



**APRIL 2012**

## **FOUNDATION INVESTIGATION REPORT**

**WICK DRAIN FOUNDATION TREATMENT AREAS - PHASE 3  
HIGHWAY 69 FOUR-LANING  
FROM 3.5 KM NORTH OF HIGHWAY 522  
NORTHERLY TO 4.5 KM NORTH OF HIGHWAY 64  
MINISTRY OF TRANSPORTATION, ONTARIO  
G.W.P. 5203-06-00**

**Submitted to:**

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**REPORT**



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# **PART A**

**FOUNDATION INVESTIGATION REPORT**

**WICK DRAIN FOUNDATION TREATMENT SWAMP AREAS – PHASE 3**

**HIGHWAY 69 FOUR-LANING**

**FROM 3.5 KM NORTH OF HIGHWAY 522**

**NORTHERLY TO 4.5 KM NORTH OF HIGHWAY 64**

**MINISTRY OF TRANSPORTATION, ONTARIO**

**G.W.P. 5203-06-00**



## 1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by McCormick Rankin, a member of MMM Group Limited (MRC) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation investigation services for five (5) swamp crossings, which are considered to be candidate sites for wick drain foundation, along the proposed new Highway 69. This work is being carried out in support of the detail foundation investigation and design by Peto MacCallum Limited (Peto) in the Phase 3 section of Highway 69 Four-Laning from 3.5 km north of Highway 522, northerly to 4.5 km north of Highway 64, under G.W.P. 5378-02-00. The general location of this section of the proposed Highway 69 Four-Laning alignment is shown on Drawing 1.

The terms of reference and the scope of work for the foundation investigation services are outlined in MTO's Request for Proposal, dated January 2006. Golder's proposal for foundation engineering services associated with the wick drain areas is contained in Section 6.8 of MRC's Technical Proposal for this assignment and in Golder's letter titled "Proposal for Additional Foundation Engineering Services, Detail Wick Drain Design (Rev. 1)", dated February 2, 2009. The work has been carried out in accordance with Golder's Supplemental Specialty Quality Control Plan for foundation engineering services for this project, dated June 2, 2006. The General Arrangement (GA) Drawing for the proposed new alignment of Highway 69 was provided to Golder by MRC on February 11, 2009.

## 1.1 Background

Swamp crossings considered potentially suitable for wick drain foundation treatment as a means of increasing the rate of construction, reducing the magnitude of long-term settlement and enhancing the stability of the proposed roadway embankments were identified by Peto, as discussed at a meeting between MTO, MRC, Peto and Golder on March 12, 2007. At that time, Peto was still in the process of gathering subsurface information at most of the swamps, however the swamp crossing on the west side of the Highway 69 / Highway 64 Interchange was considered by Peto a potential candidate site for wick drain foundation treatment. Following Golder's review and assessment of the available subsurface information provided by Peto and forwarded to us by MRC by email on February 8, 26 and 28, 2007, it was concluded that this site was not suitable for such foundation treatment, as discussed in Golder's Technical Memorandum dated June 19, 2007.

Subsequently, Golder carried out a preliminary assessment of available information provided by Peto, which was forwarded to us by MRC on March 25, April 3, 12 and 28, 2008 for an additional seven (7) swamp crossings identified by Peto as potential candidate sites for wick drain foundation treatment. Based on our review of the subsurface information provided, we considered that these swamps would be potentially suitable for such foundation treatment, as discussed in our Technical Memorandum dated July 4, 2008. At a follow-up meeting on December 9, 2008 between MTO, MRC, Peto and Golder, and further to the review of the July 4, 2008 Memorandum, available additional subsurface information and re-evaluation of alternative foundation treatment methods, it was concurred that Golder would proceed with the investigation and gathering of pertinent subsurface information for the design of wick drain foundation treatments at five (5) of the seven (7) swamp crossings originally identified, namely:

Swamp Crossing	Designation
Highway 69 SBL and NBL STA 17+700 to 18+150	Swamp 302 SBL/NBL
Highway 69 SBL STA 16+050 to 16+350	Swamp 305 SBL



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 – HIGHWAY 69 G.W.P. 5203-06-00

Swamp Crossing	Designation
Highway 69 SBL STA 15+350 to 15+800	Swamp 306 SBL
Highway 69 SBL STA 14+425 to 14+500	Swamp 307 SBL
Highway 69 SBL STA 13+160 to 13+450	Swamp 310 SBL

However, following completion of additional investigation by Peto and foundation investigation by Golder, only four (4) swamps crossings have been identified as candidate sites for wick drain foundation treatment.

This report addresses the foundation investigation work carried out for the above all five (5) swamp crossings where wick drain foundation treatment was considered suitable to mitigate settlement and stability issues associated with the roadway embankment through these areas.

A detailed list of the wick drain swamp crossings investigated, including proposed embankment heights and number of boreholes, dynamic cone penetration tests and cone penetration tests advanced at the five (5) sites is presented in Table 1. A separate report will be submitted detailing the foundation investigation for the culverts located within the wick drain foundation treatment areas.

The purpose of this investigation is to supplement the subsurface information obtained by Peto in the swamps along the roadway alignment within the wick drain areas by borehole drilling, cone penetration testing, in situ testing and laboratory testing of selected samples. Golder's investigation is specific to obtaining subsurface information pertinent for the assessment of wick drain foundation treatment at the critical embankment section(s) within the swamp crossings. In describing the subsurface conditions at the wick drain foundation treatment swamp areas, Golder has relied on the data as provided by Peto in their Technical Memorandum titled "06TF033C 889Tech memo Wick Drain Swamps" dated December 14, 2007.

The swamp limits for this investigation were located in the field by Callon Dietz Inc. (Callon Dietz), a professional surveying company retained by MRC.

## 2.0 SITE DESCRIPTION

The section of the new Highway 69 alignment in which the five swamps considered candidate sites for wick drain foundation treatment addressed in this report extends from approximately 2.7 km north of the intersection with Highway 522 and approximately follows the alignment of the existing Highway 69 for about 3.7 km northerly to approximately 1 km north of Pickerel River Road. The future Highway 69 will run generally in a southwest-northeast direction with the project limits located within the Township of Mowat.

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, various vegetation types and surficial organic soils. The ground surface along the new highway alignment within the limits of the study area varies between about Elevation 206 m and Elevation 186 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 approximate locations of the five swamp areas investigated are shown on Drawing 2.



## **3.0 INVESTIGATION PROCEDURES**

### **3.1 Investigation by Golder**

The field work for the additional foundation investigation pertinent for wick drain foundation design was carried out in March 2009 during which time a total of twelve (12) boreholes and twenty-six (26) cone penetration tests (CPTs) were advanced along the proposed alignment of the new Highway 69 within the swamps identified as noted above. The locations of the boreholes and CPTs are shown in plan on Drawings A1 to E1, included in the respective appendices.

The field investigation was carried out using D-50 and D-25 track-mounted drill rigs supplied and operated by Walker Drilling Ltd. of Utopia, Ontario. The boreholes were advanced through the overburden using 108 mm inside diameter (I.D.) hollow-stem augers, 108 mm outside diameter (O.D.) solid-stem augers and NW casing. Soil samples were taken at varying depths and depth intervals, depending on the depth to and thickness of the cohesive deposits, using a 50 mm outer diameter (O.D.) split-spoon sampler operated by an automatic hammer, performed in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586-08a Standard Test Method for Standard Penetration Test). At select locations, a 76 mm O.D. thin-walled 'Shelby' tube sampler (ASTM D1587-08 Standard Practice for Thin-Walled Tube Sampling) was utilized to obtain relatively undisturbed samples of cohesive soils. Field vane shear tests were conducted in cohesive soils for measurement of undrained shear strengths (ASTM D2573-08 Standard Test Method for Field Vane Shear Test). All boreholes were backfilled with bentonite upon completion in accordance with Ontario Regulation 903 (as amended by).

The boreholes were advanced to depths up to about 20.7 m below existing ground surface, generally penetrating at least 1.5 m below the cohesive deposit, or terminated on refusal to further sampler and/or auger advancement. In three boreholes, dynamic cone penetration tests (DCPTs) were advanced through the bottom of the boreholes to refusal to further penetration at depths up to about 30.5 m below ice/snow surface. The depths to refusal do not confirm bedrock, but may be inferred to indicate potential proximity to the bedrock surface.

The CPTs, an in situ testing technique used for the nearly continuous characterisation of subsurface soils, were advanced to refusal, encountered at depths ranging from about 9.1 m to 22.7 m below ice/snow or ground surface. The CPT consists of a special probe equipped with electronic sensing elements to continuously measure tip resistance, local side friction on a sleeve and porewater pressure. It is pushed into the ground at a constant rate (ASTM D5778-07 Standard Test Method for Piezocone Penetration) and a nearly continuous stratigraphic profile together with inferred engineering properties such as shear strength and stress history, can be interpreted from the results.

At this site, the CPT equipment was advanced using the hydraulic system on the drill rig. Cone Penetration Test sheets are included with the Record of Borehole sheets in Appendices A to E. Profiles of tip resistance, friction and porewater pressure are presented together with interpreted profiles of undrained shear strength and classification index that is used to infer the soil type (i.e. soil stratigraphy).

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 E. 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 and fluctuate depending on seasonal precipitation and local soil permeability.

The field work was carried out under the overall supervision of members of our engineering and technical staff, who located the boreholes and CPTs, supervised the drilling, sampling and in situ testing operations, logged the boreholes, and examined and cared for the soil samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Mississauga geotechnical laboratory where the samples underwent further visual examination and laboratory testing. All of the laboratory tests were carried out to relevant MTO and/or ASTM Standards. Index testing such as water content, grain size distribution, specific gravity, unit weight, and Atterberg limits were carried out. In addition, one dimensional consolidation



(oedometer) tests (both horizontally and vertically trimmed) as well as consolidated isotropic undrained (CIU) triaxial tests with pore pressure measurements were carried out on select samples of the cohesive deposits.

The results of the laboratory testing on samples obtained from the swamp crossings are included in Appendices A to E. A summary of the consolidation test and the triaxial test results is presented in Table 2.

The proposed centreline of the highway was staked in the field by Callon Dietz prior to drilling. The as-drilled borehole locations, in stations and offsets, were measured in reference to the centreline alignment and were subsequently converted into MTM NAD 83 coordinates in AutoCAD. Borehole elevations were surveyed by a member of our technical staff in reference to the ground surface elevations at the centreline median stakes which were referenced to the contour plan provided to Golder by Callon Dietz (received on April 23, 2009). The borehole locations presented in the Record of Borehole sheets and shown on Drawings A1 to E1 are positioned relative to MTM NAD 83 northing and easting coordinates and the ground surface elevations are referenced to Geodetic datum.

### 3.2 Investigation by Others

The original foundation investigation of the swamps for which wick drain foundation treatment was proposed was carried out by Peto MacCallum Limited (Peto) and provided to us as follows:

- Borehole Records, Dynamic Cone Penetration Test (DCPT) Records and laboratory index testing data as reported in Peto's Technical Memorandum titled, "06TF033C 889 Tech memo Wick Drain Swamps December 14, 2007.pdf";
- The results of ten (10) laboratory consolidation tests as reported in emails dated April 3 and April 11, 2008 and February 2, 2009;
- Eight (8) Record of Borehole sheets for additional boreholes advanced in Swamp 305 as reported in an email dated July 30, 2008.

The locations of the Peto boreholes and DCPTs advanced within the extent of the wick drain area for each swamp have been converted from station and offset to MTM NAD 83 coordinates, as presented on Drawings A1 to E1.

The Record of Borehole and Record of Penetration Test sheets for the applicable Peto boreholes and DCPTs, together with the results of the laboratory tests carried out on selected soil samples as summarized on the Record of Borehole sheets, are presented in Appendix F.

The results of the laboratory consolidation tests performed by Peto on selected samples of the cohesive deposits for each swamp crossing, together with the results of the consolidation and triaxial tests performed by Golder, are summarized in Table 2.

The data from the Peto investigations, together with the supplemental investigation carried out by Golder, have been utilized to develop the subsurface model of critical areas (combination of greatest thickness of cohesive deposit, highest embankment, lowest shear strength of the cohesive deposit) within the five swamp crossings and to identify the required extent of the wick drain area for each swamp crossing.,



## 4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

### 4.1 Regional Geology

As delineated in *The Physiography of Southern Ontario*<sup>1</sup>, 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 overlying 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 overlying soft/loose native soils, are present in valleys between the bedrock outcrops 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*<sup>2</sup>. Deposition of Paleozoic strata initially covered and later erosion during glaciation subsequently exposed these Precambrian rocks.

### 4.2 General Overview of Local Subsurface Conditions

The detailed subsurface soil and groundwater conditions as encountered in the boreholes and CPTs advanced by Golder during this investigation, together with the results of the laboratory tests carried out on selected soil samples, are given on the Record of Borehole and Cone Penetration Test sheets in Appendices A to E. More detailed results from the laboratory testing are provided in Appendices A to E. The stratigraphic boundaries shown on the Record of Borehole sheets and on the stratigraphic profiles shown on Drawings A1, A2, B2, C1, D1 and E1 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, DCPT and CPT locations.

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.

In general, the stratigraphy encountered at the various areas investigated by Golder and Peto is similar. The overburden (soil materials) thickness is variable, ranging from no cover (i.e. bedrock outcrops present at ground surface) to about 30.5 m. The simplified stratigraphy generally consists of:

- surficial layers of topsoil, peat and organic material up to about 4.9 m thick, but typically less than about 2.0 m thick;
- upper deposits of sand to silt in some areas up to about 5.5 m thick;
- deposits of clayey silt to clay ranging in thickness from about 2.7 m to 25 m, interbedded with silt and sand layers in some areas; and
- lower deposits of silt and sand underlying the cohesive deposits in some areas, with thickness up to about 6 m where fully penetrated.

<sup>1</sup> 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.

<sup>2</sup> *Geology of Ontario*, 1991. Ontario Geological Society, Special Volume 4, Part 2. Ministry of Northern Development and Mines, Ontario.



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.

### **4.3 Highway 69 SBL and NBL – STA 17+700 to 18+150 (Swamp 302 SBL/NBL)**

The plan and profile along the centreline of the embankment of the new Highway 69 SBL and NBL alignments showing the borehole, Dynamic Cone Penetration Test (DCPT) and Cone Penetration Test (CPT) locations, and interpreted stratigraphy within the extent of the swamp area considered for the wick drain foundation treatment in the Township of Mowat are shown on Drawings A1 and A2 in Appendix A. These alignments extend across a swamp area and the proposed roadway embankments will be up to about 6.5 m high above the existing grade. A total of four (4) boreholes (Boreholes 302-1 to 302-4) and eight (8) cone penetration tests (CPTs 302-1 to 302-8) were advanced by Golder, and a total of thirty four (34) boreholes (Boreholes 302-19 to 302-21, 302-23 to 302-25, 302-27, 302-29 to 302-35, 302-37, 302-39 to 302-41, 302-43 to 302-45, 302-47, 302-49 to 302-51, 302-53 to 302-55, 302-57, 302-59, 302-60 and 302-63 to 302-65) and twelve (12) dynamic cone penetration tests (DCPTs 302-22, 302-26, 302-28, 302-36, 302-38, 302-42, 302-46, 302-48, 302-52, 302-56, 302-58 and 302-62) were advanced by Peto to investigate the subsurface conditions within this swamp area. The topography along these alignments is generally flat to low-lying with ground cover consisting of a wet grassy area in the northern portion of the swamp and a moderately treed area in the southern portion of the swamp with occasional shallow open water.

In general, the subsurface soils along the NBL and SBL alignments in this area consist of a surficial layer of peat and/or organic clayey silt to silty clay underlain by a deposit of clayey silt to clay. The clayey silt to clay deposit is in turn underlain by a deposit of silt to sand and silt. Towards the southern portion of the proposed wick drain area (south of STA 17+850), a deposit of sand to silt was encountered at ground surface or beneath the ice/snow cover and peat. Resistance to dynamic cone penetration, cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greater depths near the north limit of the swamp at about STA 18+050 and near the south limit of the swamp at about STA 17+800. Bedrock outcrops are present to the north and south of the swamp and at some locations to the south of the swamp.

#### **Ice / Snow / Water**

Ice and packed snow or water to depths of about 0.1 m to 0.8 m was encountered in Boreholes 302-1 to 302-4, 302-19, 302-20, 302-24 and 302-63 to 302-65.

#### **Peat / Topsoil**

A deposit of dark brown fibrous peat containing wood fragments was encountered at the ground surface or below the ice and snow cover in all boreholes except in Boreholes 302-1, 302-3, 302-4, 302-19 and 302-24. The top of the peat deposit ranges from about Elevation 189.5 to 185.3 m and its thickness ranges from about 0.1 m to 2.1 m. In Borehole 302-41, an approximately 0.3 m thick layer of topsoil was encountered at the ground surface at about Elevation 186.7 m.

The Standard Penetration Test (SPT) 'N'-values recorded within the peat deposit range from 0 blows (weight of hammer) to 10 blows per 0.3 m of penetration, indicating a very soft to stiff consistency.

The natural water content measured on samples of the peat is between about 24 percent and 1609 percent, and the organic content measured on selected samples of the peat is between about 10 percent and 95 percent.



### **Organic Clayey Silt to Silty Clay / Organic Silt**

A deposit of grey organic clayey silt to silty clay or organic silt containing trace peat and trace sand was encountered below the ice and snow cover in Borehole 302-1, and below the peat deposit in Boreholes 302-33, 302-35, 302-43, 302-44, 302-45, 302-47, 302-49, 302-54, 302-55, 302-57, 302-60 and 302-63 to 302-65. The top of this deposit ranges from about Elevation 186.3 m to 185.8 m and its thickness varies between about 0.3 m and 2.6 m.

The SPT 'N'-values measured within the organic clayey silt to silty clay were between 0 blows (weight of hammer) and 21 blows per 0.3 m of penetration, indicating generally a very soft consistency to very stiff consistency where roots are present. The SPT 'N'-values recorded within the organic silt range between 0 blows (weight of hammer and rods) and 2 blows per 0.3 m of penetration, indicative of a very loose relative density.

The natural water content measured on samples of the organic deposits ranges from about 44 percent to 128 percent and the measured organic content on samples of these deposits ranges from about 3 percent to 6 percent.

Grain size distribution tests were performed by Peto on three (3) samples of these organic deposits and the results are summarized on the Record of Borehole sheets in Appendix F.

An Atterberg limits test carried out by Peto on a sample of the organic deposit measured a liquid limit of about 45 percent, a plastic limit of about 22 percent and a corresponding plasticity index of about 23 percent. The results of the Atterberg limits test are summarized on the Record of Borehole sheet in Appendix F and indicate the soil to be silty clay of intermediate plasticity.

### **Sand to Silt**

A mottled brown to grey cohesionless deposit comprised of sand, silty sand, sand and silt, sandy silt and silt was encountered below the ice and snow cover in Boreholes 302-3, 302-4 and 302-24, and below the peat/topsoil in Boreholes 302-21, 302-23 to 302-25, 302-27, 302-29, 302-30, 302-31, 302-32, 302-34, 302-37 and 302-41. The deposit generally contains trace to some clay, trace gravel, organics and rootlets. In Borehole S302-20 a pocket of clayey silt was encountered overlying the silty sand deposit, and in Boreholes 302-27, 302-39 and 302-51, the sand and silt to silty sand deposit was encountered as an interlayer within the silty clay to clayey silt deposit. In general, this deposit was encountered primarily to the south of STA 17+900. The top of this deposit varies between about Elevation 189.4 m and 185.4 m, and its thickness varies between about 0.6 m and 5.7 m.

The SPT 'N'-values measured within the sand to silt deposit range from 1 blow to 77 blows per 0.3 m of penetration, indicating a very loose to very dense relative density.

The natural water content measured on samples of this deposit ranges from about 15 percent to 44 percent.

Grain size distribution tests were performed by Peto on seven (7) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

An Atterberg limits test carried out by Peto on a sample of the silt deposit measured a liquid limit of about 20 percent, a plastic limit of about 17 percent and a corresponding plasticity index of about 3 percent. The results of the Atterberg limits test are summarized on the Record of Borehole sheet in Appendix F and indicate the material to be silt of low plasticity.

As noted above, an approximately 1.6 m thick pocket of grey and brown clayey silt containing organics was encountered overlying the silty sand deposit in Borehole 302-20. A single SPT 'N'-value of 4 blows per 0.3 m of penetration was recorded within this cohesive material indicating a soft consistency.



## Clayey Silt to Clay

A deposit of brown to grey clayey silt to clay, trace sand and containing occasional layers of silt was encountered either below the sand to silt or below the organic deposits in all the boreholes considered in this swamp area except Borehole 302-19 to 302-21. As noted above, in Boreholes 302-27, 302-39 and 302-51, an approximately 1.4 m to 1.6 m thick interlayer of sand and silt to silty sand was encountered within the silty clay to clayey silt deposit. The top of this cohesive deposit ranges from about Elevation 187.5 m to 183.3 m and its thickness ranges from about 3.0 m to 10.5 m. Where encountered, the clayey silt to clay deposit was fully penetrated in the boreholes advanced between about STA 17+750 and 18+150.

The SPT 'N'-values recorded within the cohesive deposit range between 0 blows (weight of hammer) and 10 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 11 kPa to 84 kPa, but typically less than about 35 kPa. The sensitivity is calculated to range between about 2 and 10, and typically about 3. The field vane test results together with the SPT 'N'-values indicate that the clayey silt to clay deposit has a generally very soft to firm consistency.

The natural water content measured on samples of this deposit ranges from about 21 percent to 79 percent.

Grain size distribution tests were carried out by Peto on eighteen (18) samples of this cohesive deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

Atterberg limits tests were carried out by Golder on six (6) specimens of this cohesive deposit and by Peto on eighteen (18) specimens of this deposit. The liquid limits range from about 20 percent to 55 percent, the plastic limits range from about 18 percent to 24 percent, and the plasticity indices range from about 6 percent to 33 percent. The results of the Atterberg limits tests carried out by Golder are shown on the plasticity chart on Figure A.S302-1 in Appendix A and the results of the Atterberg limits tests carried out by Peto are summarized on the Record of Borehole sheets in Appendix F. The results indicate that the soil ranges from a clayey silt of low plasticity to clay of high plasticity.

A total of eight (8) cone penetration tests (CPTs 302-1 to 302-8) were performed in this swamp crossing of which four (4) tests were used for determination of the pore pressure designation at specific horizon within the clay deposit. The range of the coefficient of consolidation in the horizontal direction ( $c_h$ ) obtained from a total of nineteen (19) CPT pore pressure dissipation tests is summarized below.

<b><math>C_h</math> CPT-Field (<math>\text{cm}^2/\text{s}</math>)</b>		
<b>Upperbound</b>	<b>Lowerbound</b>	<b>Average</b>
$1.2 \times 10^{-1}$	$1.1 \times 10^{-2}$	$3.0 \times 10^{-2}$

Laboratory consolidation tests were carried out by Golder on six (6) specimens of the cohesive deposit obtained from Shelby tube samples in Boreholes 302-1 and 302-2. Preconsolidation stresses ranging between about 100 kPa and 140 kPa were estimated from the void ratio versus logarithmic pressure plots and from the total work versus pressure plots. Bulk unit weights ranging between about  $15.6 \text{ kN/m}^3$  and  $20.4 \text{ kN/m}^3$ , and specific gravities ranging between about 2.72 and 2.77 were measured on the consolidation test specimens. Details of the Golder test results are shown on Figures A.S302-2 to A.S302-7 in Appendix A and are summarized below, together with the results of two (2) consolidation tests performed on this deposit by Peto.



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Borehole Sample No.	Sample Depth / Elevation	$\sigma_{vo}'$ (kPa)	$\sigma_p'$ (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	$C_c$	$C_r$	$e_o$	$c_v^*$ (cm <sup>2</sup> /s)
Borehole 302-1 Sample 6	4.1 m / 182.2 m	20	140	120	7.0	0.62	0.04	1.50	$1.0 \times 10^{-1}$
Borehole 302-1 Sample 7	6.4 m / 179.9 m	35	135	100	3.9	0.17	0.02	0.87	$1.0 \times 10^{-1}$
Borehole 302-2 Sample 3	4.1 m / 182.0 m	20	140	120	7.0	0.78	0.08	1.87	$7.0 \times 10^{-2}$
Borehole 302-2 Sample 4	6.4 m / 179.7 m	35	110	75	3.1	0.12	0.03	0.69	$6.7 \times 10^{-2}$
Borehole 302-2 Sample 5	9.4 m / 176.7 m	55	110	55	2	0.22	0.03	1.23	$8.1 \times 10^{-2}$
Borehole 302-2 Sample 5 <sup>(2)</sup>	9.4 m / 176.7 m	55	100	45	1.8	0.23	0.02	1.07	$7.5 \times 10^{-2}$
Borehole 302-29 Sample 7 <sup>(1)</sup>	7.9 m / 181.1 m	100	250	150	2.5	0.85	0.06	1.62	$1.3 \times 10^{-2}$
Borehole 302-44 Sample 5 <sup>(1)</sup>	4.9 m / 181.6 m	30	205	175	6.8	0.18	0.02	0.9	$2.1 \times 10^{-2}$

Note: \* For stress range of  $19 \text{ kPa} \leq \sigma_v' \leq 314 \text{ kPa}$  (for Golder test results)  
 For stress range of  $17 \text{ kPa} \leq \sigma_v' \leq 532 \text{ kPa}$  (for Peto test results)  
 1 Laboratory consolidation test results obtained from Peto  
 2 Vertically Trimmed Oedometer (VTO) sample orientation, measured  $C_h$  (cm<sup>2</sup>/s)

where:  $\sigma_{vo}'$  is the effective overburden stress in kPa  
 $\sigma_p'$  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<sup>2</sup>/s

Laboratory consolidated isotropic undrained triaxial compression tests (CIU) with pore pressure measurement were carried out on four (4) samples of the cohesive deposit obtained from Shelby tube samples in Boreholes 302-1 and 302-2. In total, four (4) sets of three (3) specimens were tested. The details of the test results are shown on Figure A.S302-8 to A.S302-11 in Appendix A and the results are summarized below.



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Borehole Sample No.	Sample Depth / Elevation	Effective Cohesion, $c'$ (kPa)	Effective Angle of Internal Friction, $\phi'$ (degrees)
Borehole 302-1 Sample 6	4.1 m / 182.2 m	6	34
Borehole 302-1 Sample 7	6.4 m / 179.9 m	0	35
Borehole 302-2 Sample 3	4.1 m / 182.0 m	10	34
Borehole 302-2 Sample 5	9.4 m / 176.7 m	4	33

Note: Assessed shear strength parameters are only valid over range of stress conditions used in the laboratory test.

The triaxial test samples were consolidated to pressures representative of the estimated in situ effective stresses and maximum effective stresses under the proposed embankment loads, at the respective sample depths. The interpreted effective strength parameters provided above are applicable only to design situations for which the stress conditions during testing are representative. Reference should be made to individual test results for details of the testing conditions.

### Silt to Sand and Silt

A deposit of grey silt to sand and silt, trace to some clay, was encountered below the clayey silt to clay deposit in all the boreholes except in Boreholes 302-19 to 302-21 which encountered refusal at shallow depth. The top of this deposit varies between about Elevation 182.6 m and 174.5 m and its thickness ranges from about 0.6 m to 5.7 m as delineated in the boreholes, and extends to a thickness of about 12.2 m as inferred from the resistance to dynamic cone penetration. Most boreholes and DCPTs advanced in this swamp were terminated within the silt to sand and silt deposit to depths of up to about 19.8 m below ground/ice surface, corresponding to about Elevation 166.7 m.

The SPT 'N'-values measured within the silt to sand and silt deposit range from 0 blows (weight of rod) to 22 blows per 0.3 m of penetration, indicating a very loose to compact relative density.

The natural water content measured on samples of this deposit ranges between about 20 percent and 30 percent.

Grain size distribution tests were performed by Peto on twenty six (26) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

Atterberg limits tests were carried out by Golder and by Peto on three (3) separate samples of this deposit. One Atterberg limits test performed by Golder measured a liquid limit of about 26 percent, a plastic limit of about 23 percent and a corresponding plasticity index of about 3 percent. The results of this Atterberg limits test are shown on the plasticity chart on Figure A.S302-12 in Appendix A, indicating the material to be silt of low plasticity. The other two Atterberg limits tests performed by Golder and those carried out by Peto indicate the material to be non-plastic.

### Refusal

In Boreholes 302-19 to 302-21, 302-23 to 302-25, 302-27, 302-35, 302-40, 302-41, 302-43 to 302-45, 302-49, 302-50 and 302-63, and DCPTs 302-22, 302-26, 302-42, 302-46, 302-48, 302-56 and 302-62, refusal to further



auger / sampler advancement and/or cone penetration, indicating the potential bedrock surface, was encountered at depths ranging between about 0.8 m and 18.8 m below ground/ice surface, corresponding to about Elevation 188.2 m and 167.7 m.

### Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. Water levels observed in the boreholes upon completion of drilling range from about Elevation 188.8 m to 182.3 m, measured at ice/ground surface or up to a depth of about 6.1 m below ground surface. Boreholes 302-20, 302-29 and 302-31 were observed to be dry upon completion of drilling.

### 4.4 Highway 69 SBL – STA 16+050 to 16+350 (Swamp 305 SBL)

The plan and profile along the centreline of the embankment of the new Highway 69 SBL alignment showing the borehole, Dynamic Cone Penetration Test (DCPT) and Cone Penetration Test (CPT) locations, and interpreted stratigraphy within the extent of the swamp area considered for the wick drain foundation treatment in the Township of Mowat are shown on Drawings B1 and B2 in Appendix B. The alignment extends across a swamp area and the proposed embankment will be up to about 2.5 m high above existing grade. A total of three (3) boreholes (Boreholes 305-1 to 305-3) and six (6) cone penetration tests (CPTs 305-1 to 305-6) were advanced by Golder, and a total of fourteen (14) boreholes (Boreholes 305-7, 305-9, 305-13, 305-16, 305-19, 305-21, 305-25, 305-28, 305-31, 305-33, 305-37, 305-39, 305-40 and 305-43) and five (5) dynamic cone penetration tests (DCPTs 305-10, 305-15, 305-22, 305-27, and 305-34) were advanced by Peto to investigate the subsurface conditions within this swamp area. The topography in the swamp is generally flat, encompassing an open, wet, grassy area and shallow open water.

In general, the subsurface soils along the SBL alignment in this swamp consist of surficial deposits of peat/topsoil and/or organic clay to organic silt, underlain by an upper deposit of silty clay to clayey silt at some locations. The organic deposits and/or the upper silty clay to clayey silt deposit are underlain by a deposit of sand to silt, which in turn is underlain by a lower deposit of clay to clayey silt. At some locations, a deposit of silt to sand was encountered underlying the clay to clayey silt deposit prior to refusal on probable bedrock or to cone penetration. Resistance to dynamic cone penetration, cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greater depths between about STA 16+175 and 16+225. Bedrock outcrops are present to the north and south limits of the swamp.

### Ice / Snow / Water

Ice or snow and water to depths between about 0.3 m and 1.7 m was encountered in all boreholes advanced within the main lower portion of the swamp area, in Boreholes 305-10 to 305-33.

### Peat / Topsoil

A deposit of dark brown to grey fibrous to amorphous peat containing roots and topsoil was encountered at the ground surface and/or underlying the ice/water/snow cover in all boreholes except in Boreholes 305-13 and 305-40. The top of this organic deposit ranges from about Elevation 188.1 m to 185 m to the south of STA 16+300, and at about Elevation 192.1 m to the north of STA 16+300 as a thin veneer over bedrock outcrop or shallow soil over bedrock. The thickness of this deposit ranges from about 0.1 m to 3.2 m. It is noted that some discrepancy exists between the elevation of the ground surface or top of peat as encountered in the Peto boreholes and as defined by the ground surface survey in this area.



The Standard Penetration Test (SPT) 'N'-values recorded within the peat deposit are 0 blows (weight of hammer and/or rod) per 0.3 m of penetration, indicating a very soft consistency.

The natural water content measured on samples of this deposit ranges from about 45 percent to 620 percent, and the organic content measured on samples of this deposit are about 13 percent and 65 percent.

### **Organic Clay to Clayey Silt / Organic Silt**

A deposit of brown to grey organic clay to organic clayey silt and/or organic silt containing trace sand, sandy silt and sand seams was encountered underlying the peat deposit in Boreholes 305-1, 305-16, 305-19, 305-25, 305-31, 305-33 and 305-37, and below the ice/water cover in Borehole 305-13. The top of this organic deposit ranges from about Elevation 186.9 m to 183.7 m and its thickness ranges from about 0.3 m to 1.9 m.

The SPT 'N'-values measured within the organic deposit range from 0 blows (weight of hammer and/or rod) to 4 blows per 0.3 m of penetration, indicating a very soft to soft consistency / very loose relative density.

The natural water content measured on samples of this organic deposit ranges from about 40 percent to 141 percent, and the organic content measured on a sample of this deposit is about 7 percent.

### **Silty Clay to Clayey Silt (Upper)**

Discontinuous layers of silty clay to clayey silt containing silty sand seams was encountered below the topsoil in Borehole 305-7, and below the peat and organic clayey silt in Boreholes 305-21 and 305-33, respectively. The top of the layers range from about Elevation 187.7 m to 182.9 m, and the thickness ranges from about 0.5 m to 1.5 m.

The SPT 'N'-values measured within the layers are 0 blows (weight of hammer and rod) and 2 blows per 0.3 m of penetration, indicating a very soft consistency.

The natural water content measured on a sample of this deposit is about 36 percent.

### **Sand to Silt**

A deposit of comprised of grey sand trace to some silt, silty sand, sandy silt and silt trace to some sand was encountered below the organic deposit or below the upper silty clay to clayey silt layers in all boreholes advanced within the extent of the swamp area except in Boreholes 305-39 and 305-40. The deposit generally contains trace to some clay, trace gravel, occasional thin layers of clay and silty sand (within the silt deposit). Also, localized pockets of clay to clayey silt were encountered within the deposit in Boreholes 305-2, 305-3, 305-7, 305-9, 305-13, 305-16 and 305-37, as further described below. The top of the deposit typically ranges from about Elevation 187.8 m to 181.4 m, except in Borehole 305-43 where the silt deposit was encountered on the higher ground at about Elevation 191.8 m. The thickness of the deposit ranges from about 0.3 m to 6.4 m. Borehole 305-3 was terminated within the silt deposit at a depth of about 6.7 m, corresponding to about Elevation 180.5 m.

The SPT 'N'-values recorded within this deposit range from 0 blows (weight of hammer and/or rod) to 10 blows, per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on samples of this deposit ranges from about 21 percent to 53 percent. In Borehole 305-2, the upper portion of the silt deposit was observed to be slightly organic and an organic content test performed on a sample of this deposit is about 4.9 percent.



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A grain size distribution test carried out by Golder on one (1) sample of the silt deposit is shown on Figure B.S305-1 in Appendix B. Peto performed grain size distribution tests on eight (8) samples of the sand to silt deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

An Atterberg limits test was carried out by Golder on one (1) specimen of the silt deposit and by Peto on two (2) specimens of the silt deposit. In general, the liquid limits range between about 18 percent and 19 percent, plastic limits range between about 14 percent and 17 percent, and the plasticity indices range between about 2 percent and 4 percent. The results of the Atterberg limits test carried out by Golder are shown on the plasticity chart on Figure B.S305-2 in Appendix B and the results of the Atterberg limits tests carried out by Peto are summarized on the Record of Borehole sheets in Appendix F. The results indicate the material is a silt of low plasticity.

A laboratory multistage consolidated isotropic undrained triaxial compression test (CIU) with pore pressure measurement was carried out on one (1) sample of the silt deposit at two (2) different confining pressures. The details of the test results are shown on Figure B.S305-3 in Appendix B, and the results are summarized below.

Borehole / Sample No.	Sample Depth / Elevation	Effective Cohesion, $c'$ (kPa)	Effective Angle of Internal Friction, $\phi'$ (degrees)
Borehole 305-3 / Sample 2	7.9 m / 178.9 m	0	32

The triaxial test sample was consolidated to pressures representative of the estimated in situ effective stresses and maximum effective stresses under the proposed embankment loads at the sample depth. The interpreted effective strength parameters provided above are applicable only to design situations for which the stress conditions during testing are representative.

### Clay to Clayey Silt (Lower)

A deposit of mottled brown to grey clay to clayey silt, trace to some sand and trace gravel containing silt interlayers and sand and silt seams was encountered below the sand to silt deposit in all boreholes advanced within the extent of the swamp area except in Boreholes 305-7, 305-9, 305-13, 305-39, 305-40 and 305-43 drilled on the south and north perimeters of the swamp. The top of this deposit varies between about Elevation 182.2 m and 178.2 m, and its thickness varies between about 3.7 m and 17.7 m, but is typically greater than 7 m thick. As noted above, approximately 0.9 m to 2.8 m thick localized pockets of grey clayey silt to clay trace to some silt and trace sand were encountered within the sand to silt deposit, between about Elevation 187.4 m and 181.2 m in Boreholes 305-2, 305-3, 305-7, 305-9, 305-13, 305-16 and 305-37.

The SPT 'N'-values recorded within the cohesive deposit and the cohesive pockets typically range from 0 blows (weight of hammer and/or rod) to 4 blows per 0.3 m of penetration, with a SPT 'N'-value as high as 6 blows per 0.3 m of penetration recorded within the cohesive deposit containing silt and sand interlayers or seams. In Borehole 305-2, a SPT 'N'-value of 29 blows per 0.3 m of penetration was recorded at the bottom of the deposit straddling a layer of silt below the clayey silt and this higher 'N'-value is influenced by the presence of gravel and cobbles within the lower portion of the deposit. In situ field vane tests carried out within the cohesive deposits measured undrained shear strengths between about 18 kPa and 100 kPa, but typically less than about 50 kPa. The sensitivity is calculated to range between about 1 and 8, and is typically about 4. The field vane test results together with the SPT 'N'-values indicate that the clay to clayey silt deposit has a generally very soft to firm consistency.

The natural water content measured on samples of the cohesive deposit and pockets ranges from about 25 percent to 80 percent.



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Atterberg limits tests were carried out by Golder on five (5) specimens of the cohesive deposits and by Peto on twelve (12) specimens of this deposit. The liquid limits range from about 24 percent to 102 percent, the plastic limits range from about 14 percent to 31 percent, and the plasticity indices range from about 7 percent to 72 percent. The results of the Atterberg limits tests carried out by Golder are shown on the plasticity chart on Figure B.S305-4 in Appendix B and the results of the Atterberg limits tests carried out by Peto are summarized on the Record of Borehole sheets in Appendix F. The results indicate that the soil in this cohesive deposits range from a clay of high plasticity to clayey silt of low plasticity.

A total of six (6) cone penetration tests (CPTs 305-1 to 305-6) were performed in this swamp crossing of which three (3) tests were used for determination of the pore pressure dissipation at specific horizons within the clay deposit. The range of the coefficient of consolidation in the horizontal direction ( $c_h$ ) obtained from a total of twelve (12) CPT pore pressure dissipation tests carried out is summarized below.

<b><math>C_h</math> CPT-Field (<math>\text{cm}^2/\text{s}</math>)</b>		
<b>Upperbound</b>	<b>Lowerbound</b>	<b>Average</b>
$6.2 \times 10^{-2}$	$1.9 \times 10^{-3}$	$4.6 \times 10^{-3}$

Laboratory consolidation tests were carried out by Golder on two (2) specimens of the cohesive deposit obtained from Shelby tube samples in Boreholes 305-1 and 305-3. Preconsolidation stresses of about 100 kPa and 40 kPa were estimated from the void ratio versus logarithmic pressure plots and from the total work versus pressure plots. Bulk unit weights of about  $16.8 \text{ kN/m}^3$  and  $15.0 \text{ kN/m}^3$ , and specific gravities of about 2.78 were measured on the consolidation test specimens. Details of the Golder test results are shown on Figures B.S305-5 and B.S305-6 in Appendix B and are summarized below, together with the results of four (4) consolidation tests performed on samples of this deposit by Peto.

<b>Borehole Sample No.</b>	<b>Sample Depth / Elevation</b>	<b><math>\sigma_{vo}'</math> (kPa)</b>	<b><math>\sigma_p'</math> (kPa)</b>	<b><math>\sigma_p' - \sigma_{vo}'</math> (kPa)</b>	<b>OCR</b>	<b><math>C_c</math></b>	<b><math>C_r</math></b>	<b><math>e_o</math></b>	<b><math>c_v^*</math> (<math>\text{cm}^2/\text{s}</math>)</b>
Borehole 305-1 Sample 7	13.8 m / 172.9 m	80	100	20	1.3	0.63	0.06	1.49	$1.3 \times 10^{-2}$
Borehole 305-3 Sample 1	3.4 m / 183.8 m	20	40	20	2	1.06	0.10	2.30	$2.0 \times 10^{-3}$
Borehole 305-16 Sample 8 <sup>(1)</sup>	11.0 m / 176.5 m	50	180	130	3.6	0.95	0.09	1.79	$2.7 \times 10^{-3}$
Borehole 305-20 Sample 10 <sup>(1)</sup>	14.0 m / 174.3 m	115	205	90	1.8	0.70	0.07	1.44	$3.7 \times 10^{-3}$
Borehole 305-20 Sample 17 <sup>(1)</sup>	21.0 m / 167.3 m	150	420	270	2.8	1.26	0.08	1.71	$9.4 \times 10^{-3}$
Borehole 305-23 Sample 10 <sup>(1)</sup>	12.5 m / 179.6 m	65	290	225	4.5	1.16	0.08	1.89	$6.2 \times 10^{-3}$

Note: \* For stress range of  $19 \text{ kPa} \leq \sigma_v' \leq 156 \text{ kPa}$  (for Golder test results)

For stress range of  $34 \text{ kPa} \leq \sigma_v' \leq 532 \text{ kPa}$  (for Peto test results)

(1) Laboratory consolidation test results obtained from Peto



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where:  $\sigma_{vo}'$  is the effective overburden stress in kPa  
 $\sigma_p'$  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  $\text{cm}^2/\text{s}$

Laboratory consolidated isotropic undrained triaxial compression tests (CIU) with pore pressure measurement were carried out on three (3) samples of the cohesive deposits obtained from Shelby tube samples in Boreholes 305-1, 305-2 and 305-3. In total, two (2) sets of three (3) specimens were tested for the CIU, and one (1) specimen was tested using a multistage CIU at three (3) difference confining pressures. The details of the test results are shown on Figure B.S305-7 to B.S305-9 in Appendix B, and the results are summarized below.

Borehole / Sample No.	Sample Depth / Elevation	Effective Cohesion, $c'$ (kPa)	Effective Angle of Internal Friction, $\phi'$ (degrees)
Borehole 305-1 / Sample 7	13.8 m / 172.9 m	7	30
Borehole 305-2 / Sample 2	4.8 m / 181.9 m	0	30
Borehole 305-3 / Sample 1	3.4 m / 183.8 m	3	45

Note: Assessed shear strength parameters are only valid over range of stress conditions used in the laboratory test.

The triaxial test samples were consolidated to pressures representative of the estimated in situ effective stresses and maximum effective stresses under the proposed embankment loads, at the respective sample depths. The interpreted effective strength parameters provided above are applicable only to design situations for which the stress conditions during testing are representative. Reference should be made to individual test reports for details of the testing conditions.

### Silt to Sand

A deposit of grey silt to sand, trace to some clay and trace gravel was encountered below the clay to clayey silt deposit in Boreholes 305-2, 305-19, 305-21 and 305-37 and inferred from the dynamic cone penetration test in Borehole 305-1, 305-22 and 305-27. The silt deposit encountered in Borehole 305-2 was noted to contain sand and gravel layers in the split-spoon sample. The top of this deposit ranges from about Elevation 175.0 m to 163.2 m, and its thickness ranges from about 0.2 m to 2.3 m, extending to an interpreted thickness of about 9.8 m as inferred from the resistance to dynamic cone penetration. The DCPT driven from the bottom of the Borehole 305-1 and DCPTs 305-22 and 305-27 were terminated within the silt deposit at depths of between about 25.9 m and 30.5 m, corresponding to Elevation 161.6 m and 156.2 m.

The SPT 'N'-values recorded within this deposit typically range from 0 blows (weight of hammer and rod) to 4 blows, per 0.3 m of penetration, indicating a very loose to loose relative density. In Borehole 305-2, a SPT 'N' value of 29 blows was recorded at the bottom of the borehole, indicative of a compact relative density, followed by auger refusal on sloping surface.

The natural water content measured on samples of this deposit is between about 23 percent and 30 percent.



Grain size distribution tests were carried out by Peto on two (2) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

An Atterberg limits test carried out by Peto on one (1) sample of the silt deposit measured a liquid limit of about 21 percent, a plastic limit of about 19 percent and a corresponding plasticity index of about 2 percent. The results of the Atterberg limits test are summarized on the Record of Borehole sheet in Appendix F and indicate the material to be silt of low plasticity.

### Bedrock / Refusal

Bedrock was encountered at ground surface in Borehole 305-40 at about Elevation 191.2 m. In all boreholes and DCPTs, except in Borehole 305-1 and DCPTs 305-22 and 305-27, refusal to further sampler and/or auger advancement or cone penetration, indicative of the potential bedrock surface, was encountered at depths between about 0.6 m and 31.7 m below ice/snow or ground surface, corresponding to between about Elevation 190.6 m and 155.8 m.

### Groundwater Conditions

In general, the samples taken in the boreholes were wet. Water levels observed in the boreholes upon completion of drilling range from about Elevation 187.5 m to 186.5 m, measured at ice/snow and ground surface or up to a depth of about 1.0 m below ice surface, while Borehole 305-9, 305-39 and 306-43 were observed to be dry upon completion of drilling.

## 4.5 Highway 69 SBL – STA 15+350 to 15+800 (Swamp 306 SBL)

The plan and profile along the centreline of the embankment of the new Highway 69 SBL alignment showing the borehole, Dynamic Cone Penetration Test (DCPT) and Cone Penetration Test (CPT) locations, and interpreted stratigraphy within the extent of the swamp area considered for the wick drain foundation treatment in the Township of Mowat 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 3 m high above existing grade. Two (2) boreholes (Boreholes 306-1 and 306-2) and six (6) cone penetration tests (CPTs 306-1 to 306-6) were advanced by Golder, and a total of twenty (20) boreholes (Boreholes 306-13, 306-16, 306-19, 306-21, 306-25, 306-28, 306-31, 306-33, 306-37, 306-40, 306-43, 306-45, 306-49, 306-52, 306-55, 306-61, 306-63, 306-64, 306-65 and 306-68), and eight (8) dynamic cone penetration tests (DCPTs 306-15, 306-22, 306-27 and 306-34, 306-39, 306-46, 306-51 and 306-58) were advanced by Peto to investigate the subsurface conditions within this swamp area. The topography of this section of proposed highway is generally flat and low-lying, sloping downwards towards a creek that traverses the northern portion of this swamp. The ground cover consists of grasses and densely treed areas.

In general, the subsurface soils along the SBL alignment in this area consist of surficial deposits of peat/topsoil and/or organic clayey silt to clay, underlain by a layer of sandy silt to silt at some locations. The organic deposit and the sandy silt layer are in turn underlain by a deposit of clay to clayey silt, which is underlain by a deposit of silt to sand in places. Resistance to dynamic cone penetration, cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greater depths between about STA 15+450 and 15+550. Bedrock outcrops are present to the north and south of the swamp.



## Peat / Topsoil

A deposit of dark brown fibrous to amorphous peat or topsoil was encountered at the ground surface in all boreholes advanced in this swamp area, except in Borehole 306-1 and 306-2. The top of the peat/topsoil layer varies between about Elevation 192.2 m and 189.0 m, and its thickness varies between about 0.1 m and 0.9 m.

The Standard Penetration Test (SPT) 'N'-values recorded within the peat layer are 0 blows (weight of hammer and rod) and 1 blow per 0.3 m of penetration, indicative of a very soft consistency.

The natural water content measured on samples of the peat is between about 92 percent and 239 percent, and the organic content of two (2) samples of the peat is about 15 percent and 42 percent.

## Organic Clayey Silt to Clay

A deposit of grey to brown organic clayey silt to clay, trace sand, was encountered at the ground surface or below the peat deposit in Borehole 306-1, 306-2, 306-16, 306-19, 306-25, 306-28, 306-31, 306-33, 306-37 and 306-40, all located to the south of creek traversing the area. The organic deposit generally contains layers of silt, wood fragments, shell fragments and layers of fibrous/amorphous peat. The top of this deposit ranges from about Elevation 189.4 m to 188.1 m, and its thickness ranges from about 0.6 m to 2.3 m.

The SPT 'N'-values measured within the organic clayey silt to clay are 0 blows (weight of hammer and rod) and 1 blow per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 18 kPa to 24 kPa, and the sensitivity is calculated to be about 4. The field vane test results together with the SPT 'N'-values indicate that the organic clayey silt to silty clay deposit has a very soft to soft consistency.

The natural water content measured on samples of this deposit is between about 87 percent and 119 percent, and the organic content measured on samples of this deposit is between about 4 percent and 6 percent.

Grain size distribution tests were carried out by Peto on two (2) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

An Atterberg limits test carried out by Peto on a sample of the organic clay deposit measured a liquid limit of about 54 percent, a plastic limit of about 36 percent and a corresponding plasticity index of about 18 percent. The results of the Atterberg limits test are summarized on the Record of Borehole sheet in Appendix F and indicate the material to be organic clay of high plasticity.

## Sandy Silt to Silt

A layer of brown to grey sandy silt to silt was encountered below the organic deposit in Boreholes 306-31, 306-33, 306-37, 306-43 and 306-61. The top of this layer ranges from about Elevation 190.6 m to 187.8 m, and its thickness ranges from about 0.4 m to 0.9 m.

The SPT 'N'-values measured within this layer range from 0 blows (weight of hammer and rod) to 4 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on one (1) sample of this layer is about 85 percent.

## Clay to Clayey Silt

A deposit of brown to grey clay to clayey silt, trace sand and containing thin layers of silt throughout was encountered below the organic clayey silt to silty clay and sandy silt to silt deposits in all boreholes. The top of this deposit ranges from about Elevation 192.1 m to 186 m, and its thickness ranges from about 1.8 m to 13.2 m.



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The clay to clayey silt deposit was fully penetrated in the boreholes advanced between about STA15+400 and 15+750, or extended to refusal condition.

The SPT 'N'-values recorded within the cohesive deposit range from 0 blows (weight of hammer and rod) to 10 blow per 0.3 m of penetration, with SPT 'N'-values up to 10 blows per 0.3 m of penetration recorded near the surface of this deposit in some boreholes. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 9 kPa to 64 kPa, but typically less than about 20 kPa. The sensitivity is calculated to range from about 1 to 9 and is typically less than 4. The field vane test results, together with the SPT 'N'-values, indicate that the clay to clayey silt deposit has a generally very soft to firm consistency.

The natural water content measured on samples of this deposit ranges from about 14 percent to 97 percent.

A grain size distribution test carried out by Golder on one (1) sample of this deposit is shown on Figure C.S306-1 in Appendix C. Peto performed grain size distribution tests on eighteen (18) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F

Atterberg limits tests were carried out by Golder on three (3) specimens of the cohesive deposit and by Peto on seventeen (17) specimens of this deposit. The liquid limits range from about 21 percent to 81 percent, the plastic limits range from about 14 percent to 36 percent, and the plasticity indices range from about 6 percent to 57 percent. The results of the Atterberg limits tests carried out by Golder are shown on the plasticity chart on Figure C.S306-2 in Appendix C and the results of the Atterberg limits tests carried out by Peto are summarized on the Record of Borehole sheets in Appendix F. The results indicate that the soil ranges from a clay of high plasticity to clayey silt of low plasticity.

