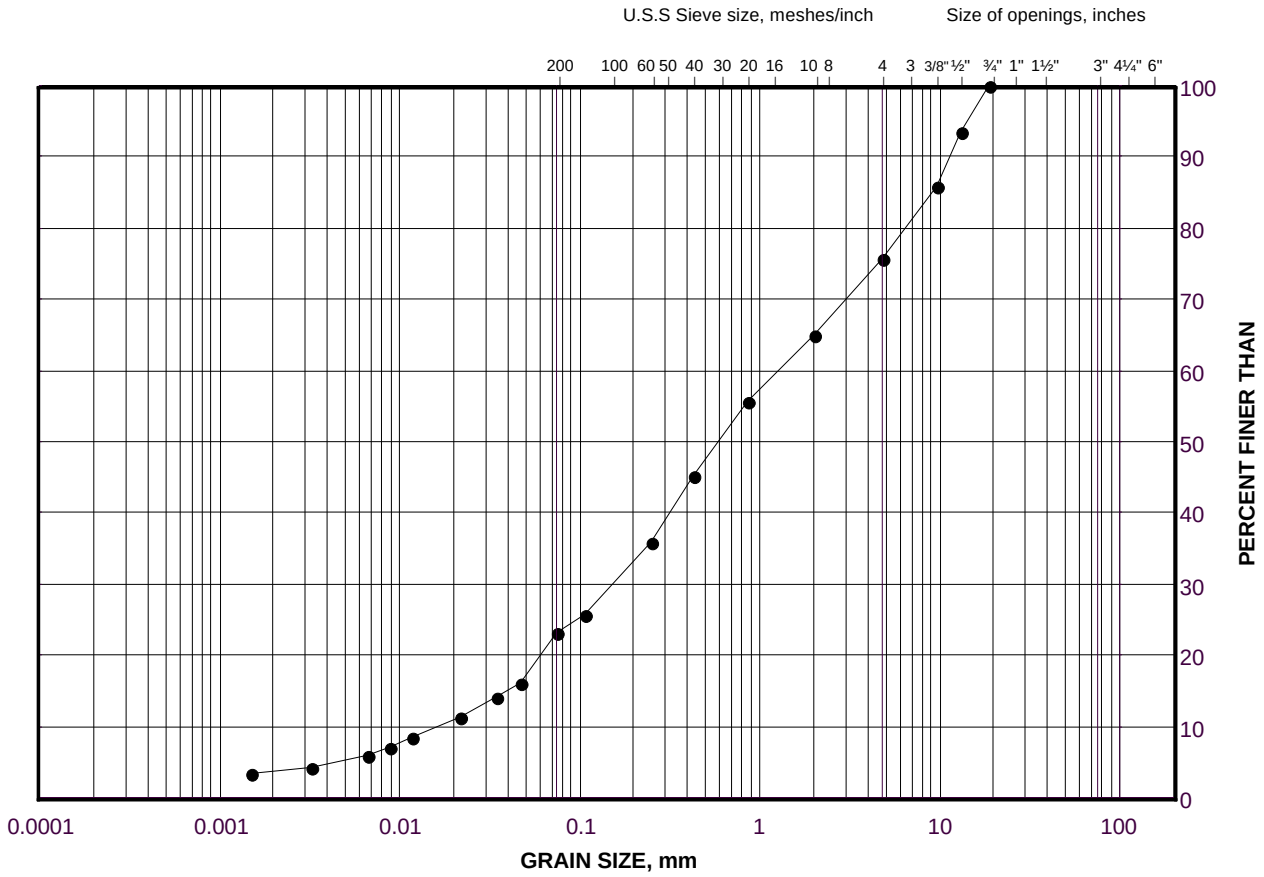
Date: 22-May-15

GRAIN SIZE DISTRIBUTION

Gravelly Sand

Site 9 Road STA 10+225 to 10+300

FIGURE D.S26-3



LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	S26-01	4	208.9

Project Number: 07-1111-0029

Checked By: CN

Golder Associates

Date: 22-May-15

At Golder Associates we strive to be the most respected global group of companies specializing in ground engineering and environmental services. Employee owned since our formation in 1960, we have created a unique culture with pride in ownership, resulting in long-term organizational stability. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees now operating from offices located throughout Africa, Asia, Australasia, Europe, North America and South America.

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