A total of six (6) cone penetration tests (CPTs 306-1 to 306-6) were performed in this swamp area of which three (3) tests were used for determination of the pore pressure dissipation at specific horizons within the clay deposit. The range of the coefficient of consolidation in the horizontal direction ( $c_h$ ) obtained from a total of eleven (11) CPT pore pressure dissipation tests carried out is summarized below.

<b><math>C_h</math> CPT-Field (<math>\text{cm}^2/\text{s}</math>)</b>		
<b>Upperbound</b>	<b>Lowerbound</b>	<b>Average</b>
$3.0 \times 10^{-2}$	$3.1 \times 10^{-3}$	$6.8 \times 10^{-3}$

Laboratory consolidation tests were carried out by Golder on two (2) specimens of the cohesive deposit obtained from Shelby tube samples in Boreholes 306-1 and 306-2. Preconsolidation stresses of about 35 kPa and 65 kPa were estimated from the void ratio versus logarithmic pressure plots and from the total work versus pressure plots. Bulk unit weights of about  $14.5 \text{ kN/m}^3$  and  $14.9 \text{ kN/m}^3$  and specific gravities of about 2.75 and 2.76 were measured on the corresponding consolidation test specimens. Details of the test results are shown on Figures C.S306-3 and C.S306-4 in Appendix C and are summarized below, together with the results of three (3) consolidation tests performed on this deposit by Peto.

<b>Borehole Sample No.</b>	<b>Sample Depth / Elevation</b>	<b><math>\sigma_{vo}'</math> (kPa)</b>	<b><math>\sigma_p'</math> (kPa)</b>	<b><math>\sigma_p' - \sigma_{vo}'</math> (kPa)</b>	<b>OCR</b>	<b><math>C_c</math></b>	<b><math>C_r</math></b>	<b><math>e_o</math></b>	<b><math>c_v^*</math> (<math>\text{cm}^2/\text{s}</math>)</b>
Borehole 306-1 Sample 5	7.9 m / 180.7 m	45	65	20	1.4	1.21	0.11	2.33	$2.5 \times 10^{-2}$
Borehole 306-2 Sample 3	4.9 m / 184.5 m	25	35	10	1.4	1.16	0.09	2.68	$2.5 \times 10^{-3}$



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Borehole 306-16 Sample 7 <sup>(1)</sup>	6.4 m / 182.6 m	50	170	120	3.4	0.86	0.07	1.78	$6.4 \times 10^{-3}$
Borehole 306-55 Sample 5 <sup>(1)</sup>	4.9 m / 185.0 m	60	110	50	1.8	0.99	0.08	1.94	$4.1 \times 10^{-3}$
Borehole 306-28 Sample 7 <sup>(1)</sup>	7.9 m / 181.3 m	50	170	120	3.4	0.63	0.04	1.37	$4.1 \times 10^{-3}$

Note: \* For stress range of  $19 \text{ kPa} \leq \sigma_v' \leq 155 \text{ kPa}$  (for Golder test results)  
 For stress range of  $34 \text{ kPa} \leq \sigma_v' \leq 255 \text{ kPa}$  (for Peto test results)  
 1 Laboratory consolidation test results obtained from Peto

where:  $\sigma_{vo}'$  is the effective overburden stress in kPa  
 $\sigma_p'$  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  $\text{cm}^2/\text{s}$

Laboratory consolidated isotropic undrained triaxial compression tests (CIU) with pore pressure measurement were carried out on two (2) samples of the cohesive deposit obtained from Shelby tube samples in Boreholes 306-1 and 306-2. In total, two (2) sets of three (3) specimens were tested at different confining pressures. The details of the test results are shown on Figure C.S306-5 and C.S306-6 in Appendix C, and the results are summarized below.

Borehole Sample No.	Sample Depth / Elevation	Effective Cohesion, $c'$ (kPa)	Effective Angle of Internal Friction, $\phi'$ (degrees)
Borehole 306-1 Sample 5	7.9 m / 180.7 m	7	25
Borehole 306-2 Sample 3	4.9 m / 184.5 m	5	25

Note: Assessed shear strength parameters are only valid over range of stress conditions used in the laboratory test.

The triaxial test samples were consolidated to pressures representative of the estimated in situ effective stresses and maximum effective stresses under the proposed embankment loads, at the respective sample depths. The interpreted effective strength parameters provided above are applicable only to design situations for which the stress conditions during testing are representative. Reference should be made to the individual test reports for details of the testing conditions.

### Silt to Sand

A deposit of grey silt, trace to some sand and trace to some clay, sandy silt with gravel, and sand some gravel and trace silt was encountered below the clay to clayey silt deposit and extends to refusal on probable bedrock in Boreholes 306-13, 306-16, 306-28, 306-31, 306-33, 306-37, 306-40, 306-43, 306-45, 306-52, 306-55, 306-61 and 306-65. The silt deposit generally contains thin layers of silty clay to clay and occasional sandy layers. The top of this deposit ranges from about Elevation 189.4 m to 174.2 m and its thickness ranges from about 0.3 m to 4.9 m.



The SPT 'N'-values recorded within this deposit range from 0 blows (weight of hammer and rod) to 10 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on samples of this deposit ranges from about 13 percent to 28 percent.

Grain size distribution tests were carried out by Peto on ten (10) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

Atterberg limits tests were carried out by Peto on seven (7) samples of the silt deposit. Five of the Atterberg limits tests measured liquid limits ranging from about 20 percent to 22 percent, plastic limits ranging from about 17 percent to 20 percent, and plasticity indices ranging from about 2 percent to 4 percent. The results of these Atterberg limits test are summarized on the Record of Borehole sheet in Appendix F and indicate the material to be silt of low plasticity. Two tests indicate the material to be non-plastic.

### Refusal

In all boreholes and DCPTs, refusal to further sampler and auger advancement or cone penetration, indicative of the potential bedrock surface, was encountered at depths between about 1.1 m and 18.0 m, corresponding to about Elevation 190.1 m and 171.2 m.

### Groundwater Conditions

In general, the samples taken in the boreholes were moist to wet. Water levels observed in the boreholes upon completion of drilling range from about Elevation 189.5 to Elevation 183.4, measured at the ground surface or up to a depth of about 6.1 m below ground surface. Boreholes 306-13, 306-16, 306-19, 306-63 and 306-68 were observed to be dry upon completion of drilling.

## 4.6 Highway 69 SBL – STA 14+425 to 14+500 (Swamp 307 SBL)

The plan and profile along the centreline of the embankment of the new Highway 69 SBL alignment showing the borehole, Dynamic Cone Penetration Test (DCPT) and Cone Penetration Test (CPT) locations and interpreted stratigraphy within the extent of the swamp area considered for the wick drain foundation treatment between in the Township of Mowat 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 3 m high above existing grade. Golder advanced one (1) borehole (Borehole 307-1) and two (2) cone penetration tests (CPTs 307-1 and 307-2) and Peto advanced nine (9) boreholes (Boreholes 307-19, 307-21, 307-23, 307-27, 307-28, 307-34, 307-36, 307-37 and 307-40) and four (4) dynamic cone penetration tests (DCPTs 307-22, 307-26, 307-30 and 307-31) to investigate the subsurface conditions in this swamp area. The topography of this section of proposed highway is generally flat, encompassing an open, wet, grassy area and shallow open water, with upward sloping grass-covered terrain towards the northern limit of the swamp.

In general, the subsurface soils along the SBL alignment in this area consist of a surficial deposit of peat and/or organic silt underlain by an upper deposit of silt, which in turn is underlain by a deposit of clayey silt to clay. At some locations, the cohesive deposit is underlain by a deposit of silt to sand. Resistance to dynamic cone penetration, cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greater depth at about STA 14+460. Bedrock outcrops are present to the north and south limits of the swamp.



## Ice / Snow / Water

Ice or snow and water to depths of between about 0.3 m and 0.5 m was encountered in Boreholes 307-1, 307-21, 307-27, 307-28 and 307-34.

## Peat / Organic Silt

A deposit of dark brown root mat / fibrous peat containing roots and trace gravel, and/or organic silt, trace gravel and trace sand was encountered at the ground surface or below the ice/snow and water cover in all boreholes, except in Boreholes 307-36 and 307-40. The top of the peat/organic silt deposit ranges from about Elevation 193.4 m to 192.3 m and its thickness ranges from about 0.1 m to 2.4 m.

The Standard Penetration Test (SPT) 'N'-values recorded within the peat/organic silt deposit are 1 blow and 2 blows per 0.3 m of penetration, indicative of a very soft consistency / very loose relative density.

The natural water content measured on two samples of the peat is about 37 percent and 263 percent and the organic content on these samples is about 4 percent and 27 percent.

## Silt (Upper)

An upper deposit of grey to brown silt, trace to some clay and trace to some sand containing organics and sandy layers within the upper and lower portions of the deposit was encountered below the peat / organic silt in Boreholes 307-21, 307-23, 307-28 and 307-37. The top of this deposit ranges from about Elevation 193.3 m to 191.0 m, and its thickness ranges from about 1.5 m to 4.4 m.

The SPT 'N'-values recorded within this deposit range from 1 blow to 10 blows per 0.3 m of penetration, indicating a very loose to loose relative density.

The natural water content measured on a sample of this deposit is about 19 percent.

A grain size distribution test was performed by Peto on a sample of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

## Clayey Silt to Clay

A deposit of reddish brown to grey clayey silt to clay, trace gravel and trace sand was encountered below the organic deposits or silt deposit in all boreholes, except in Boreholes 307-36 and 307-40. The upper portion of this deposit in Boreholes 307-1 and 307-27 contains peat intermixed with the silty clay. The top of this deposit ranges from about Elevation 192.0 m to 188.3 m and its thickness ranges from about 2.3 m to 12.6 m. DCPT 307-22 was terminated on refusal at the bottom of within this deposit, as inferred from the resistance to cone penetration test, at a depth of about 8 m.

The SPT 'N'-values recorded within the cohesive deposit range from 0 blows (weight of hammer and rod) to 9 blows per 0.3 m of penetration, but are typically between 1 blow and 2 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 28 kPa to greater than 95 kPa, typically less than about 40 kPa. The sensitivity is calculated to range from about 2 to 10, but is typically about 6. The field vane test results together with the SPT 'N'-values indicate that the clayey silt to clay deposit has a generally very soft to firm consistency.

The natural water content measured on samples of this deposit ranges from about 22 percent to 79 percent.

Grain size distribution tests were carried out by Peto on ten (10) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.



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Atterberg limits tests were carried out by Golder on three (3) specimens of this deposit and by Peto on seven (7) specimens of this deposit. The liquid limits range from about 26 percent to 77 percent, the plastic limits range from about 16 percent to 25 percent and the plasticity indices range from about 10 percent to 55 percent. The results of the Atterberg limits tests carried out by Golder are shown on the plasticity chart on Figure D.S307-1 in Appendix D and the results of the Atterberg limits tests carried out by Peto are summarized on the Record of Borehole sheets in Appendix F. The results indicate that the soil ranges from a clayey silt of low plasticity to clay of high plasticity.

A total of two (2) cone penetration tests (CPTs 307-1 and 307-2) were performed in this swamp crossing of which one (1) test was used for determination of the pore pressure dissipation at specific horizons within the clay deposit. The range of the coefficient of consolidation in the horizontal direction ( $c_h$ ) obtained from a total of six (6) CPT pore pressure dissipation tests carried out is summarized below.

$C_h$ CPT-Field ( $cm^2/s$ )		
Upperbound	Lowerbound	Average
$2.8 \times 10^{-2}$	$8.6 \times 10^{-3}$	$1.2 \times 10^{-2}$

Laboratory consolidation tests were carried out by Golder on two (2) specimens of the cohesive deposit obtained from Shelby tube samples in Borehole 307-1. Preconsolidation stresses of about 100 kPa and 90 kPa were estimated from the void ratio versus logarithmic pressure plots and from the total work versus pressure plots. Bulk unit weights of about  $14.9 \text{ kN/m}^3$  and  $15.2 \text{ kN/m}^3$  and specific gravities of about 2.71 and 2.76 were measured on the consolidation test specimens. Details of the test results are shown on Figures D.S307-2 and D.S307-3 in Appendix D and are summarized below, together with the results of one (1) consolidation test performed on this deposit by Peto.

Borehole Sample No.	Sample Depth / Elevation	$\sigma_{vo}'$ (kPa)	$\sigma_p'$ (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	$C_c$	$C_r$	$e_o$	$c_v^*$ ( $cm^2/s$ )
Borehole 307-1 Sample 6	5.3 m / 187.5 m	25	100	75	4.0	1.14	0.09	2.19	$7.4 \times 10^{-2}$
Borehole 307-1 Sample 7	8.9 m / 183.9 m	45	90	45	2.0	1.01	0.08	1.93	$8.7 \times 10^{-2}$
Borehole 307-29 Sample 7 <sup>(1)</sup>	6.4 m / 188.6 m	60	270	210	4.5	1.21	0.14	2.07	$1.7 \times 10^{-3}$

Note: \* For stress range of  $19 \text{ kPa} \leq \sigma_v' \leq 310 \text{ kPa}$  (for Golder test results)  
 For stress range of  $35 \text{ kPa} \leq \sigma_v' \leq 557 \text{ kPa}$  (for Peto test results)  
 1 Laboratory consolidation test results obtained from Peto

where:  $\sigma_{vo}'$  is the effective overburden stress in kPa  
 $\sigma_p'$  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  $cm^2/s$



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Laboratory consolidated isotropic undrained triaxial compression tests (CIU) with pore pressure measurement were carried out by Golder on two (2) samples of the cohesive deposit obtained from Shelby tube samples in Borehole 307-1. In total, two (2) sets of three (3) specimens were tested at different confining pressures. The details of the test results are shown on Figure D.S307-4 and D.S307-5 in Appendix D, and the results are summarized below.

Borehole Sample No.	Sample Depth / Elevation	Effective Cohesion Intercept, $c'$ (kPa)	Effective Angle of Internal Friction, $\phi'$ (degrees)
Borehole 307-1 Sample 6	5.3 m / 187.5 m	0	34
Borehole 307-1 Sample 7	8.9 m / 183.9 m	18	25

Note: Assessed shear strength parameters are only valid over range of stress conditions used in the laboratory test.

The triaxial test samples were consolidated to pressures representative of the estimated in situ effective stresses and maximum effective stresses under the proposed embankment loads, at the respective sample depths. The interpreted effective strength parameters provided above are applicable only to design situations for which the stress conditions during testing are representative. Reference should be made to individual test reports for details of the testing conditions.

### Silt (Lower)

A lower deposit of grey silt, trace to some clay and trace sand was encountered below the clayey silt to silt deposit in Boreholes 307-1, 307-19, 307-27, 307-28, 307-34 and 307-37. The top of this deposit ranges from about Elevation 188.8 m to 179.0 m, and its thickness ranges from about 0.9 m to 3.5 m, and potentially to a thickness of about 5 m in Borehole 307-1 as inferred from the resistance to cone penetration for the DCPT driven from the bottom of the borehole. DCPTs 307-30 and 307-31 were terminated within the silt deposit, as inferred from the resistance to cone penetration, at depths of between about 11.9 m and 18.8 m below ice surface, corresponding to between Elevation 181.1 m and 174.0 m.

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

The natural water content measured on samples of this deposit ranges from about 26 percent to 31 percent.

Grain size distribution tests were carried out by Peto on four (4) samples of this deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

An Atterberg limits test carried out by Peto on a sample of the silt deposit measured a liquid limit of about 21 percent, a plastic limit of about 19 percent and a corresponding plasticity index of about 2 percent. The results of the Atterberg limits test are summarized on the Record of Borehole sheet in Appendix F and indicate the material to be silt of low plasticity.

### Sand

Underlying the silt deposit in Borehole 307-34, an approximately 1.4 m thick deposit of brown sand with gravel and trace silt was encountered at about Elevation 177.1 m.

A single SPT 'N'-value recorded within this deposit is about 20 blows per 0.3 m of penetration, indicating a compact relative density.



The natural water content measured on a sample of this deposit is 18 percent.

A grain size distribution test was performed by Peto on a sample of this deposit and the results are summarized on the record of Borehole sheet in Appendix F.

### **Bedrock / Refusal**

Bedrock was encountered at ground surface in Boreholes 307-36 and 307-40 at about Elevation 193 m and 193.4 m, respectively. In Boreholes 307-19, 307-21, 307-23, 307-27, 307-28, 307-34 and 307-37, and DCPTS 307-22 and 307-26, refusal to further sampler and/or auger advancement or cone penetration, indicative of the potential bedrock surface, was encountered at depths between about 5.7 m and 17.3 m below ice/ground surface, corresponding to between about Elevation 187.3 m and 175.7 m.

### **Groundwater Conditions**

In general, the samples taken in the boreholes were moist to wet. The water level observed in the boreholes upon completion of drilling ranges from about Elevation 192.8 m to 191.3 m, measured at the ice surface or up to a depth of 1.7 m below ice/ground surface.

## **4.7 Highway 69 SBL – STA 13+160 to 13+450 (Swamp 310 SBL)**

The plan and profile along the centreline of the embankment of the new Highway 69 SBL alignment showing the borehole, Dynamic Cone Penetration Test (DCPT) and Cone Penetration Test (CPT) locations and interpreted stratigraphy within the extent of the swamp area considered for the wick drain foundation treatment in the Township of Mowat are shown on Drawing E1 in Appendix E. The alignment extends across a swamp area and the proposed roadway embankment will be up to about 2 m high above existing grade. Golder advanced two (2) boreholes (Boreholes 310-1 and 310-2) and four (4) cone penetration tests (CPTS 310-1 to 310-4), and based on the information received to date, Peto advanced five (5) boreholes (Boreholes 310-1, 310-4, 310-7, 310-9 and 310-13) and two (2) dynamic cone penetration tests (DCPTS 310-3 and 310-10) to investigate the subsurface conditions at the north end of this swamp. The topography of this section of proposed highway is generally flat to low-lying with surface cover consisting of wet grassy areas, shallow open water and occasional bedrock outcrops, with upward sloping grass-covered terrain towards the northern limit 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 clayey silt to clay. At one borehole location, the clayey silt to clay deposit is underlain by a deposit of sand extending to refusal on probable bedrock. Resistance to dynamic cone penetration, cone penetration and borehole advancement, indicative of the potential bedrock surface, was encountered at greater depths at about STA 13+275 and 13+400. Bedrock outcrops are present to the north of the swamp.

### **Ice / Snow**

Ice and snow to a depth of about 0.3 m was encountered in Borehole 310-9.

### **Peat**

A deposit of dark brown to black fibrous to amorphous peat containing layers of organic silty clay was encountered at the ground surface or below the ice/snow cover in all boreholes advanced within the swamp limits. The top of the peat deposit varies between about Elevation 195.2 m and 194.6 m and its thickness ranges from about 0.5 m to 4.9 m.



The Standard Penetration Test (SPT) 'N'-values recorded within the peat deposit are typically 0 blows (weight of hammer and rod) per 0.3 m of penetration, with a single SPT 'N' value of 8 blows per 0.3 m of penetration encountered near the surface in Borehole 310-13, indicating a very soft to firm consistency.

The natural water content measured on samples of the peat ranges from about 89 percent to 988 percent and the organic content measured on samples of this deposit ranges from about 10 percent to 90 percent.

### Clayey Silt to Clay

A deposit of grey, varved, clayey silt to clay, trace sand and containing layers of silt and organic silty clay, seashells and organics, was encountered below the peat deposit in all the boreholes advanced within the swamp limits. The lower portion of this deposit in Boreholes 310-4 and 310-9 contains layers of sandy silt, trace gravel and cobbles. The surface of this deposit ranges from about Elevation 194.7 m to 189.7 m and its thickness ranges from about 3.2 m to 7.2 m.

The SPT 'N'-values recorded within the cohesive deposit range from 0 blows (weight of hammer and rod) to 5 blows per 0.3 m of penetration. In situ field vane tests carried out within this deposit measured undrained shear strengths ranging from about 2 kPa to 38 kPa. The sensitivity is calculated to range from about 1 to 7, and is typically less than 3. The field vane test results together with the SPT 'N'-values indicate that the clayey silt to clay deposit has a very soft to firm consistency.

The natural water content measured on samples of this deposit ranges from about 25 percent to 102 percent.

Grain size distribution tests were carried out by Peto on four (4) specimens of this cohesive deposit and the results are summarized on the Record of Borehole sheets in Appendix F.

Atterberg limits tests were carried out by Golder on four (4) specimens of the clay deposit and by Peto on five (5) specimens of the clayey silt to silty clay deposit. The liquid limits range from about 30 percent to 106 percent, the plastic limits range from about 19 percent to 33 percent, and the plasticity indices range from about 11 percent to 73 percent. The results of the Atterberg limits tests carried out by Golder are shown on the plasticity chart on Figure E.S310-1 in Appendix E and the results of the Atterberg limits tests carried out by Peto are summarized on the Record of Borehole sheets in Appendix F. The results indicate that the soil ranges from clayey silt of low plasticity to clay of high plasticity.

A total of four (4) cone penetration tests (CPTs 310-1 to 310-4) were performed in this swamp area of which two (2) tests were used for the determination of the pore pressure dissipation at specific horizons within the clay deposit. The range of the coefficient of consolidation in the horizontal direction ( $c_h$ ) obtained from a total of six (6) CPT pore pressure dissipation tests carried out is summarized below.

<b><math>c_h</math> CPT-Field (<math>\text{cm}^2/\text{s}</math>)</b>		
<b>Upperbound</b>	<b>Lowerbound</b>	<b>Average</b>
$5.9 \times 10^{-1}$	$1.6 \times 10^{-3}$	$1.4 \times 10^{-2}$

### Sand

A deposit of grey sand trace to some silt and trace gravel containing cobbles was encountered underlying the cohesive deposit in Borehole 310-7. The surface of this deposit is at about Elevation 189.2 m and its thickness is about 0.8 m.

A SPT 'N'-value of 10 blows per 0.07 m of penetration was recorded within this deposit, indicating a compact relative density.

A grain size distribution test was performed by Peto on a sample of this deposit and the results are summarized on the Record of Borehole sheet in Appendix F.



## **Refusal**

In all boreholes and DCPTs, refusal to further auger or cone penetration, indicative of the potential bedrock surface, was encountered at depths between about 4.9 m and 10.7 m below ice/ground surface, corresponding to between about Elevation 190.1 m and 184.3 m.

## **Groundwater Conditions**

In general, the samples taken in the boreholes were wet. The water level observed in the boreholes upon completion of drilling ranges from about Elevation 195.2 m to 194.6 m, measured at the ground/ice surface.

## **5.0 CLOSURE**

The field engineer and technician directing the drilling program were Messrs. Matt Kelly and Matt Rhody, respectively. This report was prepared by Mr. Matthew Kelly, P. Eng., and Ms. T. Veronica Ayetan, P. Eng., and was reviewed by Mr. J. Paul Dittrich, Ph.D., P. Eng., a Senior Geotechnical Engineer and Principal with Golder. Mr. Jorge M. A. Costa, P. Eng., Golder's Designated MTO Contact for this project and Principal with Golder, conducted an independent quality control review of the report.



## Report Signature Page

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MWK/TVA/CN/JPD/JMAC/jl/sm

n:\active\2006\1111\06-1111-025 mrc hwy 69-522 to 64 french river\reporting\wick drain embankments\final\06-1111-025-1 rpt 12apr26 highway 69 wick drain foundation treatment swamp areas.docx



## REFERENCES

Chapman, L.J., and Putnam, D.F. 1984. The Physiography of Southern, 3<sup>rd</sup> Edition. Ontario Geological Survey, Special Volume 2. Ontario Ministry of Natural Resources.

Geology of Ontario. 1991. Ontario Geological Society, Special Volume 4, Part 1. Eds. P.C. Thurston, H.R. Williams, R.H. Sutcliffe and G.M. Stott. Ministry of Northern Development and Mines, Ontario.

### STANDARDS:

ASTM International:

ASTM D1586-08a	Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
ASTM D1587-08	Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
ASTM D2573-08	Standard Test Method for Field Vane Shear Test in Cohesive Soil
ASTM D5778-07	Standard Test Method for Electronic Friction Cone and Piezocone Penetration Testing of Soils

Ontario Water Resources Act:

Ontario Regulation 903/90 Wells



## LIST OF SYMBOLS

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

### I. GENERAL

$\pi$	3.1416
$\ln x$ ,	natural logarithm of x
$\log_{10} x$	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

$\gamma$	shear strain
$\Delta$	change in, e.g. in stress: $\Delta \sigma$
$\varepsilon$	linear strain
$\varepsilon_v$	volumetric strain
$\eta$	coefficient of viscosity
$\nu$	Poisson's ratio
$\sigma$	total stress
$\sigma'$	effective stress ( $\sigma' = \sigma - u$ )
$\sigma'_{vo}$	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
$\sigma_{oct}$	mean stress or octahedral stress = $(\sigma_1 + \sigma_2 + \sigma_3)/3$
$\tau$	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
$\gamma'$	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  $\rho$ . Unit weight symbol is  $\gamma$  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
$C_{\alpha}$	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
$\sigma'_p$	pre-consolidation stress
OCR	over-consolidation ratio = $\sigma'_p / \sigma'_{vo}$

#### (d) Shear Strength

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

Notes: 1  
2

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



## LIST OF ABBREVIATIONS

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

### I. SAMPLE TYPE

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

### II. PENETRATION RESISTANCE

#### Standard Penetration Resistance (SPT), N:

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

#### Dynamic Cone Penetration Resistance; $N_d$ :

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

**PH:** Sampler advanced by hydraulic pressure

**PM:** Sampler advanced by manual pressure

**WH:** Sampler advanced by static weight of hammer

**WR:** Sampler advanced by weight of sampler and rod

#### Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm<sup>2</sup> 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.

### V. MINOR SOIL CONSTITUENTS

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

### III. SOIL DESCRIPTION

#### (a) Cohesionless Soils

Density Index	N
Relative Density	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

	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 <sup>1</sup>
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement <sup>1</sup>
$D_R$	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 <sub>4</sub>	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
$\gamma$	unit weight

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



**FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3  
HIGHWAY 69 G.W.P. 5203-06-00**

**TABLE 1 – SUMMARY OF WICK DRAIN SWAMP CROSSINGS**

<i>Highway</i>	<i>Approximate Station</i>	<i>Designation</i>	<i>Proposed Embankment Height<sup>1</sup></i>	<i>Golder Boreholes/CPT</i>	<i>Peto Boreholes/DCPT</i>
Highway 69 SBL and NBL	17+700 to 18+150	Swamp 302 SBL/NBL	3.5 m to 6.5 m	4 Boreholes (302-1 to 302-4) 8 CPTs (302-1 to 302-8)	34 Boreholes (302-19 to 302-21, 302-23 to 302-25, 302-27, 302-29 to 302-35, 302-37, 302-39 to 302-41, 302-43 to 302-45, 302-47, 302-49 to 302-51, 302-53 to 302-55, 302-57, 302-59, 302-60 and 302-63 to 302-65) 12 DCPTs (302-22, 302-26, 302-28, 302-36, 302-38, 302-42, 302-46, 302-48, 302-52, 302-56, 302-58 and 302-62)
Highway 69 SBL	16+050 to 16+350	Swamp 305 SBL	2.0 m to 2.5 m	3 Boreholes (305-1 to 305-3) 6 CPTs (305-1 to 305-6)	14 Boreholes (305-7, 305-9, 305-13, 305-16, 305-19, 305-21, 305-25, 305-28, 305-31, 305-33, 305-37, 305-39, 305-40 and 305-43) 5 DCPTs (305-10, 305-15, 305-22, 305-27, and 305-34)
Highway 69 SBL	15+350 to 15+800	Swamp 306 SBL	0.0 m to 3.0 m	2 Boreholes (306-1 and 306-2) 6 CPTs (306-1 to 306-6)	20 Boreholes (306-13, 306-16, 306-19, 306-21, 306-25, 306-28, 306-31, 306-33, 306-37, 306-40, 306-43, 306-45, 306-49, 306-52, 306-55, 306-61, 306-63, 306-64, 306-65 and 306-68) 8 DCPTs (306-15, 306-22, 306-27, 306-34, 306-39, 306-46, 306-51 and 306-58)
Highway 69 SBL	14+425 to 14+500	Swamp 307 SBL	2.5 m to 3.0 m	1 Borehole (307-1) 2 CPTs (307-1 and 307-2)	9 Boreholes (307-19, 307-21, 307-23, 307-27, 307-28, 307-34, 307-36, 307-37 and 307-40) 4 DCPTs (307-22, 307-26, 307-30 and 307-31)



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

**TABLE 1 – SUMMARY OF WICK DRAIN SWAMP CROSSINGS**

<i>Highway</i>	<i>Approximate Station</i>	<i>Designation</i>	<i>Proposed Embankment Height<sup>1</sup></i>	<i>Golder Boreholes/CPT</i>	<i>Peto Boreholes/DCPT</i>
Highway 69 SBL	13+160 to 13+450	Swamp 310 SBL	1.5 m to 2.0 m	2 Boreholes (310-1 and 310-2) 4 CPTs (CPTS 310-1 to 310-4)	5 Boreholes (310-1, 310-4, 310-7, 310-9 and 310-13) 2 DCPTs (310-3 and 310-10)

Note: 1. Based on centreline of highway alignments and existing ground surface profiles provided by Callon Dietz on April 23, 2009.

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Prepared By: VA

Reviewed By: JPD/JMAC



## FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3 HIGHWAY 69 G.W.P. 5203-06-00

**TABLE 2 – SUMMARY OF CONSOLIDATION AND TRIAXIAL TEST RESULTS**

<i>Location</i>	<i>Borehole and Sample No.</i>	<i>Elevation (m)</i>	$\sigma_{vo}'$ (kPa)	$\sigma_p'$ (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	$C_c$	$C_r$	$e_o$	$c_v^*$ (cm <sup>2</sup> /s)	$c'$ (kPa)	$\phi'$ (degrees)
Swamp 302 SBL/NBL	Borehole S302-1 Sample 6	182.2 m	20	140	120	7.0	0.62	0.04	1.50	$1.0 \times 10^{-1}$	6	34
	Borehole S302-1 Sample 7	179.9 m	35	135	100	3.9	0.17	0.02	0.87	$1.0 \times 10^{-1}$	0	35
	Borehole S302-2 Sample 3	182.0 m	20	140	120	7.0	0.78	0.08	1.82	$7.0 \times 10^{-2}$	0	34
	Borehole S302-2 Sample 4	179.7 m	35	110	75	3.1	0.12	0.03	0.69	$6.7 \times 10^{-2}$	-	-
	Borehole S302-2 Sample 5	176.7 m	55	110	55	2	0.22	0.03	1.23	$8.1 \times 10^{-2}$	4	33
	Borehole S302-2 Sample 5 <sup>(2)</sup>	176.7 m	55	100	45	1.8	0.23	0.02	1.07	$7.5 \times 10^{-2}$	-	-
	Borehole S302-29 Sample 7 <sup>(1)</sup>	181.1 m	100	250	150	2.5	0.85	0.06	1.62	$9.6 \times 10^{-3}$	-	-
	Borehole S302-44 Sample 5 <sup>(1)</sup>	181.6 m	30	205	175	6.8	0.18	0.02	0.9	$2.2 \times 10^{-2}$	-	-
Swamp 305 SBL	Borehole S305-1 Sample 7	172.9 m	80	100	20	1.3	0.63	0.06	1.49	$1.3 \times 10^{-2}$	7	30
	Borehole S305-2 Sample 2	181.9 m	-	-	-	-	-	-	-	-	0	30
	Borehole S305-3 Sample 1	183.8 m	20	40	20	2	1.06	0.10	2.30	$2.0 \times 10^{-3}$	-	-
	Borehole S305-16 Sample 8 <sup>(1)</sup>	176.5 m	50	180	130	3.6	0.95	0.09	1.79	$3.0 \times 10^{-3}$	-	-
	Borehole S305-20 Sample 10 <sup>(1)</sup>	174.3 m	115	205	90	1.8	0.70	0.07	1.44	$4.0 \times 10^{-3}$	-	-
	Borehole S305-20 Sample 17 <sup>(1)</sup>	167.3 m	150	420	270	2.8	1.26	0.08	1.71	$9.8 \times 10^{-3}$	-	-
	Borehole S305-23 Sample 10 <sup>(1)</sup>	179.6 m	65	290	225	3.2	1.16	0.08	1.89	$5.6 \times 10^{-3}$	-	-



**FOUNDATION REPORT – WICK DRAIN TREATMENT AREAS – PHASE 3  
HIGHWAY 69 G.W.P. 5203-06-00**

**TABLE 2 – SUMMARY OF CONSOLIDATION AND TRIAXIAL TEST RESULTS**

Location	Borehole and Sample No.	Elevation (m)	$\sigma_{vo}'$ (kPa)	$\sigma_p'$ (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	OCR	$C_c$	$C_r$	$e_o$	$c_v^*$ (cm <sup>2</sup> /s)	$c'$ (kPa)	$\phi'$ (degrees)
Swamp 306 SBL	Borehole S306-1 Sample 5	180.7 m	45	65	20	1.4	1.21	0.11	2.33	$1.3 \times 10^{-3}$	7	25
	Borehole S306-2 Sample 3	184.5 m	25	35	10	1.4	1.16	0.09	2.68	$2.5 \times 10^{-3}$	5	25
	Borehole S306-16 Sample 7 <sup>(1)</sup>	182.6 m	50	170	120	3.4	0.86	0.07	1.78	$6.4 \times 10^{-3}$	-	-
	Borehole S306-55 Sample 5 <sup>(1)</sup>	185.0 m	60	110	50	1.8	0.99	0.08	1.94	$4.1 \times 10^{-3}$	-	-
	Borehole S306-28 Sample 7 <sup>(1)</sup>	181.3 m	50	170	120	3.4	0.63	0.04	1.37	$4.1 \times 10^{-3}$	-	-
Swamp 307 SBL	Borehole S307-1 Sample 6	187.5 m	25	100	75	4.0	1.14	0.09	2.19	$7.4 \times 10^{-2}$	0	34
	Borehole S307-1 Sample 7	183.9 m	45	90	45	2.0	1.01	0.08	1.93	$8.0 \times 10^{-4}$	18	25
	Borehole S307-29 Sample 7 <sup>(1)</sup>	188.6 m	60	270	210	4.5	1.21	0.14	2.07	$1.7 \times 10^{-3}$	-	-

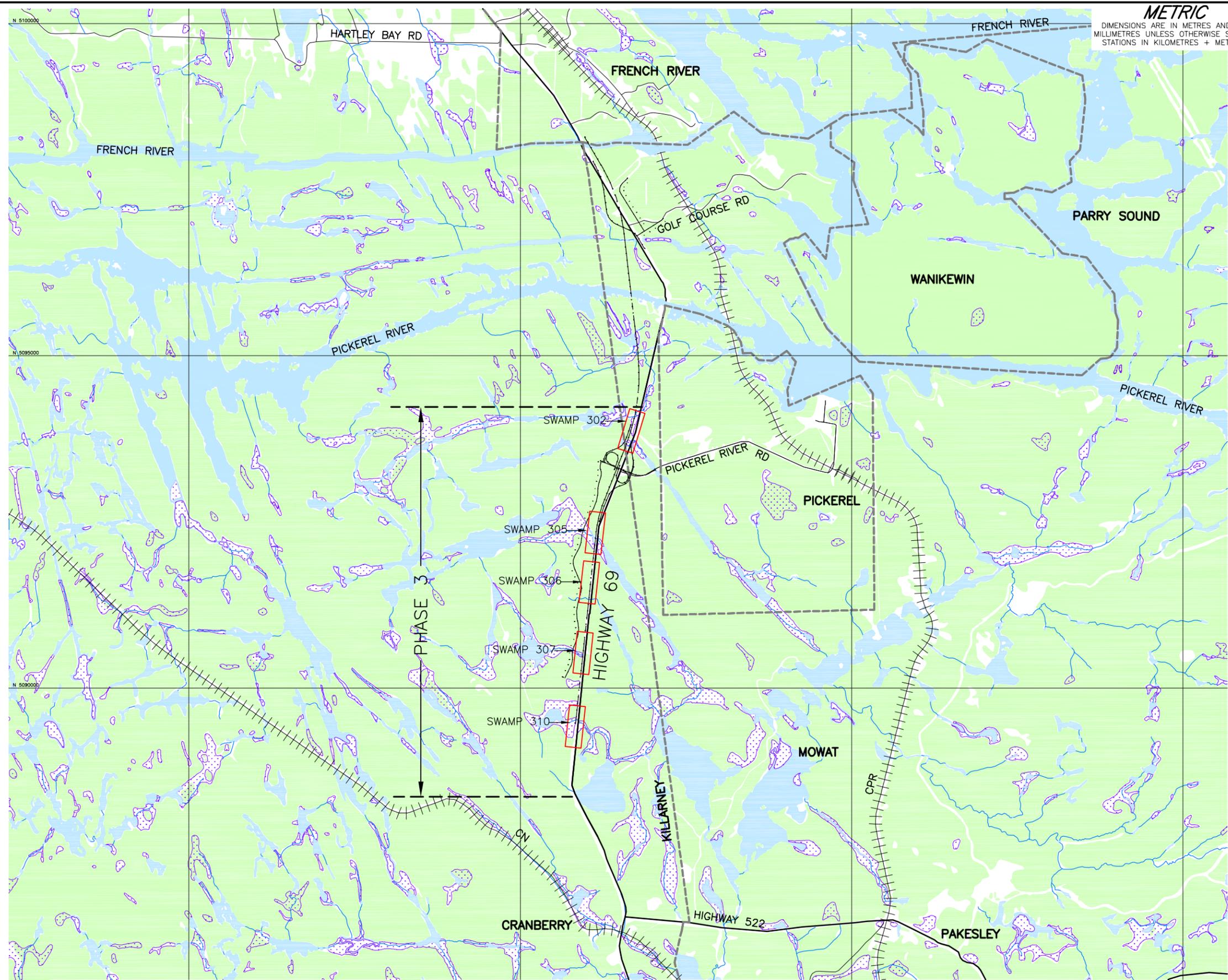
Note: \* For stress range of  $19 \leq \sigma_v' \leq 314$  kPa (for Golder test results)      <sup>1</sup> Laboratory consolidation test results obtained from Peto  
 For stress range of  $17 \text{ kPa} \leq \sigma_v' \leq 557$  kPa (for Peto test results)      <sup>2</sup> VTO sample orientation, measured  $c_h$  (cm<sup>2</sup>/s)  
 Assessed shear strength parameters ( $c'$  and  $\phi'$ ) are only valid over range of stress conditions in the test.

where:  $\sigma_{vo}'$  is the effective overburden stress in kPa  
 $\sigma_p'$  is the preconsolidation stress in kPa  
 OCR is the overconsolidation ratio  
 $C_c$  is the compression index  
 $C_r$  is the recompression index  
 $e_o$  is the initial void ratio  
 $c_v$  is the coefficient of consolidation in cm<sup>2</sup>/s  
 $c'$  is the effective cohesion intercept in kPa  
 $\phi'$  is the effective angle of internal friction in degrees  
 $\sigma_v'$  is the vertical effective stress in kPa

Prepared By: VA

Reviewed By: JPD/JMAC

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

CONT No. GWP No. 5203-06-00  
 HIGHWAY 69  
 WICK DRAIN FOUNDATION TREATMENT SWAMP AREAS  
 SITE LOCATION PLAN



SHEET



**Golder Associates Ltd.**  
 MISSISSAUGA, ONTARIO, CANADA



KEY PLAN  
 NOT TO SCALE

**NOTE**

□ APPROXIMATE LOCATION OF SWAMP AREAS (REFER TO DRAWING 2)



**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-106			
HWY. 69		PROJECT NO. 06-1111-025	DIST.
SUBM'D. VA	CHKD. VA	DATE: Feb. 2012	SITE:
DRAWN: DD/RJ	CHKD. VA	APPD. JPD/JMAC	DWG. 1





# **APPENDIX A**

**Highway 69 SBL and NBL – STA 17+700 to 18+150  
(Swamp 302 SBL/NBL)**

PROJECT <u>06-1111-025</u>	<b>RECORD OF BOREHOLE No 302-1</b>	1 OF 1 <b>METRIC</b>
G.W.P. <u>5203-06-00</u>	LOCATION <u>N 5093962.4 ; E 221675.2</u>	ORIGINATED BY <u>MWK</u>
DIST <u>HWY 69</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>MWK</u>
DATUM <u>Geodetic</u>	DATE <u>March 2, 2009</u>	CHECKED BY <u>VA</u>

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W			W <sub>L</sub>
186.3	ICE SURFACE													
0.0	Ice and Snow													
185.8	Organic CLAYEY SILT Very soft Grey Wet		1	SS	WH								OC = 4.2%	
0.5			2	SS	WH									
			3	TO	PH									
183.3	CLAY, some silt Very soft to firm Grey Wet		5	SS	WH								C/CIU	
3.1			6	TO	PH									
180.2	CLAYEY SILT Soft Grey Wet		7	TO	PH								C/CIU	
6.1			8	TO	PH									
177.2	SILT, containing sand seams Loose Grey Wet		9	SS	8									
9.1														
176.6	END OF BOREHOLE													
9.8	NOTES: 1. Borehole caved at ice surface (Elev. 186.3 m) upon removal of augers. 2. Water level inside augers at a depth of 0.5 m below ice surface (Elev. 185.8 m) upon completion of drilling.													

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

**RECORD OF BOREHOLE No 302-2** 1 OF 1 **METRIC**

PROJECT 06-1111-025 G.W.P. 5203-06-00 LOCATION N 5093807.7 ; E 221670.0 ORIGINATED BY MWK

DIST                      HWY 69 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers COMPILED BY MWK

DATUM Geodetic DATE March 2, 2009 CHECKED BY VA/JPD

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)									
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)								
						20	40	60	80	100	20	40	60	80	100	10	20	30		GR	SA	SI	CL		
186.1	ICE SURFACE																								
0.0	Ice and Snow																								
185.3	PEAT, containing wood fragments, (Fibrous) Very soft Dark brown Wet		1	SS	WH																				
0.8																									
183.6	CLAY, some silt Very soft to stiff Brown and grey Wet		2	SS	2																				
2.5			3	TO	PH																				
180.0	CLAYEY SILT Soft to firm Grey Wet		4	TO	PH																				
6.1																									
175.4	SILT, some sand, some clay Loose Grey Wet		5	TO	PH																				
10.7																									
174.8																									
11.3	END OF BOREHOLE																								
	NOTES:																								
	1. Borehole caved at ice surface (Elev. 186.1 m) upon removal of augers.																								
	2. Water level in open borehole at a depth of 0.8 m below ice surface (Elev. 185.3 m) upon completion of drilling.																								
	* Bulk unit weight measured on consolidation test specimen for Vertically Trimmed Oedometer sample orientation.																								

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

**RECORD OF BOREHOLE No 302-3** 1 OF 2 **METRIC**

PROJECT 06-1111-025 LOCATION N 5093819.2 ; E 221633.7 ORIGINATED BY MWK

G.W.P. 5203-06-00 DIST HWY 69 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers COMPILED BY MWK

DATUM Geodetic DATE March 3, 2009 CHECKED BY VA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)						
						20	40	60	80	100	20	40	60	80	100	10	20	30		GR	SA	SI	CL
188.2 0.0	ICE SURFACE Ice and Snow																						
187.6 0.6	SAND, some silt Very loose to compact Brown to grey Wet																						
			1	SS	18																		
			2	SS	6																		
			3	SS	3																		
183.4 4.8	SILTY CLAY Firm to stiff Grey Wet		4	SS	3																		44.5
			5	TO	PH																		63.7
			6	TO	PH																		45.4
177.6 10.6	SILT, trace to some clay, trace to some sand Loose Grey Wet		7	TO	PH																		
			8	SS	6																		
173.9 14.3			9	SS	9																		

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

Continued Next Page

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

PROJECT <u>06-1111-025</u>	<b>RECORD OF BOREHOLE No 302-3</b>	2 OF 2 <b>METRIC</b>
G.W.P. <u>5203-06-00</u>	LOCATION <u>N 5093819.2 ; E 221633.7</u>	ORIGINATED BY <u>MWK</u>
DIST <u>        </u> HWY <u>69</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>MWK</u>
DATUM <u>Geodetic</u>	DATE <u>March 3, 2009</u>	CHECKED BY <u>VA</u>

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
	END OF BOREHOLE															
	NOTES:  1. Borehole caved at a depth of 4.6 m below ice surface (Elev. 183.6 m) upon removal of augers.  2. Water level in open borehole at a depth of 0.6 m below ice surface (Elev. 187.6 m) upon completion of drilling.															

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

**RECORD OF BOREHOLE No 302-4** 1 OF 2 **METRIC**

PROJECT 06-1111-025 G.W.P. 5203-06-00 LOCATION N 5093721.8 ; E 221641.3 ORIGINATED BY MWK

DIST                      HWY 69 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers COMPILED BY MWK

DATUM Geodetic DATE March 5, 2009 CHECKED BY VA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa						WATER CONTENT (%)
188.2 0.0	ICE SURFACE Ice and Snow													
187.4 0.8	Silty SAND Compact Brown Wet		1	SS	17									
183.6 4.6	CLAY, varved Very soft to stiff Grey Wet		3	SS	WH									
					4	TO	PH							
					5	TO	PH							
179.5 8.7	SILT, some sand, some clay, containing layers of clayey silt Compact Grey Wet		6	TO	PH									
174.5 13.7	SAND and SILT Loose Grey Wet		7	SS	10									
173.9 14.3														
			8	SS	6									

GTA-MTO 001\_06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

Continued Next Page

 +<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT <u>06-1111-025</u>	<b>RECORD OF BOREHOLE No 302-4</b>	2 OF 2 <b>METRIC</b>
G.W.P. <u>5203-06-00</u>	LOCATION <u>N 5093721.8 ; E 221641.3</u>	ORIGINATED BY <u>MWK</u>
DIST <u>          </u> HWY <u>69</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>MWK</u>
DATUM <u>Geodetic</u>	DATE <u>March 5, 2009</u>	CHECKED BY <u>VA</u>

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT  <b>γ</b> kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
	END OF BOREHOLE															
	NOTE: 1. Water level in open borehole at ice surface (Elev. 188.2 m) upon completion of drilling.															

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

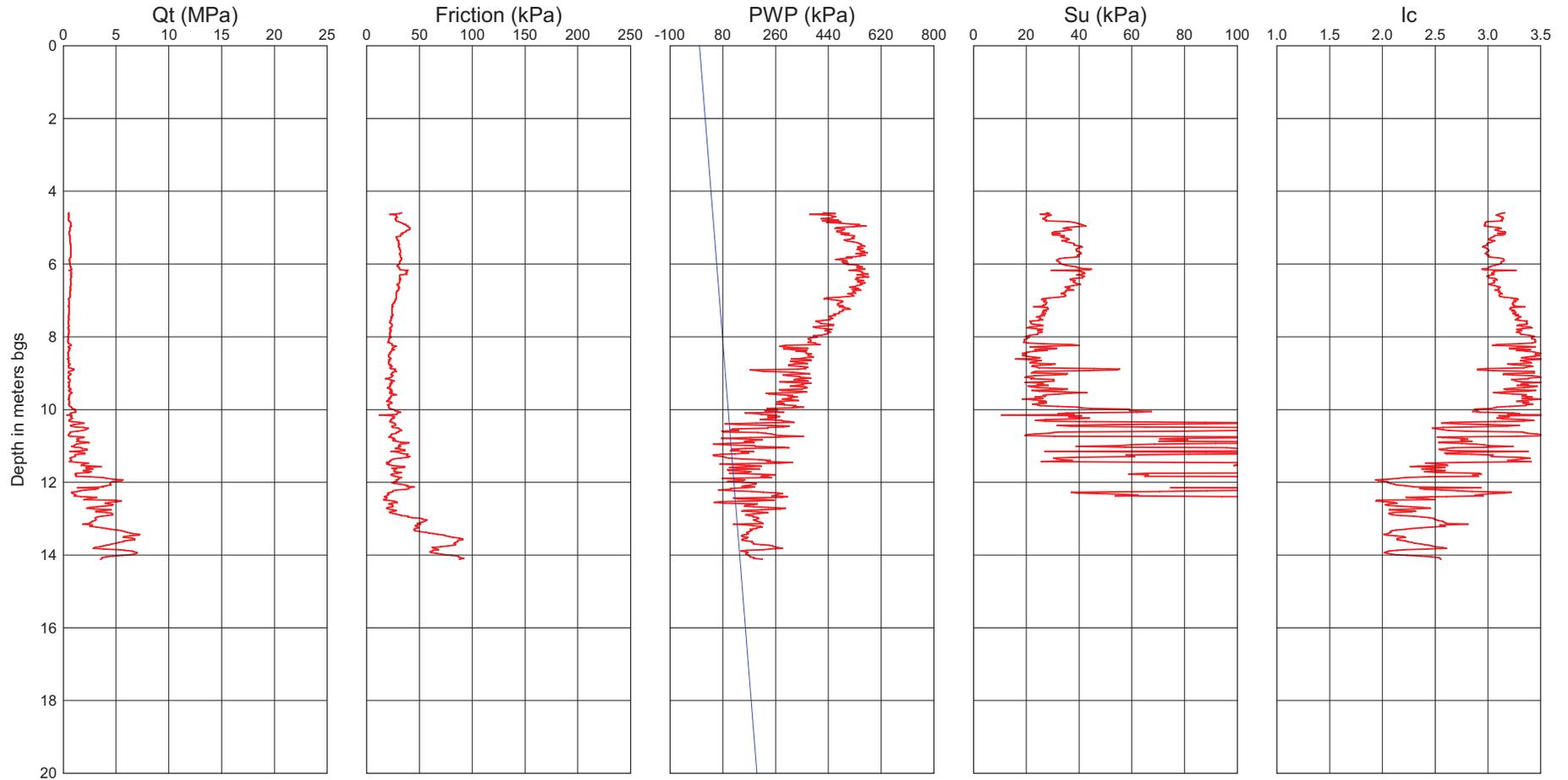
+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

# Cone Penetration Test - CPT302-1

Test Date : March 08, 2009  
 Location : Highway 69 - STA 17+761 o/s 19.5 m Right

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 188.20  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

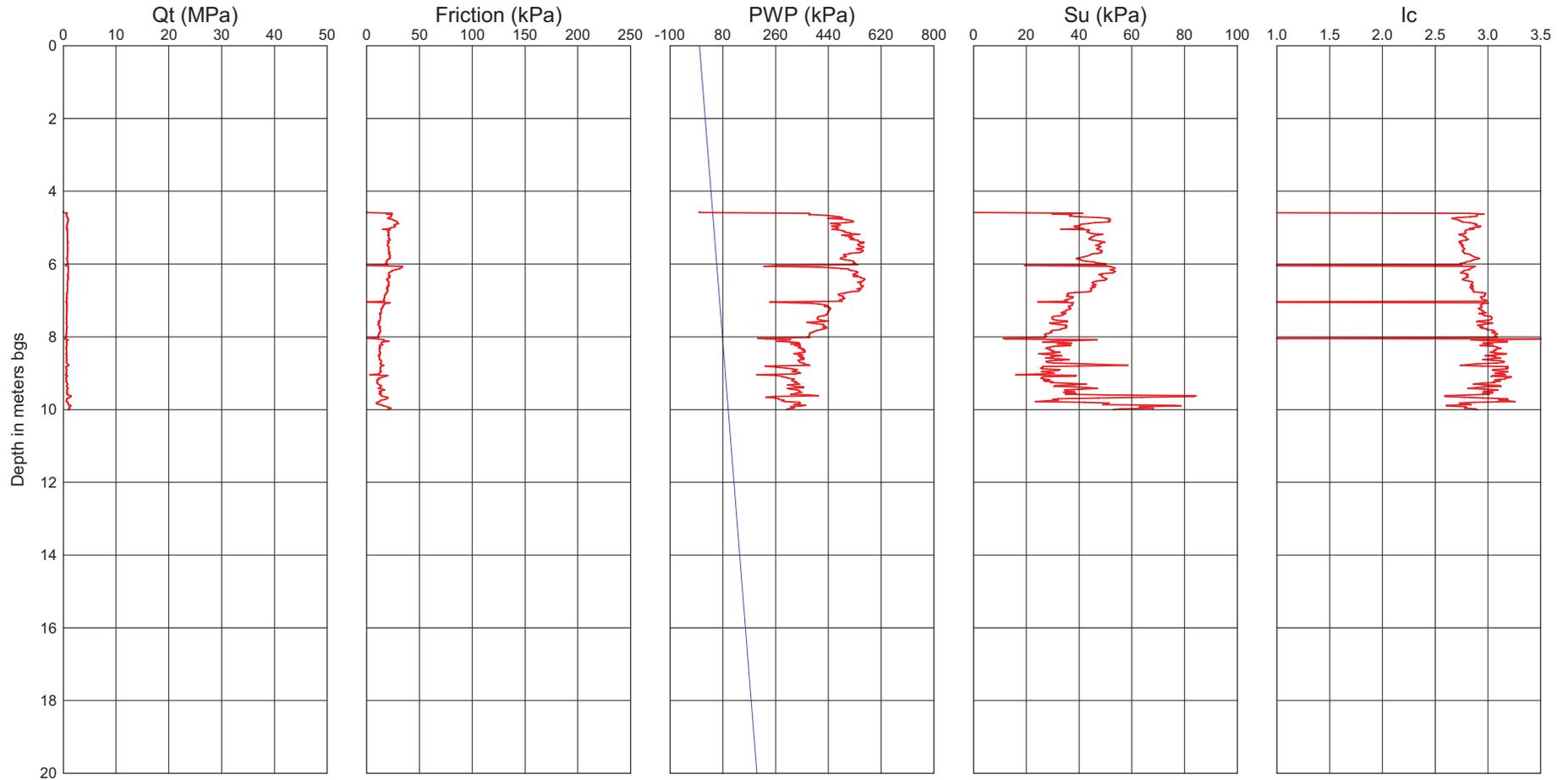
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT302-2

Test Date : March 08, 2009  
 Location : Highway 69 - STA 17+761 o/s 18.5 m Right

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 188.20  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

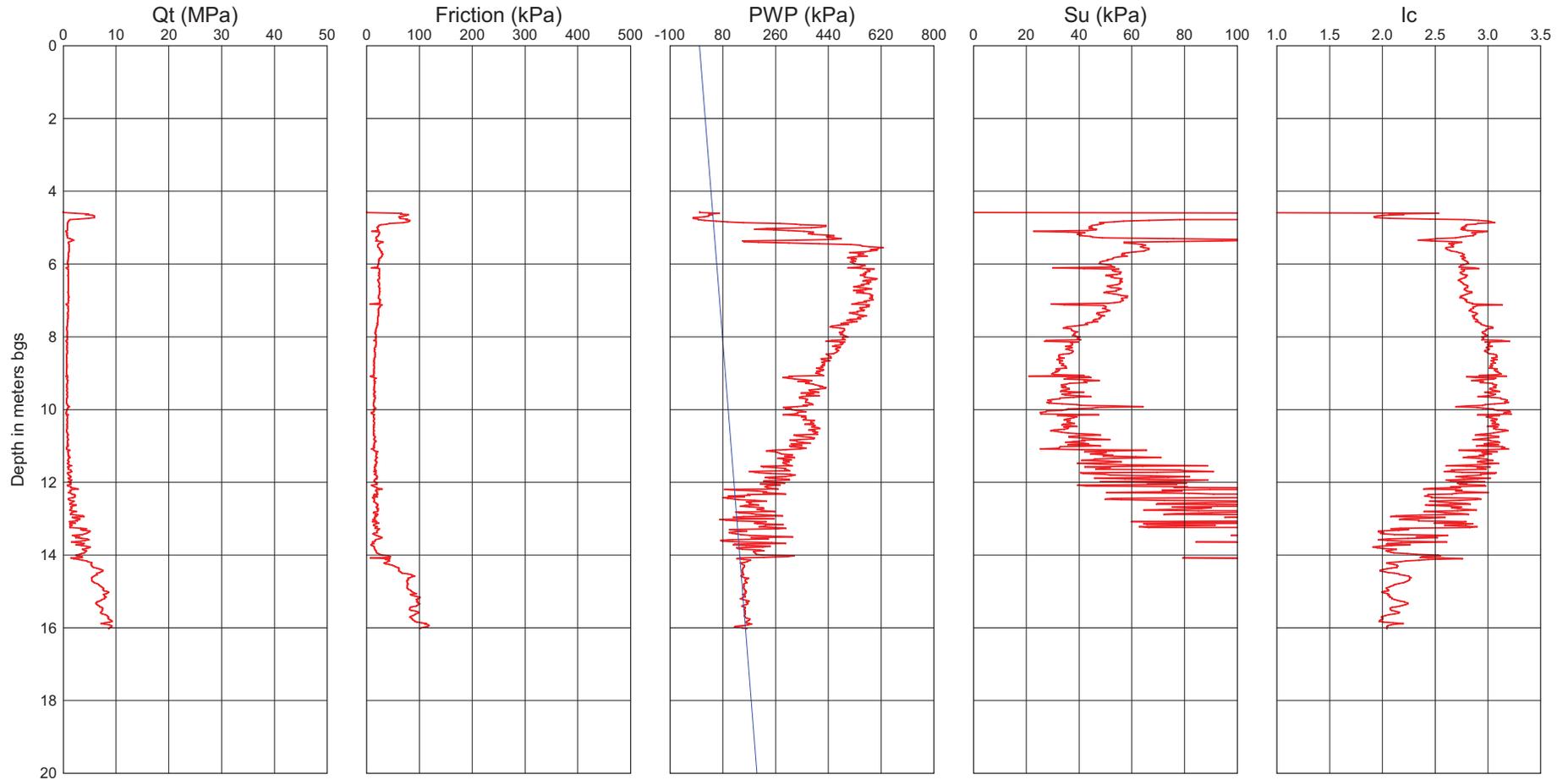
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT302-3

Test Date : March 08, 2009  
 Location : Highway 69 - STA 17+849 o/s 19 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 188.20  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

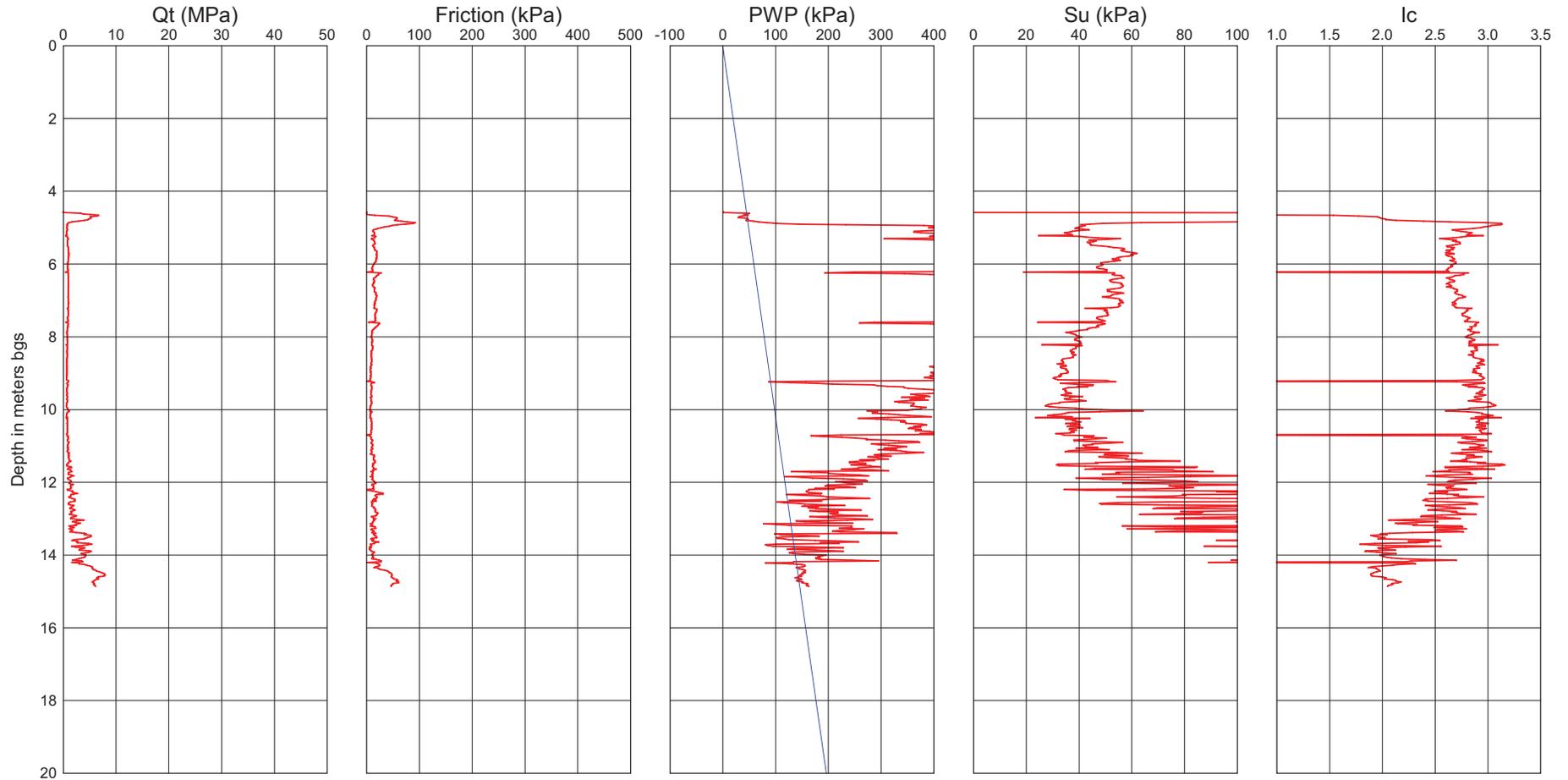
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT302-4

Test Date : March 08, 2009  
 Location : Highway 69 - STA 17+849 o/s 18.5 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 188.20  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

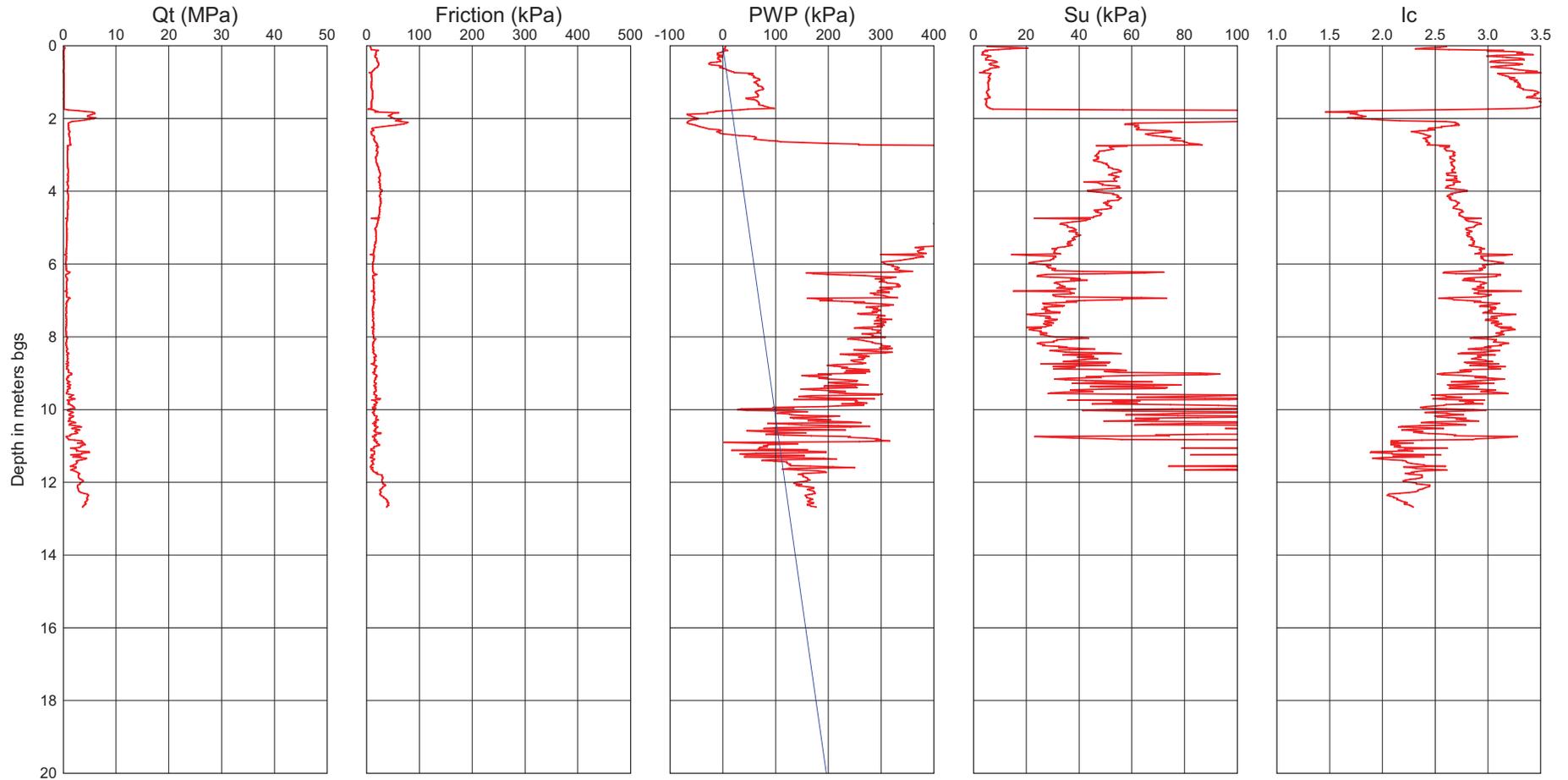
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT302-5

Test Date : March 08, 2009  
 Location : Highway 69 - STA 17+851 o/s 19 m Right

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.10  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

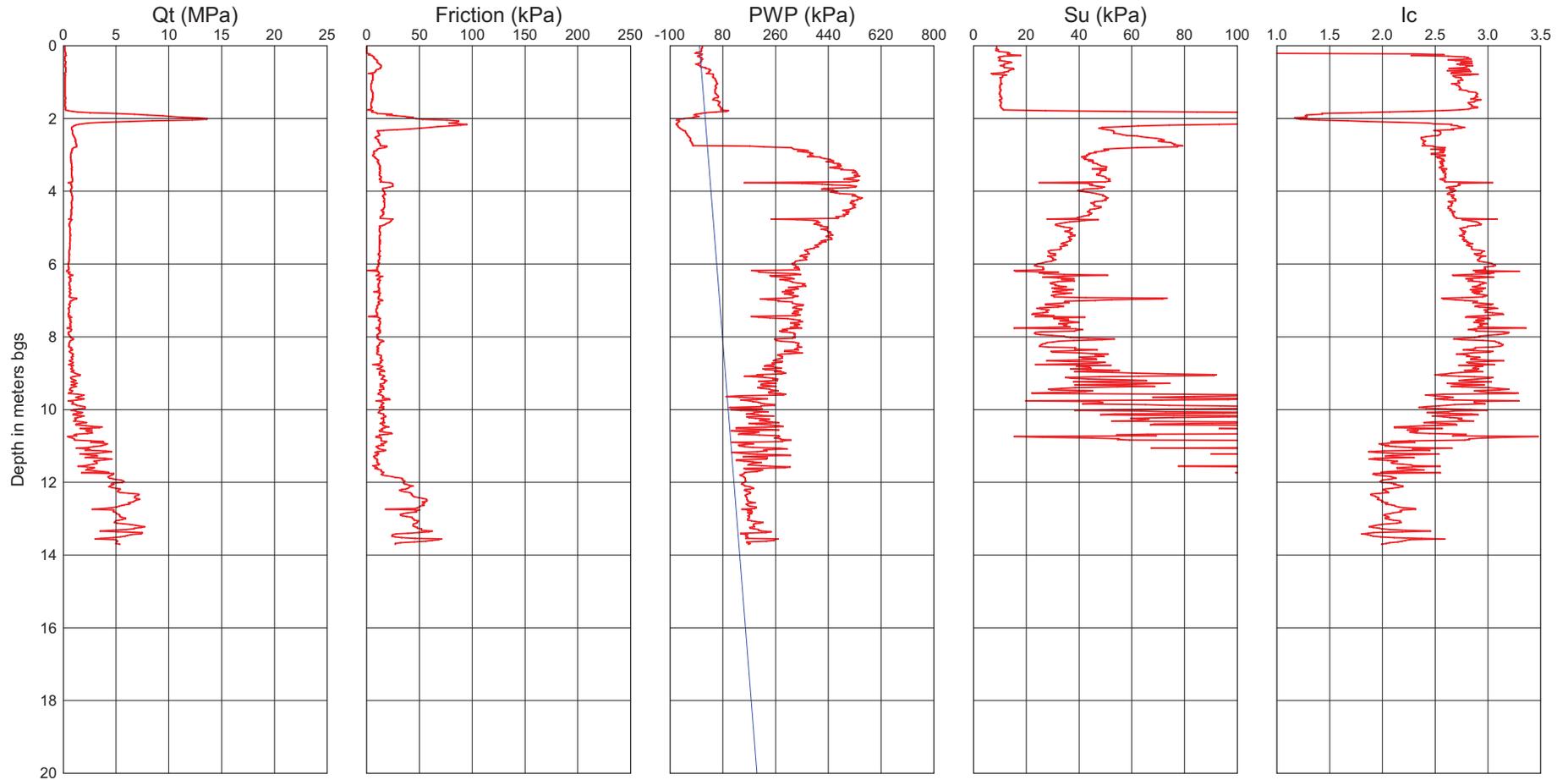
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT302-6

Test Date : Mach 08, 2009  
 Location : Highway 69 - STA 17+852 o/s 19 m Right

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.10  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$Su = (Qt - \text{Sigma}V) / Nk$   
 $Nk = 15.5$   
 $\text{Gamma} = 17 \text{ kN/m}^3$

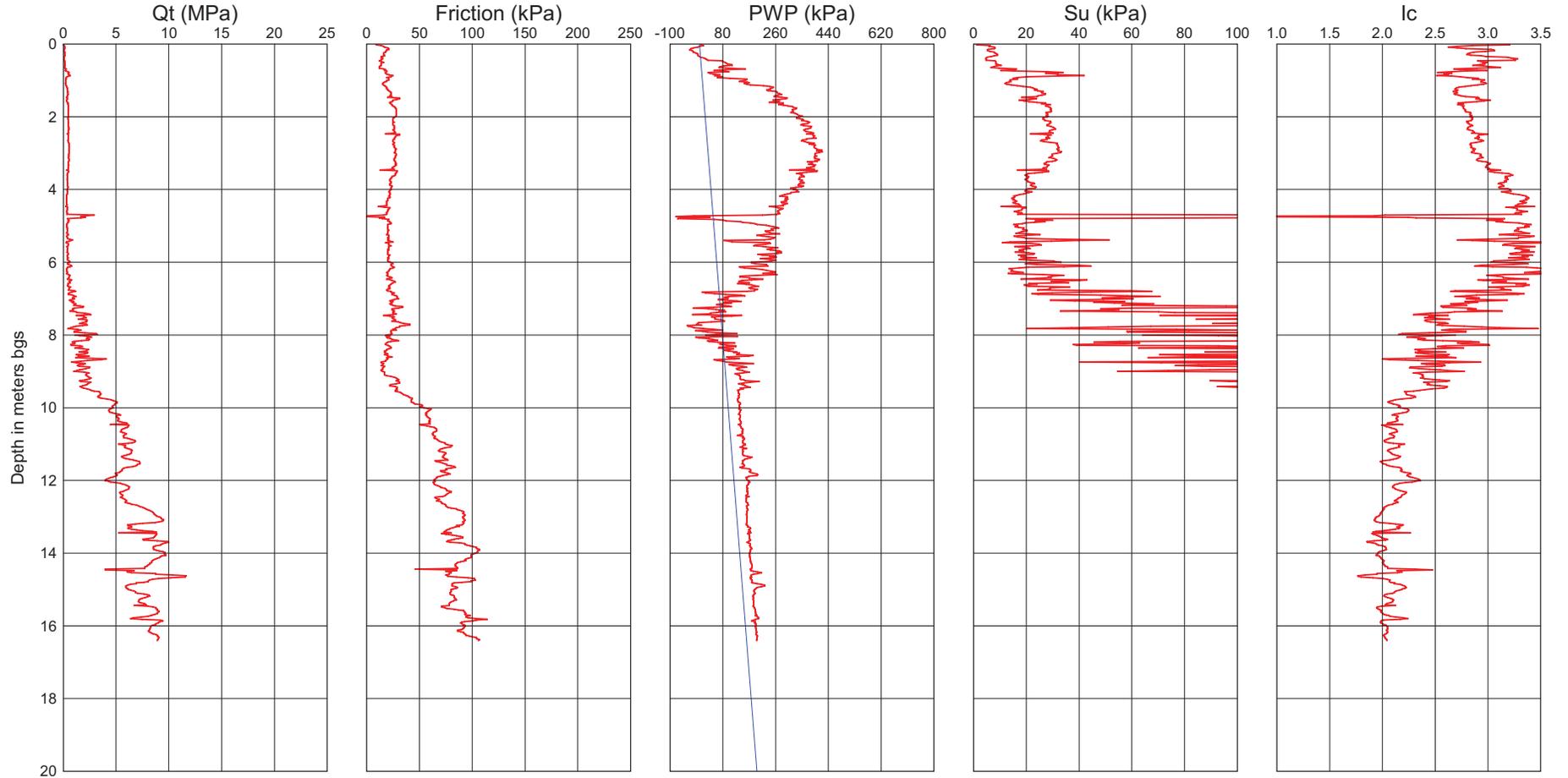
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT302-7

Test Date : March 08, 2009  
 Location : Highway 69 - STA 18+001 o/s 19 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.30  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 17 \text{ kN/m}^3$

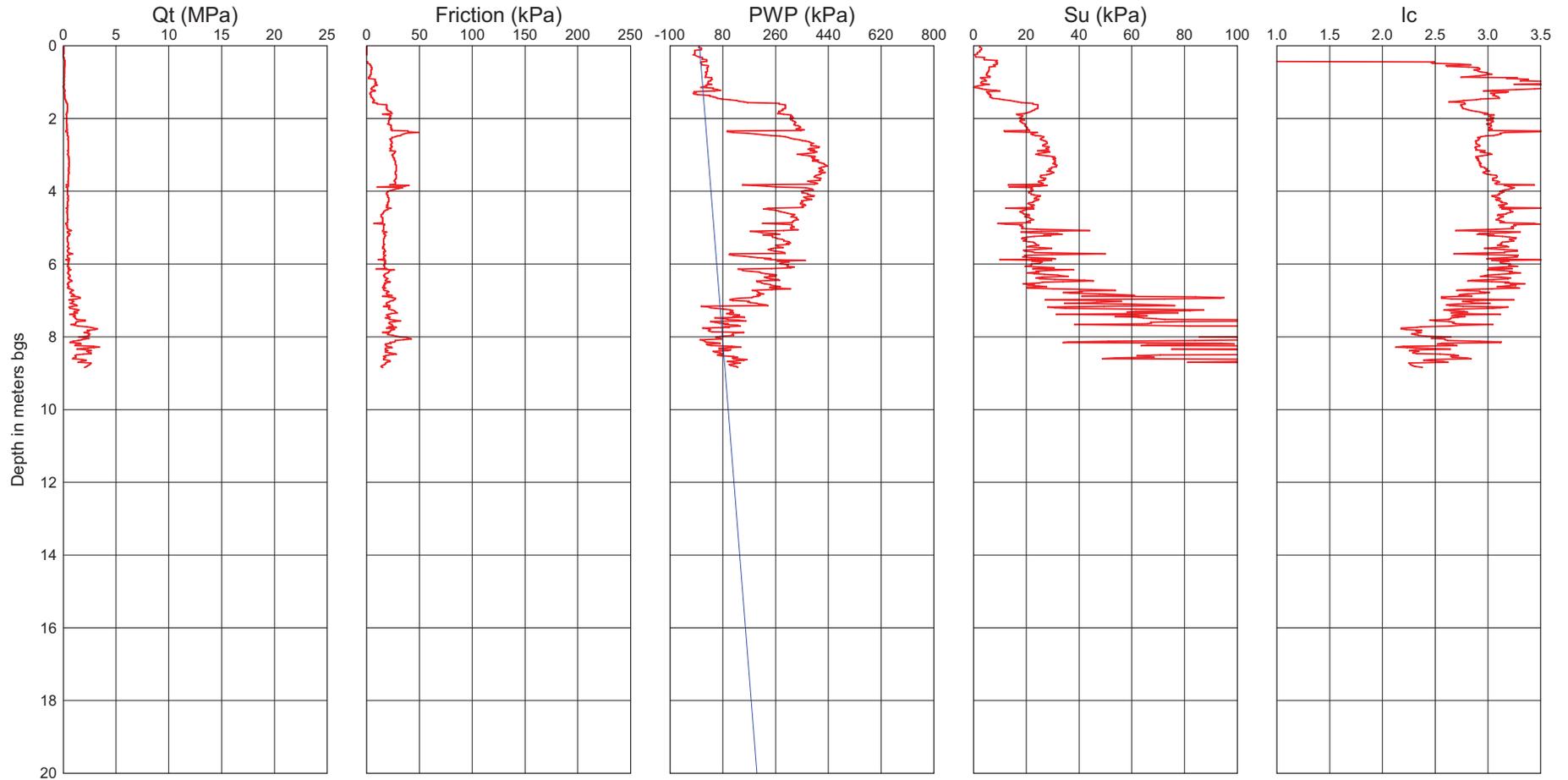
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT302-8

Test Date : March 08, 2008  
 Location : Highway 69 - STA 18+001 o/s 18 m Left

Operator : Golder Associates Ltd.

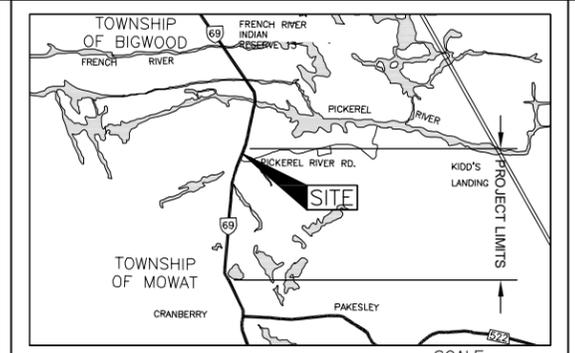
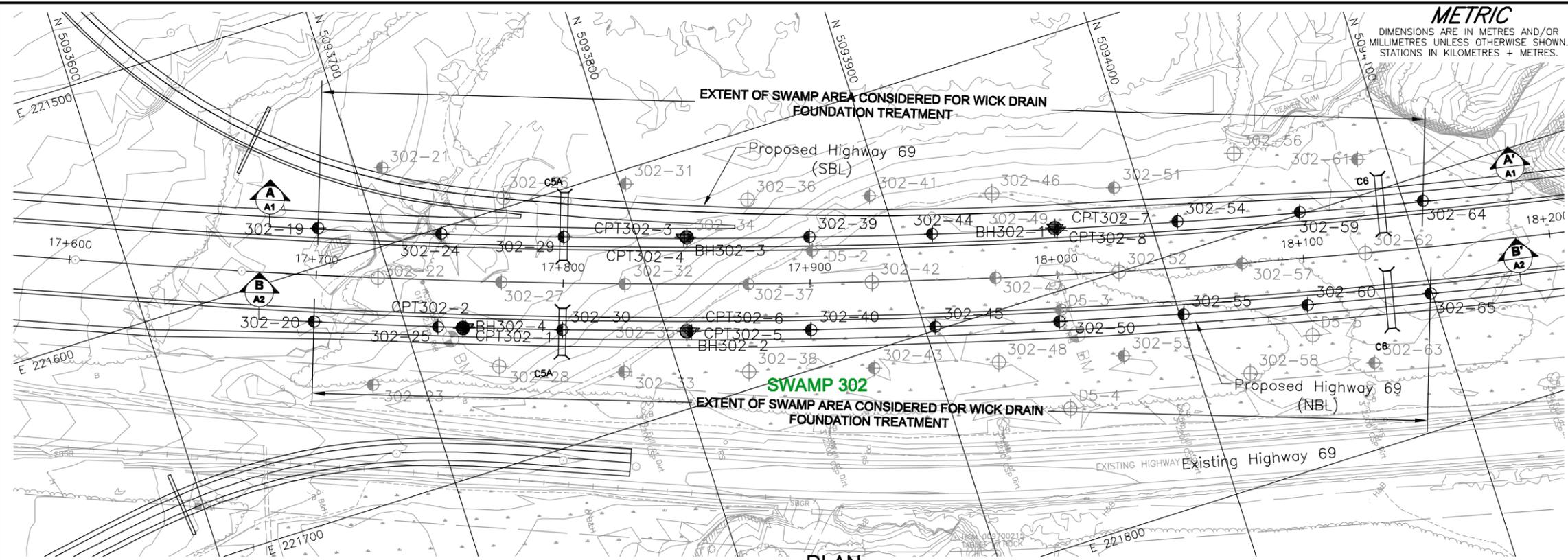
Ground Surf. Elev. : 186.30  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$Su = (Qt - \text{Sigma}V) / Nk$   
 $Nk = 15.5$   
 $\text{Gamma} = 17 \text{ kN/m}^3$

After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays



KEY PLAN SCALE 0 800 m

**LEGEND**

- Borehole - Current Investigation
- ⊕ CPT - Current Investigation
- ⊕ Borehole - Previous Investigation (Peto MacCallum Ltd.)
- ⊕ Dynamic Cone Penetration Test - Previous Investigation (Peto MacCallum Ltd.)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ▽ WL observed during or upon completion of drilling
- R Refusal

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
BH302-1	186.3	5093962.4	221675.2
BH302-2	186.1	5093807.7	221670.0
BH302-3	188.2	5093819.2	221633.7
BH302-4	188.2	5093721.8	221641.3
CPT302-1	188.2	5093722.8	221641.6
CPT302-2	188.2	5093723.0	221641.1
CPT302-3	188.2	5093818.3	221633.4
CPT302-4	188.2	5093818.1	221633.9
CPT302-5	186.1	5093808.7	221670.3
CPT302-6	186.1	5093809.7	221670.6
CPT302-7	186.3	5093962.4	221675.2
CPT302-8	186.3	5093963.1	221676.5

**NOTES**

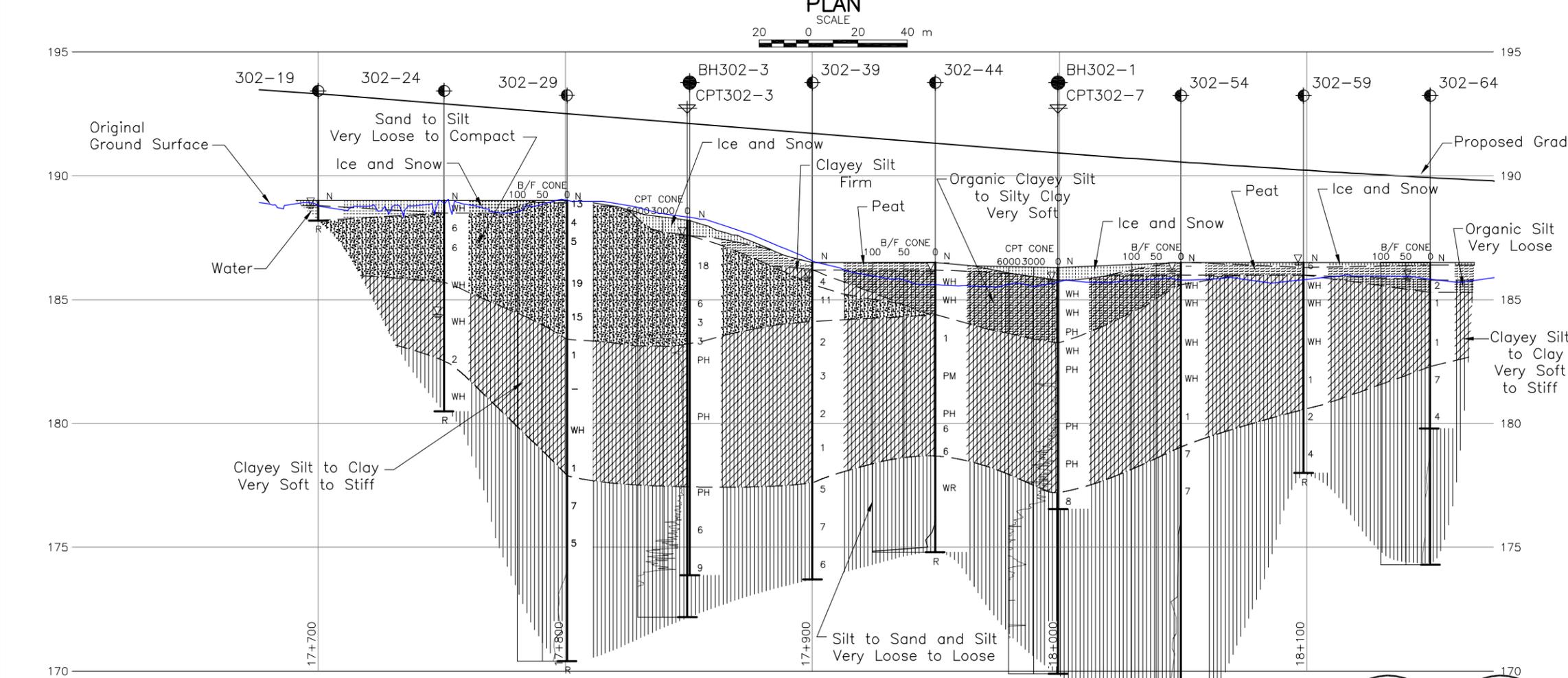
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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

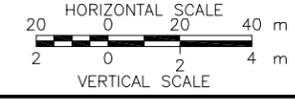
The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS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

**REFERENCE**

Base plans and Profile provided in digital format by MRC, drawing file's no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009. 1-6454\_Phase3-ML PROFILE-Mar 26-09.dwg, received Sept. 30, 2009.



**A-A' CENTRELINE PROFILE**



**PROFESSIONAL ENGINEER**  
J. P. DITTRICH  
PROVINCE OF ONTARIO  
Jan. 16, 2012

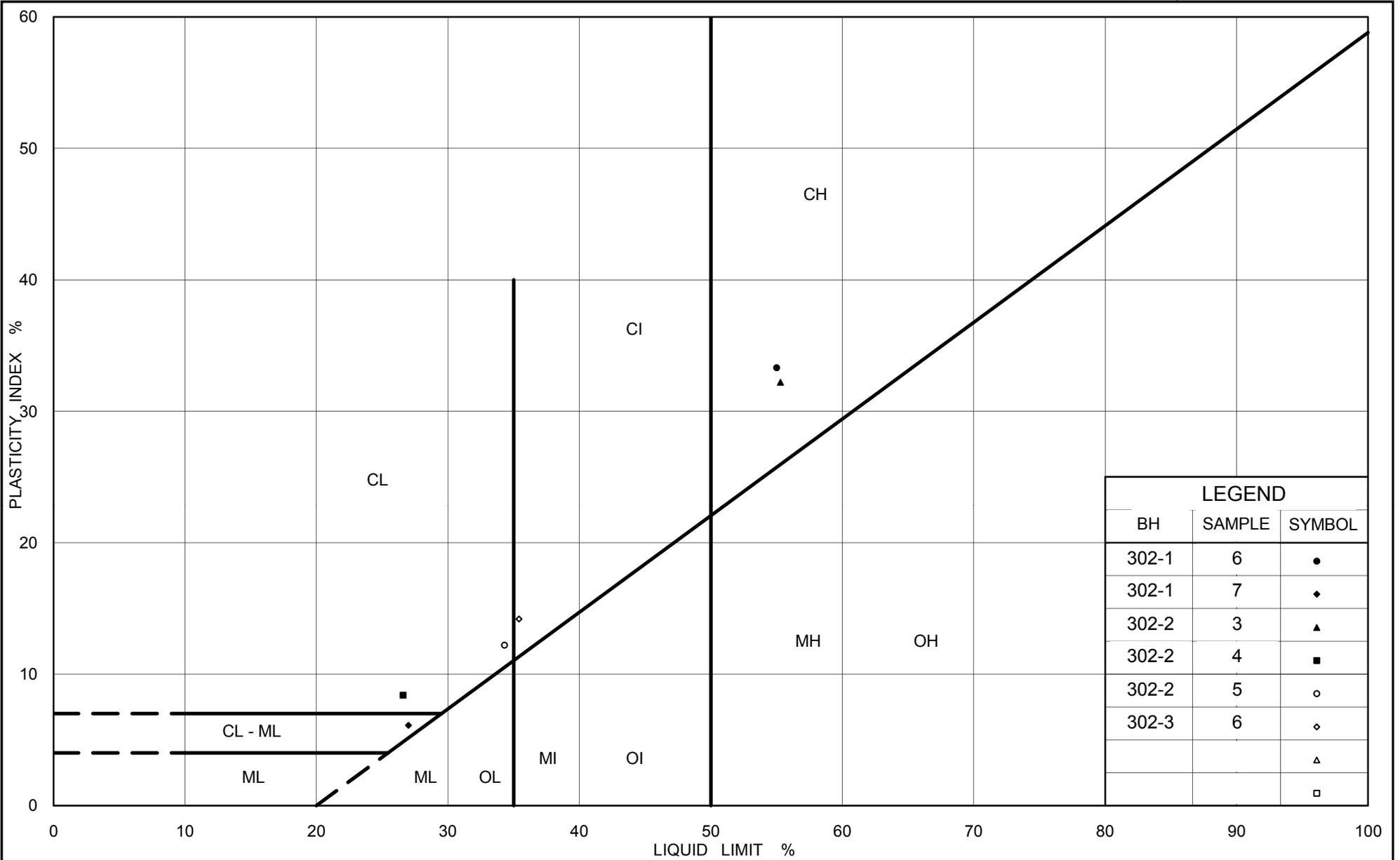
**PROFESSIONAL ENGINEER**  
J. M. A. COSTA  
PROVINCE OF ONTARIO  
Jan. 16, 2012

NO.	DATE	BY	REVISION

Geocres No. 41H-106

HWY. 69	PROJECT NO. 06-1111-025	DIST.
SUBM'D. MWK	CHKD. MWK	DATE: Feb. 2012
DRAWN: RJ/JFC	CHKD. VA	APPD. JPD/JMAC
		DWG. A1





Ministry of Transportation

Ontario

**PLASTICITY CHART**  
 Clayey Silt to Clay  
 Highway 69 (SBL and NBL) STA 17+700 to 18+150

Figure No. A.S302-1

Project No. 06-1111-025

Checked By: TVA

## CONSOLIDATION TEST SUMMARY

**Highway 69 (SBL and NBL) STA 17+700 to 18+150**

**FIGURE A.S302-2**

**Sheet 1 of 4**

### SAMPLE IDENTIFICATION

Project Number	06-1111-025	Sample Number	6
Borehole Number	302-1	Sample Depth, m	3.8-4.4

### TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	4		
Date Started	04/03/2009		
Date Completed	04/18/2009		

### SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m <sup>3</sup>	16.31
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	10.83
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.76
Volume, cm <sup>3</sup>	80.19	Solids Height, cm	1.016
Water Content, %	50.58	Volume of Solids, cm <sup>3</sup>	32.09
Wet Mass, g	133.35	Volume of Voids, cm <sup>3</sup>	48.10
Dry Mass, g	88.56	Degree of Saturation, %	93.1

### TEST COMPUTATIONS

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv. cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	2.540	1.499	2.540				
4.77	2.482	1.442	2.511	1	1.34E+00	4.79E-03	6.27E-04
9.58	2.472	1.432	2.477	9	1.45E-01	8.19E-04	1.16E-05
19.31	2.456	1.416	2.464	8	1.61E-01	6.47E-04	1.02E-05
38.80	2.429	1.390	2.443	9	1.41E-01	5.45E-04	7.51E-06
77.64	2.386	1.348	2.408	10	1.23E-01	4.36E-04	5.25E-06
155.06	2.295	1.258	2.341	18	6.45E-02	4.63E-04	2.93E-06
310.20	2.099	1.065	2.197	51	2.01E-02	4.97E-04	9.78E-07
619.87	1.927	0.896	2.013	63	1.36E-02	2.19E-04	2.92E-07
1239.98	1.796	0.767	1.862	22	3.34E-02	8.32E-05	2.72E-07
2482.66	1.686	0.659	1.741	32	2.01E-02	3.48E-05	6.86E-08
1239.98	1.694	0.667	1.690				
310.20	1.754	0.726	1.724				
77.64	1.785	0.756	1.770				
19.34	1.785	0.756	1.785				
4.77	1.799	0.770	1.792				

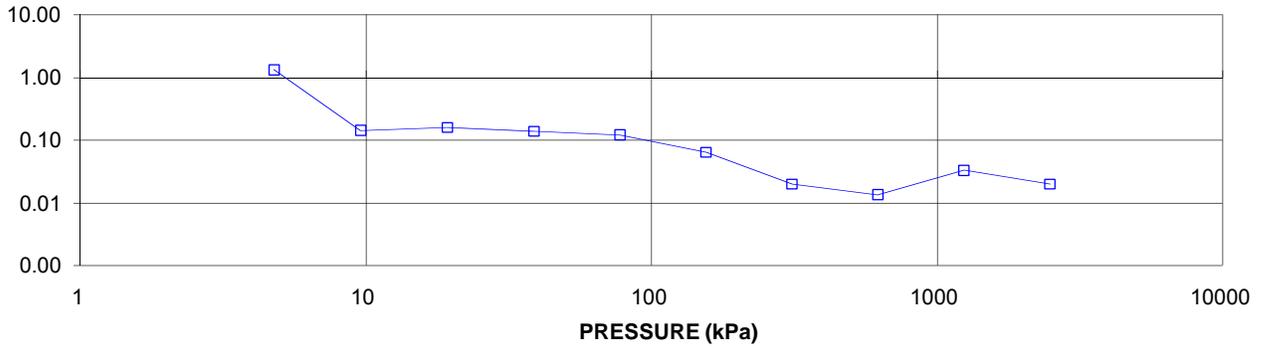
Note:  
k calculated using cv based on t<sub>90</sub> values.

### SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.80	Unit Weight, kN/m <sup>3</sup>	19.96
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	15.29
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.76
Volume, cm <sup>3</sup>	56.79	Solids Height, cm	1.016
Water Content, %	30.50	Volume of Solids, cm <sup>3</sup>	32.09
Wet Mass, g	115.57	Volume of Voids, cm <sup>3</sup>	24.71
Dry Mass, g	88.56		

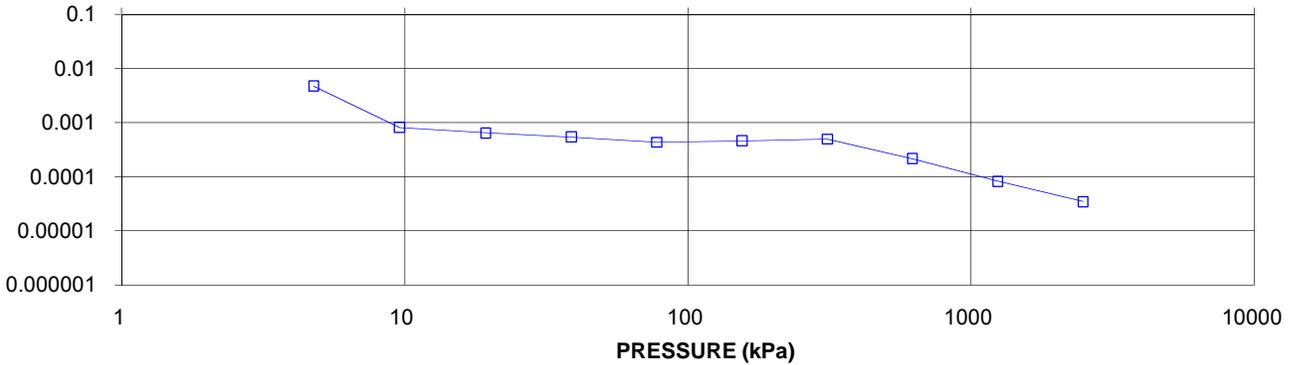
COEFFICIENT OF CONSOLIDATION,  
 cm<sup>2</sup>/s

**CONSOLIDATION TEST**  
 CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
 BH 302-1 SA 6



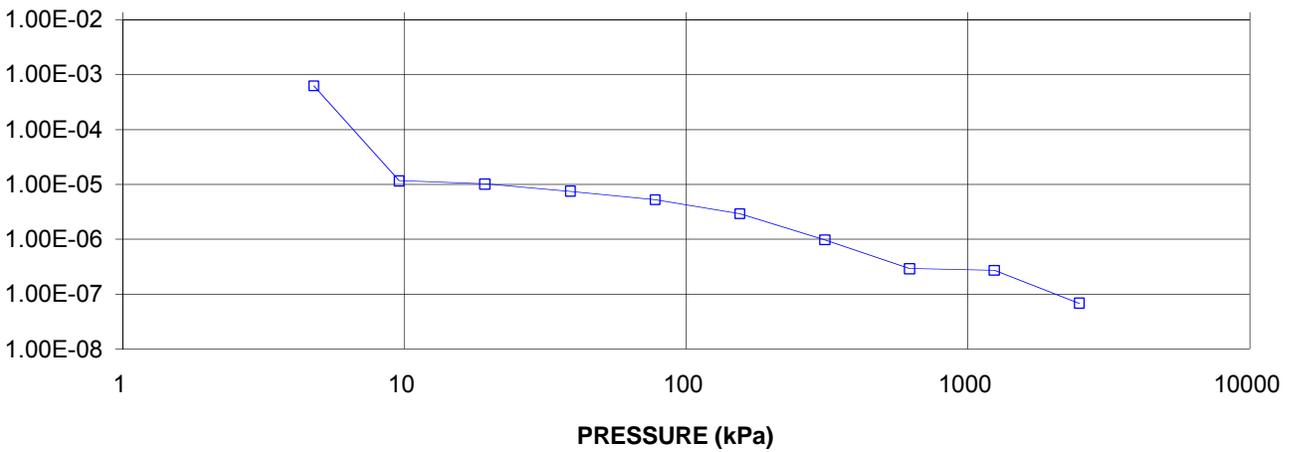
VOLUME COMPRESSIBILITY, m<sup>2</sup>/kN

**CONSOLIDATION TEST**  
 MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
 BH 302-1 SA 6

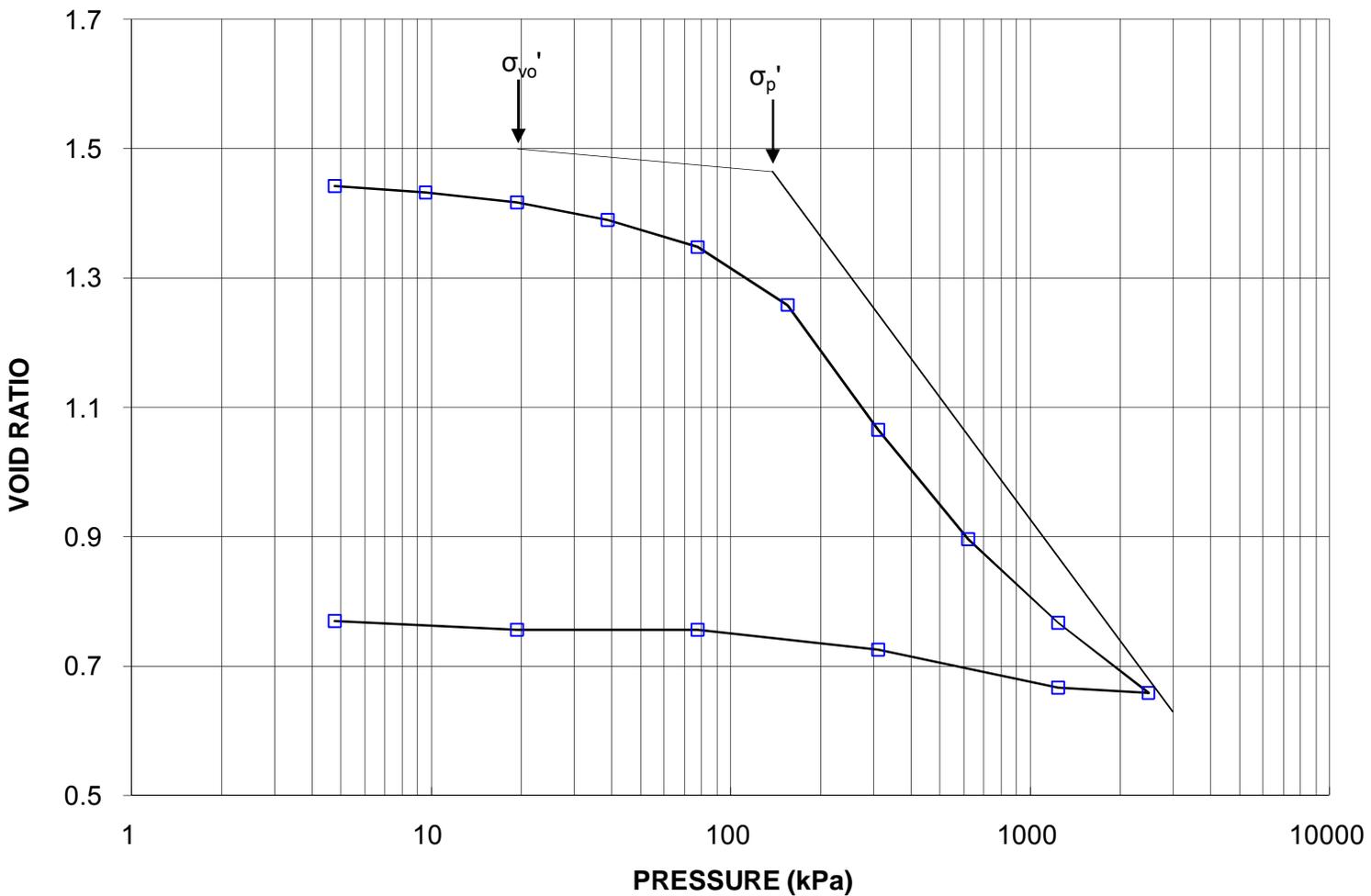


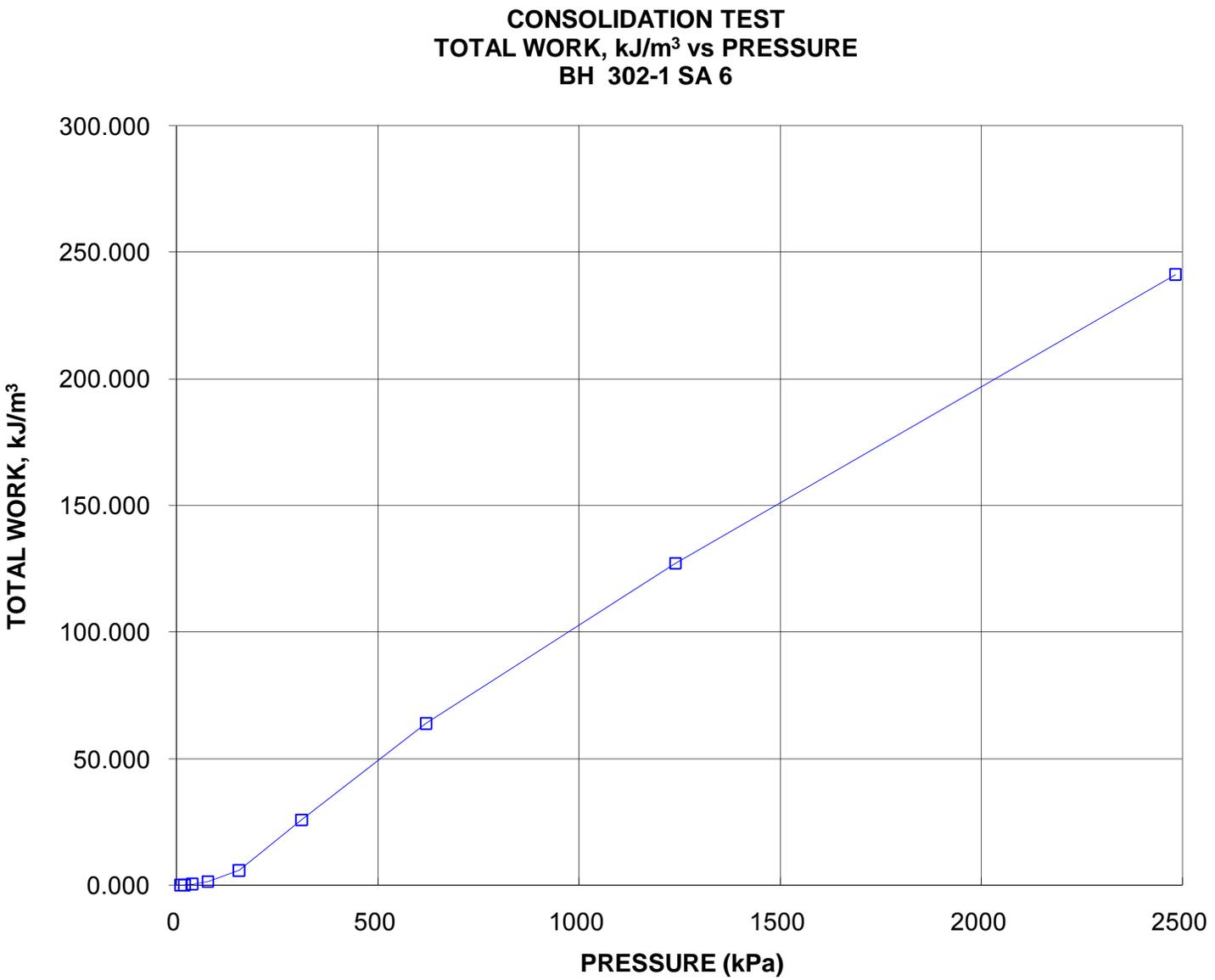
HYDRAULIC CONDUCTIVITY, cm/s

**CONSOLIDATION TEST**  
 HYDRAULIC CONDUCTIVITY vs PRESSURE  
 BH 302-1 SA 6



CONSOLIDATION TEST  
VOID RATIO vs PRESSURE  
BH 302-1 SA 6





**CONSOLIDATION TEST SUMMARY****Highway 69 (SBL and NBL) STA 17+700 to 18+150****FIGURE A.S302-3****Sheet 1 of 4****SAMPLE IDENTIFICATION**

Project Number	06-1111-025	Sample Number	7
Borehole Number	302-1	Sample Depth, m	6.1-6.7

**TEST CONDITIONS**

Test Type	Standard	Load Duration, hr	24
Oedometer Number	1		
Date Started	04/09/2009		
Date Completed	04/24/2009		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	2.54	Unit Weight, kN/m <sup>3</sup>	18.84
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	14.38
Area, cm <sup>2</sup>	31.61	Specific Gravity, measured	2.74
Volume, cm <sup>3</sup>	80.38	Solids Height, cm	1.361
Water Content, %	30.96	Volume of Solids, cm <sup>3</sup>	43.03
Wet Mass, g	154.40	Volume of Voids, cm <sup>3</sup>	37.35
Dry Mass, g	117.9	Degree of Saturation, %	97.7

**TEST COMPUTATIONS**

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv. cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	2.543	0.868	2.543				
4.70	2.495	0.833	2.519	2	6.73E-01	4.02E-03	2.65E-04
9.56	2.484	0.824	2.489	19	6.91E-02	9.14E-04	6.19E-06
19.29	2.474	0.817	2.479	41	3.18E-02	4.00E-04	1.25E-06
38.75	2.459	0.806	2.466	14	9.21E-02	3.05E-04	2.75E-06
77.53	2.438	0.791	2.448	9	1.41E-01	2.11E-04	2.92E-06
154.98	2.403	0.765	2.420	14	8.87E-02	1.77E-04	1.54E-06
309.92	2.332	0.713	2.367	15	7.92E-02	1.81E-04	1.40E-06
620.47	2.265	0.664	2.298	14	8.00E-02	8.52E-05	6.68E-07
1240.29	2.202	0.618	2.233	28	3.78E-02	3.94E-05	1.46E-07
2478.90	2.149	0.578	2.175	15	6.69E-02	1.71E-05	1.12E-07
1240.29	2.152	0.581	2.150				
309.92	2.174	0.597	2.163				
77.53	2.190	0.609	2.182				
19.29	2.208	0.622	2.199				
4.70	2.222	0.633	2.215				

Note:

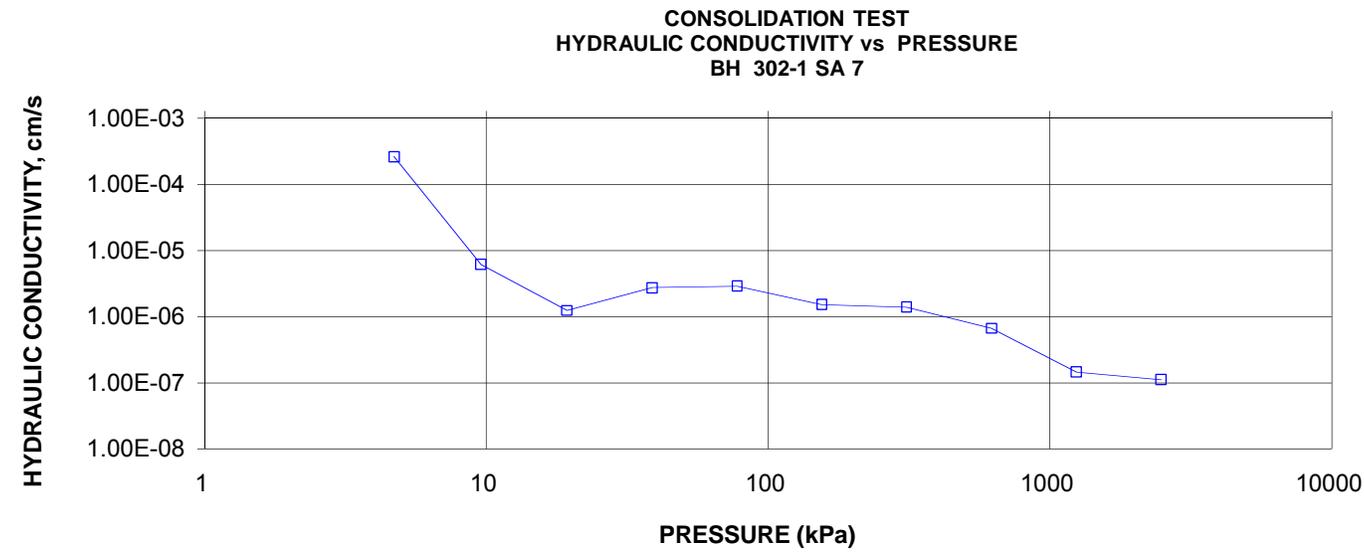
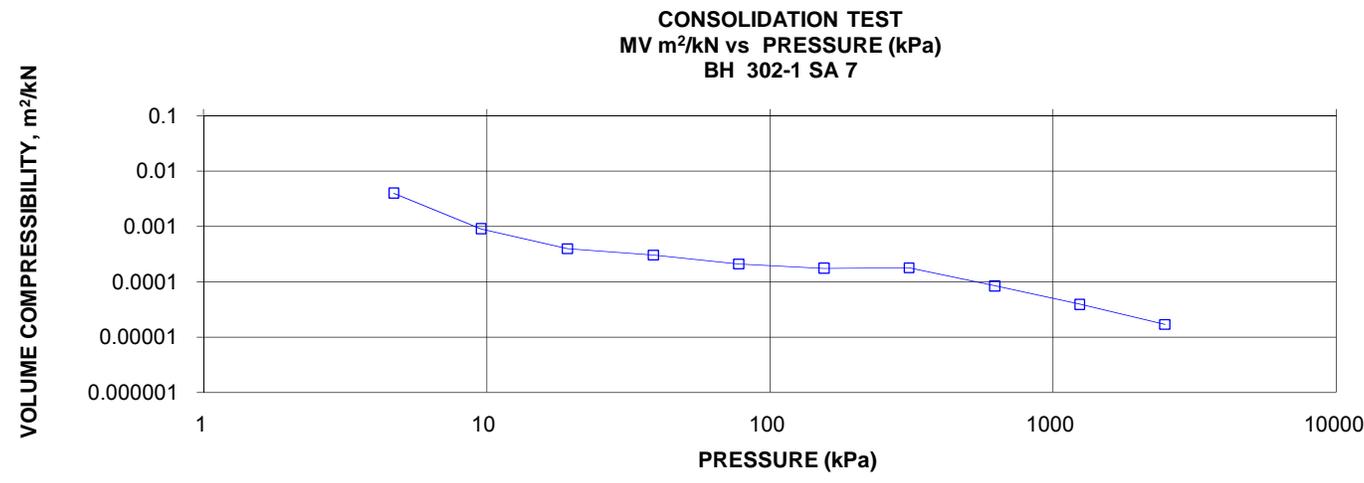
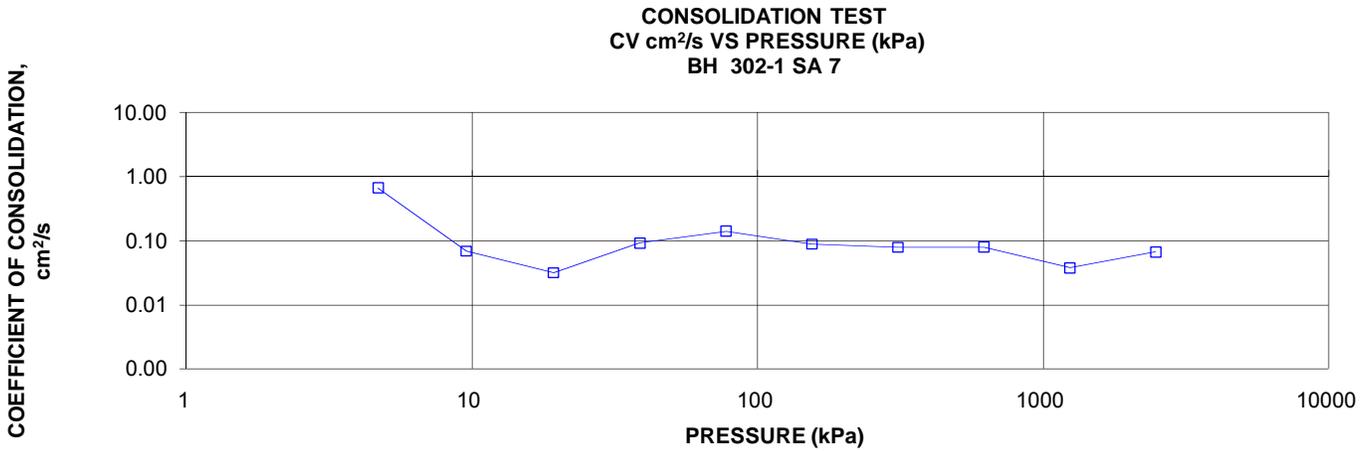
k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

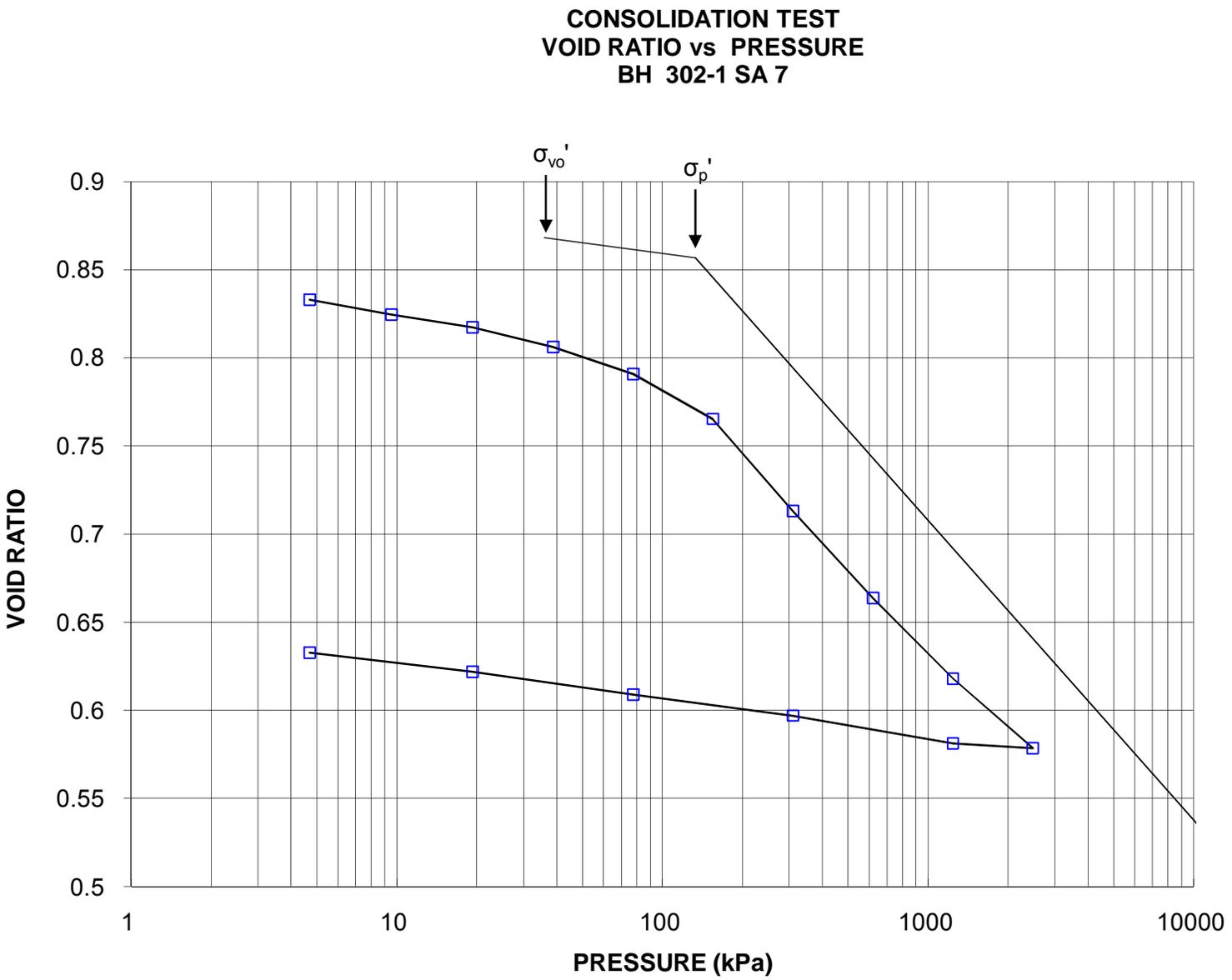
Sample Height, cm	2.22	Unit Weight, kN/m <sup>3</sup>	20.39
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	16.46
Area, cm <sup>2</sup>	31.61	Specific Gravity, measured	2.74
Volume, cm <sup>3</sup>	70.25	Solids Height, cm	1.361
Water Content, %	23.90	Volume of Solids, cm <sup>3</sup>	43.03
Wet Mass, g	146.08	Volume of Voids, cm <sup>3</sup>	27.22
Dry Mass, g	117.9		

Prepared By: LH

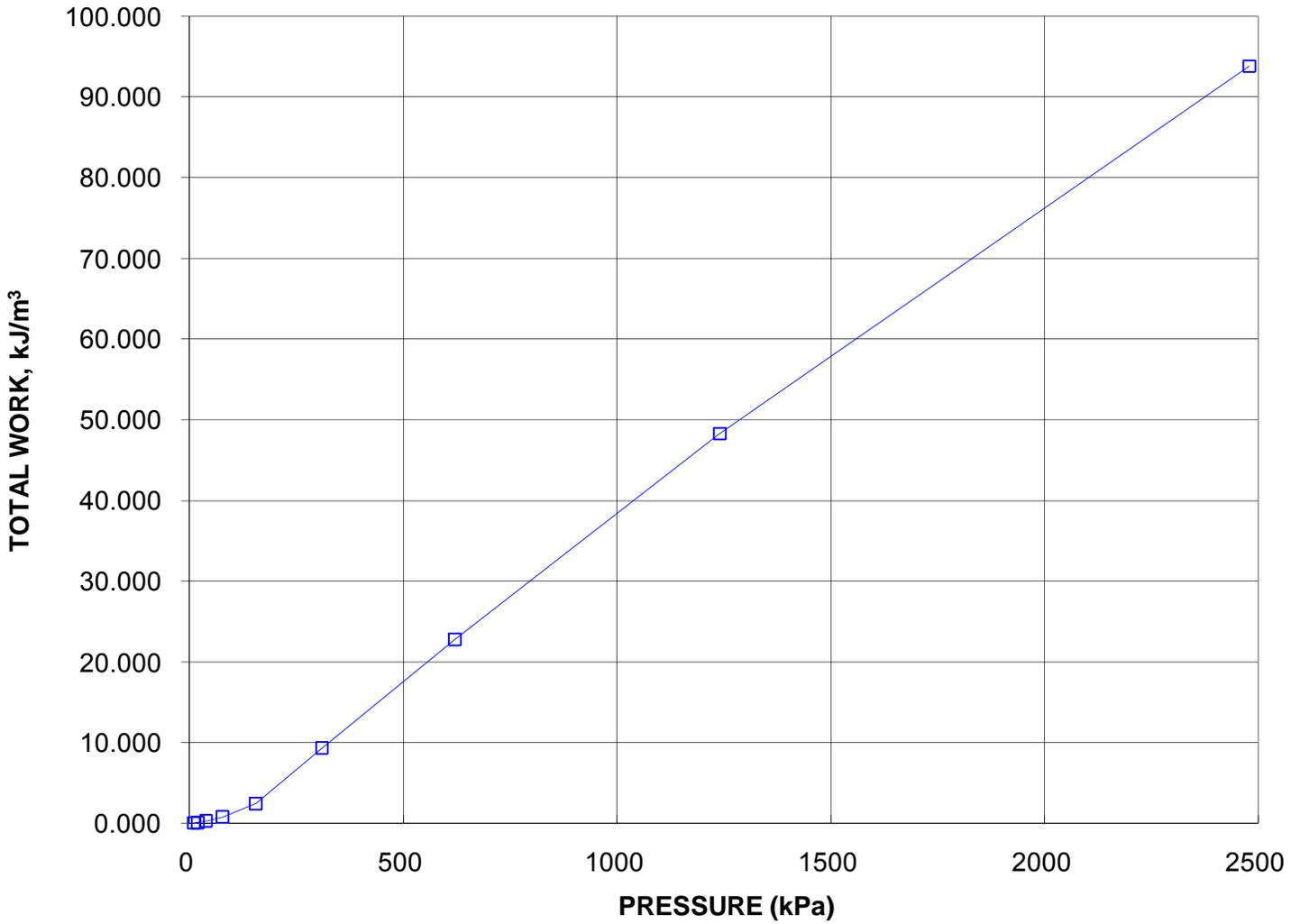
**Golder Associates**

Checked By: MM





CONSOLIDATION TEST  
TOTAL WORK, kJ/m<sup>3</sup> vs PRESSURE  
BH 302-1 SA 7



**CONSOLIDATION TEST SUMMARY**  
**Highway 69 (SBL and NBL) STA 17+700 to 18+150**

**FIGURE A.S302-4**  
**Sheet 1 of 4**

**SAMPLE IDENTIFICATION**

Project Number	06-1111-025	Sample Number	3
Borehole Number	302-2	Sample Depth, m	3.8-4.4

**TEST CONDITIONS**

Test Type	Standard	Load Duration, hr	24
Oedometer Number	2		
Date Started	04/15/2009		
Date Completed	04/30/2009		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	2.54	Unit Weight, kN/m <sup>3</sup>	15.61
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	9.39
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.75
Volume, cm <sup>3</sup>	80.28	Solids Height, cm	0.885
Water Content, %	66.32	Volume of Solids, cm <sup>3</sup>	27.94
Wet Mass, g	127.80	Volume of Voids, cm <sup>3</sup>	52.34
Dry Mass, g	76.84	Degree of Saturation, %	97.4

**TEST COMPUTATIONS**

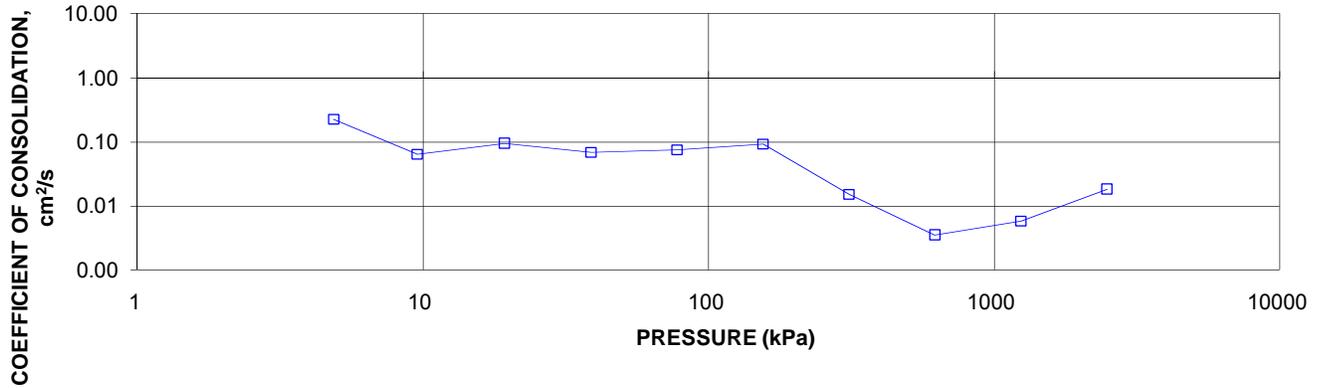
Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv. cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	2.543	1.873	2.543				
4.87	2.534	1.863	2.539	6	2.28E-01	7.27E-04	1.62E-05
9.56	2.525	1.853	2.530	21	6.46E-02	7.55E-04	4.78E-06
19.31	2.506	1.831	2.516	14	9.58E-02	7.66E-04	7.20E-06
38.81	2.480	1.802	2.493	19	6.93E-02	5.24E-04	3.56E-06
77.62	2.441	1.758	2.461	17	7.55E-02	3.95E-04	2.92E-06
155.06	2.343	1.647	2.392	13	9.33E-02	4.98E-04	4.55E-06
310.20	2.116	1.391	2.230	69	1.53E-02	5.75E-04	8.61E-07
619.74	1.903	1.150	2.010	240	3.57E-03	2.71E-04	9.46E-08
1240.00	1.741	0.967	1.822	120	5.86E-03	1.03E-04	5.90E-08
2481.00	1.605	0.813	1.673	32	1.85E-02	4.31E-05	7.83E-08
1240.00	1.615	0.825	1.610				
310.20	1.655	0.870	1.635				
77.62	1.712	0.934	1.684				
19.31	1.759	0.987	1.736				
4.87	1.796	1.029	1.778				

Note:  
k calculated using cv based on t<sub>90</sub> values.

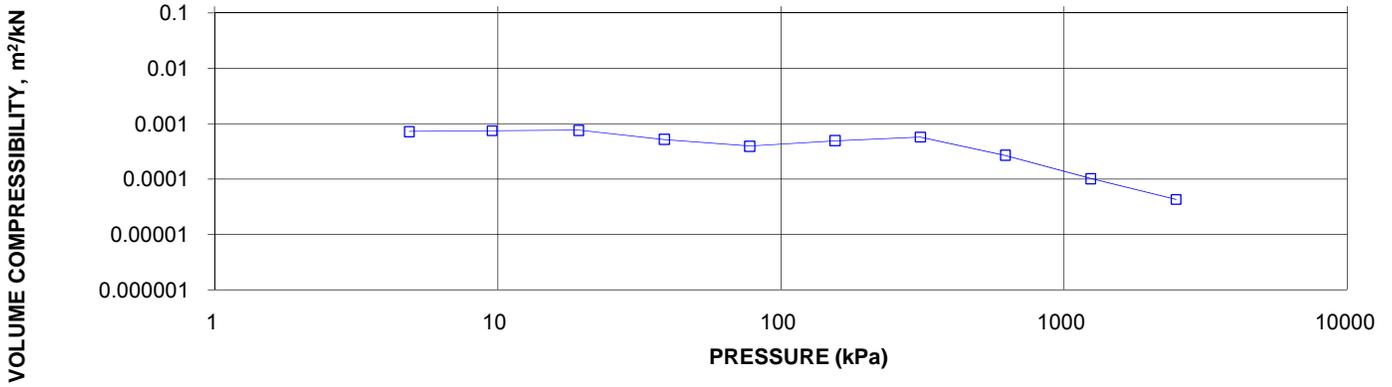
**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.80	Unit Weight, kN/m <sup>3</sup>	18.45
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	13.29
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.75
Volume, cm <sup>3</sup>	56.70	Solids Height, cm	0.885
Water Content, %	38.79	Volume of Solids, cm <sup>3</sup>	27.94
Wet Mass, g	106.65	Volume of Voids, cm <sup>3</sup>	28.76
Dry Mass, g	76.84		

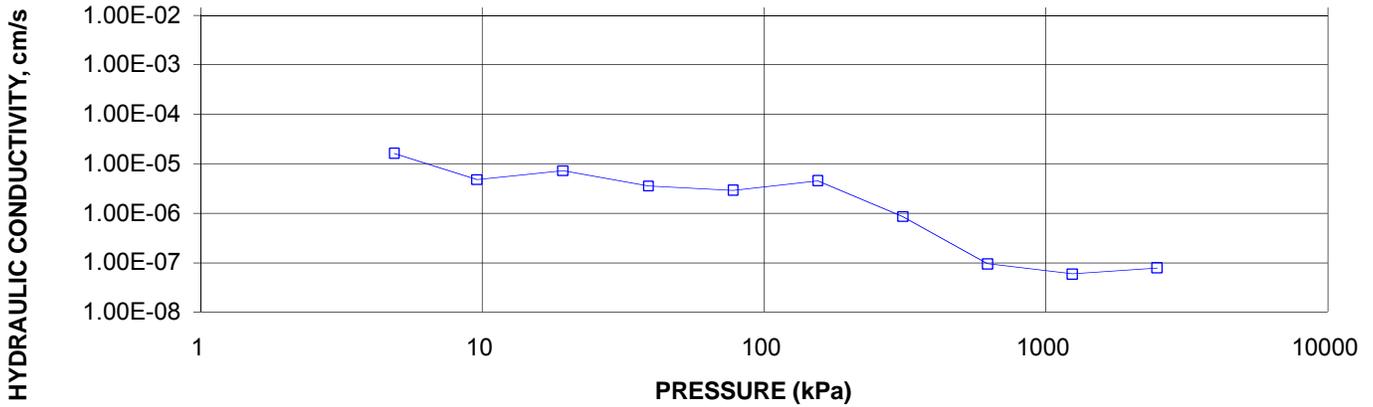
**CONSOLIDATION TEST**  
 CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
 BH 302-2 SA 3

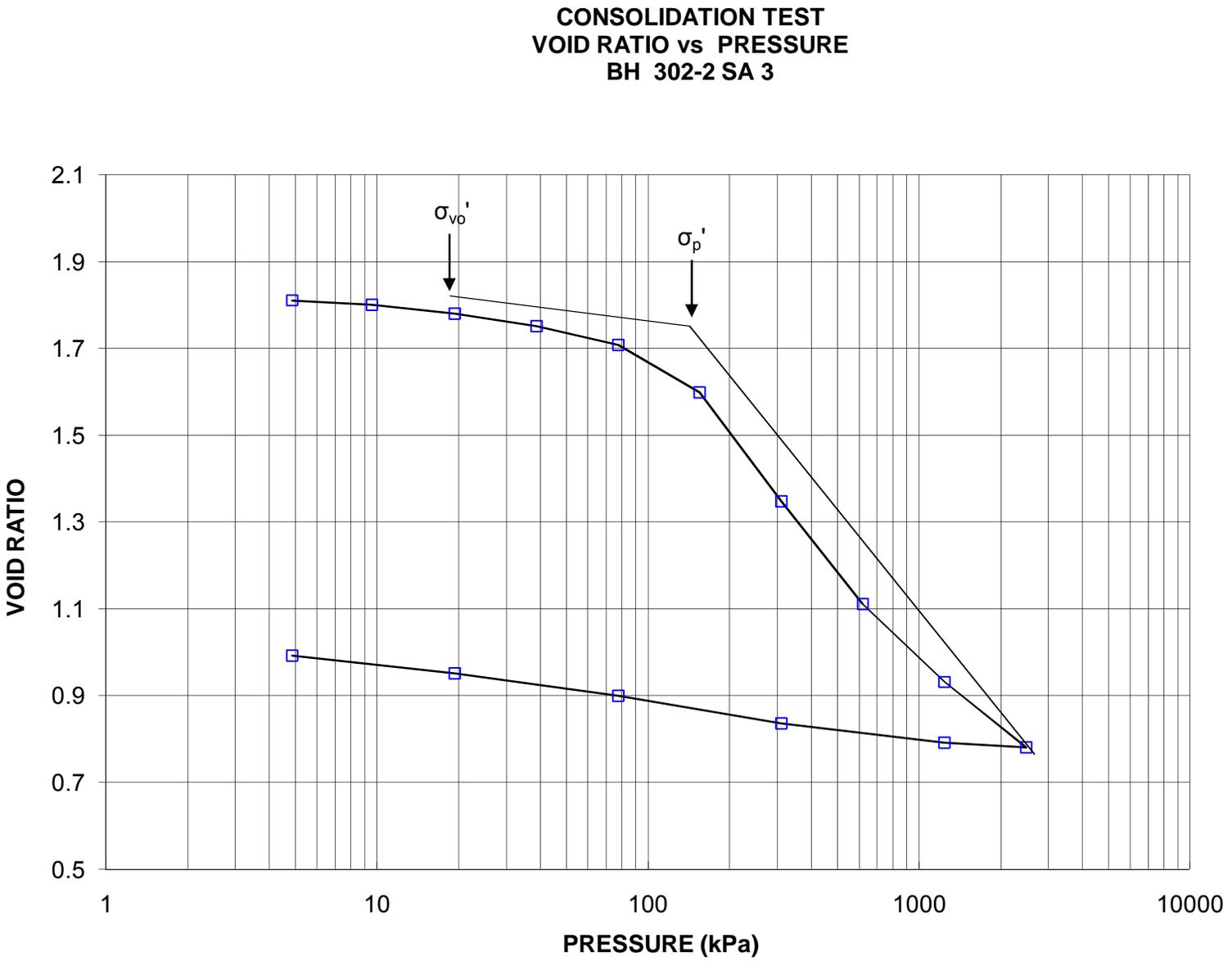


**CONSOLIDATION TEST**  
 MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
 BH 302-2 SA 3

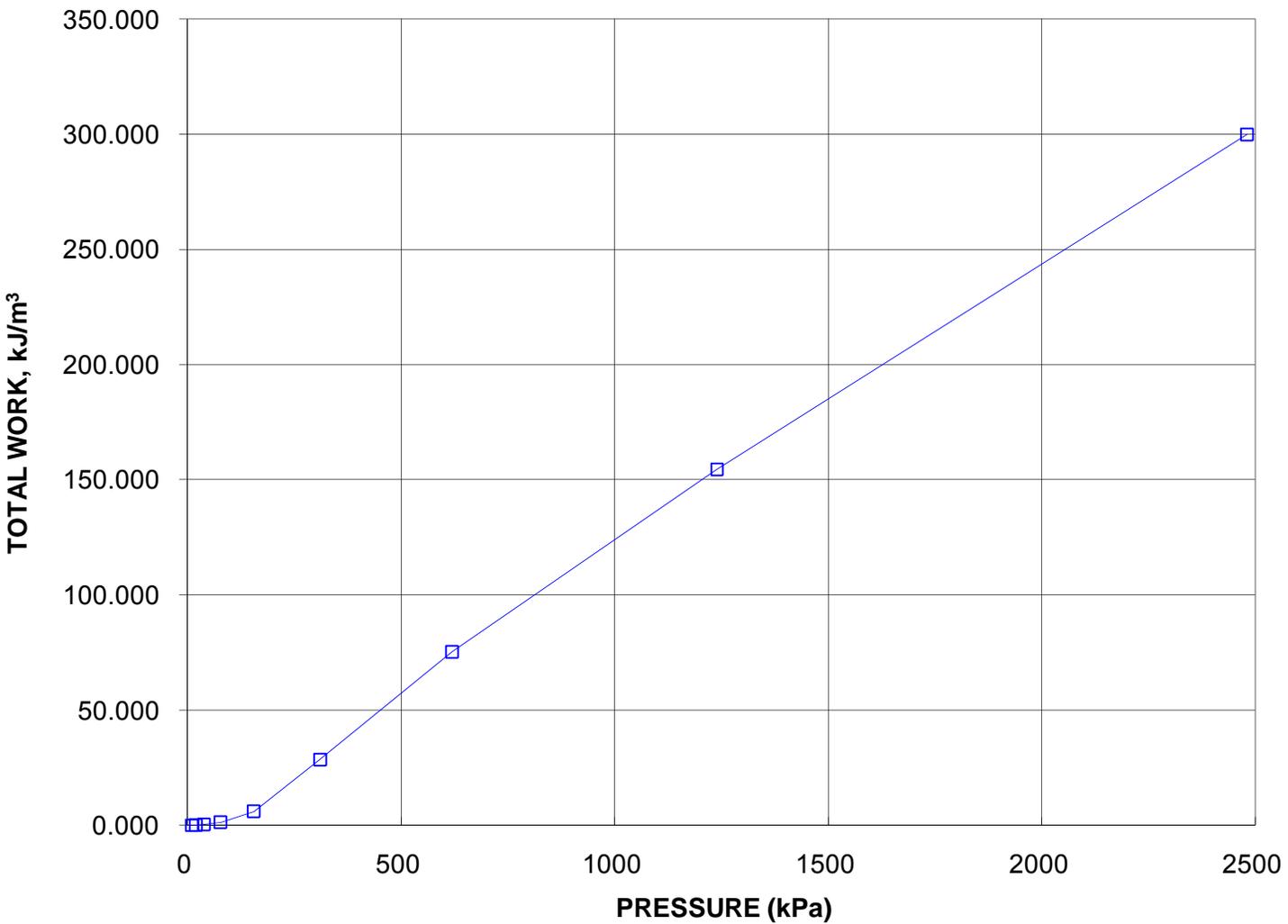


**CONSOLIDATION TEST**  
 HYDRAULIC CONDUCTIVITY vs PRESSURE  
 BH 302-2 SA 3





CONSOLIDATION TEST  
TOTAL WORK, kJ/m<sup>3</sup> vs PRESSURE  
BH 302-2 SA 3



**CONSOLIDATION TEST SUMMARY**  
**Highway 69 (SBL and NBL) STA 17+700 to 18+150**

**FIGURE A.S302-5**  
**Sheet 1 of 4**

**SAMPLE IDENTIFICATION**

Project Number	06-1111-025	Sample Number	4
Borehole Number	302-2	Sample Depth, m	6.1-6.7

**TEST CONDITIONS**

Test Type	Standard	Load Duration, hr	24
Oedometer Number	7		
Date Started	06/25/2009		
Date Completed	07/10/2009		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	1.89	Unit Weight, kN/m <sup>3</sup>	20.36
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	15.80
Area, cm <sup>2</sup>	31.55	Specific Gravity, measured	2.72
Volume, cm <sup>3</sup>	59.76	Solids Height, cm	1.122
Water Content, %	28.83	Volume of Solids, cm <sup>3</sup>	35.40
Wet Mass, g	124.04	Volume of Voids, cm <sup>3</sup>	24.36
Dry Mass, g	96.28	Degree of Saturation, %	114.0

**TEST COMPUTATIONS**

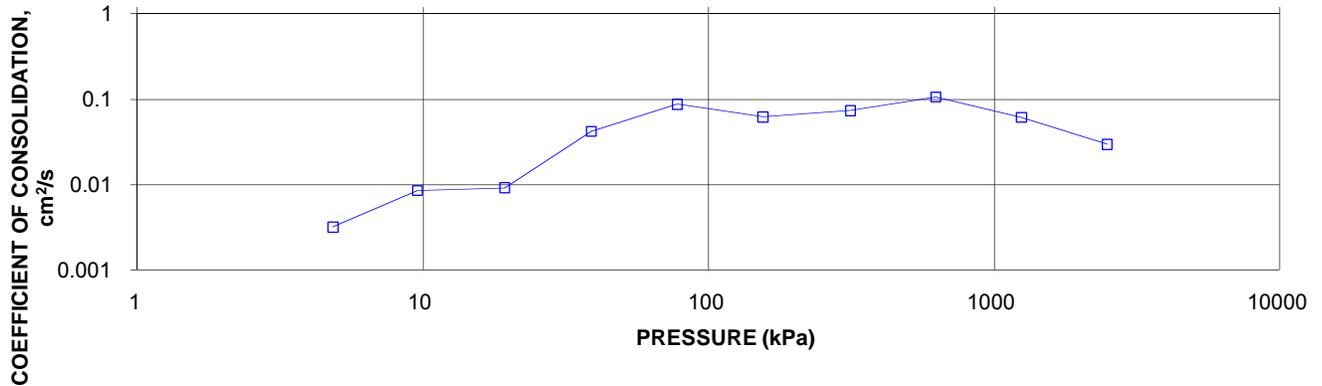
Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv. cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	1.894	0.688	1.894				
4.84	1.865	0.662	1.880	234	3.20E-03	3.15E-03	9.89E-07
9.57	1.859	0.657	1.862	86	8.55E-03	6.59E-04	5.52E-07
19.32	1.845	0.644	1.852	79	9.21E-03	7.69E-04	6.94E-07
38.83	1.829	0.630	1.837	17	4.21E-02	4.25E-04	1.75E-06
77.69	1.813	0.615	1.821	8	8.79E-02	2.28E-04	1.97E-06
155.23	1.786	0.592	1.799	11	6.24E-02	1.82E-04	1.12E-06
313.87	1.756	0.565	1.771	9	7.39E-02	9.98E-05	7.23E-07
624.22	1.721	0.534	1.738	6	1.07E-01	5.97E-05	6.25E-07
1244.13	1.691	0.507	1.706	10	6.17E-02	2.54E-05	1.53E-07
2486.90	1.657	0.477	1.674	20	2.97E-02	1.42E-05	4.13E-08
1244.13	1.667	0.486	1.662				
313.87	1.694	0.510	1.681				
77.69	1.713	0.527	1.704				
19.32	1.729	0.541	1.721				
4.84	1.737	0.549	1.733				

Note:  
k calculated using cv based on t<sub>90</sub> values.

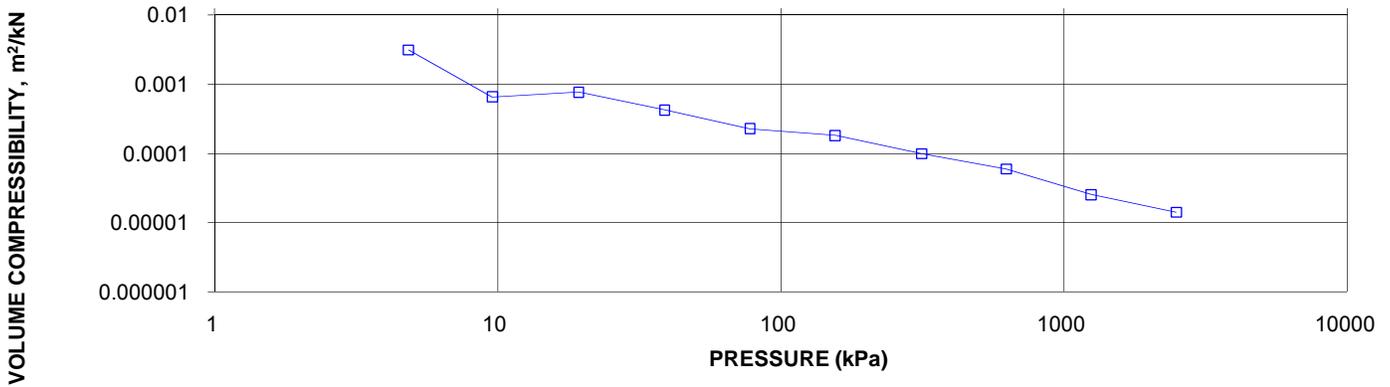
**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.74	Unit Weight, kN/m <sup>3</sup>	21.13
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	17.23
Area, cm <sup>2</sup>	31.55	Specific Gravity, measured	2.72
Volume, cm <sup>3</sup>	54.81	Solids Height, cm	1.122
Water Content, %	22.69	Volume of Solids, cm <sup>3</sup>	35.40
Wet Mass, g	118.13	Volume of Voids, cm <sup>3</sup>	19.42
Dry Mass, g	96.28		

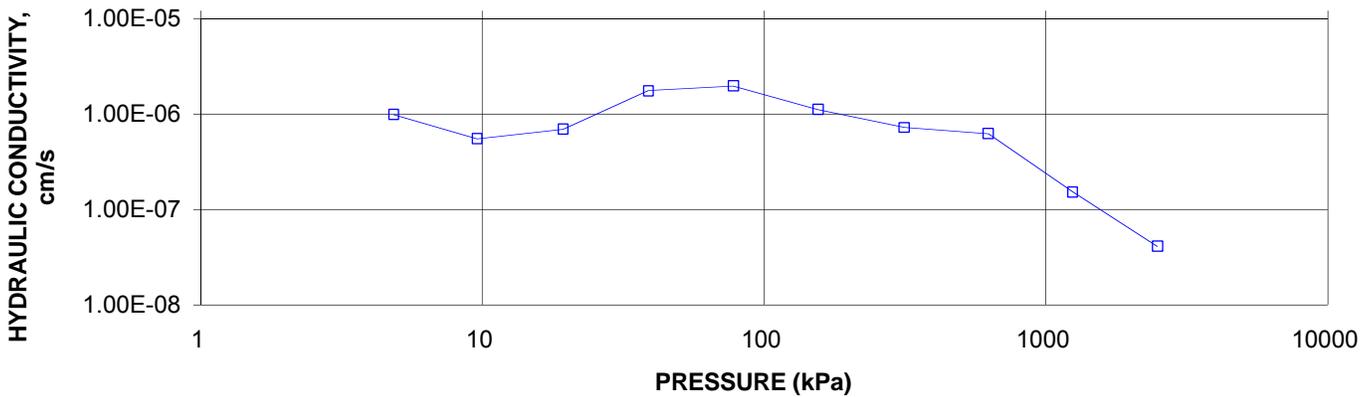
**CONSOLIDATION TEST**  
 CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
 BH 302-2 SA 4

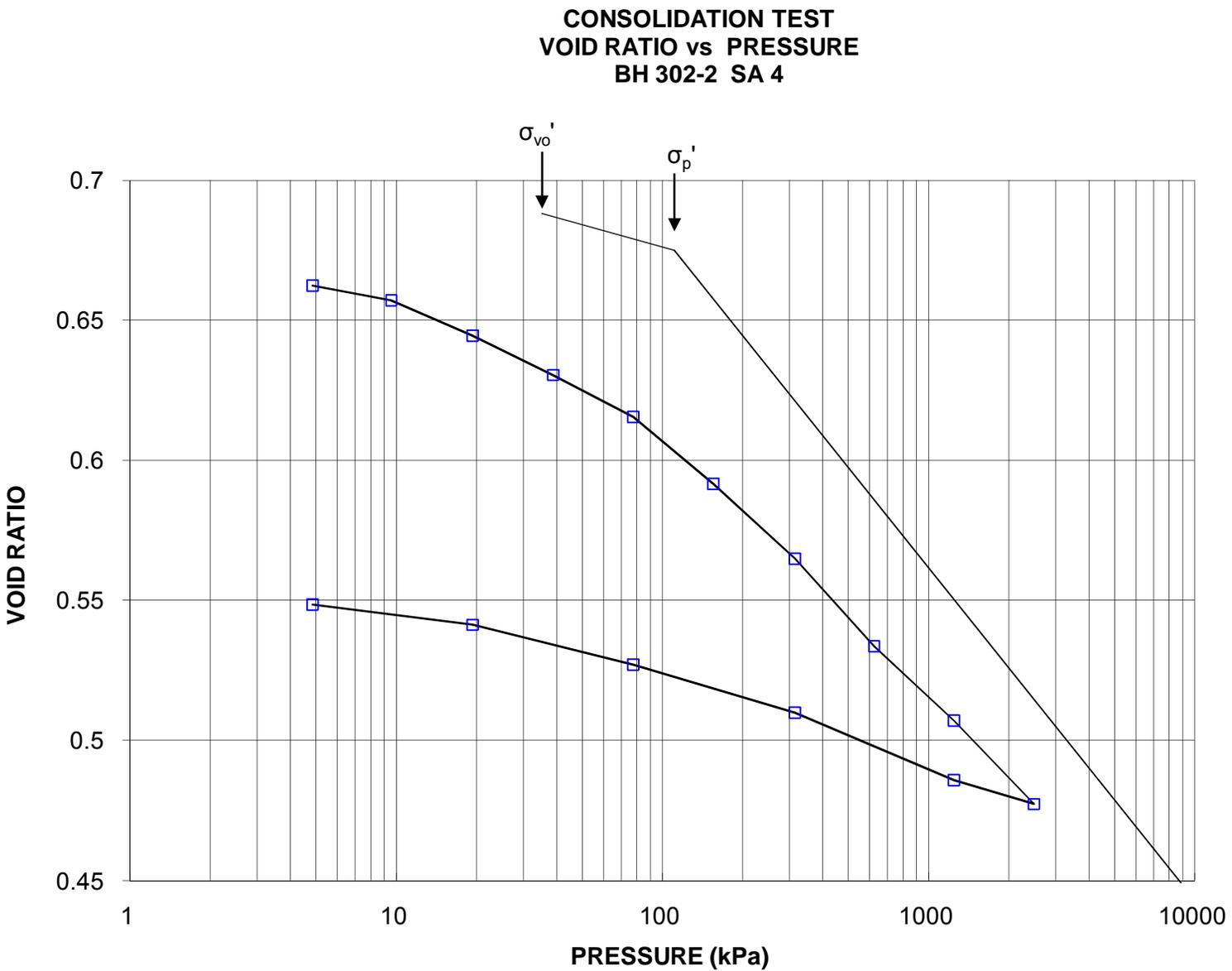


**CONSOLIDATION TEST**  
 MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
 BH 302-2 SA 4

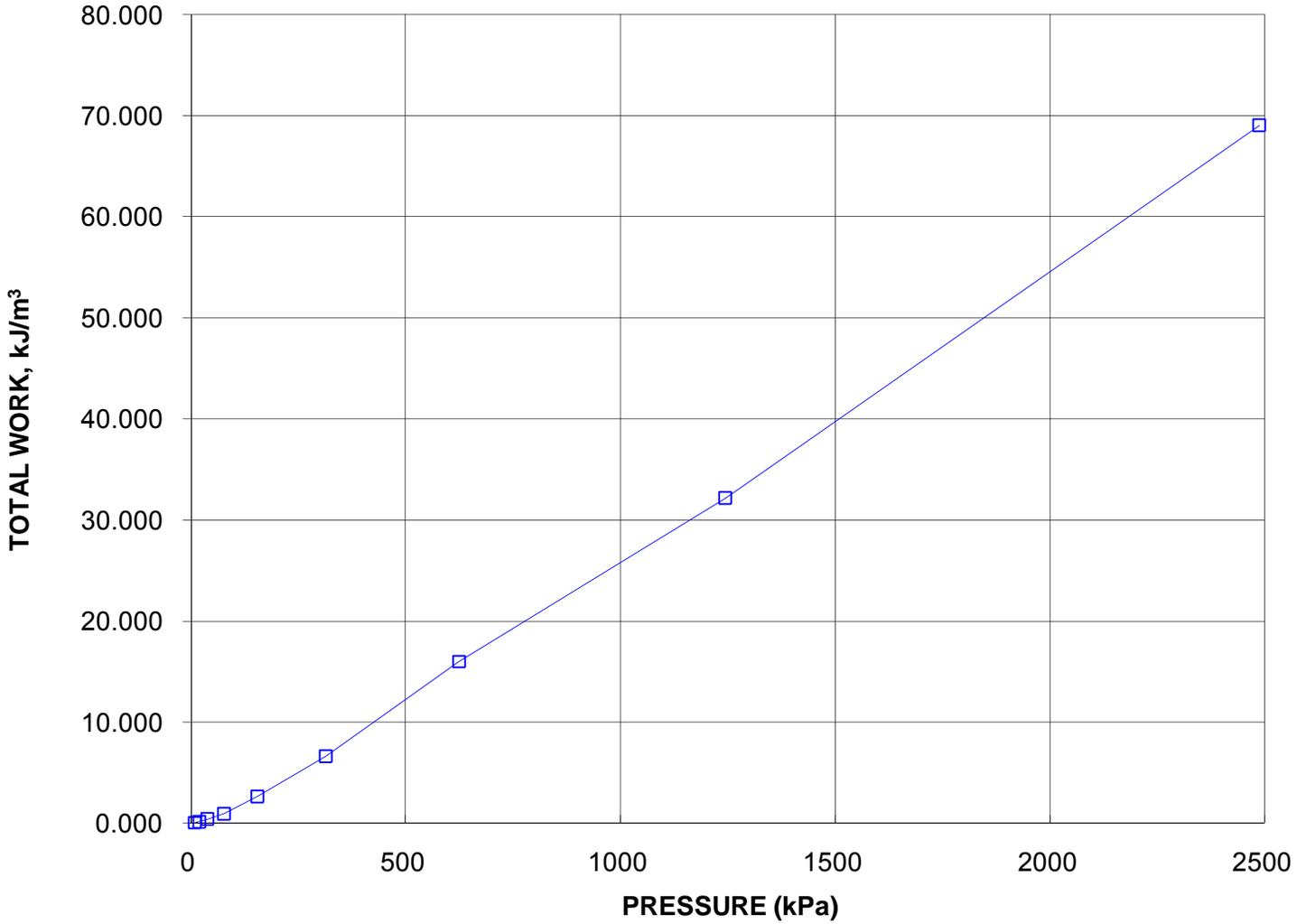


**CONSOLIDATION TEST**  
 HYDRAULIC CONDUCTIVITY vs PRESSURE  
 BH 302-2 SA 4





CONSOLIDATION TEST  
TOTAL WORK, kJ/m<sup>3</sup> vs PRESSURE  
BH 302-2 SA 4



**CONSOLIDATION TEST SUMMARY**  
**Highway 69 (SBL and NBL) STA 17+700 to 18+150**

**FIGURE A.S302-6**  
**Sheet 1 of 4**

**SAMPLE IDENTIFICATION**

Project Number	06-1111-025	Sample Number	5
Borehole Number	302-2	Sample Depth, m	9.1-9.8

**TEST CONDITIONS**

Test Type	Standard	Load Duration, hr	24
Oedometer Number	2		
Date Started	03/25/2009		
Date Completed	04/08/2009		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	2.54	Unit Weight, kN/m <sup>3</sup>	16.55
Sample Diameter, cm	6.64	Dry Unit Weight, kN/m <sup>3</sup>	12.16
Area, cm <sup>2</sup>	34.63	Specific Gravity, measured	2.77
Volume, cm <sup>3</sup>	88.06	Solids Height, cm	1.138
Water Content, %	36.12	Volume of Solids, cm <sup>3</sup>	39.41
Wet Mass, g	148.60	Volume of Voids, cm <sup>3</sup>	48.65
Dry Mass, g	109.17	Degree of Saturation, %	81.1

**TEST COMPUTATIONS**

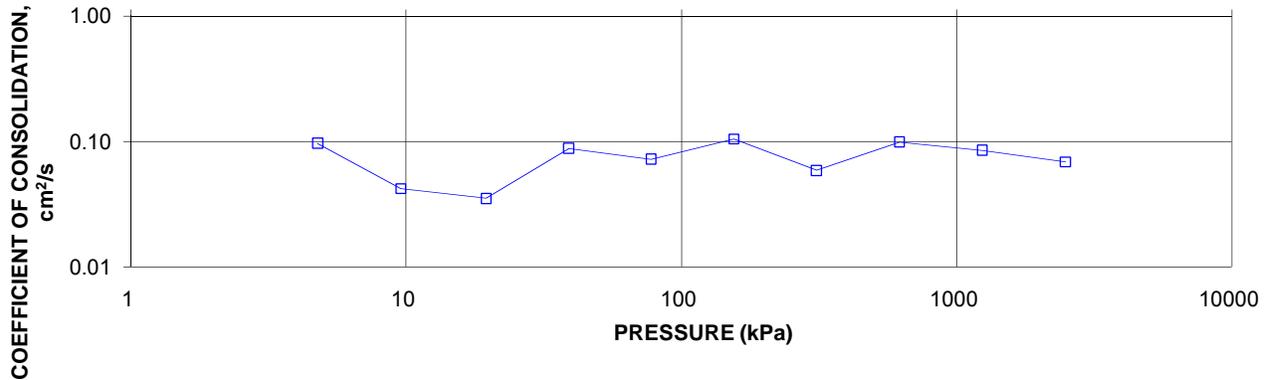
Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv. cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	2.543	1.234	2.543				
4.77	2.530	1.223	2.537	14	9.74E-02	1.07E-03	1.02E-05
9.58	2.523	1.216	2.526	32	4.23E-02	6.05E-04	2.51E-06
19.55	2.511	1.206	2.517	38	3.53E-02	4.77E-04	1.65E-06
39.01	2.496	1.193	2.503	15	8.86E-02	2.99E-04	2.60E-06
77.62	2.474	1.173	2.485	18	7.27E-02	2.26E-04	1.61E-06
155.17	2.410	1.117	2.442	12	1.05E-01	3.22E-04	3.32E-06
309.54	2.315	1.034	2.362	20	5.92E-02	2.43E-04	1.41E-06
619.20	2.237	0.966	2.276	11	9.98E-02	9.79E-05	9.58E-07
1239.49	2.170	0.906	2.203	12	8.58E-02	4.30E-05	3.62E-07
2481.87	2.106	0.851	2.138	14	6.92E-02	2.00E-05	1.36E-07
1239.49	2.108	0.852	2.107				
309.54	2.130	0.871	2.119				
77.62	2.152	0.891	2.141				
19.55	2.171	0.907	2.162				
4.77	2.184	0.919	2.178				

Note:  
k calculated using cv based on t<sub>90</sub> values.

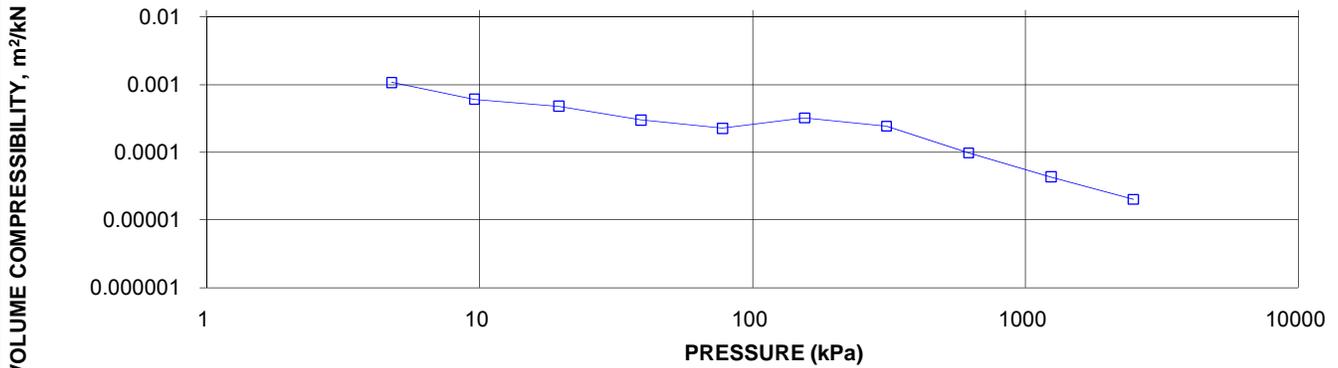
**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	2.18	Unit Weight, kN/m <sup>3</sup>	18.00
Sample Diameter, cm	6.64	Dry Unit Weight, kN/m <sup>3</sup>	14.16
Area, cm <sup>2</sup>	34.63	Specific Gravity, measured	2.77
Volume, cm <sup>3</sup>	75.63	Solids Height, cm	1.138
Water Content, %	27.14	Volume of Solids, cm <sup>3</sup>	39.41
Wet Mass, g	138.80	Volume of Voids, cm <sup>3</sup>	36.22
Dry Mass, g	109.17		

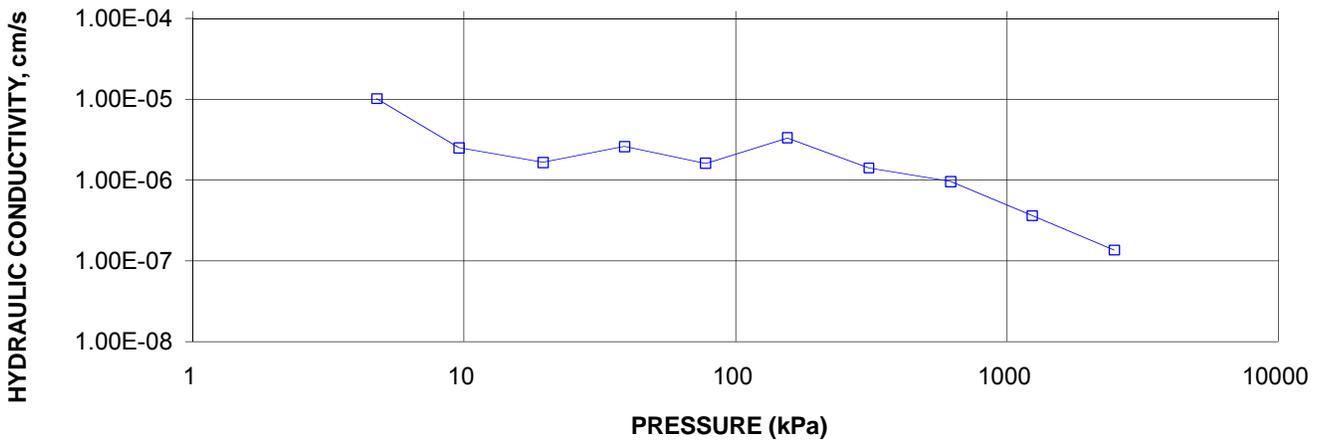
**CONSOLIDATION TEST**  
**CV cm<sup>2</sup>/s VS PRESSURE (kPa)**  
**BH 302-2 SA 5**

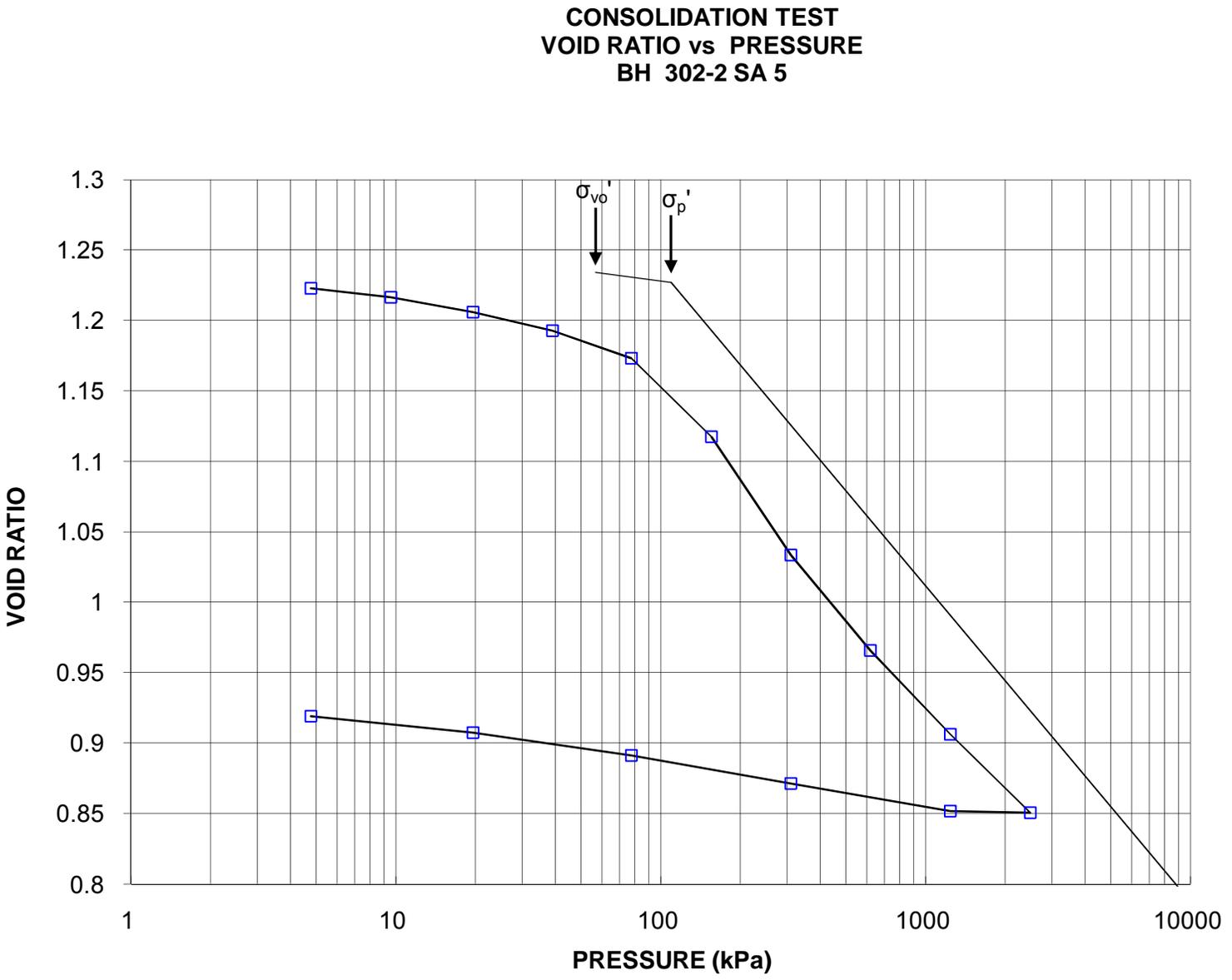


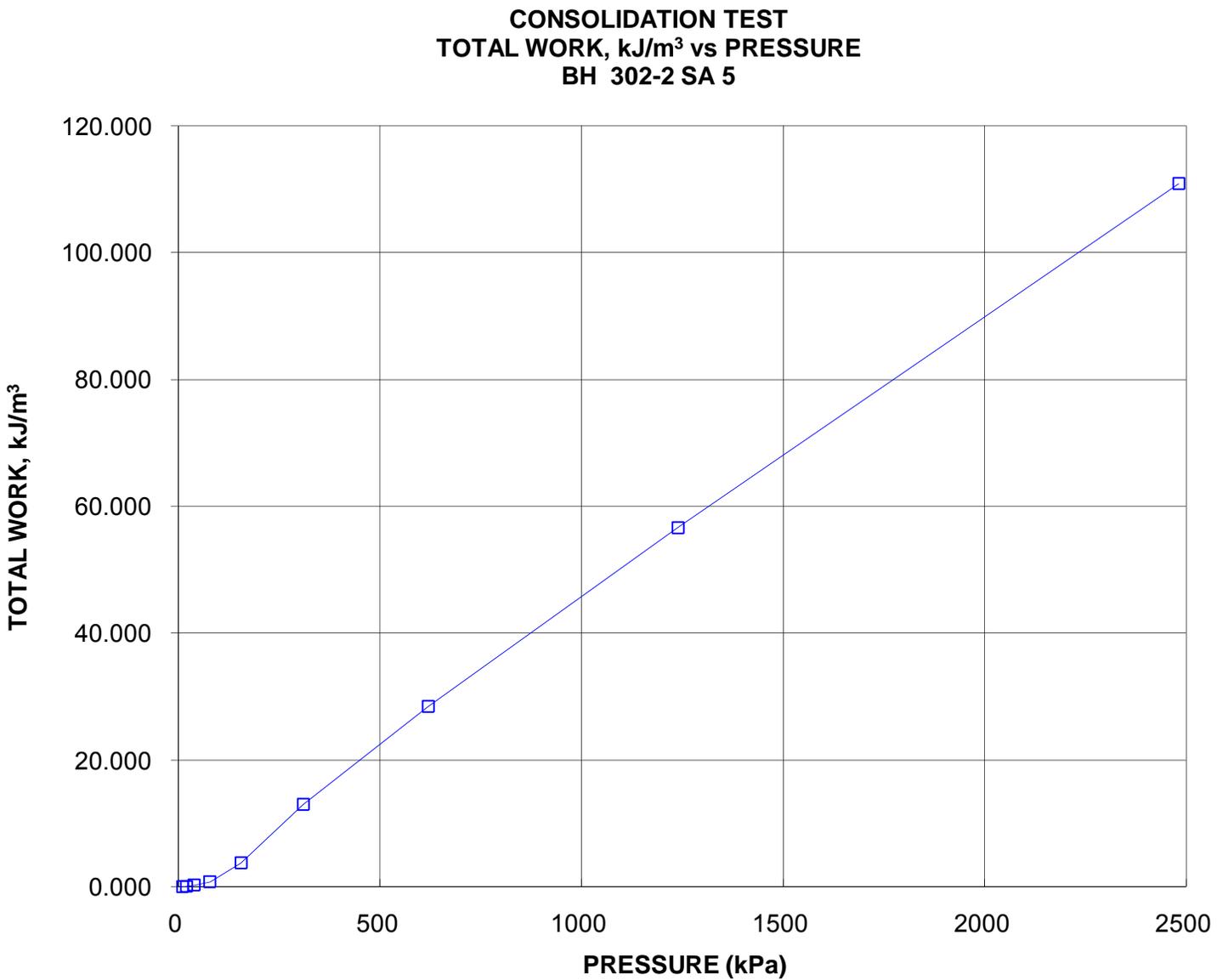
**CONSOLIDATION TEST**  
**MV m<sup>2</sup>/kN vs PRESSURE (kPa)**  
**BH 302-2 SA 5**



**CONSOLIDATION TEST**  
**HYDRAULIC CONDUCTIVITY vs PRESSURE**  
**BH 302-2 SA 5**







**CONSOLIDATION TEST SUMMARY (VTO)**  
**Highway 69 (SBL and NBL) STA 17+700 to 18+150**

**FIGURE A.S302-7**  
**Sheet 1 of 4**

**SAMPLE IDENTIFICATION**

Project Number	06-1111-025	Sample Number	5
Borehole Number	302-2	Sample Depth, m	9.1-9.8

**TEST CONDITIONS**

Test Type	Standard	Load Duration, hr	24
Oedometer Number	1		
Date Started	03/25/2009		
Date Completed	04/08/2009		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	2.54	Unit Weight, kN/m <sup>3</sup>	18.06
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	13.07
Area, cm <sup>2</sup>	31.61	Specific Gravity, measured	2.76
Volume, cm <sup>3</sup>	80.38	Solids Height, cm	1.228
Water Content, %	38.20	Volume of Solids, cm <sup>3</sup>	38.81
Wet Mass, g	148.04	Volume of Voids, cm <sup>3</sup>	41.57
Dry Mass, g	107.12	Degree of Saturation, %	98.4

**TEST COMPUTATIONS**

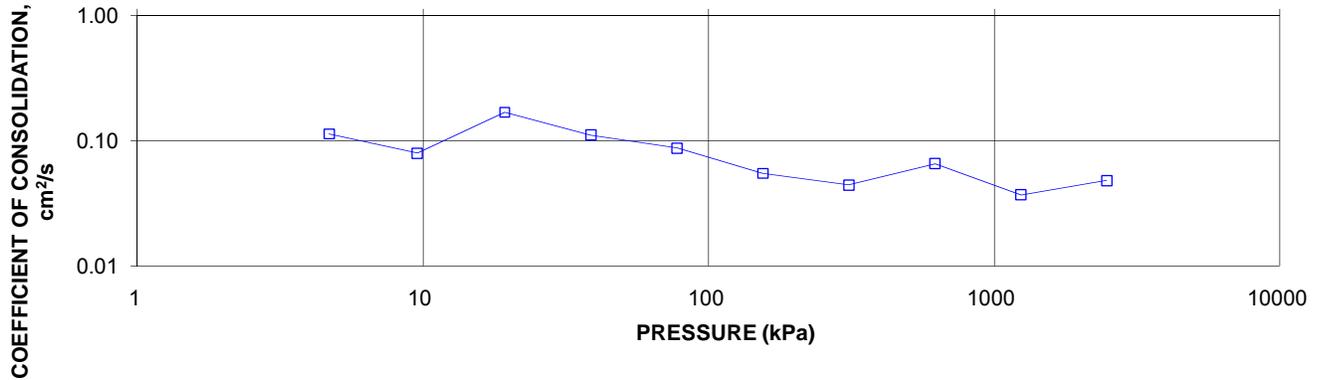
Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv. cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	2.543	1.071	2.543				
4.70	2.539	1.068	2.541	12	1.14E-01	3.23E-04	3.61E-06
9.55	2.534	1.064	2.537	17	8.02E-02	4.04E-04	3.18E-06
19.32	2.528	1.059	2.531	8	1.70E-01	2.60E-04	4.33E-06
38.76	2.512	1.046	2.520	12	1.12E-01	3.26E-04	3.58E-06
77.54	2.478	1.018	2.495	15	8.80E-02	3.43E-04	2.95E-06
154.86	2.421	0.972	2.449	23	5.53E-02	2.89E-04	1.57E-06
309.86	2.347	0.911	2.384	27	4.46E-02	1.88E-04	8.23E-07
620.17	2.263	0.843	2.305	17	6.62E-02	1.07E-04	6.93E-07
1240.42	2.177	0.773	2.220	28	3.73E-02	5.42E-05	1.98E-07
2478.93	2.101	0.711	2.139	20	4.85E-02	2.43E-05	1.15E-07
1240.42	2.103	0.713	2.102				
309.86	2.125	0.731	2.114				
77.54	2.146	0.748	2.135				
19.32	2.164	0.762	2.155				
4.70	2.181	0.777	2.173				

Note:  
k calculated using cv based on t<sub>90</sub> values.  
Specimen trimmed in a vertical plane

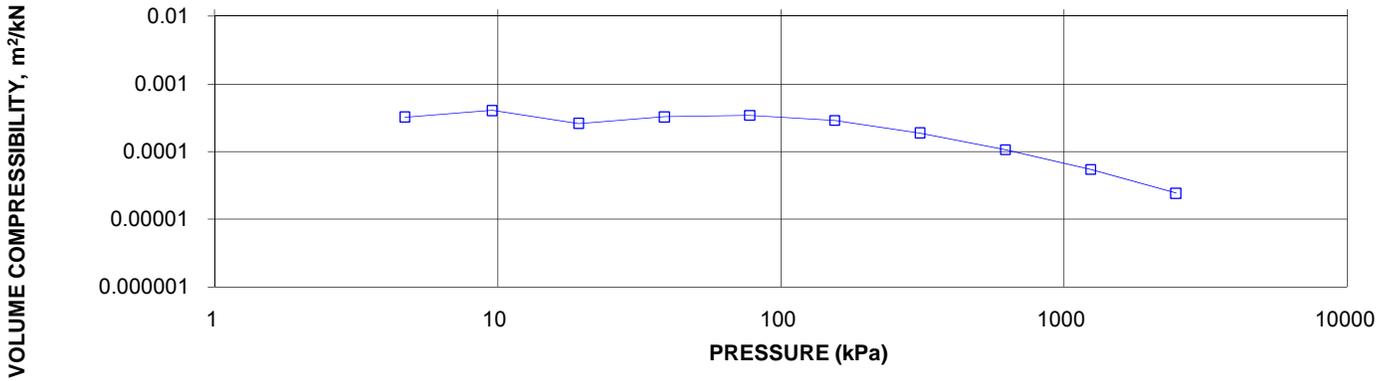
**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	2.18	Unit Weight, kN/m <sup>3</sup>	19.58
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	15.24
Area, cm <sup>2</sup>	31.61	Specific Gravity, measured	2.76
Volume, cm <sup>3</sup>	68.95	Solids Height, cm	1.228
Water Content, %	28.53	Volume of Solids, cm <sup>3</sup>	38.81
Wet Mass, g	137.68	Volume of Voids, cm <sup>3</sup>	30.14
Dry Mass, g	107.12		

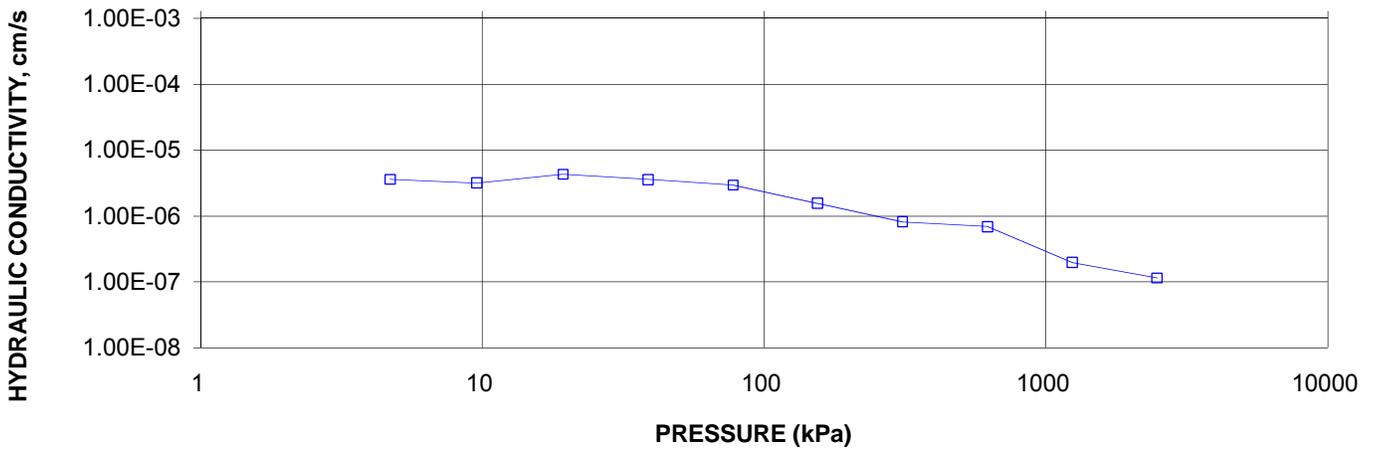
**CONSOLIDATION TEST**  
**CV cm<sup>2</sup>/s VS PRESSURE (kPa)**  
**BH 302-2 SA 5**



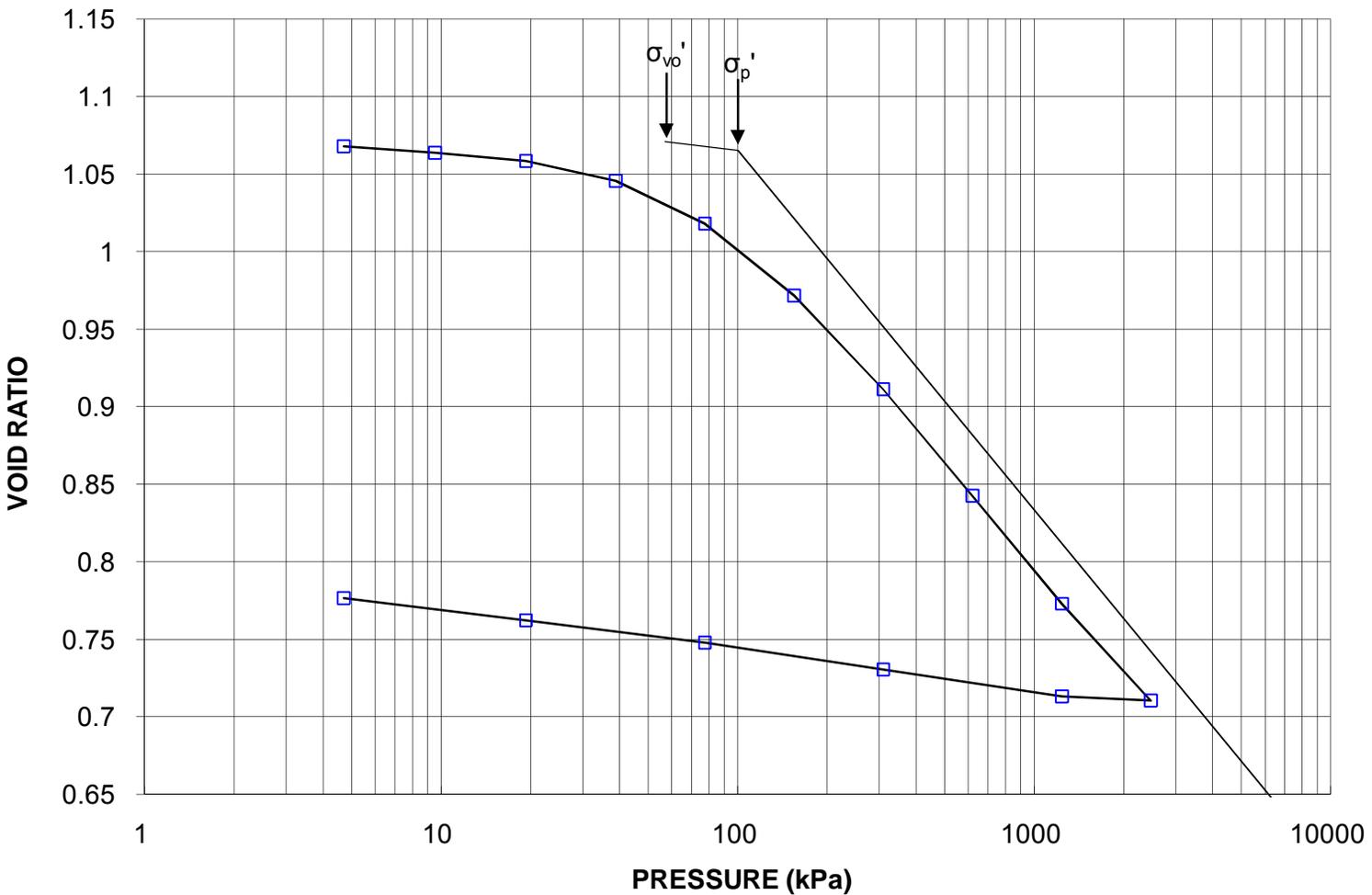
**CONSOLIDATION TEST**  
**MV m<sup>2</sup>/kN vs PRESSURE (kPa)**  
**BH 302-2 SA 5**



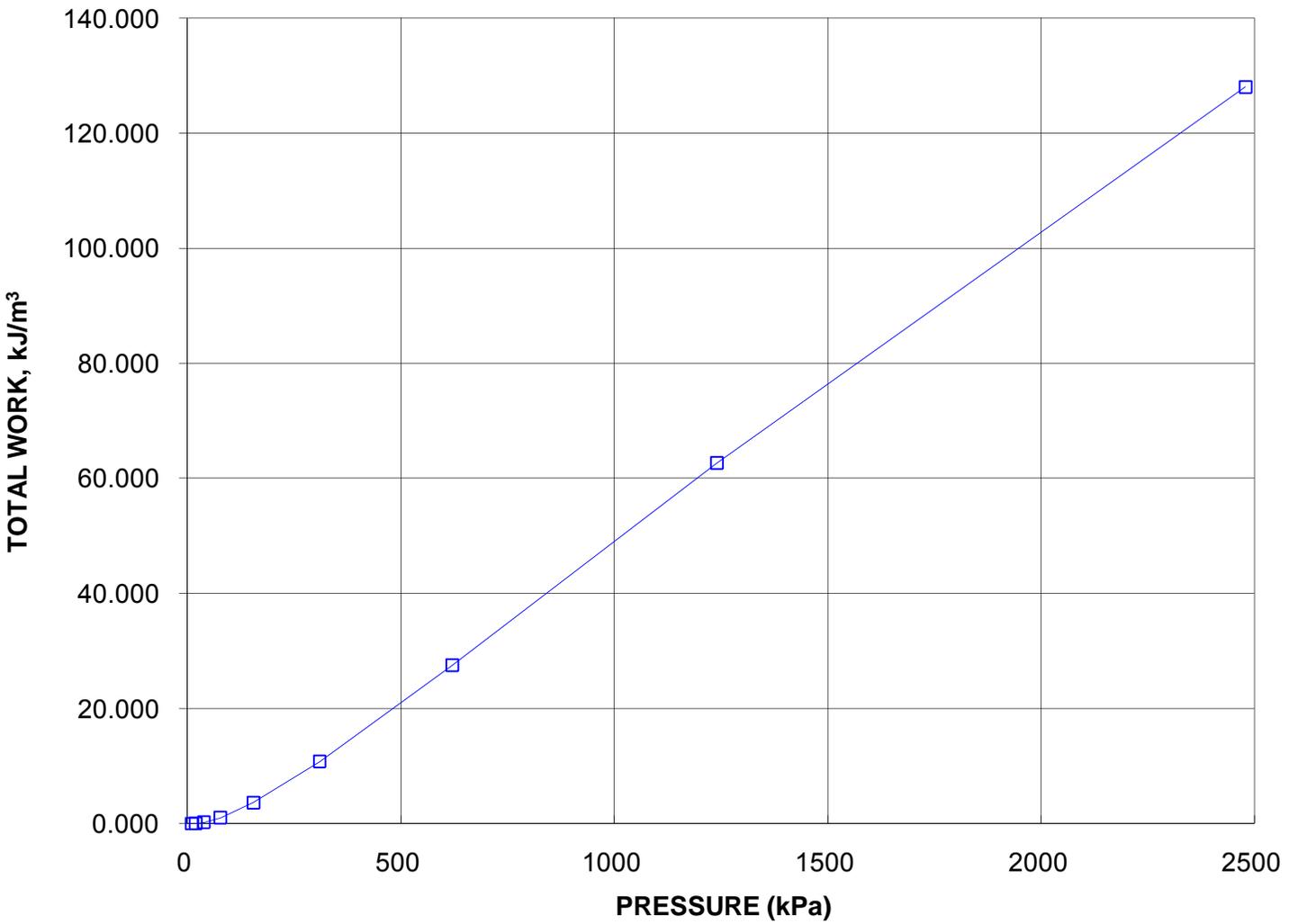
**CONSOLIDATION TEST**  
**HYDRAULIC CONDUCTIVITY vs PRESSURE**  
**BH 302-2 SA 5**



CONSOLIDATION TEST (VTO)  
VOID RATIO vs PRESSURE  
BH 302-2 SA 5



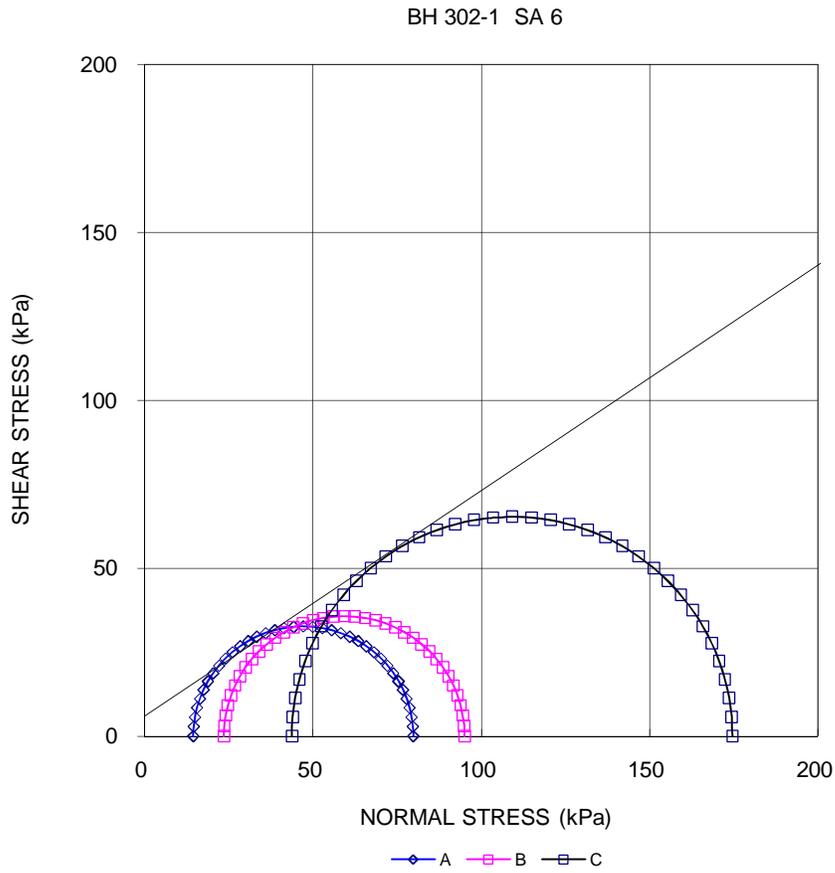
CONSOLIDATION TEST (VTO)  
TOTAL WORK, kJ/m<sup>3</sup> vs PRESSURE  
BH 302-2 SA 5



**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE A.S302-8  
Sheet 1 of 4**

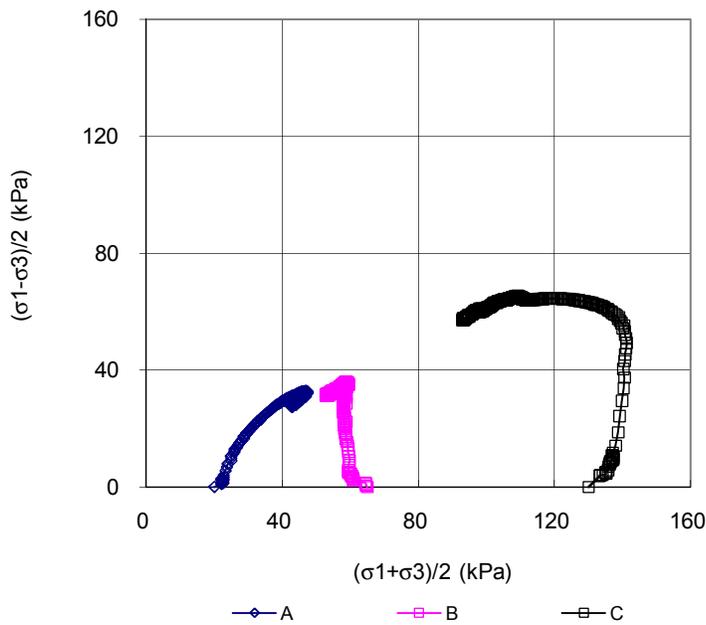
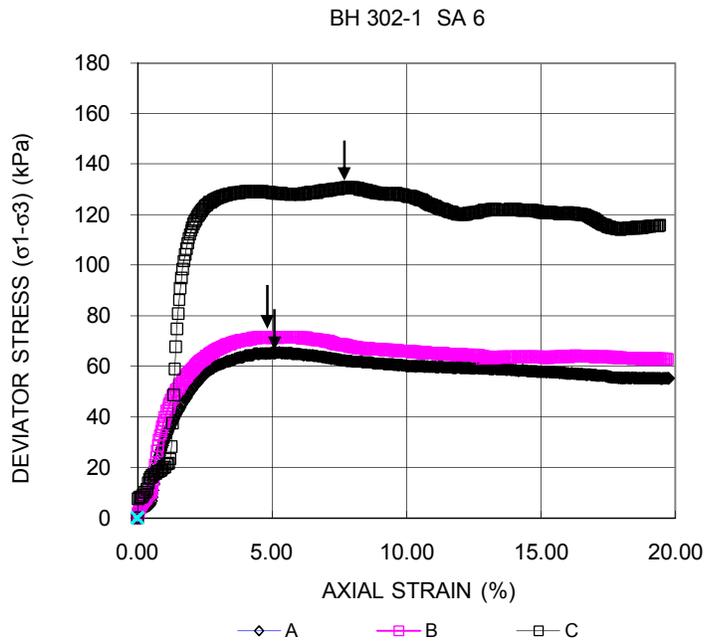
TEST STAGE	A	B	C
BOREHOLE NUMBER	302-1	302-1	302-1
SAMPLE	6	6	6
SPECIMEN DIAMETER, cm	4.99	4.99	5.02
SPECIMEN HEIGHT, cm	10.10	10.18	10.58
WATER CONTENT BEFORE CONSOLIDATION, %	49.2	53.4	51.9
CELL PRESSURE, $\sigma_3$ , kPa	575.0	480.0	615.0
BACK PRESSURE, kPa	555.0	415.0	485.0
PORE PRESSURE PARAMETER "B"	0.98	0.90	0.90
CONSOLIDATION PRESSURE, $\sigma_c$ , kPa	20.0	65.0	130.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	0.5	2.7	10.5
WATER CONTENT AFTER CONSOLIDATION, %	48.7	50.9	42.2
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, DAYS	2	2	2
WATER CONTENT AFTER TEST, %	48.9	51.2	44.2
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa	65.5	71.5	130.8
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %	5.4	4.7	7.8
MAX EFFECTIVE PRINCIPAL STRESS			
RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM	6.6	4.4	4.4
DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa	56.7	71.5	121.0
AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %	2.5	5.3	15.2
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM	0.09	0.58	0.66
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM	0.17	0.59	0.77
NATURAL WATER CONTENT, %	46.6	52.3	50.4
DRY DENSITY, Mg/m <sup>3</sup>	1.19	1.10	1.08
FILTER DRAINS USED, y/n	y	y	y
TEST NOTES:			
CHANGED RATE OF STRAIN, %/hr	-	-	-
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %	-	-	-
FAILURE PLANE NUMBER	-	1.0	-
ANGLE OF FAILURE, DEGREES	bulged	70.0	-
Date:	04/27/2009		
Project No.	06-1111-025		
<b>Golder Associates</b>		Prepared By:	LH
		Checked By:	MM



Date: 04/27/2009  
Project No. 06-1111-025

**Golder Associates**

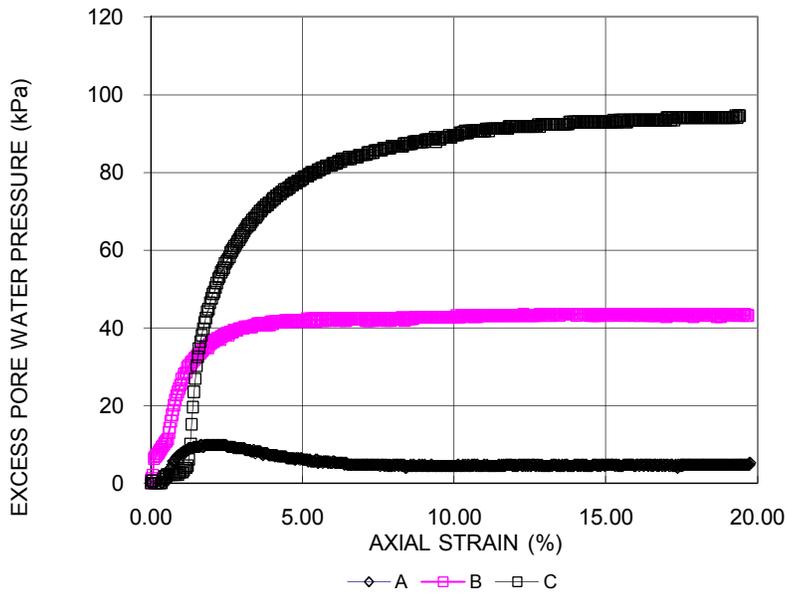
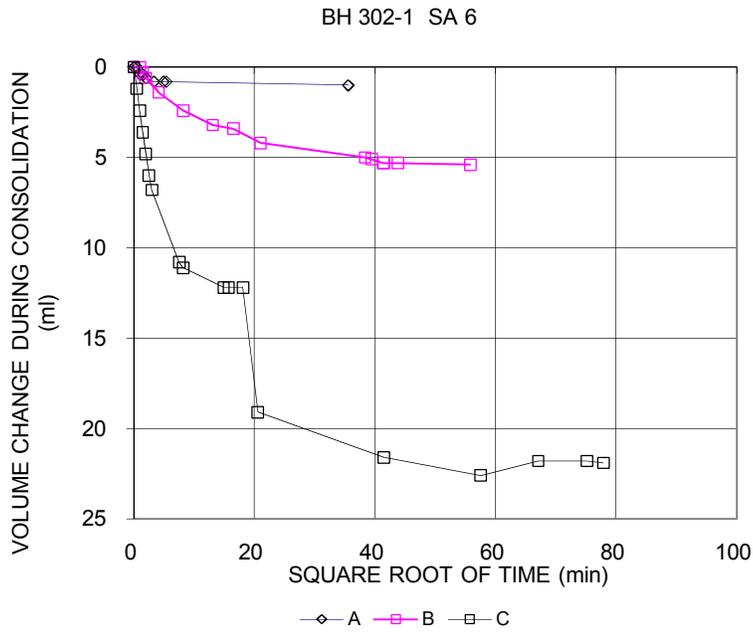
Prepared By: LH  
Checked By: MM



Date: 04/27/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: LH  
Checked By: MM



Date: 04/27/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: LH  
Checked By: MM

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

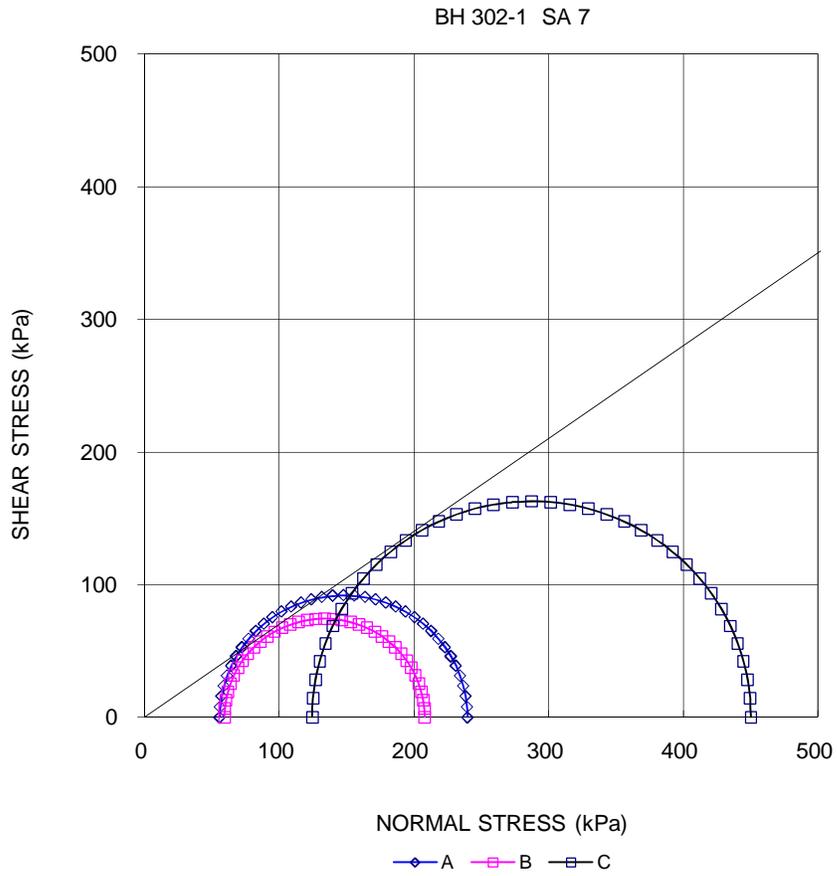
**FIGURE A.S302-9  
Sheet 1 of 4**

TEST STAGE	A	B	C
BOREHOLE NUMBER	302-1	302-1	302-1
SAMPLE	7	7	7
SPECIMEN DIAMETER, cm	4.98	5.02	5.04
SPECIMEN HEIGHT, cm	10.14	10.15	10.09
WATER CONTENT BEFORE CONSOLIDATION, %	28.9	31.7	30.8
CELL PRESSURE, $\sigma_3$ , kPa	245.0	515.0	285.0
BACK PRESSURE, kPa	205.0	415.0	135.0
PORE PRESSURE PARAMETER "B"	0.98	0.92	1.00
CONSOLIDATION PRESSURE, $\sigma_c$ , kPa	40.0	100.0	150.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	2.3	3.7	5.5
WATER CONTENT AFTER CONSOLIDATION, %	27.5	29.2	27.2
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, DAYS	2	2	2
WATER CONTENT AFTER TEST, %	26.0	28.0	25.7
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa	184.1	148.8	325.7
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %	15.4	17.2	19.5
MAX EFFECTIVE PRINCIPAL STRESS			
RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM	5.0	3.6	3.9
DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa	68.5	107.4	217.4
AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %	4.3	7.4	8.6
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM	-0.09	0.27	0.08
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM	0.34	0.55	0.35
NATURAL WATER CONTENT, %	27.4	29.2	29.4
DRY DENSITY, Mg/m <sup>3</sup>	1.58	1.49	1.52
FILTER DRAINS USED, y/n	y	y	y
TEST NOTES:			
CHANGED RATE OF STRAIN, %/hr	-	-	-
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %	-	-	-
FAILURE PLANE NUMBER	-	-	1.0
ANGLE OF FAILURE, DEGREES	bulged	bulged	70.0

Date: 04/28/2009  
Project No. 06-1111-025

**Golder Associates**

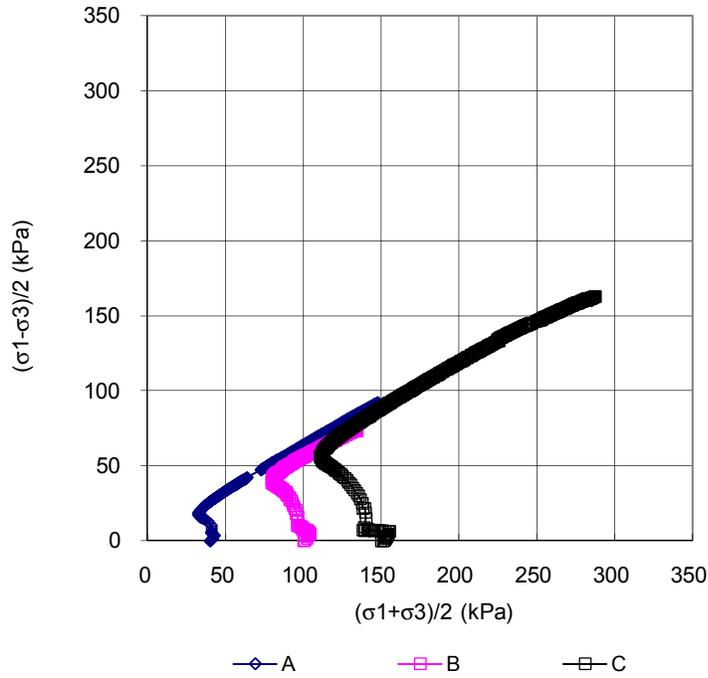
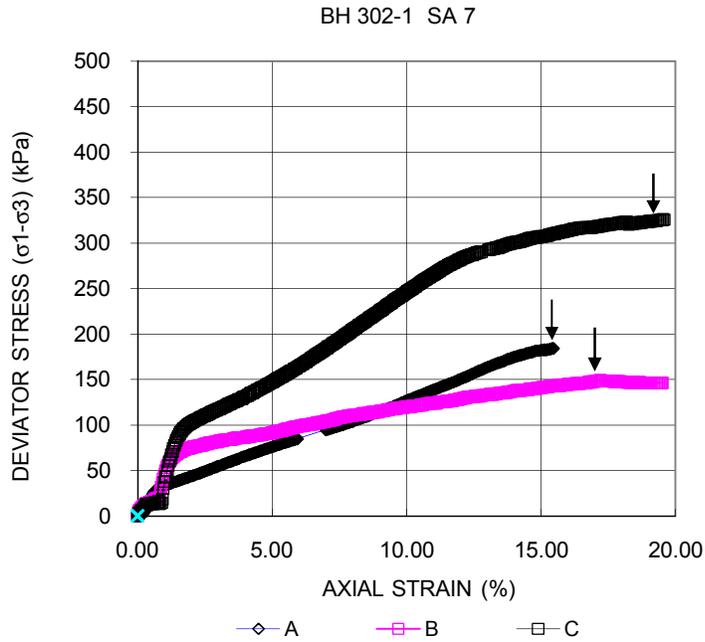
Prepared By: LH  
Checked By: MM



Date: 04/28/2009  
Project No. 06-1111-025

**Golder Associates**

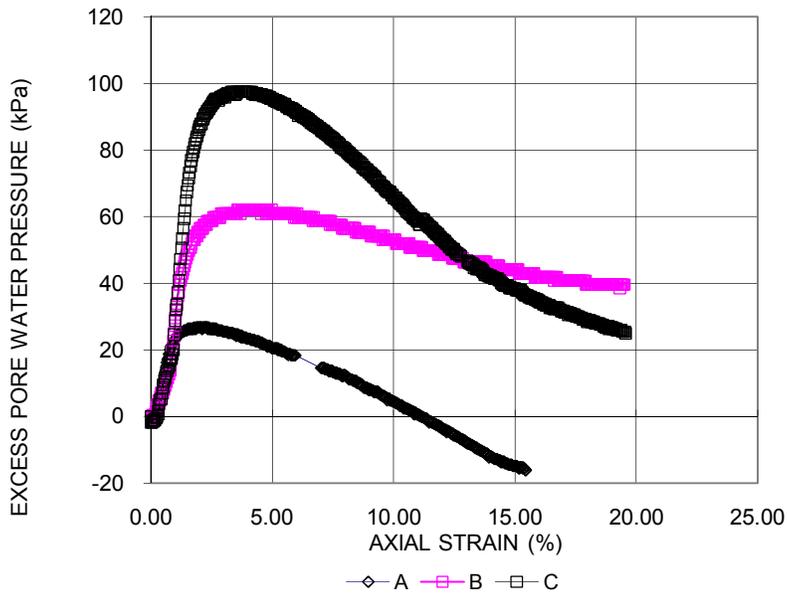
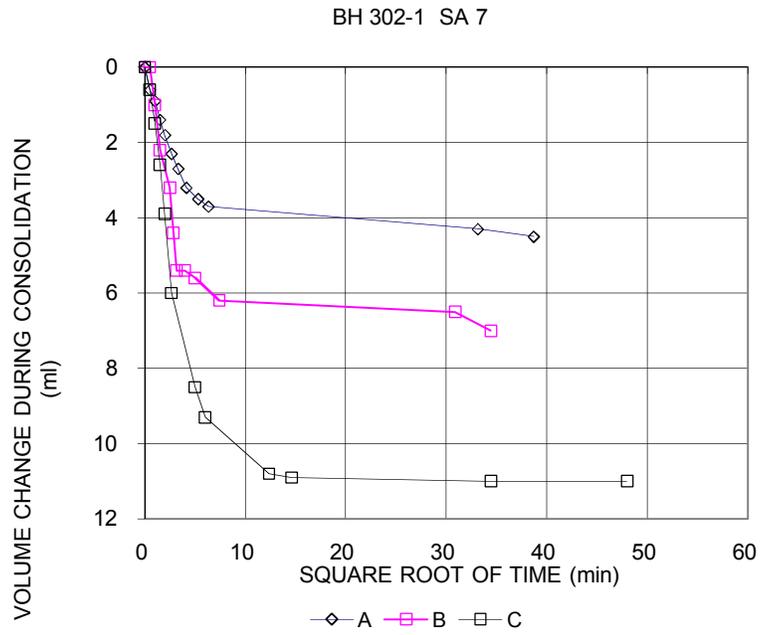
Prepared By: LH  
Checked By: MM



Date: 04/28/2009  
Project No. 06-1111-025

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Prepared By: LH  
Checked By: MM



Date: 04/28/2009  
Project No. 06-1111-025

**Golder Associates**

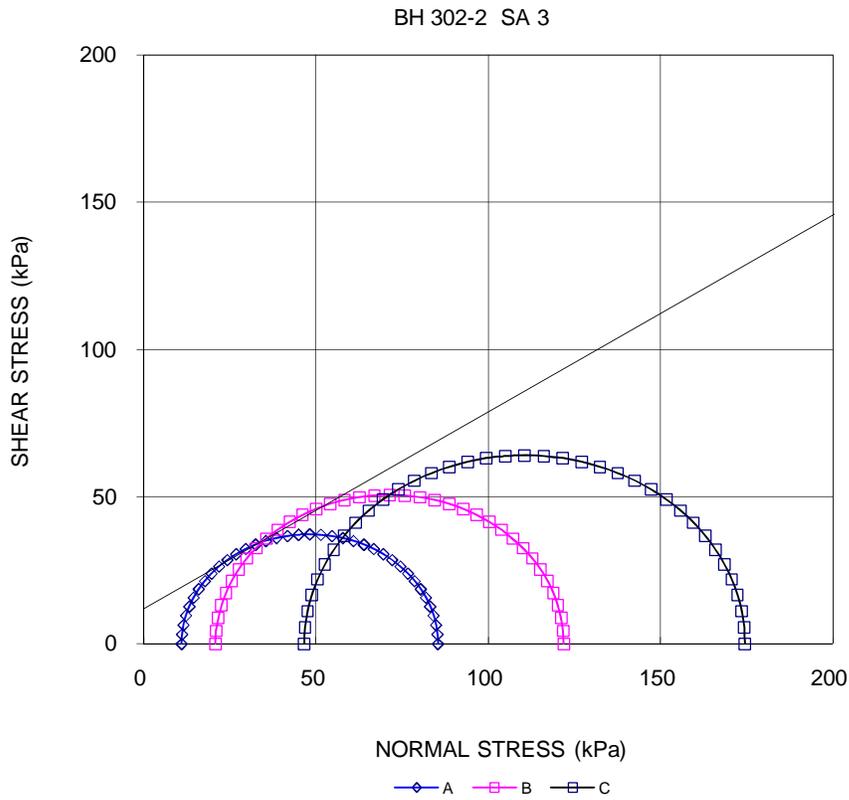
Prepared By: LH  
Checked By: MM

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE A.S302-10**

**Sheet 1 of 4**

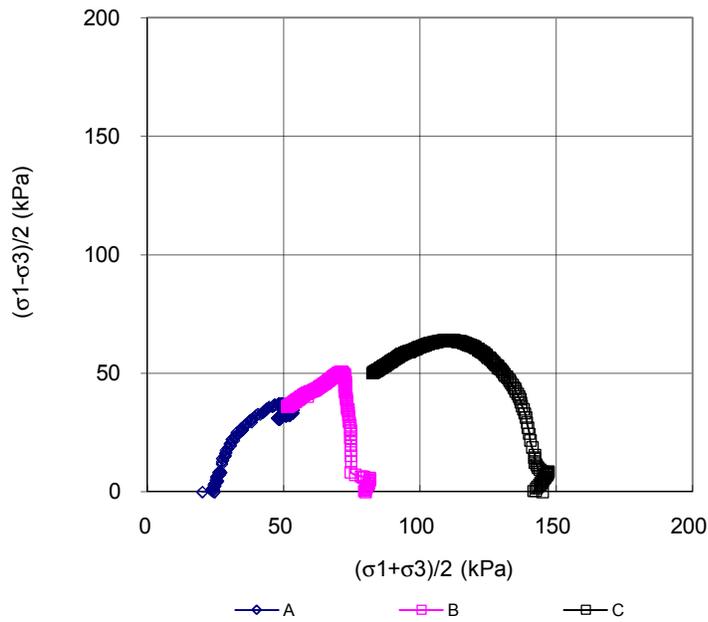
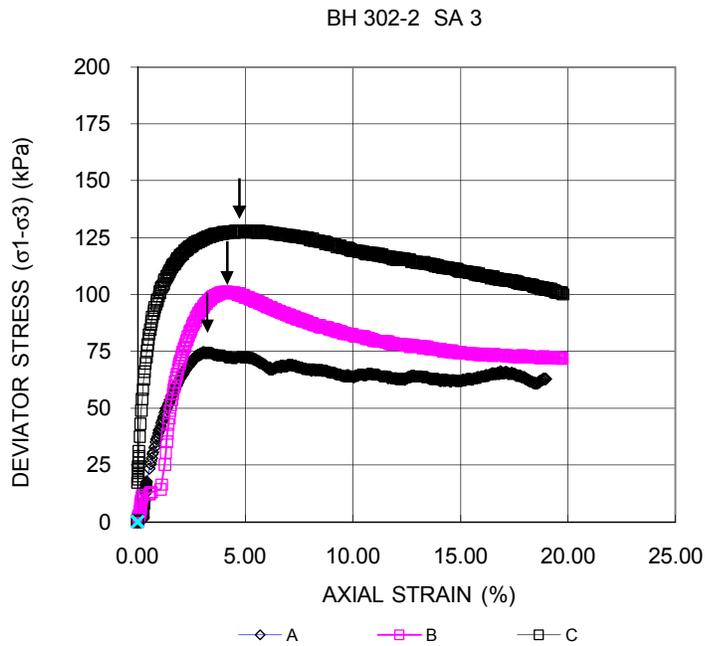
TEST STAGE	A	B	C
BOREHOLE NUMBER	302-2	302-2	302-2
SAMPLE	3	3	3
SPECIMEN DIAMETER, cm	5.03	5.05	5.03
SPECIMEN HEIGHT, cm	10.20	10.26	10.13
WATER CONTENT BEFORE CONSOLIDATION, %	66.0	71.4	69.8
CELL PRESSURE, $\sigma_3$ , kPa	295.0	495.0	420.0
BACK PRESSURE, kPa	275.0	415.0	275.0
PORE PRESSURE PARAMETER "B"	0.99	0.98	0.98
CONSOLIDATION PRESSURE, $\sigma_c$ , kPa	20.0	80.0	145.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	1.1	3.4	8.7
WATER CONTENT AFTER CONSOLIDATION, %	64.9	67.7	60.9
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, DAYS	2	2	2
WATER CONTENT AFTER TEST, %	64.6	66.1	58.6
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa	74.4	101.1	128.0
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %	3.0	4.0	5.0
MAX EFFECTIVE PRINCIPAL STRESS RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM	9.6	6.1	4.3
DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa	65.5	100.5	116.0
AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %	2.1	4.6	12.0
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM	0.12	0.59	0.77
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM	0.19	0.60	0.95
NATURAL WATER CONTENT, %	64.7	67.8	66.8
DRY DENSITY, Mg/m <sup>3</sup>	0.98	0.93	0.98
FILTER DRAINS USED, y/n	y	y	y
TEST NOTES:			
CHANGED RATE OF STRAIN, %/hr	-	-	-
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %	-	-	-
FAILURE PLANE NUMBER	1.0	-	-
ANGLE OF FAILURE, DEGREES	65.0	bulged	bulged
Date: 04/26/2009			Prepared By: MM
Project No. 06-1111-025	<b>Golder Associates</b>		Checked By: RO



Date: 04/26/2009  
Project No. 06-1111-025

**Golder Associates**

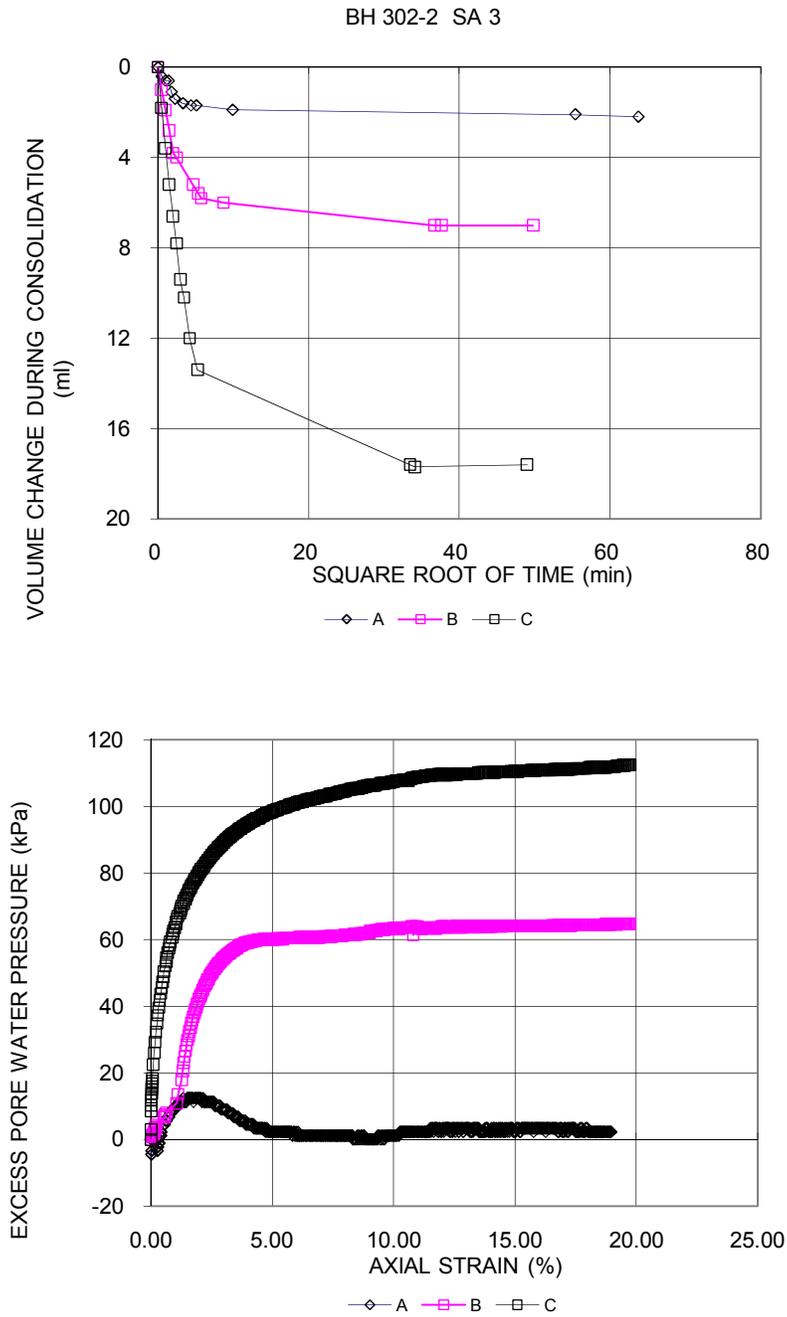
Prepared By: MM  
Checked By: RO



Date: 04/26/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO



Date: 04/26/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE A.S302-11**

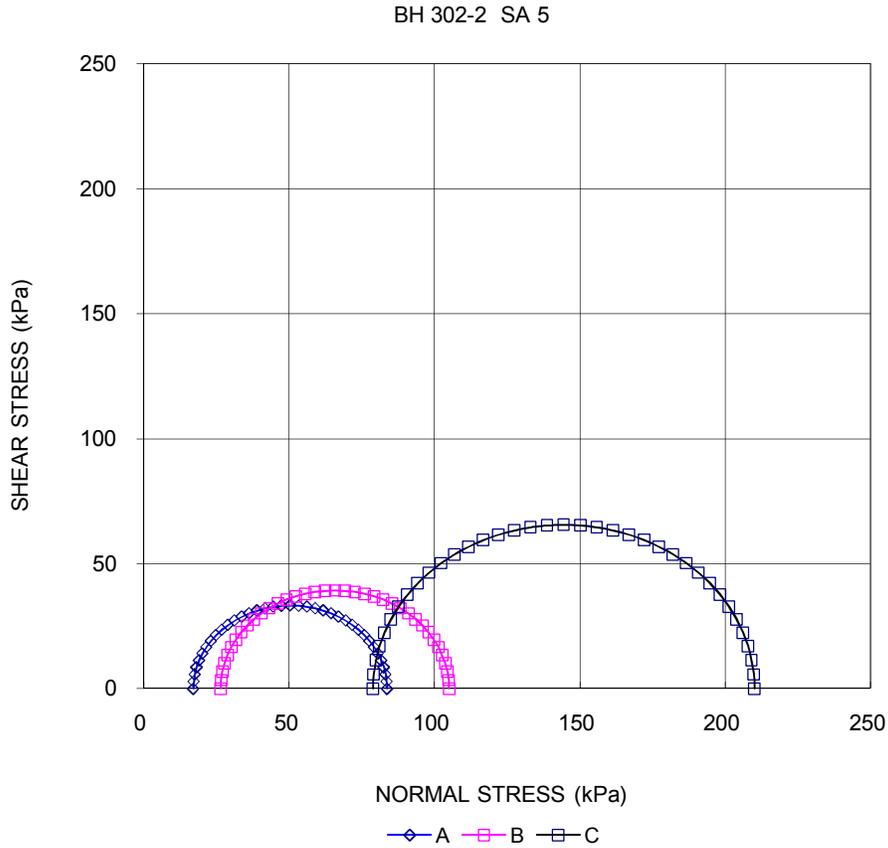
**Sheet 1 of 4**

TEST STAGE	A	B	C
BOREHOLE NUMBER	302-2	302-2	302-2
SAMPLE	5	5	5
SPECIMEN DIAMETER, cm	4.98	5.02	4.93
SPECIMEN HEIGHT, cm	10.08	10.11	10.00
WATER CONTENT BEFORE CONSOLIDATION, %	38.9	44.4	41.7
CELL PRESSURE, $\sigma_3$ , kPa	100.0	135.0	610.0
BACK PRESSURE, kPa	65.0	65.0	415.0
PORE PRESSURE PARAMETER "B"	0.98	0.98	0.96
CONSOLIDATION PRESSURE, $\sigma_c$ , kPa	35.0	70.0	195.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	3.0	7.3	8.5
WATER CONTENT AFTER CONSOLIDATION, %	36.7	38.6	35.3
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, DAYS	2	2	2
WATER CONTENT AFTER TEST, %	36.9	40.2	33.0
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa	66.6	78.6	131.2
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %	17.1	3.9	14.4
MAX EFFECTIVE PRINCIPAL STRESS			
RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM	5.4	4.1	2.3
DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa	59.9	73.7	130.8
AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %	8.3	6.8	13.4
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM	0.27	0.55	0.89
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM	0.36	0.63	0.89
NATURAL WATER CONTENT, %	38.6	41.2	39.9
DRY DENSITY, Mg/m <sup>3</sup>	1.33	1.28	1.33
FILTER DRAINS USED, y/n	y	y	y
TEST NOTES:			
CHANGED RATE OF STRAIN, %/hr	-	-	-
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %	-	-	-
FAILURE PLANE NUMBER	-	1.0	-
ANGLE OF FAILURE, DEGREES	bulged	70.0	bulged

Date: 04/16/2009  
Project No. 06-1111-025

**Golder Associates**

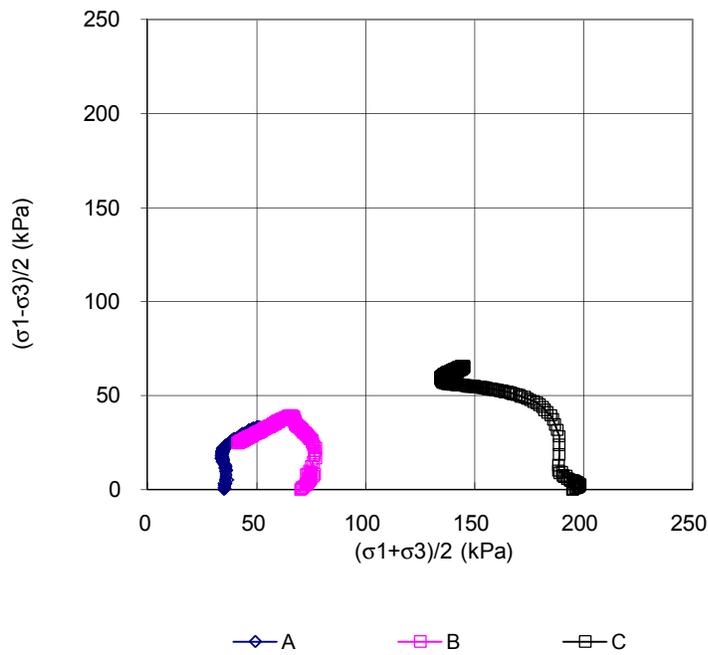
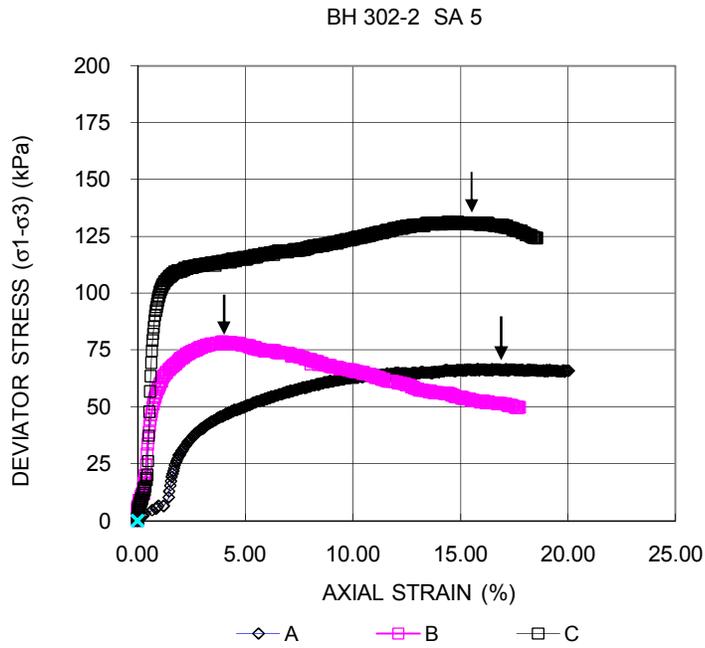
Prepared By: LH  
Checked By: MM



Date: 04/16/2009  
Project No. 06-1111-025

**Golder Associates**

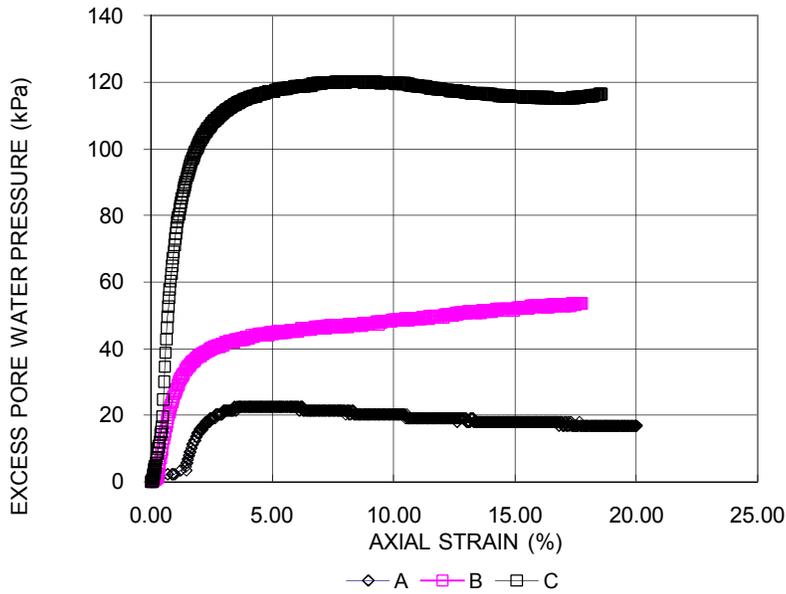
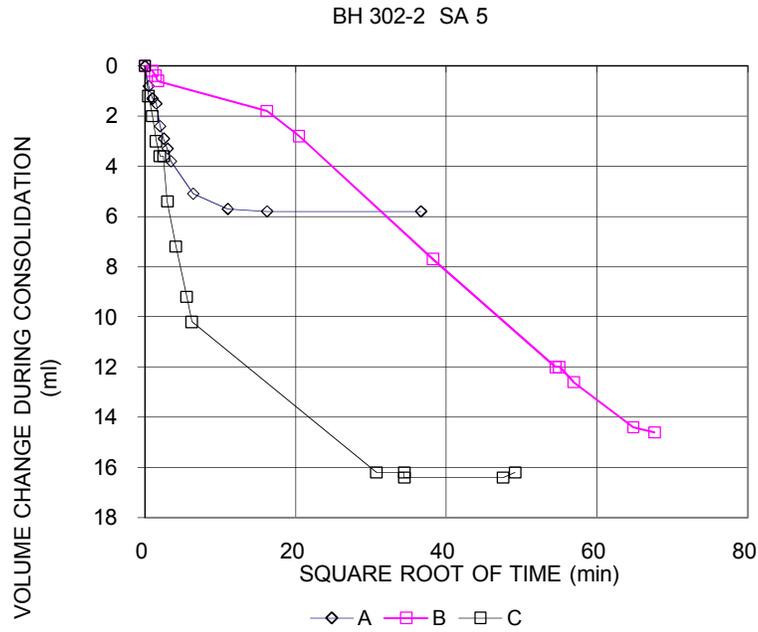
Prepared By: LH  
Checked By: MM



Date: 04/16/2009  
Project No. 06-1111-025

**Golder Associates**

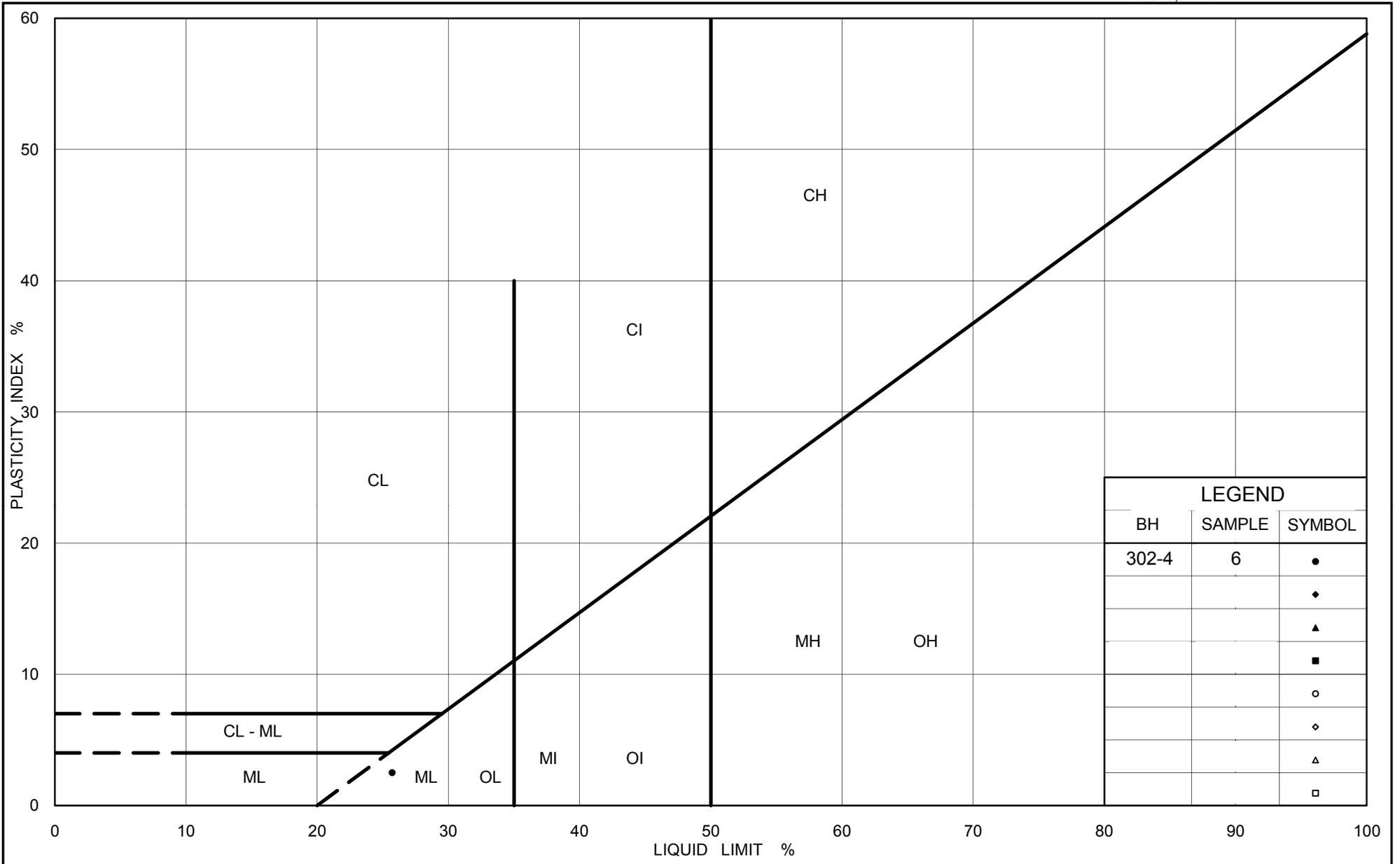
Prepared By: LH  
Checked By: MM



Date: 04/16/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: LH  
Checked By: MM





# **APPENDIX B**

**Highway 69 SBL – STA 16+050 to 16+350 (Swamp 305 SBL)**



**RECORD OF BOREHOLE No 305-1** 2 OF 3 **METRIC**

PROJECT 06-1111-025 G.W.P. 5203-06-00 LOCATION N 5092255.3 ; E 221116.7 ORIGINATED BY MR

DIST                      HWY 69 BOREHOLE TYPE NW Casing, Wash Boring COMPILED BY MWK

DATUM Geodetic DATE March 5, 2009 CHECKED BY VA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa		W <sub>p</sub>	W		
166.0 20.7	--- CONTINUED FROM PREVIOUS PAGE ---  SILTY CLAY to CLAY containing silt interlayers Very soft to stiff Brown Wet  END OF BOREHOLE  A Dynamic Cone Penetration Test (DCPT) was carried out between depths of 20.7 m and 30.5 m.	[Hatched Box]	8	TO	PH		20 40 60 80 100	20 40 60 80 100	10 20 30			85.1	
						171	+	2					
						170	+	2					
						169							
						168	+	2					
						167						85.1	
						166	+	2					
						165							
						164							
						163							
						162							
						161							
						160							
						159							
						158							
						157							

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

Continued Next Page

 +<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT <u>06-1111-025</u>	<b>RECORD OF BOREHOLE No 305-1</b>	3 OF 3 <b>METRIC</b>
G.W.P. <u>5203-06-00</u>	LOCATION <u>N 5092255.3 ; E 221116.7</u>	ORIGINATED BY <u>MR</u>
DIST <u>HWY 69</u>	BOREHOLE TYPE <u>NW Casing, Wash Boring</u>	COMPILED BY <u>MWK</u>
DATUM <u>Geodetic</u>	DATE <u>March 5, 2009</u>	CHECKED BY <u>VA</u>

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W <sub>p</sub>	W			W <sub>L</sub>	10	20	30	GR
156.2 30.5	END OF DCPT  NOTE:  1. Water level in open borehole at ice surface (Elev. 186.7 m) upon completion of drilling.																				

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE



PROJECT <u>06-1111-025</u>	<b>RECORD OF BOREHOLE No 305-2</b>	2 OF 2 <b>METRIC</b>
G.W.P. <u>5203-06-00</u>	LOCATION <u>N 5092335.0 ; E 221124.4</u>	ORIGINATED BY <u>MWK</u>
DIST <u>        </u> HWY <u>69</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>MWK</u>
DATUM <u>Geodetic</u>	DATE <u>March 6, 2009</u>	CHECKED BY <u>VA</u>

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES			20	40	60	80	100	W <sub>p</sub>	W	W <sub>L</sub>		
-- CONTINUED FROM PREVIOUS PAGE --																
	NOTES:  1. Borehole caved at a depth of 3.0 m below snow surface (Elev. 183.8 m) upon removal of augers.  2. Water level in open borehole at snow surface (Elev. 186.8 m) upon completion of drilling.  3. A Dynamic Cone Penetration Test was carried out below a depth of 12.8 m to prove refusal; rod bent on probable sloping bedrock.  * Shelby tube sampler refusal at a depth of 11.0 m below snow surface (Elev. 175.8 m)															

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT <u>06-1111-025</u>	<b>RECORD OF BOREHOLE No 305-3</b>	1 OF 1 <b>METRIC</b>
G.W.P. <u>5203-06-00</u>	LOCATION <u>N 5092337.2 ; E 221104.5</u>	ORIGINATED BY <u>MWK</u>
DIST <u>        </u> HWY <u>69</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>MWK</u>
DATUM <u>Geodetic</u>	DATE <u>March 19, 2009</u>	CHECKED BY <u>VA</u>

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT <b>γ</b> kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									
						20 40 60 80 100	○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× REMOULDED							
						20 40 60 80 100						WATER CONTENT (%)					
187.2 0.0	GROUND SURFACE Borehole augered from ground surface to a depth of 3.0 m (Elev. 184.2 m) Stratigraphy inferred from augered sample					▽	187										
184.7 2.5	SILTY CLAY to CLAY, some silt containing silt interlayers Grey Wet						186										
183.5 3.7	SILT, trace to some clay, trace sand Grey Wet		1	TO	PH		184						192	15.0	C/CIU		
180.5 6.7	END OF BOREHOLE  NOTE: 1. Water level in open borehole at ground surface (Elev. 187.2 m) upon completion of drilling.		2	TO	PH		183									CIU	
							182										
							181						H ○				

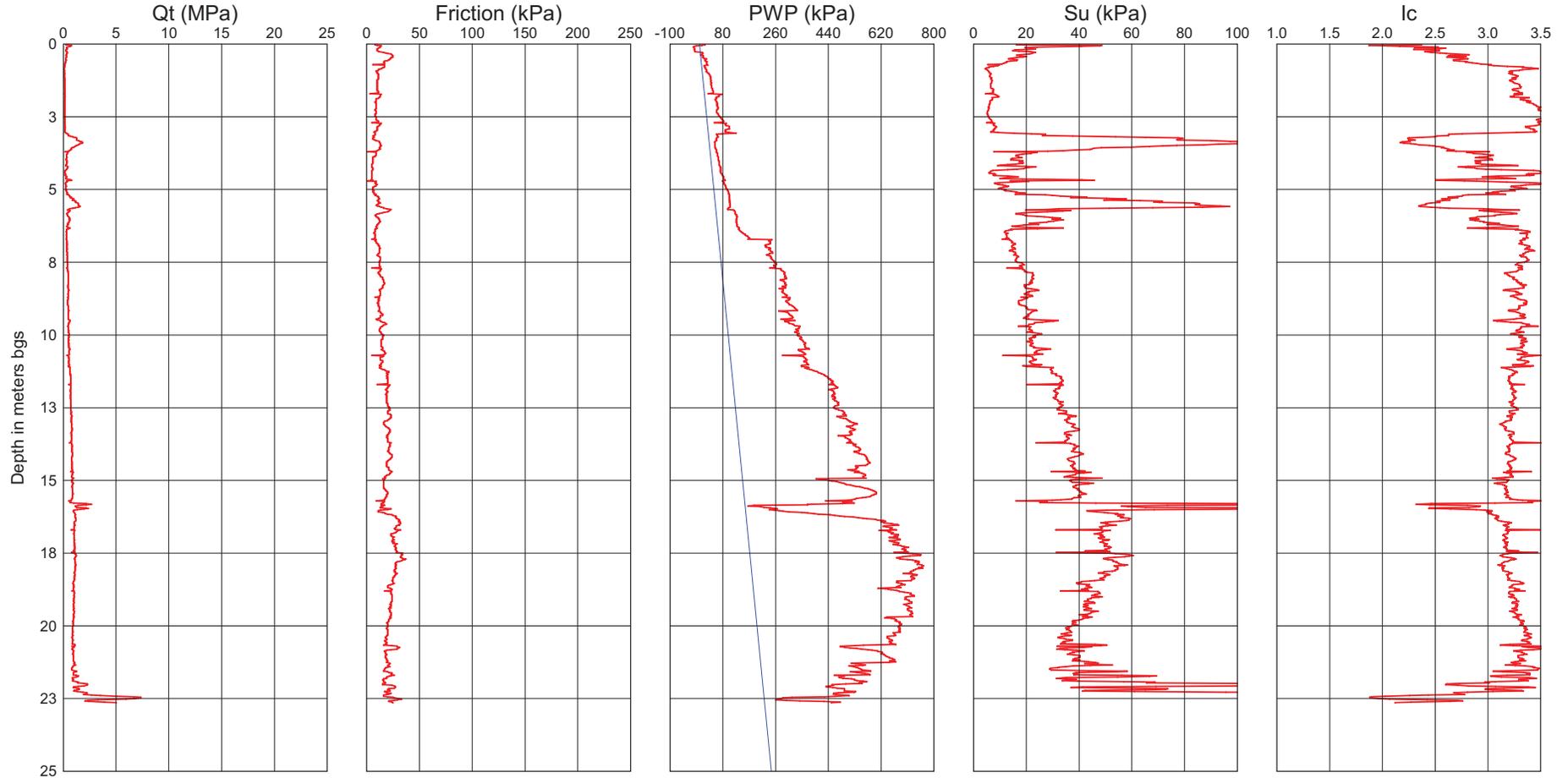
GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

# Cone Penetration Test - CPT305-1

Test Date : March 06, 2009  
 Location : Highway 69 - STA 16+217 o/s 19 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.70  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 16.5 \text{ kN/m}^3$

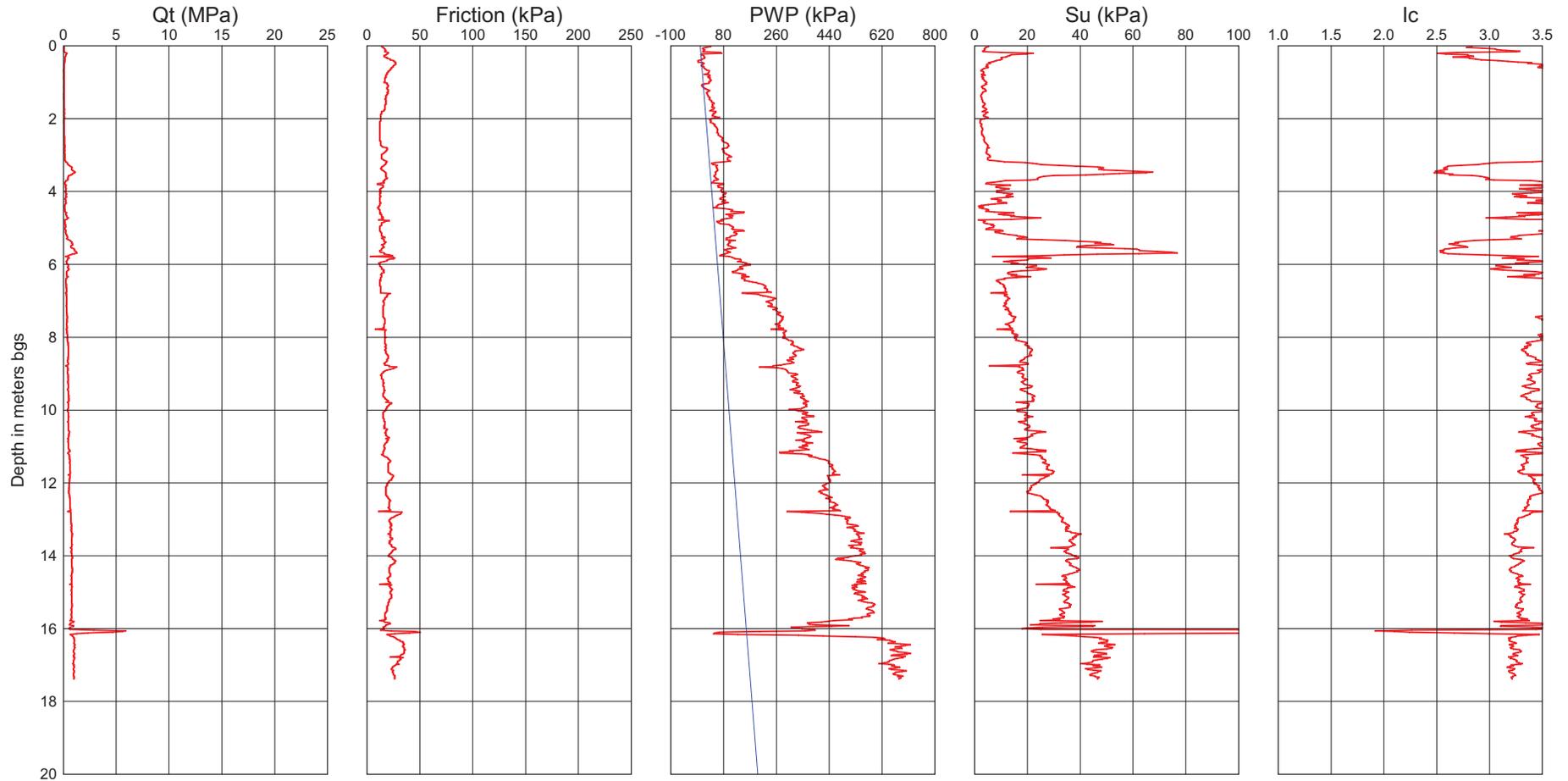
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT305-2

Test Date : March 05, 2009  
 Location : Highway 69 - STA 16+217 o/s 20 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.70  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16.5 \text{ kN/m}^3$

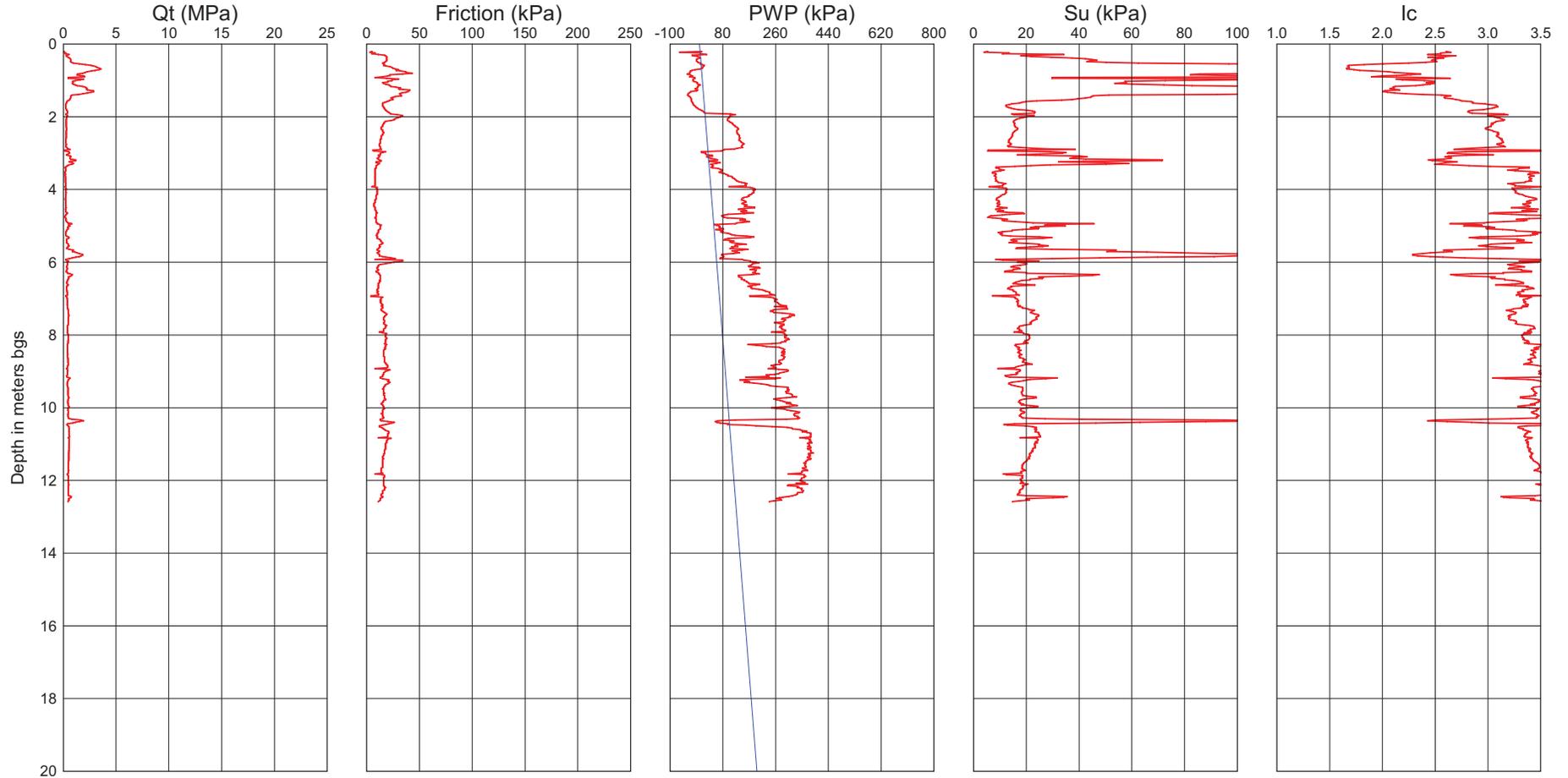
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT305-3

Test Date : March 06, 2009  
 Location : Highway 69 - STA 16+280 o/s 20 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.80  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16.5 \text{ kN/m}^3$

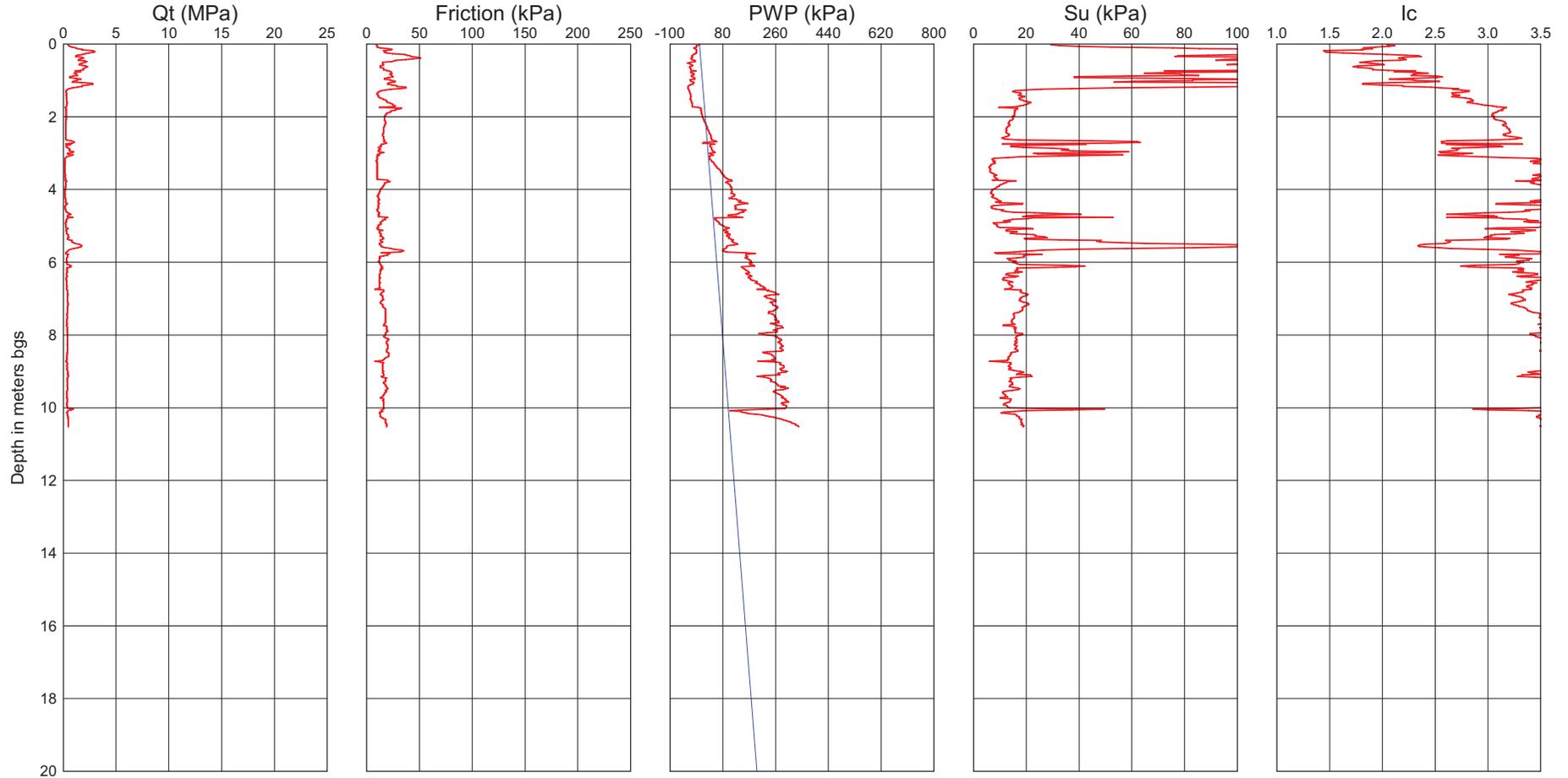
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT305-4

Test Date : March 06, 2009  
 Location : Highway 69 - STA 16+280 o/s 20.5 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.80  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16.5 \text{ kN/m}^3$

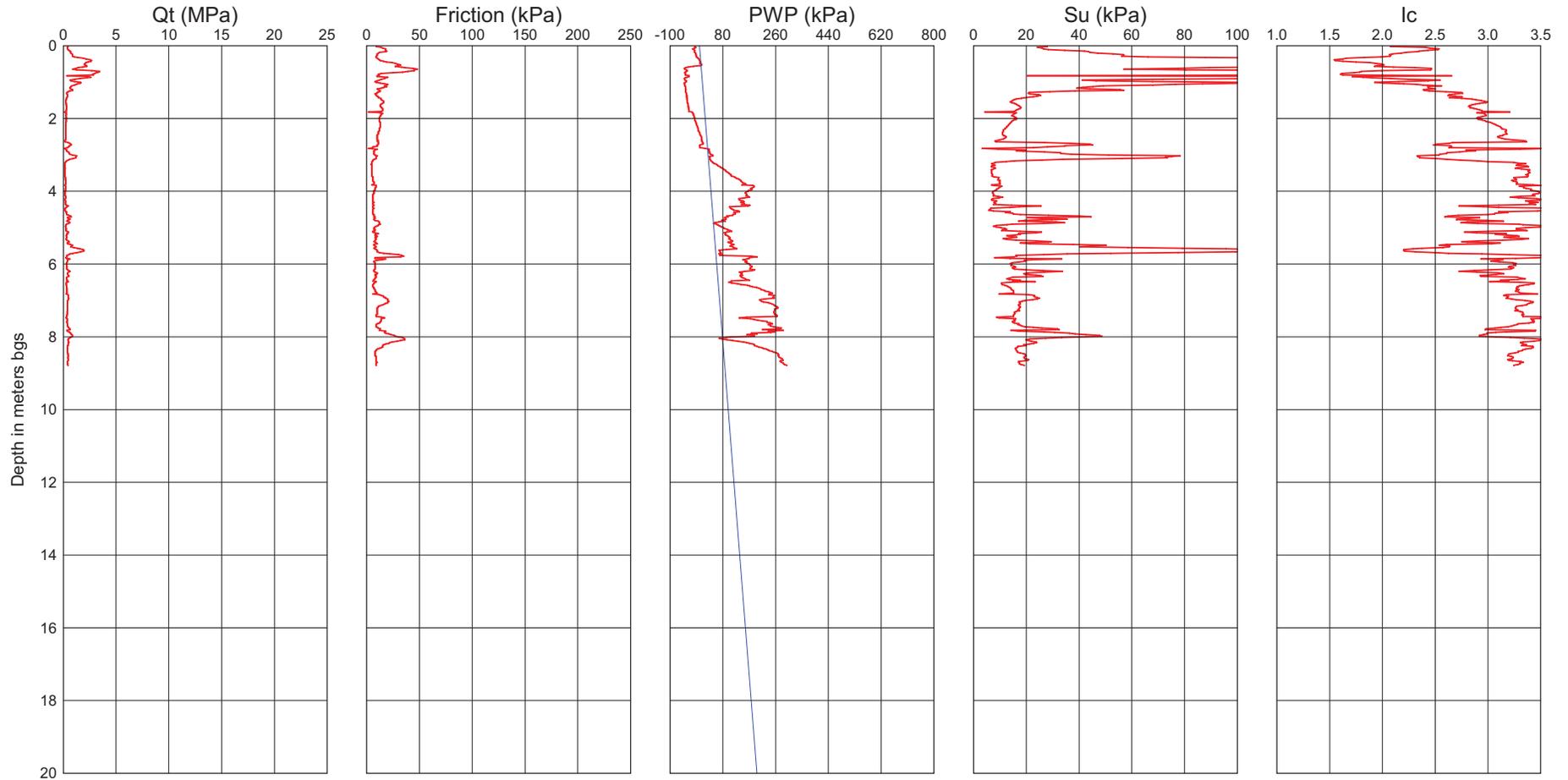
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT305-5

Test Date : March 06, 2009  
 Location : Highway 69 - STA 16+280 o/s 21 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 186.80  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 16.5 \text{ kN/m}^3$

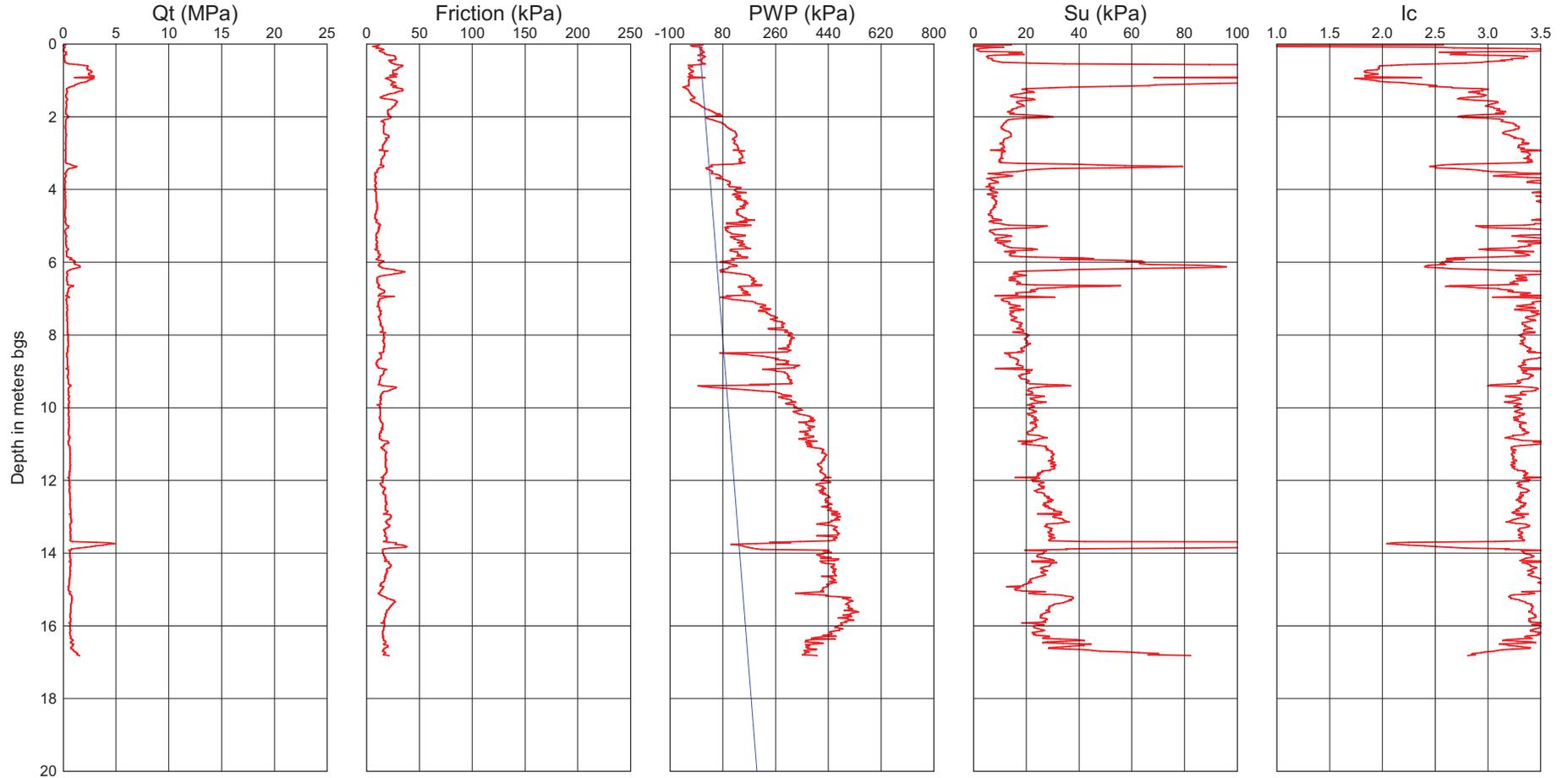
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT305-6

Test Date : March 19, 2009  
 Location : Highway 69 - STA 16+280 o/s 39 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 187.20  
 Water Table Depth : 0.00



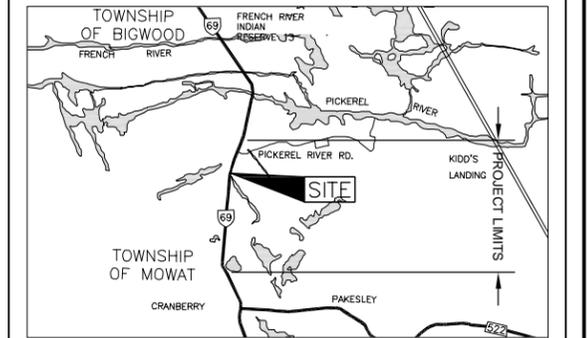
Qt normalized for  
 unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16.5 \text{ kN/m}^3$

After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA

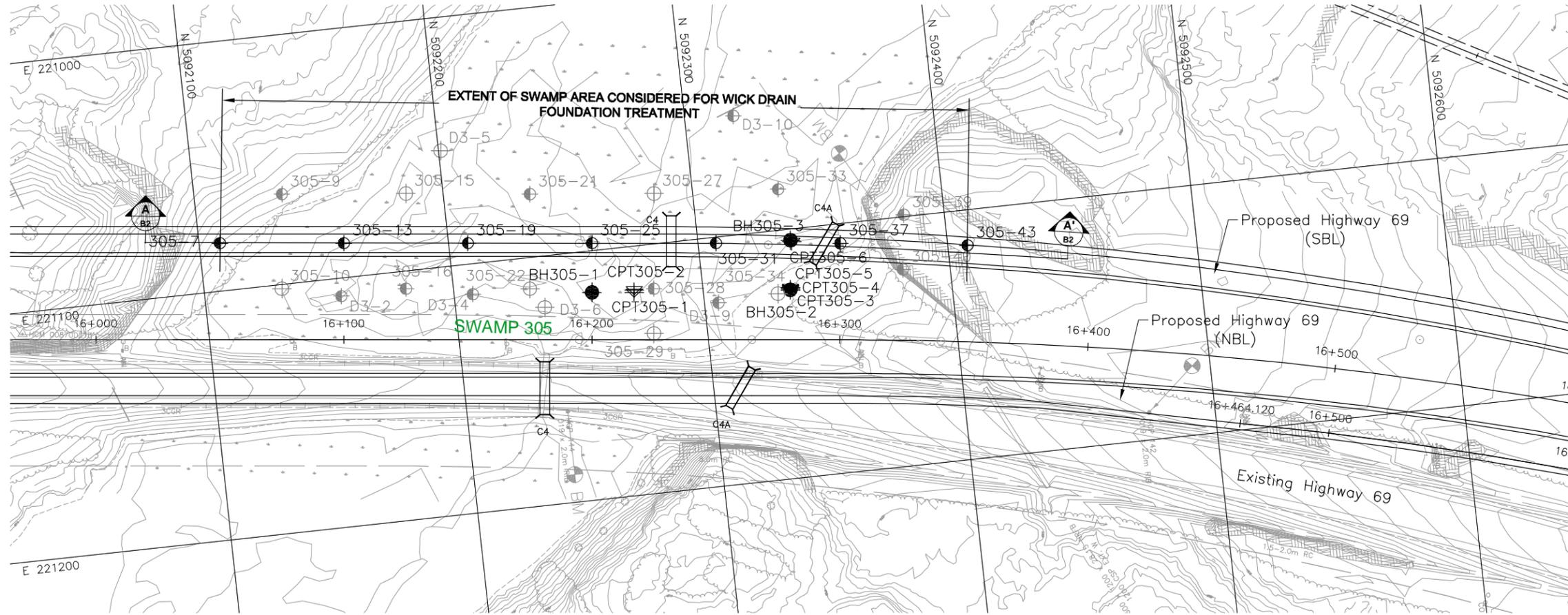


KEY PLAN

LEGEND

- Borehole - Current Investigation
- ▽ CPT - Current Investigation
- ⊕ Borehole - Previous Investigation (Peto MacCallum Ltd.)
- ⊕ Dynamic Cone Penetration Test - Previous Investigation (Peto MacCallum Ltd.)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ▽ WL observed during or upon completion of drilling
- R Refusal

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
BH305-1	186.7	5092255.3	221116.7
BH305-2	186.8	5092335.0	221124.4
BH305-3	187.2	5092337.2	221104.5
CPT305-1	186.7	5092272.2	221118.5
CPT305-2	186.7	5092272.3	221117.5
CPT305-3	186.8	5092335.0	221124.4
CPT305-4	186.8	5092335.0	221123.9
CPT305-5	186.8	5092335.1	221123.4
CPT305-6	187.2	5092337.1	221105.5



PLAN  
SCALE  
20 0 20 40 m

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 and Profile provided in digital format by MRC, drawing file's no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009. 1-6454\_Phase3-ML PROFILE-Mar 26-09.dwg, received Sept. 30, 2009.



NO.	DATE	BY	REVISION

Geocres No. 41H-106

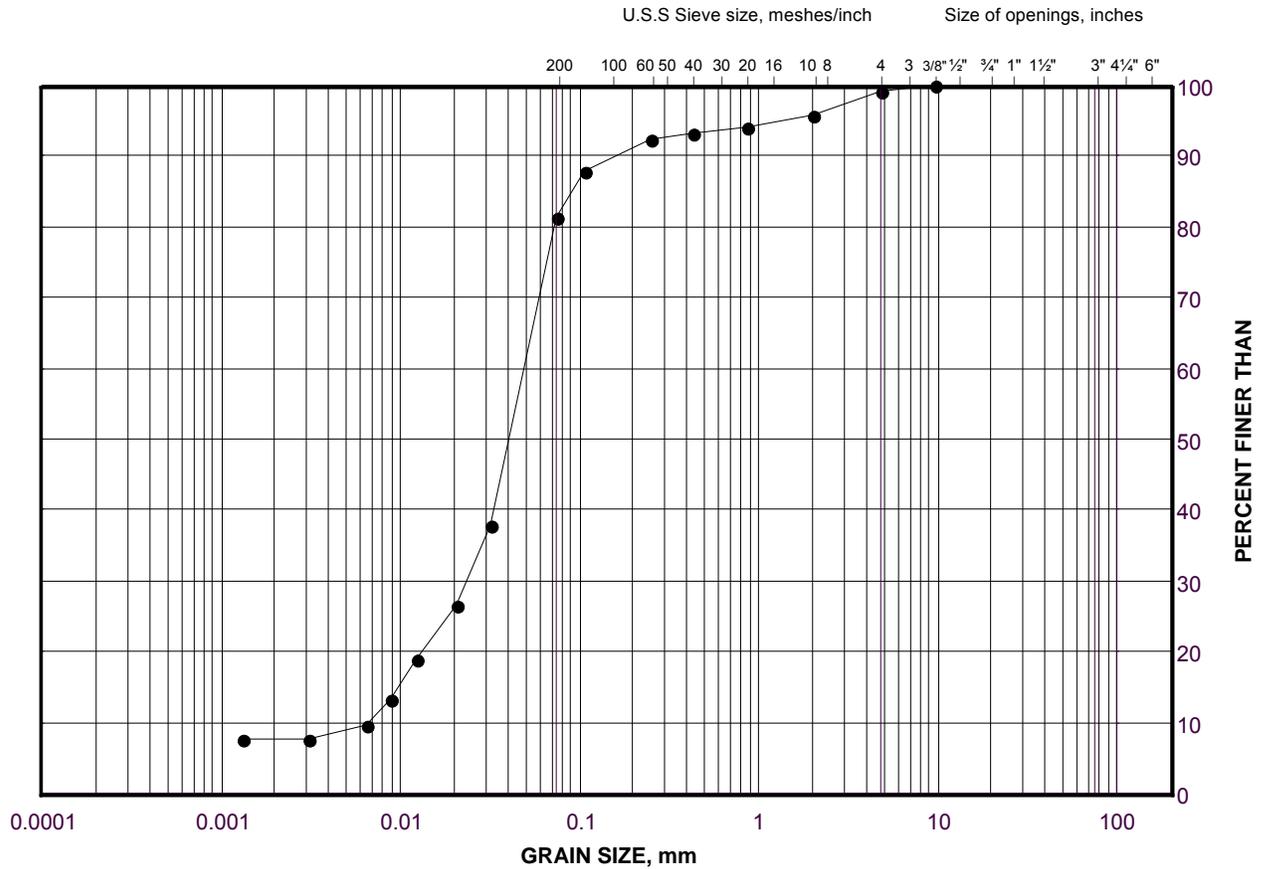
HWY: 69	PROJECT NO. 06-1111-025	DIST.
SUBM'D. MWK	CHKD. MWK	DATE: Feb. 2012
DRAWN: DD/RJ	CHKD. VA	APPD. JPD/JMAC
		DWG. B1



# GRAIN SIZE DISTRIBUTION

Silt  
Highway 69 (SBL) STA 16+050 to 16+350

FIGURE B.S305-1



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

## LEGEND

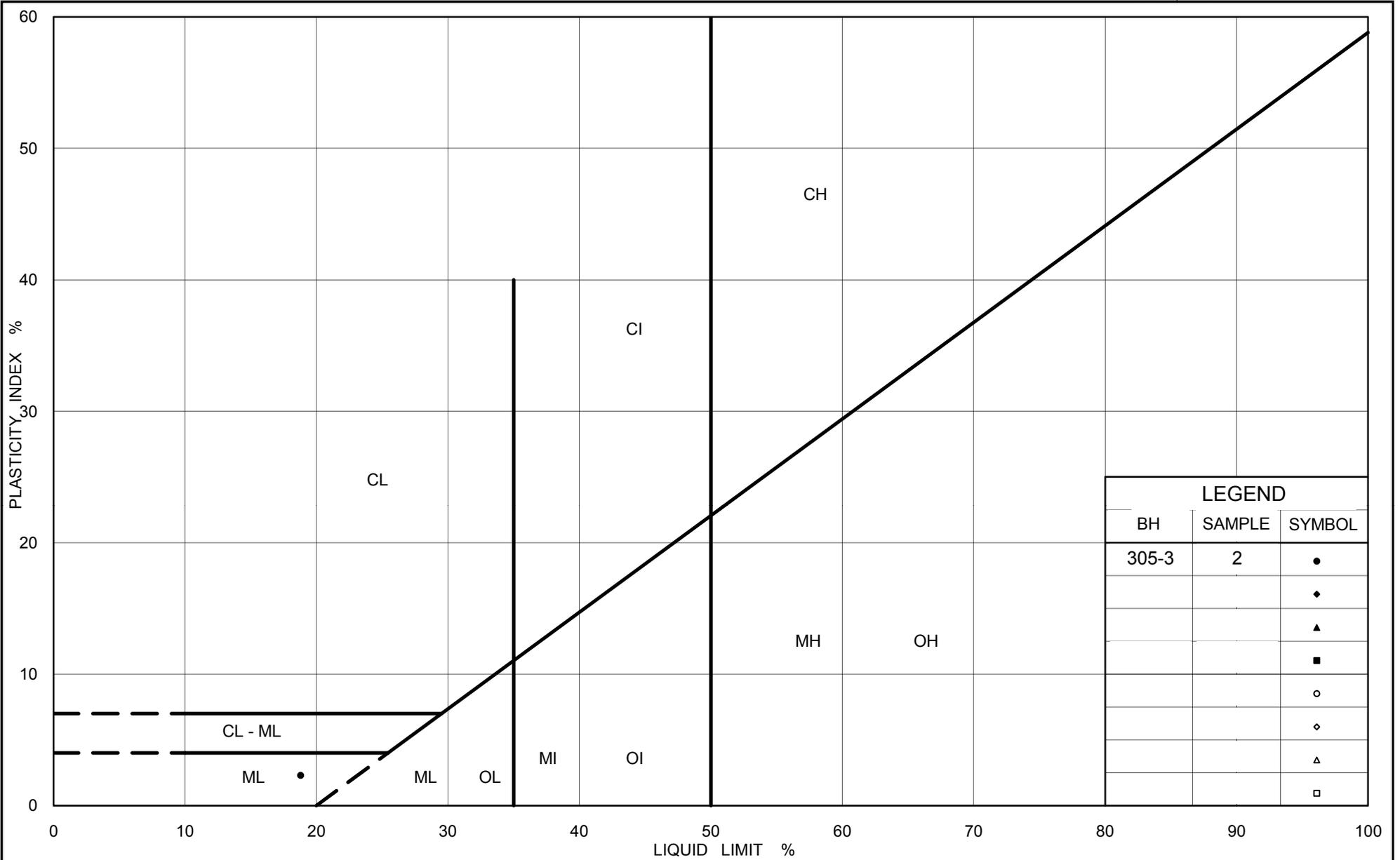
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
•	305-2	1	185.2

Project Number: 06-1111-025

Checked By:   TVA  

**Golder Associates**

Date: 01-Feb-10



Ministry of Transportation

Ontario

PLASTICITY CHART

Silt

Highway 69 (SBL) STA 16+050 to 16+350

Figure No. B.S305-2

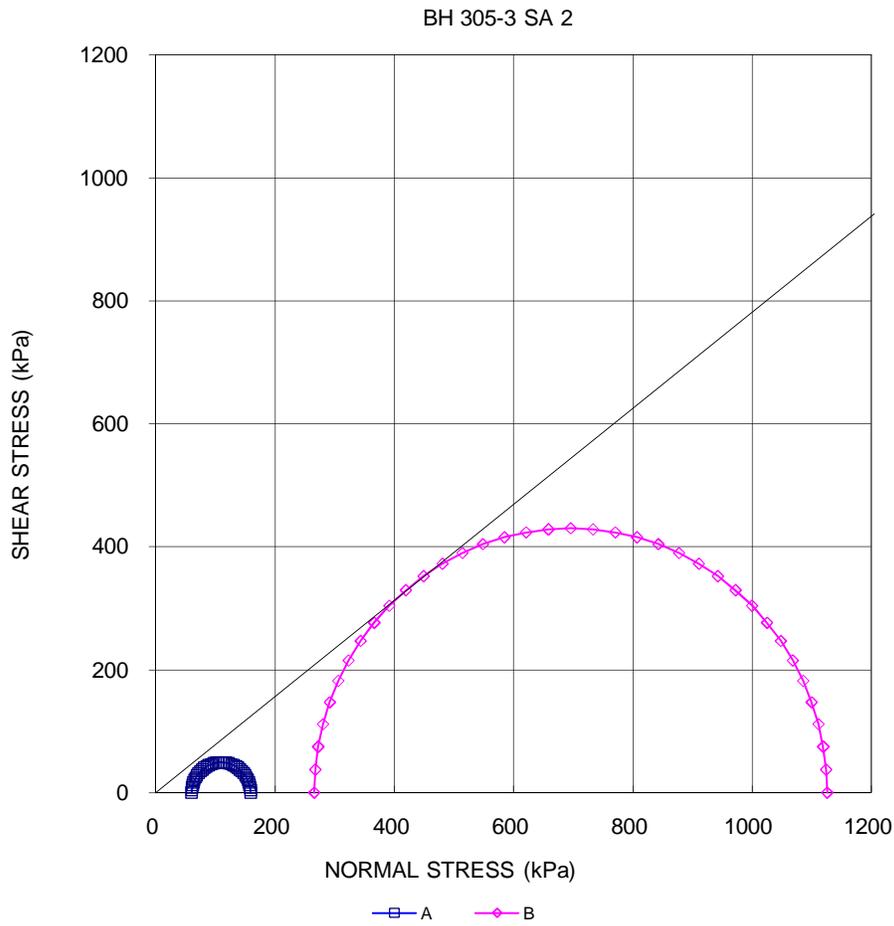
Project No. 06-1111-025

Checked By: TVA

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE B.S305-3  
Sheet 1 of 4**

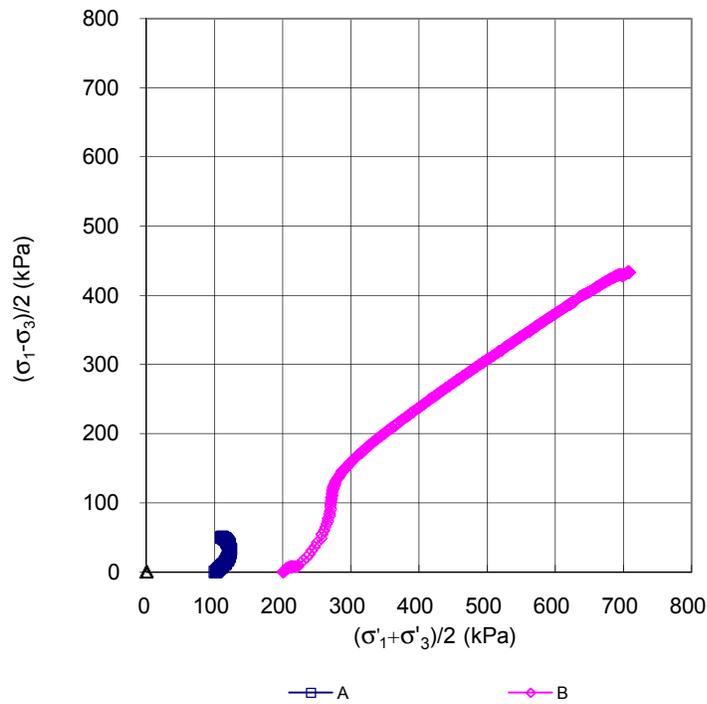
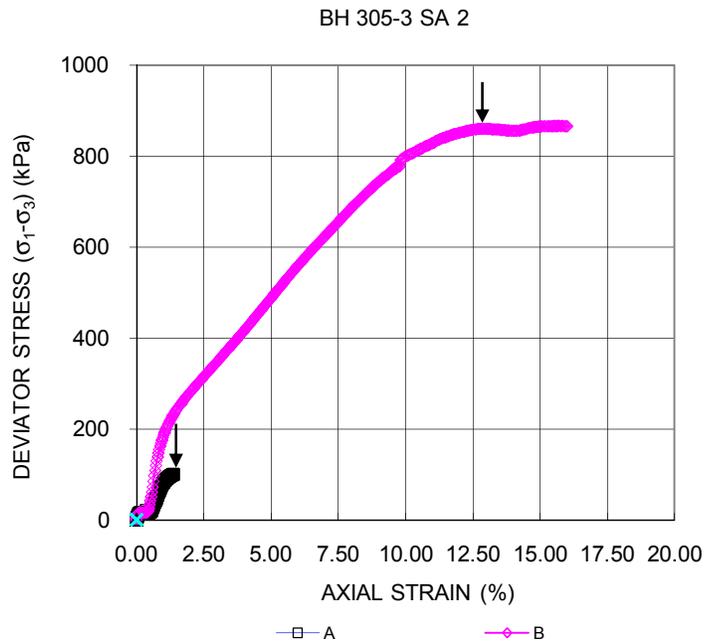
TEST STAGE	A	B
BOREHOLE NUMBER	305-3	305-3
SAMPLE	2	2
SPECIMEN DIAMETER, cm	7.06	6.74
SPECIMEN HEIGHT, cm	14.20	13.35
WATER CONTENT BEFORE CONSOLIDATION, %	23.9	20.6
CELL PRESSURE, $\sigma_3$ , kPa	165.0	265.0
BACK PRESSURE, kPa	65.0	65.0
PORE PRESSURE PARAMETER "B"	0.99	-
CONSOLIDATION PRESSURE, $\sigma_c$ , kPa	100.0	200.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	5.3	1.0
WATER CONTENT AFTER CONSOLIDATION, %	20.6	20.1
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5
TIME TO FAILURE, hours	3	25
WATER CONTENT AFTER TEST, %	20.6	18.6
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa	101.0	859.5
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ maximum, %	1.4	12.7
MAX EFFECTIVE PRINCIPAL STRESS RATIO, $(\sigma'_1 / \sigma'_3)$ maximum	2.7	4.3
DEVIATOR STRESS AT $(\sigma'_1 / \sigma'_3)$ maximum, kPa	101.0	791.2
AXIAL STRAIN AT $(\sigma'_1 / \sigma'_3)$ maximum, %	1.4	9.8
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ maximum	0.40	-0.08
PORE PRESSURE PARAMETER, Af, AT $(\sigma'_1 / \sigma'_3)$ maximum	0.40	-0.05
NATURAL WATER CONTENT, %	23.8	-
DRY DENSITY, Mg/m <sup>3</sup>	1.62	-
FILTER DRAINS USED, y/n	y	y
TEST NOTES:		
CHANGED RATE OF STRAIN, %/hr	-	-
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %	-	-
FAILURE PLANE NUMBER	-	-
ANGLE OF FAILURE, DEGREES	-	bulged
Date: 01/27/2010		Prepared By: LH
Project No. 06-1111-025	<b>Golder Associates</b>	Checked By: MM



Date: 01/27/2010  
Project No. 06-1111-025

**Golder Associates**

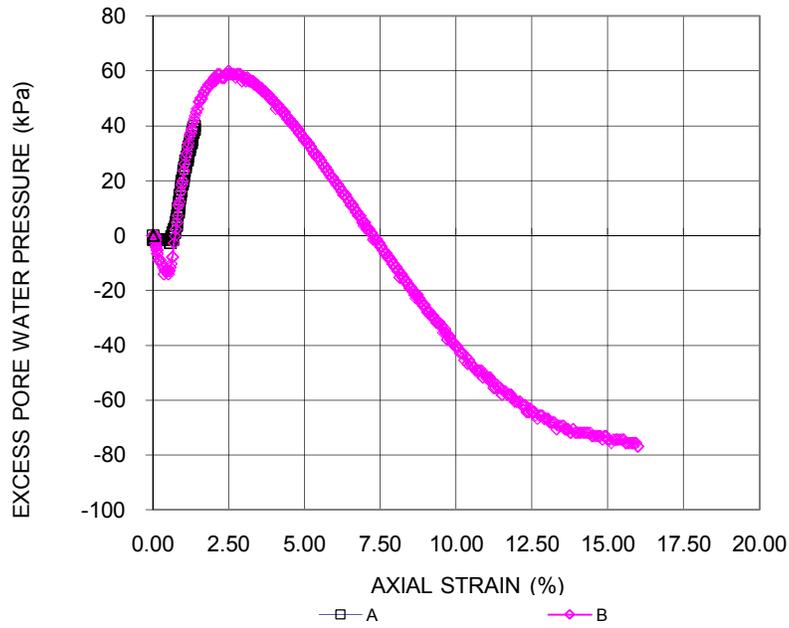
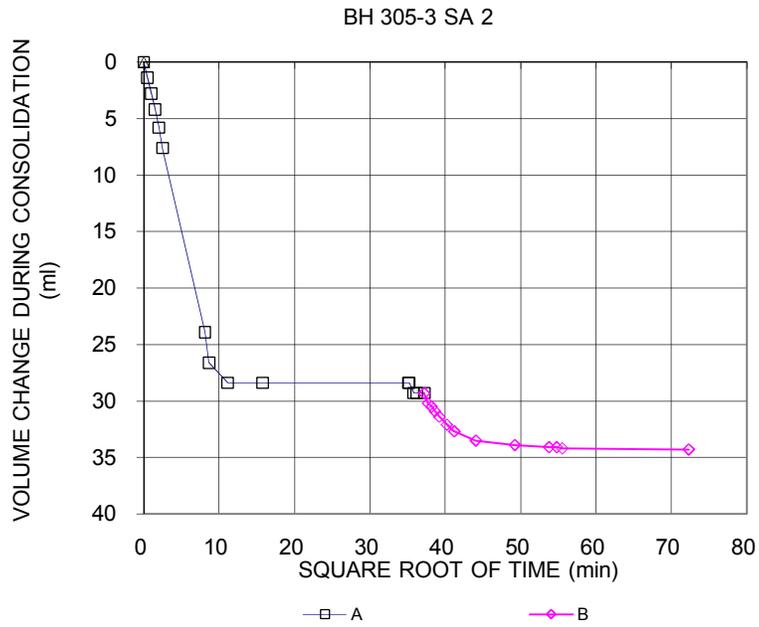
Prepared By: LH  
Checked By: MM



Date: 01/27/2010  
Project No. 06-1111-025

**Golder Associates**

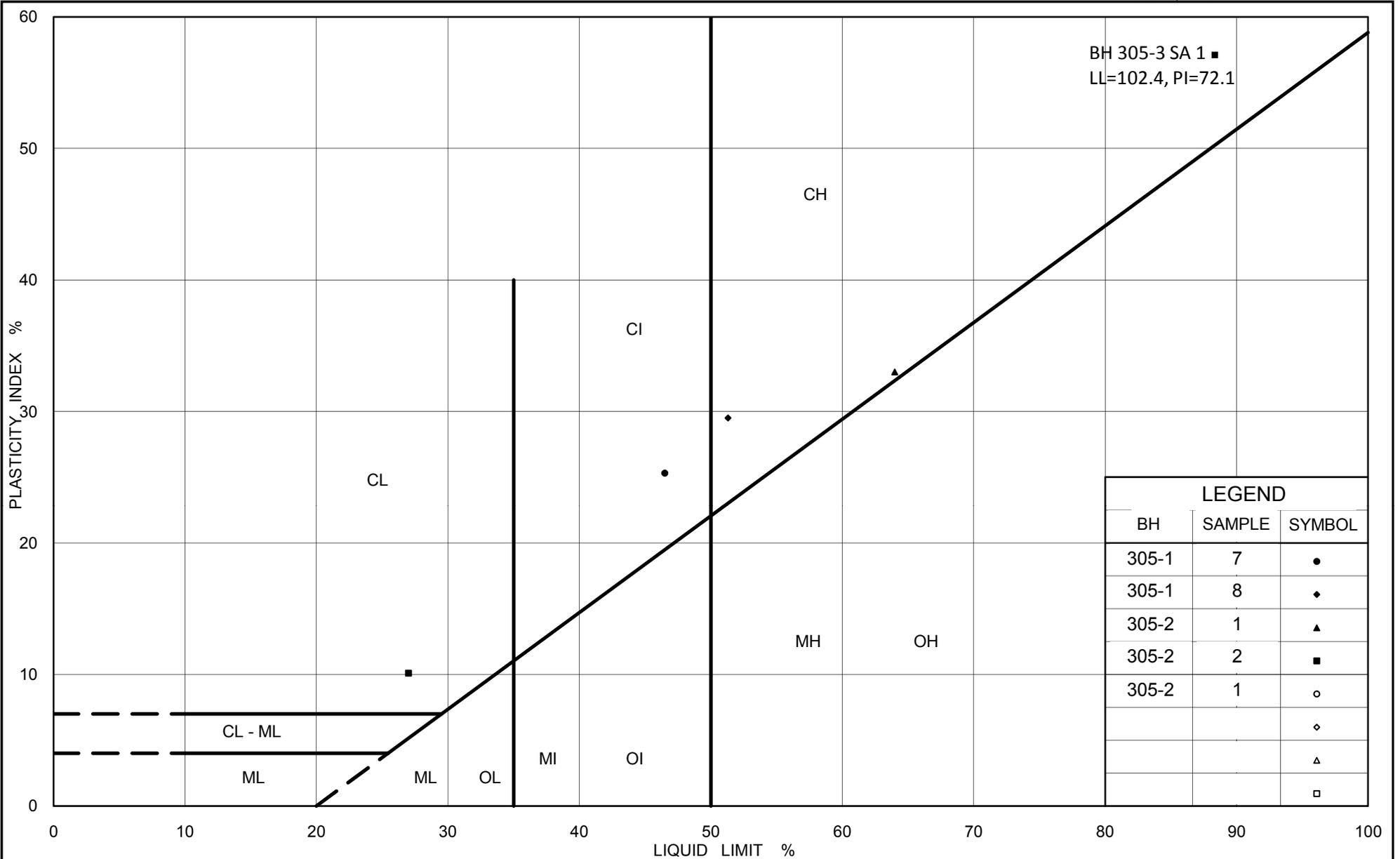
Prepared By: LH  
Checked By: MM



Date: 01/27/2010  
Project No. 06-1111-025

**Golder Associates**

Prepared By: LH  
Checked By: MM



**CONSOLIDATION TEST SUMMARY**

Highway 69 (SBL) STA 16+050 to 16+350

**FIGURE B.S305-5**

Sheet 1 of 4

**SAMPLE IDENTIFICATION**

Project Number	06-1111-025	Sample Number	7
Borehole Number	305-1	Sample Depth, m	13.8

**TEST CONDITIONS**

Test Type	Standard	Load Duration, hr	24
Oedometer Number	6		
Date Started	04/23/2009		
Date Completed	05/12/2009		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	1.90	Unit Weight, kN/m <sup>3</sup>	16.79
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	10.97
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.78
Volume, cm <sup>3</sup>	59.86	Solids Height, cm	0.763
Water Content, %	53.10	Volume of Solids, cm <sup>3</sup>	24.08
Wet Mass, g	102.49	Volume of Voids, cm <sup>3</sup>	35.78
Dry Mass, g	66.94	Degree of Saturation, %	99.4

**TEST COMPUTATIONS**

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv. cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	1.896	1.486	1.896				
4.84	1.886	1.473	1.891	9	8.42E-02	1.08E-03	8.91E-06
9.53	1.882	1.468	1.884	17	4.43E-02	4.16E-04	1.81E-06
19.47	1.871	1.453	1.877	60	1.24E-02	6.00E-04	7.31E-07
38.81	1.854	1.431	1.863	26	2.83E-02	4.58E-04	1.27E-06
77.64	1.821	1.387	1.837	60	1.19E-02	4.58E-04	5.35E-07
155.06	1.706	1.237	1.764	46	1.43E-02	7.78E-04	1.09E-06
310.20	1.531	1.007	1.619	240	2.31E-03	5.97E-04	1.35E-07
620.91	1.410	0.848	1.470	24	1.91E-02	2.06E-04	3.85E-07
1241.59	1.309	0.716	1.359	60	6.53E-03	8.55E-05	5.47E-08
2482.16	1.230	0.612	1.269	25	1.37E-02	3.36E-05	4.50E-08
1241.59	1.244	0.631	1.237				
310.20	1.259	0.650	1.251				
77.64	1.290	0.691	1.274				
19.47	1.321	0.732	1.305				
4.84	1.343	0.760	1.332				

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

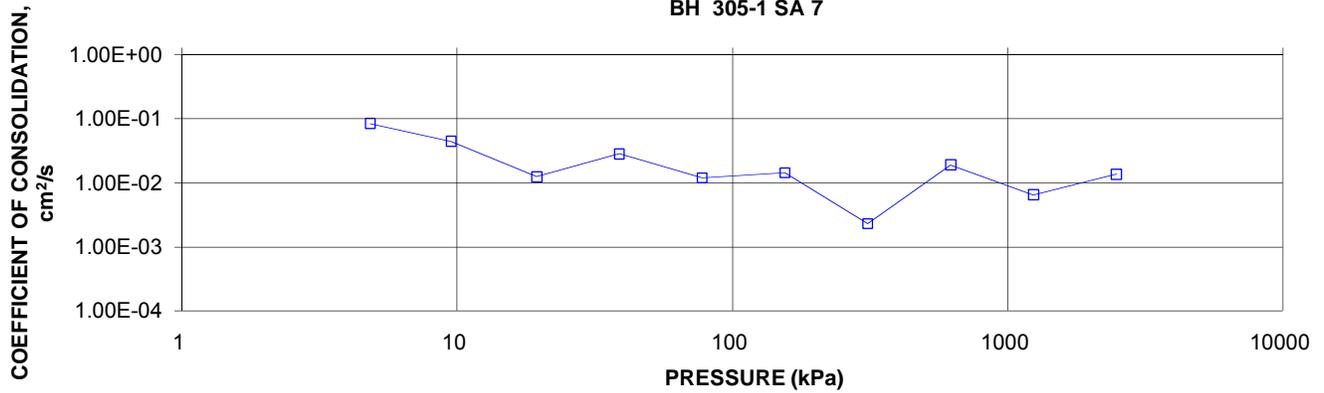
Sample Height, cm	1.34	Unit Weight, kN/m <sup>3</sup>	20.12
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	15.49
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.78
Volume, cm <sup>3</sup>	42.39	Solids Height, cm	0.763
Water Content, %	29.90	Volume of Solids, cm <sup>3</sup>	24.08
Wet Mass, g	86.96	Volume of Voids, cm <sup>3</sup>	18.30
Dry Mass, g	66.94		

Prepared By: LH

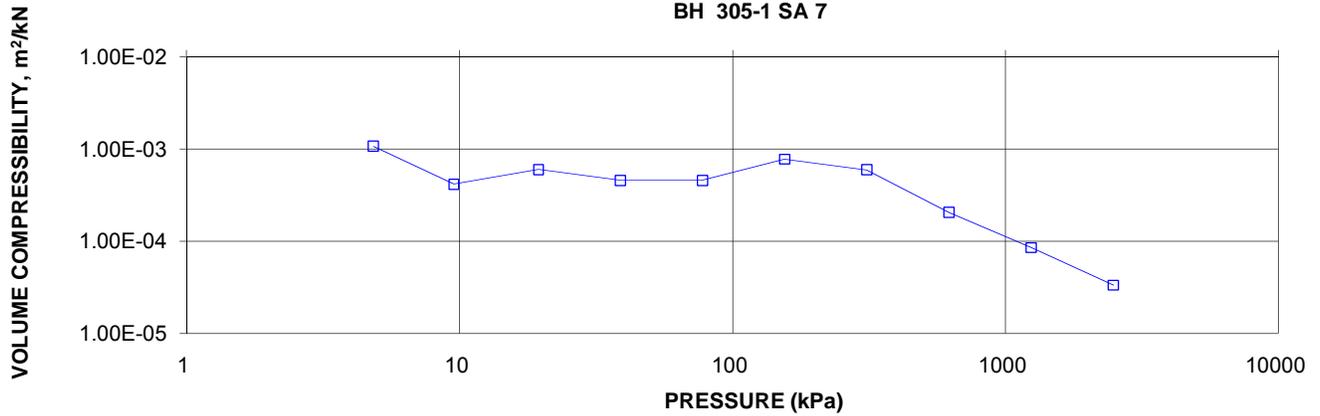
**Golder Associates**

Checked By: MM

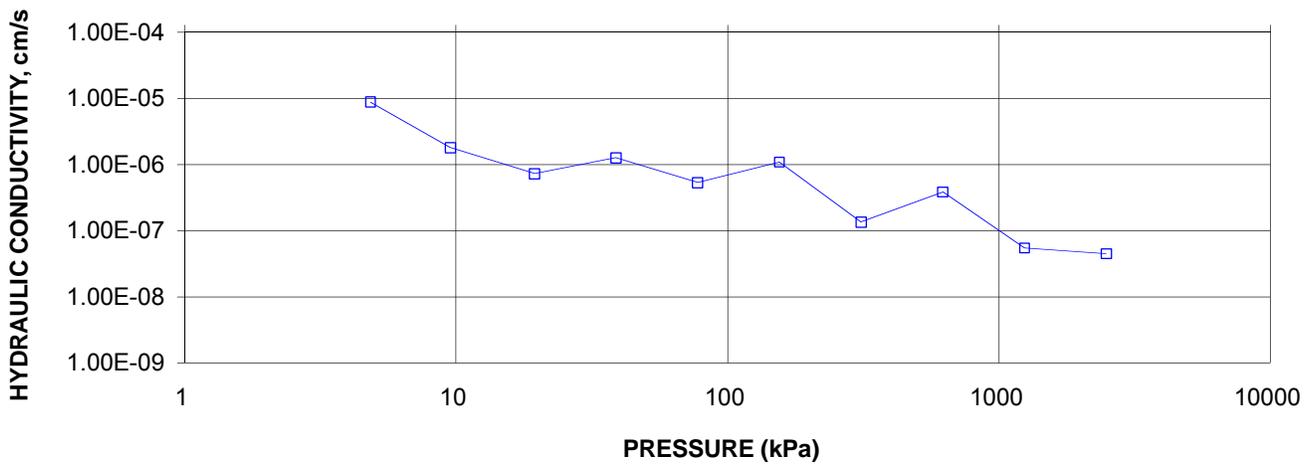
**CONSOLIDATION TEST**  
 CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
 BH 305-1 SA 7



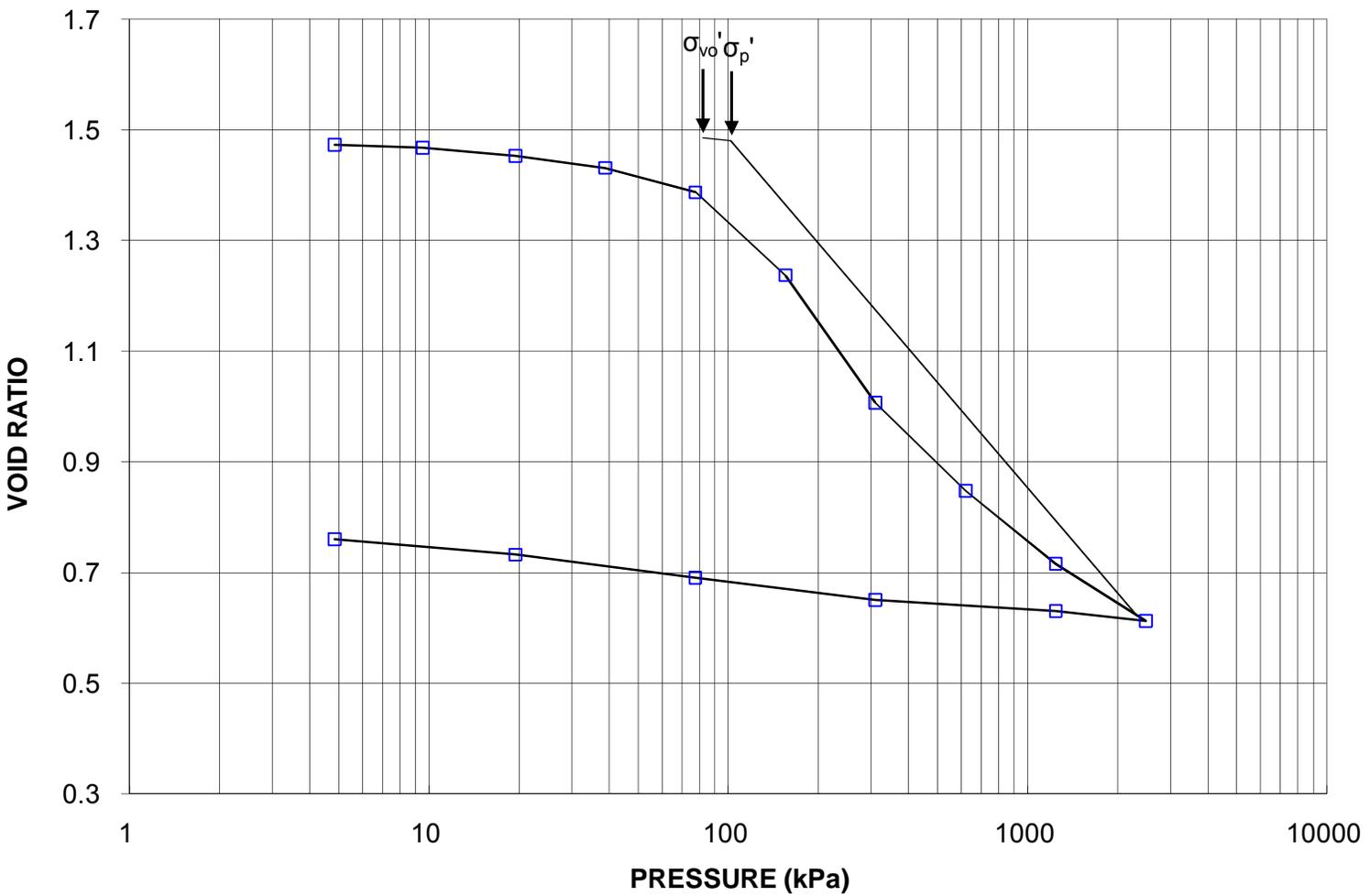
**CONSOLIDATION TEST**  
 MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
 BH 305-1 SA 7



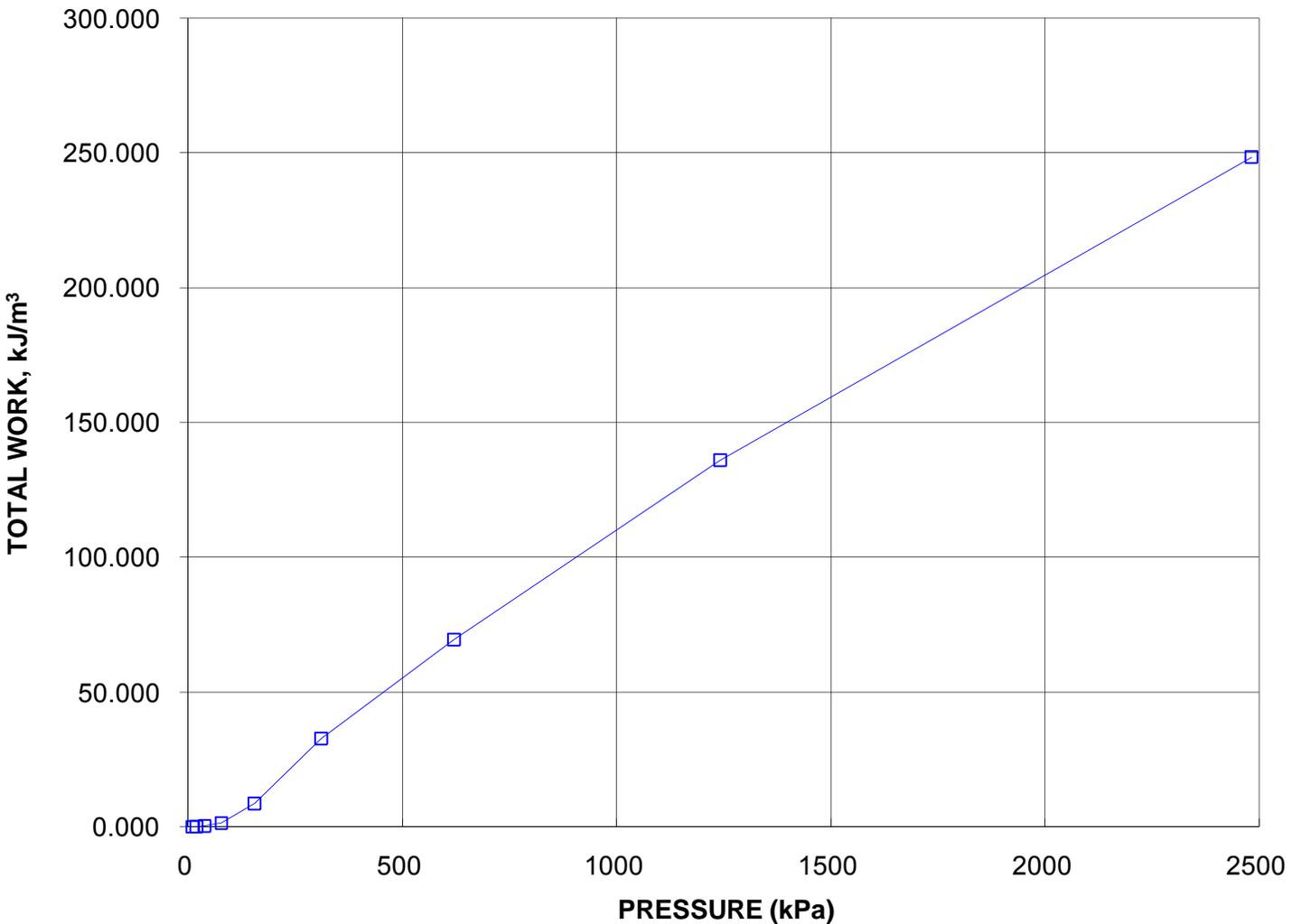
**CONSOLIDATION TEST**  
 HYDRAULIC CONDUCTIVITY vs PRESSURE  
 BH 305-1 SA 7



CONSOLIDATION TEST  
VOID RATIO vs PRESSURE  
BH 305-1 SA 7



CONSOLIDATION TEST  
TOTAL WORK, kJ/m<sup>3</sup> vs PRESSURE  
BH 305-1 SA 7



**CONSOLIDATION TEST SUMMARY**

Highway 69 (SBL) STA 16+050 to 16+350

**FIGURE B.S305-6**

Sheet 1 of 4

**SAMPLE IDENTIFICATION**

Project Number	06-1111-025	Sample Number	1
Borehole Number	305-3	Sample Depth, m	3.4

**TEST CONDITIONS**

Test Type	Standard	Load Duration, hr	24
Oedometer Number	5		
Date Started	04/30/2009		
Date Completed	05/30/2009		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	1.91	Unit Weight, kN/m <sup>3</sup>	14.96
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m <sup>3</sup>	8.27
Area, cm <sup>2</sup>	31.51	Specific Gravity, measured	2.78
Volume, cm <sup>3</sup>	60.06	Solids Height, cm	0.578
Water Content, %	80.81	Volume of Solids, cm <sup>3</sup>	18.22
Wet Mass, g	91.60	Volume of Voids, cm <sup>3</sup>	41.83
Dry Mass, g	50.66	Degree of Saturation, %	97.9

**TEST COMPUTATIONS**

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv. cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	1.906	2.296	1.906				
4.78	1.896	2.278	1.901	8	9.58E-02	1.11E-03	1.04E-05
9.58	1.882	2.254	1.889	10	7.56E-02	1.53E-03	1.13E-05
19.35	1.855	2.207	1.868	60	1.23E-02	1.46E-03	1.76E-06
38.88	1.789	2.093	1.822	175	4.02E-03	1.77E-03	6.99E-07
77.82	1.613	1.789	1.701	416	1.47E-03	2.37E-03	3.43E-07
155.56	1.427	1.467	1.520	960	5.10E-04	1.25E-03	6.27E-08
311.03	1.273	1.201	1.350	679	5.69E-04	5.20E-04	2.90E-08
621.76	1.149	0.986	1.211	329	9.45E-04	2.09E-04	1.94E-08
1244.19	1.045	0.806	1.097	315	8.10E-04	8.77E-05	6.96E-09
2486.52	0.957	0.654	1.001	46	4.62E-03	3.72E-05	1.68E-08
1244.19	0.969	0.675	0.963				
311.03	0.992	0.715	0.980				
77.82	1.033	0.786	1.012				
19.35	1.077	0.862	1.055				
4.78	1.116	0.930	1.096				

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.12	Unit Weight, kN/m <sup>3</sup>	19.24
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m <sup>3</sup>	14.13
Area, cm <sup>2</sup>	31.51	Specific Gravity, measured	2.78
Volume, cm <sup>3</sup>	35.16	Solids Height, cm	0.578
Water Content, %	36.20	Volume of Solids, cm <sup>3</sup>	18.22
Wet Mass, g	69.00	Volume of Voids, cm <sup>3</sup>	16.94
Dry Mass, g	50.66		

Prepared By: LH

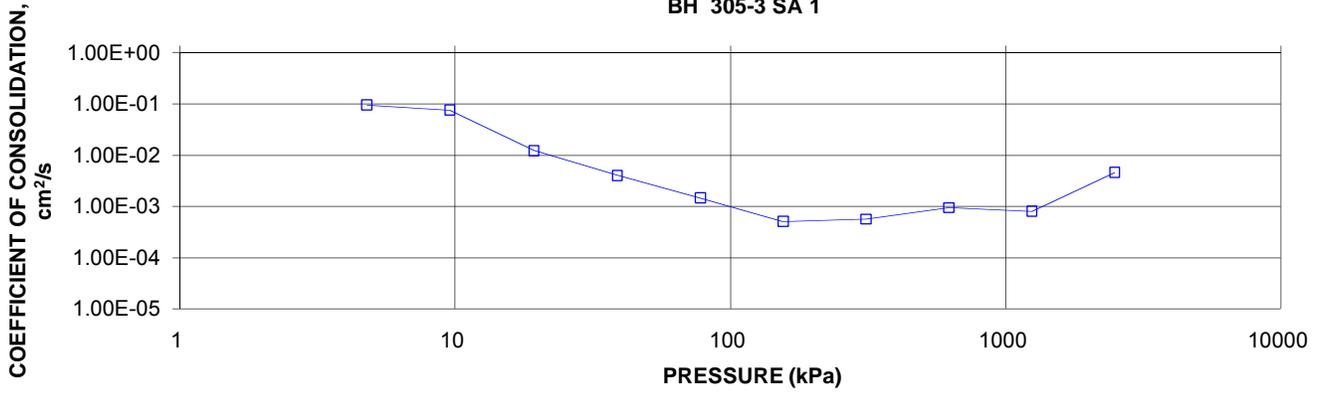
**Golder Associates**

Checked By: MM

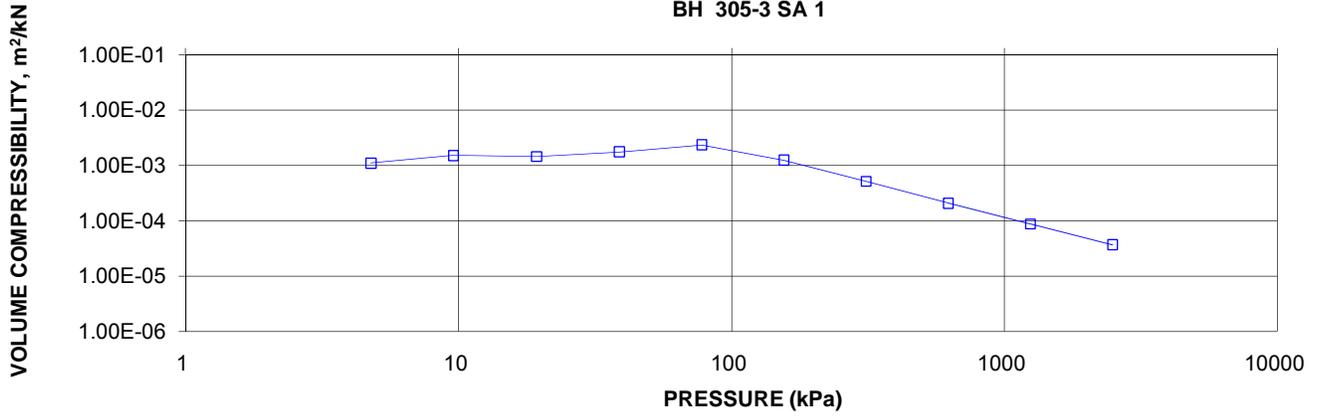
**CONSOLIDATION TEST SUMMARY**  
**Highway 69 (SBL) STA 16+050 to 16+350**

**FIGURE B.S305-6**  
**Sheet 2 of 4**

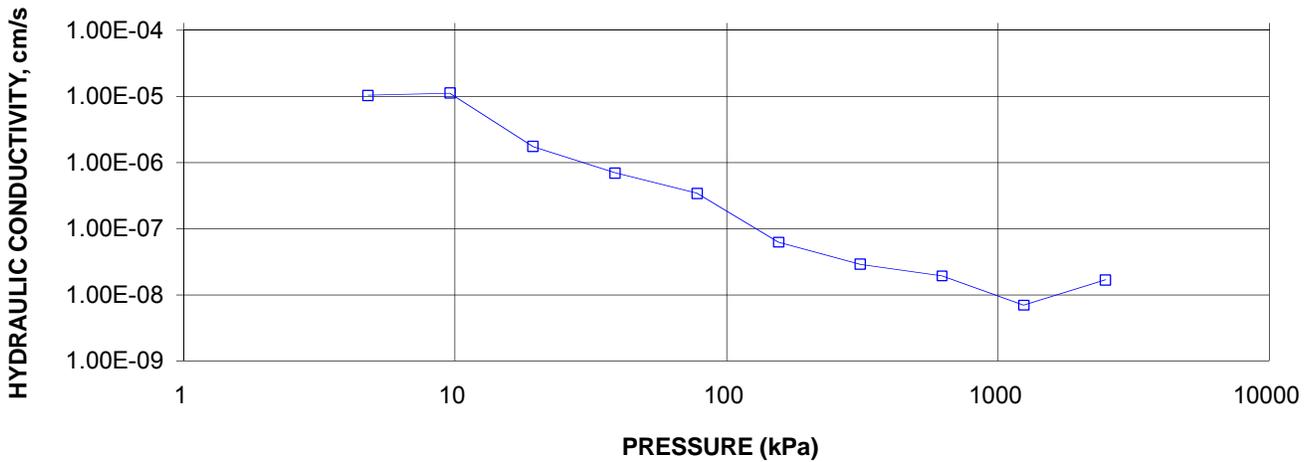
**CONSOLIDATION TEST**  
**CV cm<sup>2</sup>/s VS PRESSURE (kPa)**  
**BH 305-3 SA 1**



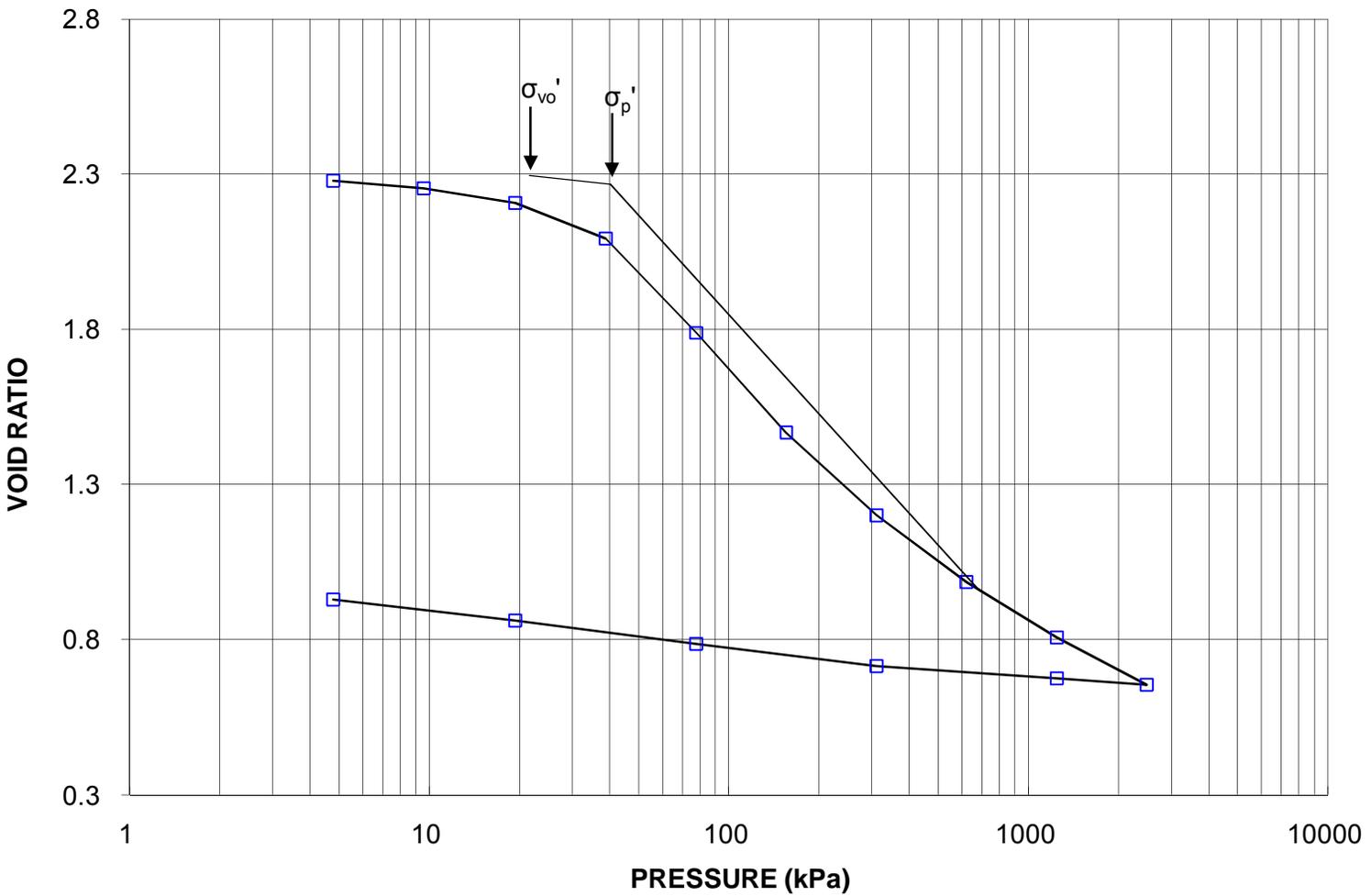
**CONSOLIDATION TEST**  
**MV m<sup>2</sup>/kN vs PRESSURE (kPa)**  
**BH 305-3 SA 1**



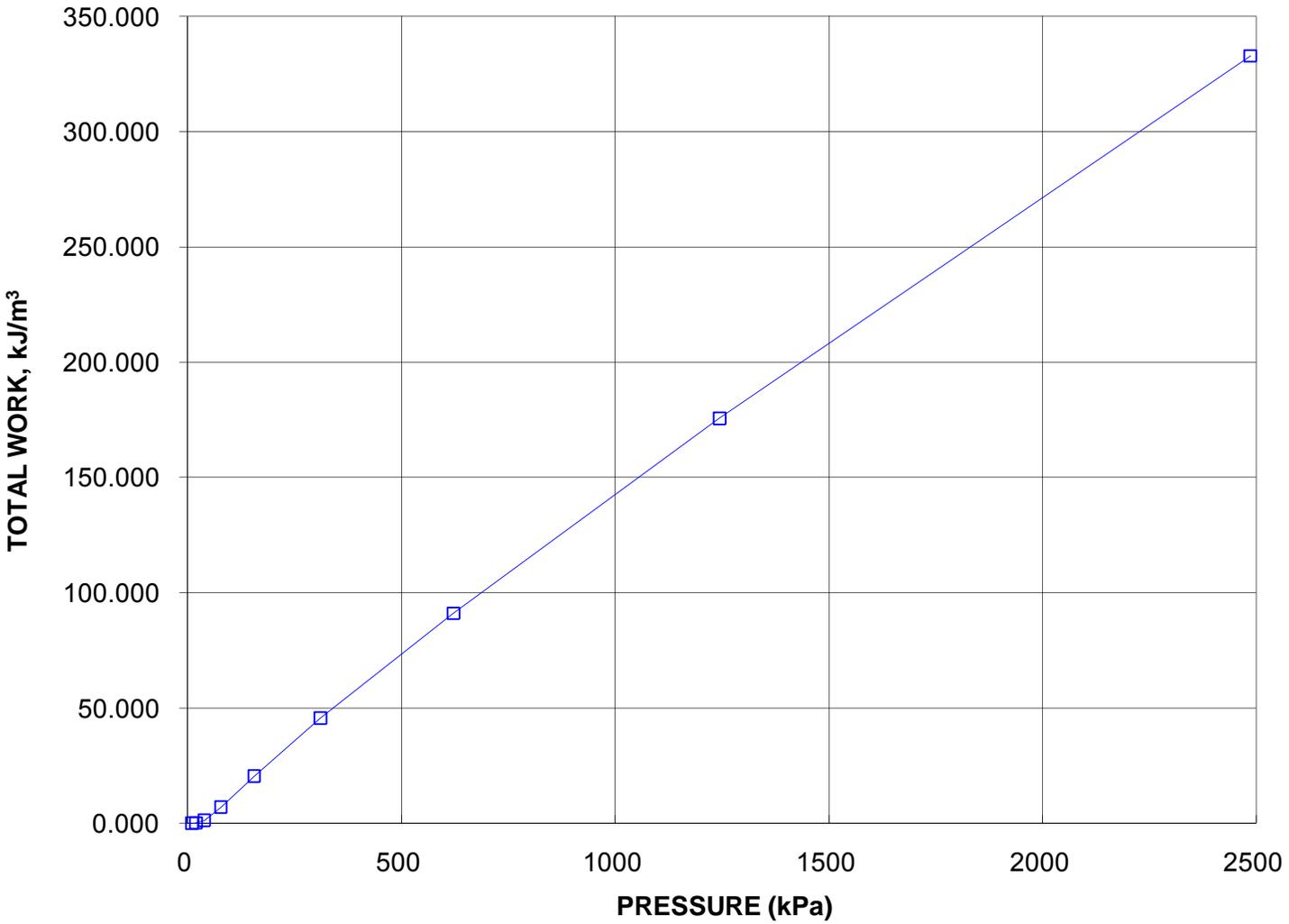
**CONSOLIDATION TEST**  
**HYDRAULIC CONDUCTIVITY vs PRESSURE**  
**BH 305-3 SA 1**



CONSOLIDATION TEST  
VOID RATIO vs PRESSURE  
BH 305-3 SA 1



CONSOLIDATION TEST  
TOTAL WORK, kJ/m<sup>3</sup> vs PRESSURE  
BH 305-3 SA 1



**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

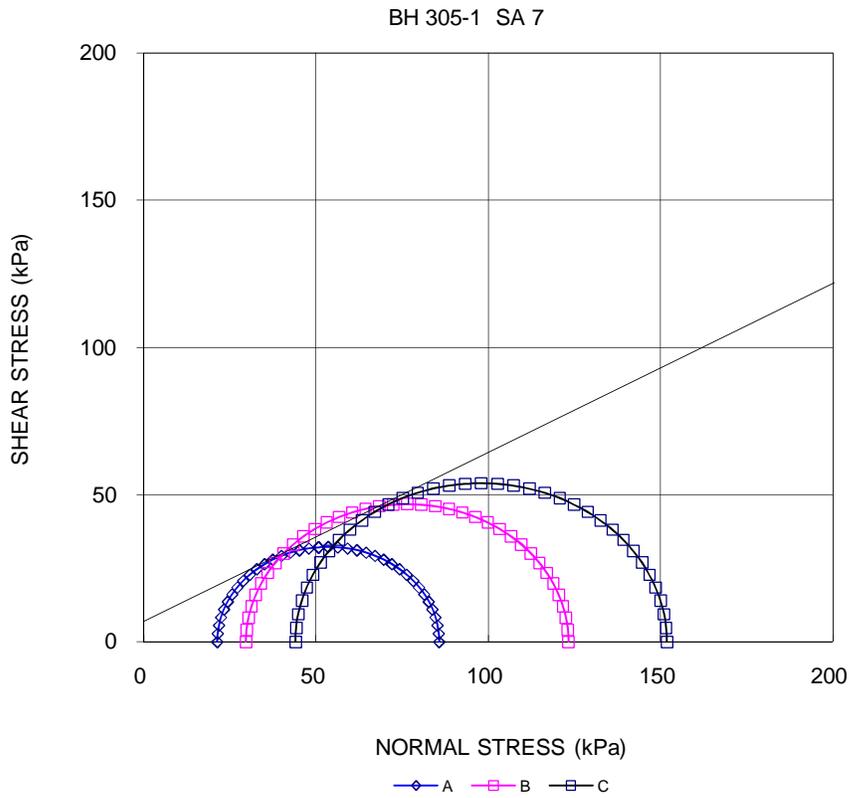
**FIGURE B.S305-7  
Sheet 1 of 4**

TEST STAGE	A	B	C
BOREHOLE NUMBER	305-1	305-1	305-1
SAMPLE	7	7	7
SPECIMEN DIAMETER, cm	5.07	5.05	5.06
SPECIMEN HEIGHT, cm	10.16	10.16	10.17
WATER CONTENT BEFORE CONSOLIDATION, %	52.4	59.8	68.5
CELL PRESSURE, $\sigma_3$ , kPa	615.0	390.0	660.0
BACK PRESSURE, kPa	555.0	275.0	485.0
PORE PRESSURE PARAMETER "B"	0.96	0.99	0.97
CONSOLIDATION PRESSURE, $\sigma_c$ , kPa	60.0	115.0	175.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	2.4	8.8	18.2
WATER CONTENT AFTER CONSOLIDATION, %	50.3	51.4	49.2
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, DAYS	2	2	2
WATER CONTENT AFTER TEST, %	48.8	51.0	49.9
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa	64.4	93.6	107.8
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %	3.2	4.7	6.9
MAX EFFECTIVE PRINCIPAL STRESS RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM	4.2	5.1	3.8
DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa	62.5	81.9	106.0
AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %	5.1	11.7	8.4
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM	0.60	0.91	1.21
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM	0.65	1.16	1.29
NATURAL WATER CONTENT, %	48.6	56.6	64.8
DRY DENSITY, Mg/m <sup>3</sup>	1.15	1.06	0.98
FILTER DRAINS USED, y/n	y	y	y
TEST NOTES:			
CHANGED RATE OF STRAIN, %/hr	-	-	-
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %	-	-	-
FAILURE PLANE NUMBER	1	1	1
ANGLE OF FAILURE, DEGREES	75	75	60

Date: 06/11/2009  
Project No. 06-1111-025

**Golder Associates**

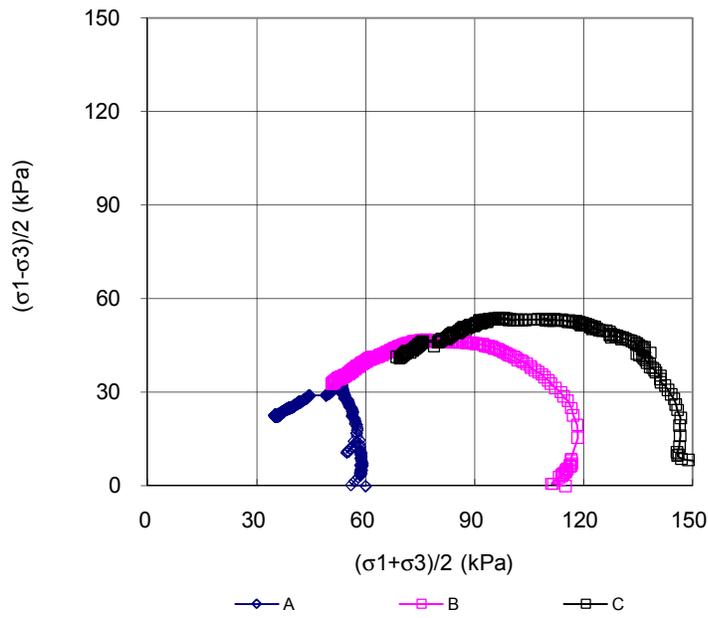
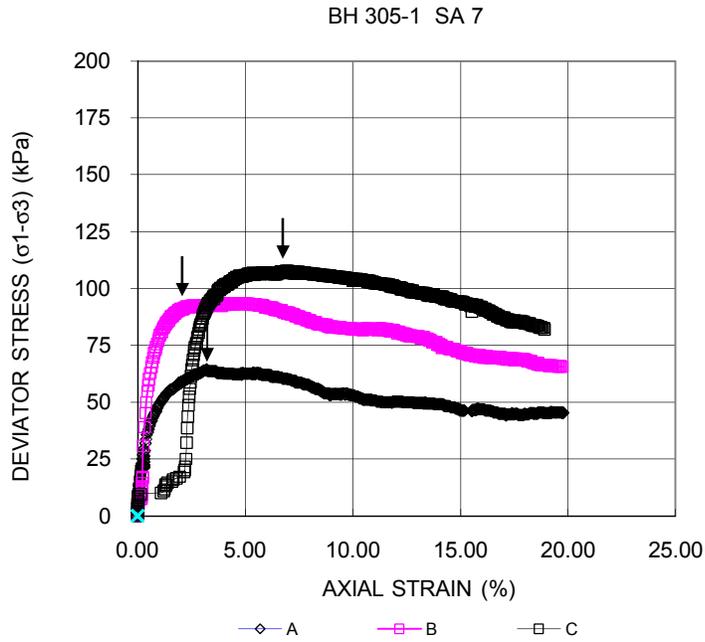
Prepared By: MM  
Checked By: RO



Date: 06/11/2009  
Project No. 06-1111-025

**Golder Associates**

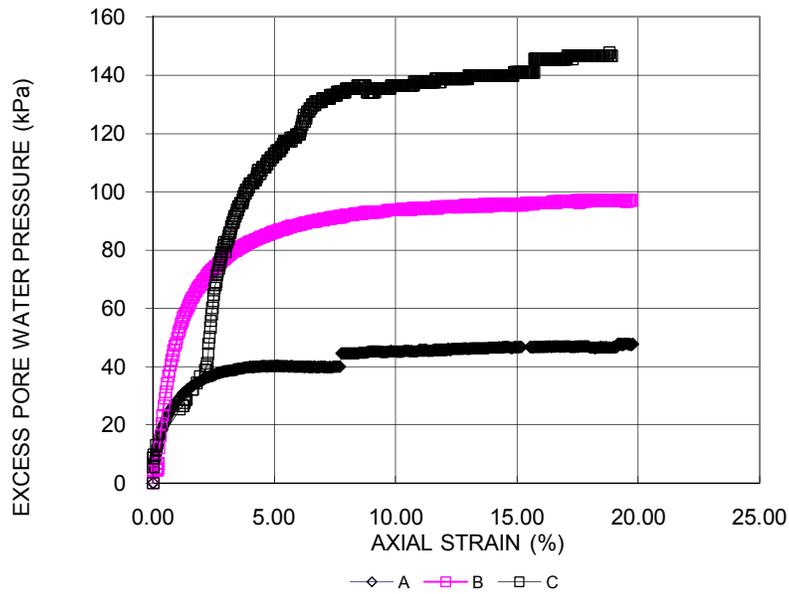
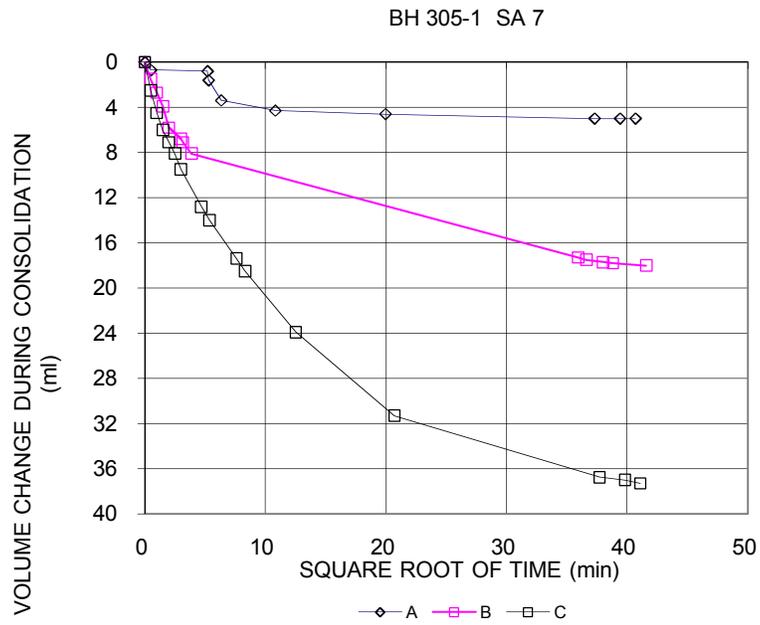
Prepared By: MM  
Checked By: RO



Date: 06/11/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

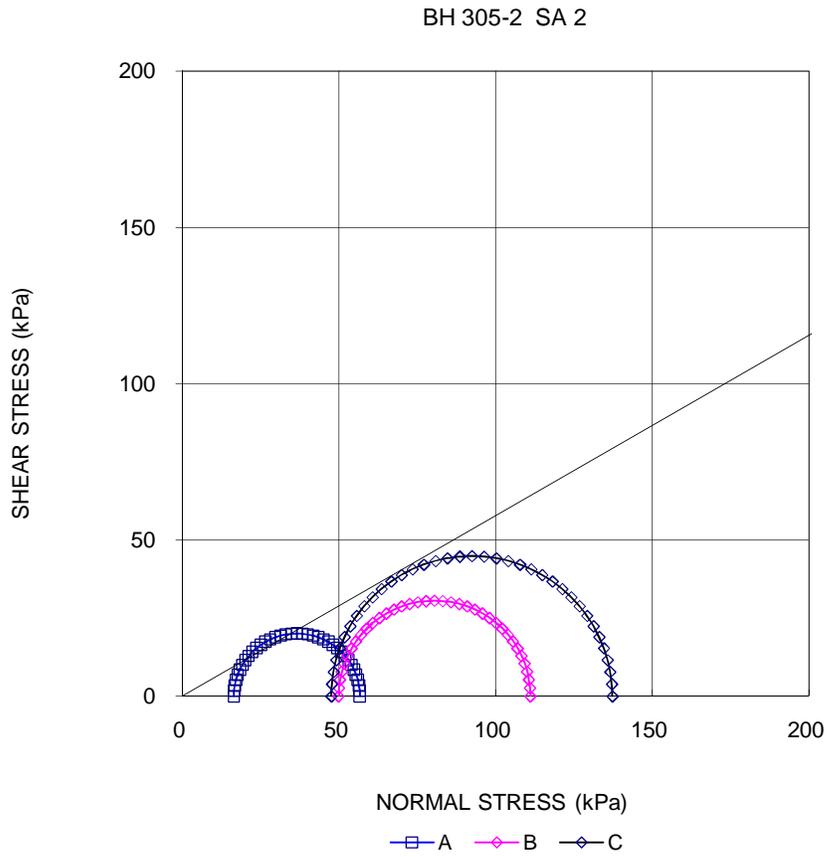


Date: 06/11/2009  
Project No. 06-1111-025

**Golder Associates**

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Checked By: RO

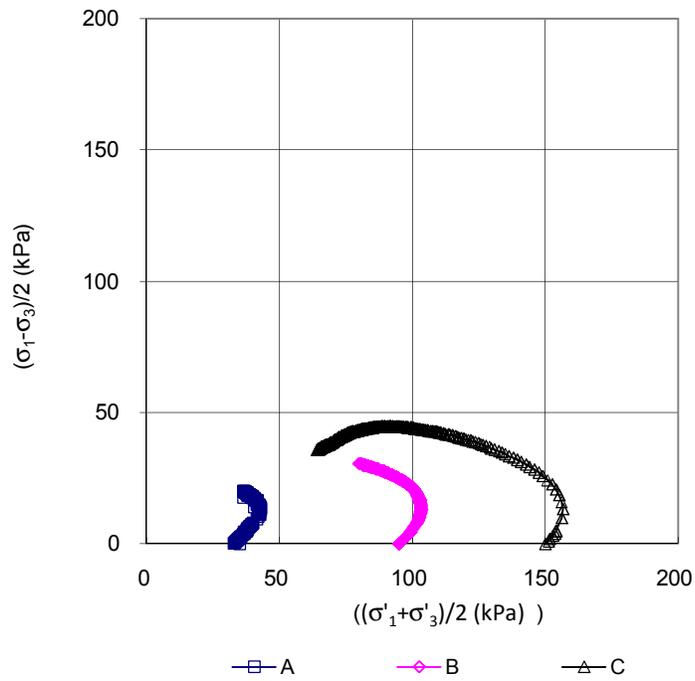
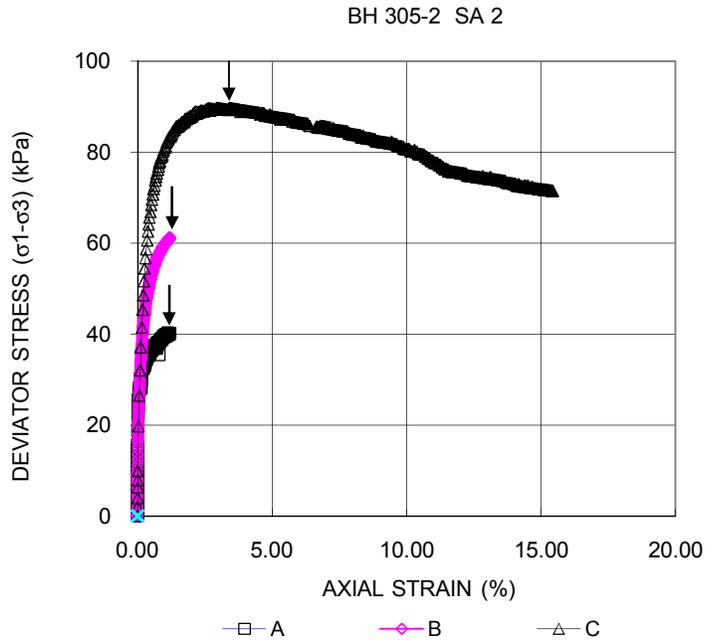
MULTISTAGE CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS		FIGURE B.S305-8 Sheet 1 of 4		
TEST STAGE	A	B	C	
BOREHOLE NUMBER	305-2	305-2	305-2	
SAMPLE	2	2	2	
SPECIMEN DIAMETER, cm	7.05	6.92	6.69	
SPECIMEN HEIGHT, cm	13.82	13.40	12.83	
WATER CONTENT BEFORE CONSOLIDATION, %	50.2	45.3	37.4	
CELL PRESSURE, $\sigma_3$ , kPa	170.0	230.0	285.0	
BACK PRESSURE, kPa	135.0	135.0	135.0	
PORE PRESSURE PARAMETER "B"	0.97	-	-	
CONSOLIDATION PRESSURE, $\sigma_c$ , kPa	35.0	95.0	150.0	
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	5.6	9.6	3.8	
WATER CONTENT AFTER CONSOLIDATION, %	45.3	37.4	34.6	
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5	
TIME TO FAILURE, hours	2	2	4	
WATER CONTENT AFTER TEST, %	-	-		
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa	40.2	61.2	89.6	
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %	1.2	1.2	2.9	
MAX EFFECTIVE PRINCIPAL STRESS RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM	3.5	2.2	3.4	
DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa	40.2	61.2	86.2	
AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %	1.2	1.2	6.2	
PORE PRESSURE PARAMETER, $A_f$ , AT $(\sigma_1 - \sigma_3)$ MAXIMUM	0.46	0.74	1.14	
PORE PRESSURE PARAMETER, $A_f$ , AT $(\sigma_1 / \sigma_3)$ MAXIMUM	0.46	0.75	1.33	
NATURAL WATER CONTENT, %	40.7	-	-	
DRY DENSITY, Mg/m <sup>3</sup>	1.13	-	-	
FILTER DRAINS USED, y/n	y	y	y	
TEST NOTES:				
CHANGED RATE OF STRAIN, %/hr	-	-	-	
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %	-	-	-	
FAILURE PLANE NUMBER	-	-	1	
ANGLE OF FAILURE, DEGREES	-	-	60	
Date:	07/31/2009		Prepared By:	MM
Project No.	06-1111-025	<b>Golder Associates</b>	Checked By:	RO



Date: 07/31/2009  
Project No. 06-1111-025

**Golder Associates**

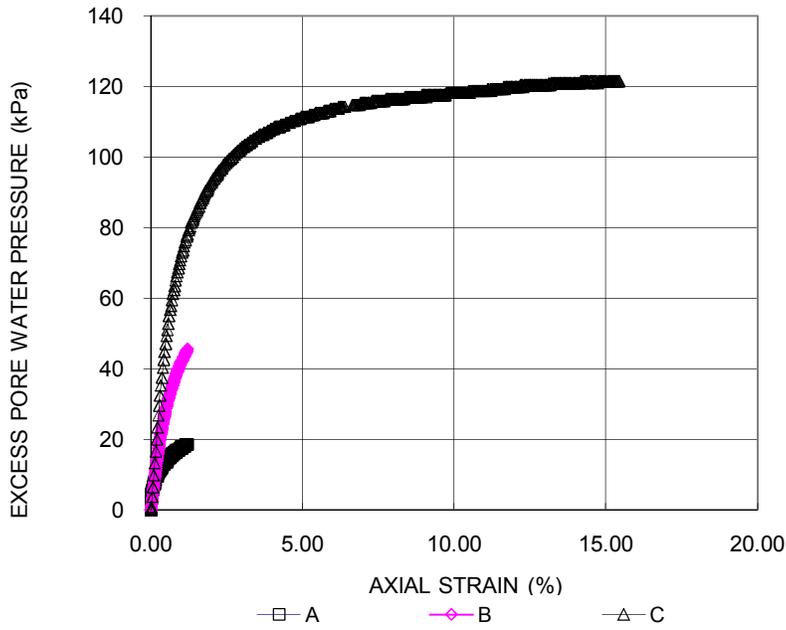
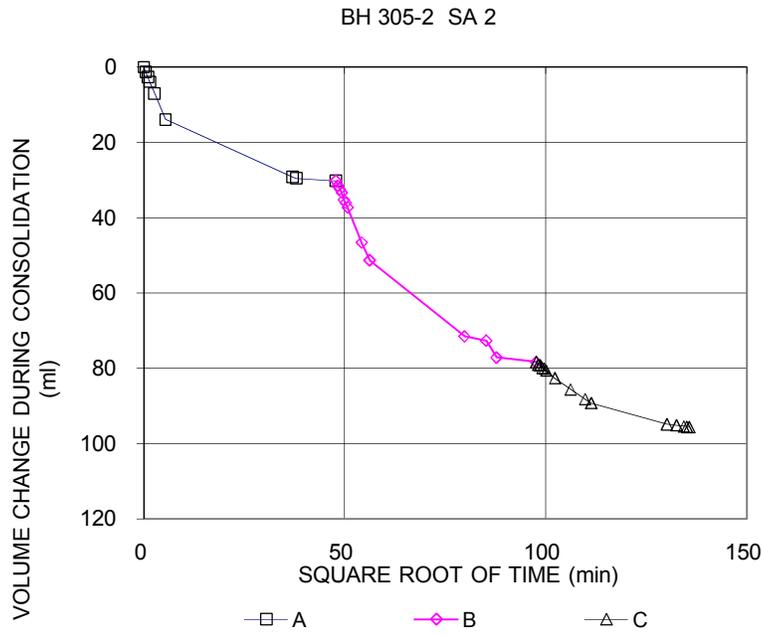
Prepared By: MM  
Checked By: RO



Date: 07/31/2009  
Project No. 06-1111-025

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Prepared By: MM  
Checked By: RO



Date: 07/31/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

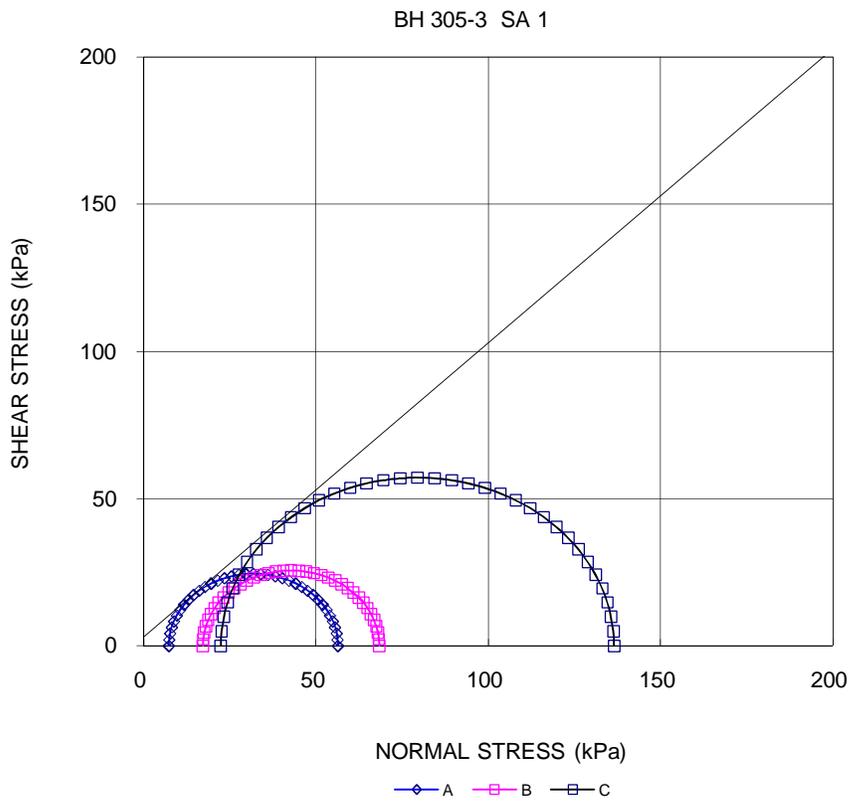
**FIGURE B.S305-9  
Sheet 1 of 4**

TEST STAGE	A	B	C
BOREHOLE NUMBER	305-3	305-3	305-3
SAMPLE	1	1	1
SPECIMEN DIAMETER, cm	4.99	5.03	5.02
SPECIMEN HEIGHT, cm	10.18	10.17	10.20
WATER CONTENT BEFORE CONSOLIDATION, %	75.4	80.0	85.7
CELL PRESSURE, $\sigma_3$ , kPa	300.0	190.0	505.0
BACK PRESSURE, kPa	275.0	135.0	415.0
PORE PRESSURE PARAMETER "B"	0.98	0.98	0.97
CONSOLIDATION PRESSURE, $\sigma_c$ , kPa	25.0	55.0	90.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	5.1	15.9	19.8
WATER CONTENT AFTER CONSOLIDATION, %	70.0	74.3	61.5
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, DAYS	2	2	2
WATER CONTENT AFTER TEST, %	56.3	60.8	52.1
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa	49.1	51.2	114.2
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %	16.1	7.6	13.0
MAX EFFECTIVE PRINCIPAL STRESS			
RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM	7.8	4.7	6.8
DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa	49.1	48.9	113.3
AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %	16.1	14.1	19.5
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM	0.36	0.74	0.59
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM	0.36	0.85	0.62
NATURAL WATER CONTENT, %	69.4	77.7	80.7
DRY DENSITY, Mg/m <sup>3</sup>	0.93	0.86	0.83
FILTER DRAINS USED, y/n	y	y	y
TEST NOTES:			
CHANGED RATE OF STRAIN, %/hr	-	-	-
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %	-	-	-
FAILURE PLANE NUMBER	-	1.0	-
ANGLE OF FAILURE, DEGREES	bulged	70.0	bulged

Date: 05/21/2009  
Project No. 06-1111-025

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Checked By: RO

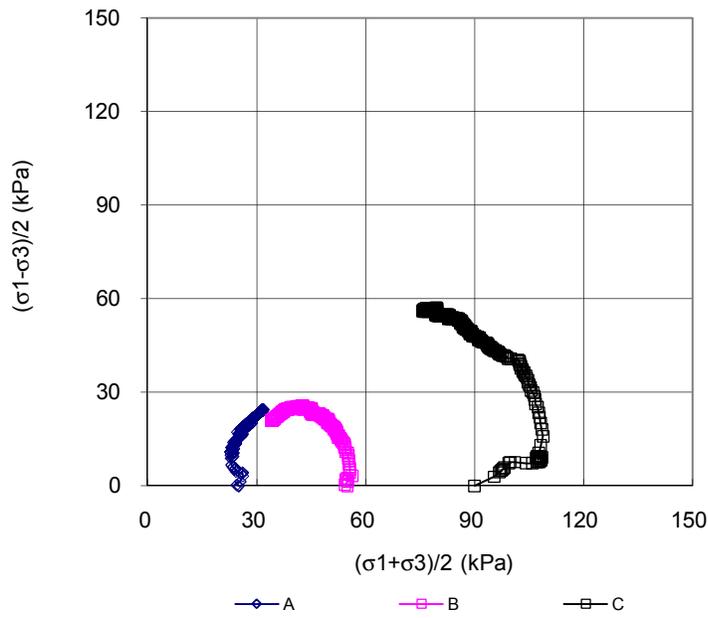
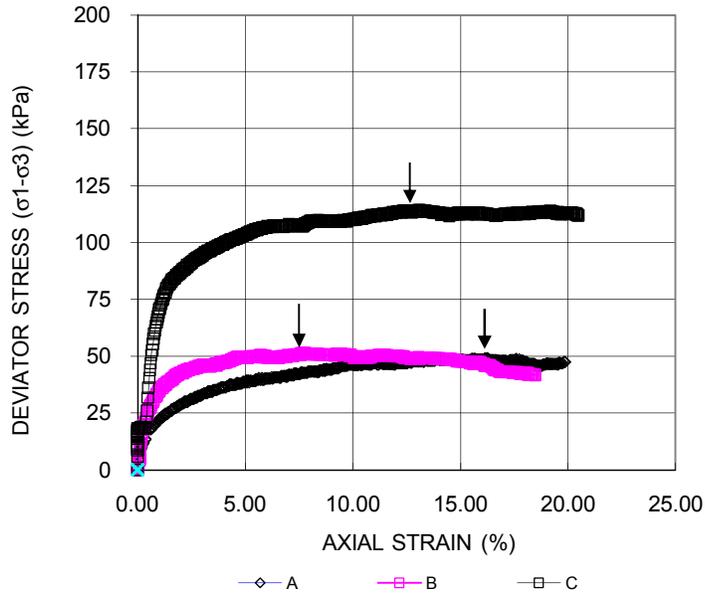


Date: 05/21/2009  
Project No. 06-1111-025

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Prepared By: MM  
Checked By: RO

BH 305-3 SA 1

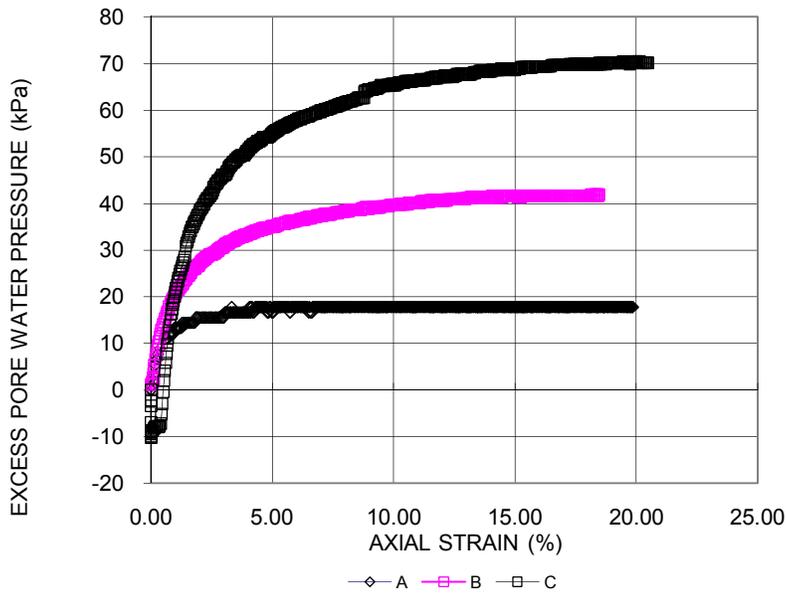
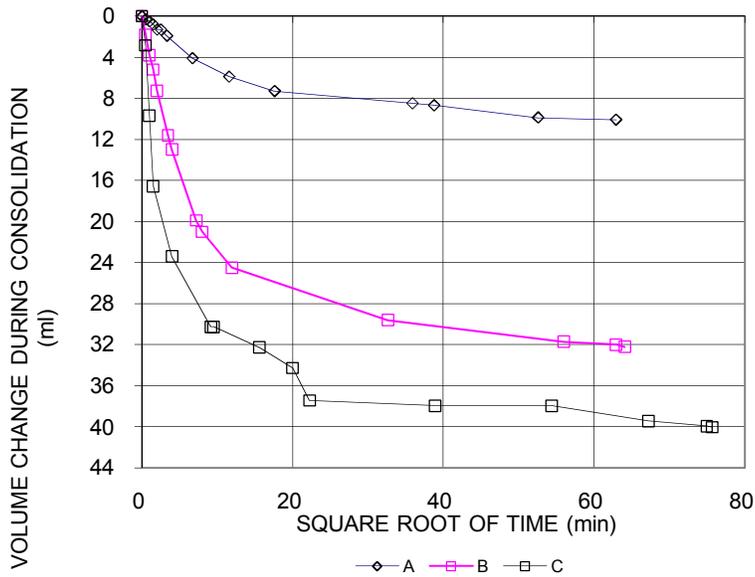


Date: 05/21/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

BH 305-3 SA 1



Date: 05/21/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO



# **APPENDIX C**

**Highway 69 NBL – STA 15+350 to 15+800 (Swamp 306 SBL)**

**RECORD OF BOREHOLE No 306-1** 1 OF 1 **METRIC**

PROJECT 06-1111-025 G.W.P. 5203-06-00 LOCATION N 5091511.9 ; E 221015.8 ORIGINATED BY MWK

DIST                      HWY 69 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers COMPILED BY MWK

DATUM Geodetic DATE March 17, 2009 CHECKED BY VA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub>	W		
189.4	GROUND SURFACE												
0.0	Organic CLAYEY SILT, containing shell fragments Very soft Grey Wet												
187.3			1	SS	WH							106.4	OC = 6.2%
2.1	CLAY, some silt Very soft to soft Grey Wet												
			2	SS	WH							90.7	
			3	TO	PH								
			4	TO	PH								
			5	TO	PH							81	C/CIU
180.3	SILTY CLAY to CLAYEY SILT Very soft Grey Wet												
9.1			6	SS	1							52.7	
			7	SS	WR								
178.0	END OF BOREHOLE AUGER REFUSAL												
11.4	NOTE:  1. Water level in open borehole at ground surface (Elev. 189.4 m) upon completion of drilling.												

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

**RECORD OF BOREHOLE No 306-2** 1 OF 1 **METRIC**

PROJECT 06-1111-025

G.W.P. 5203-06-00 LOCATION N 5091636.1 ; E 221029.3 ORIGINATED BY MWK

DIST                      HWY 69 BOREHOLE TYPE 108 mm I.D. Continuous Flight Hollow Stem Augers COMPILED BY MWK

DATUM Geodetic DATE March 18, 2009 CHECKED BY VA

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80	100	W <sub>p</sub>	W			W <sub>L</sub>	20	40	60
189.4	GROUND SURFACE																			
0.0	Organic SILTY CLAY Very soft Grey Wet																			
187.3			1	SS	WH															
2.1	CLAY, some silt Very soft to firm Grey Wet																			
			2	SS	WH															
			3	TO	PH															
			4	TO	PH															
			5	TO	PH															
			6	TO	PH															
180.1	END OF BOREHOLE SAMPLER AND AUGER REFUSAL																			
9.3	NOTES: 1. Water level in open borehole at ground surface (Elev. 189.4 m) upon completion of drilling. 2. An additional borehole was drilled adjacent to Borehole 306-2 to obtain two Shelby tube samples between depths of 1.5 m and 2.1 m (Sample 1) and between depths of 5.2 m and 5.8 m (Sample 2).																			

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

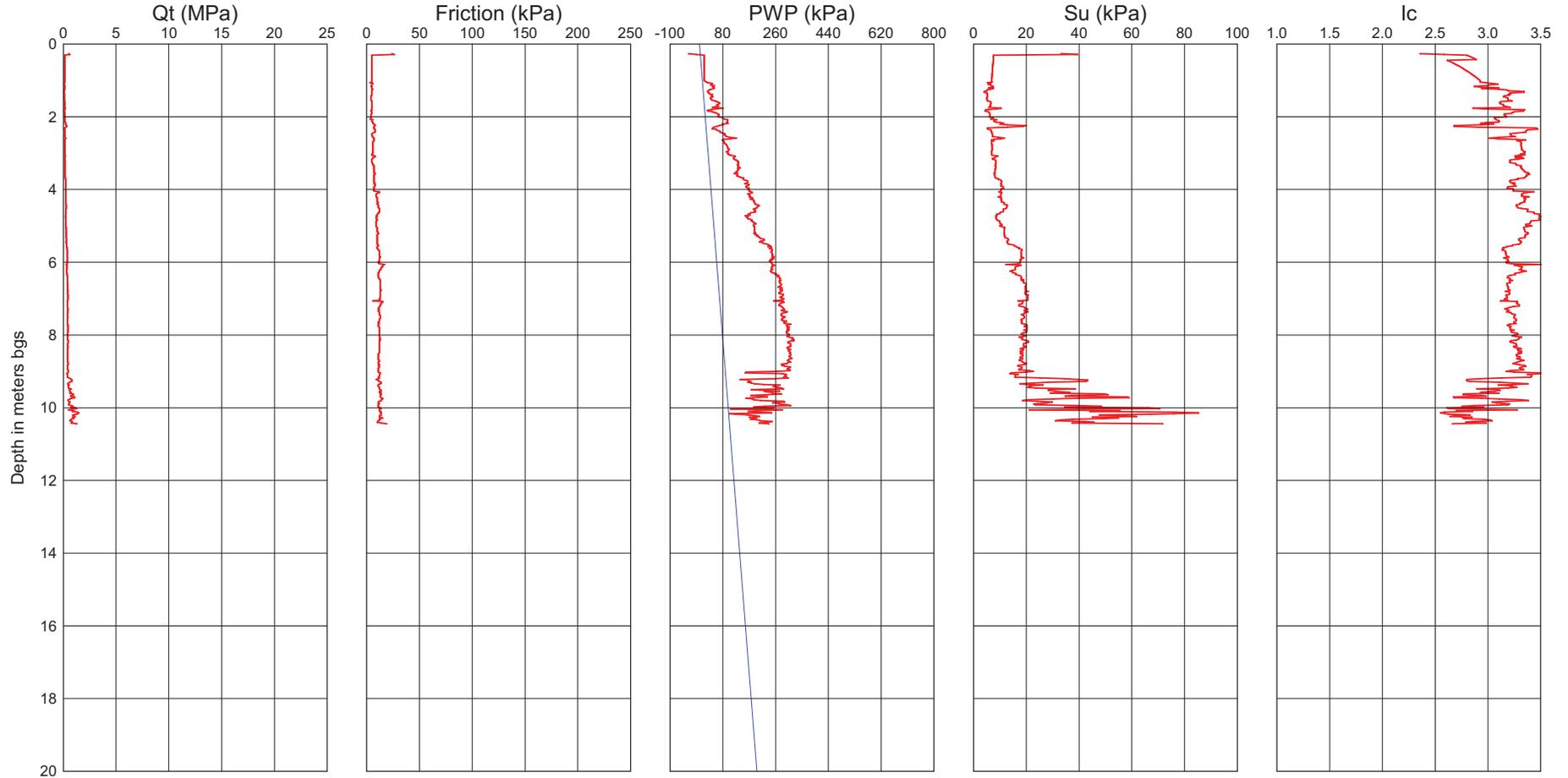
+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

# Cone Penetration Test - CPT306-1

Test Date : March 10, 2009  
 Location : Highway 69 - STA 15+450 o/s 21 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 189.40  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

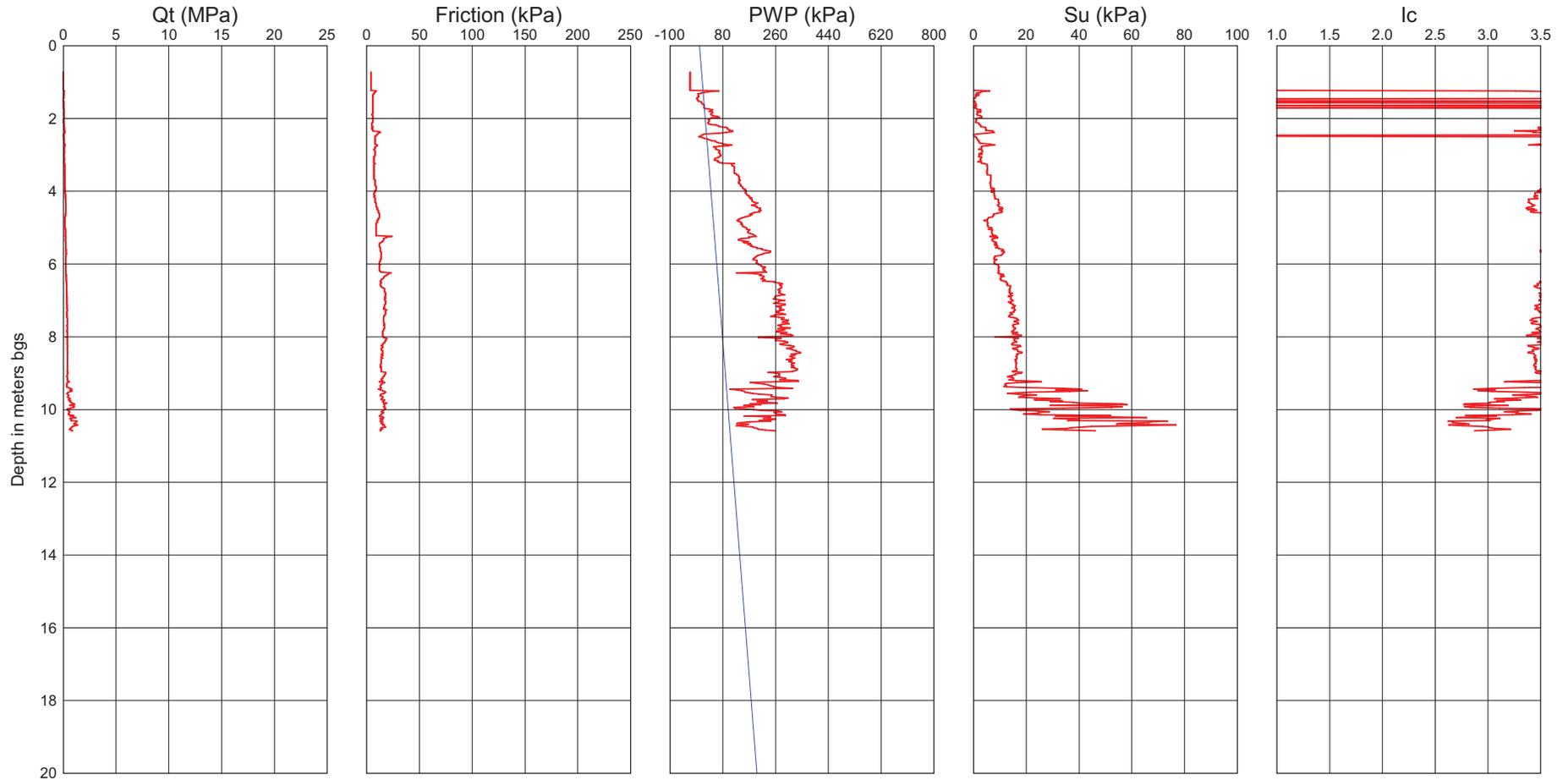
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT306-2

Test Date : March 10, 2009  
 Location : Highway 69 - STA 15+450 o/s 22 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 189.40  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$Su = (Qt - \text{Sigma}V) / Nk$   
 $Nk = 15.5$   
 $\text{Gamma} = 16.5 \text{ kN/m}^3$

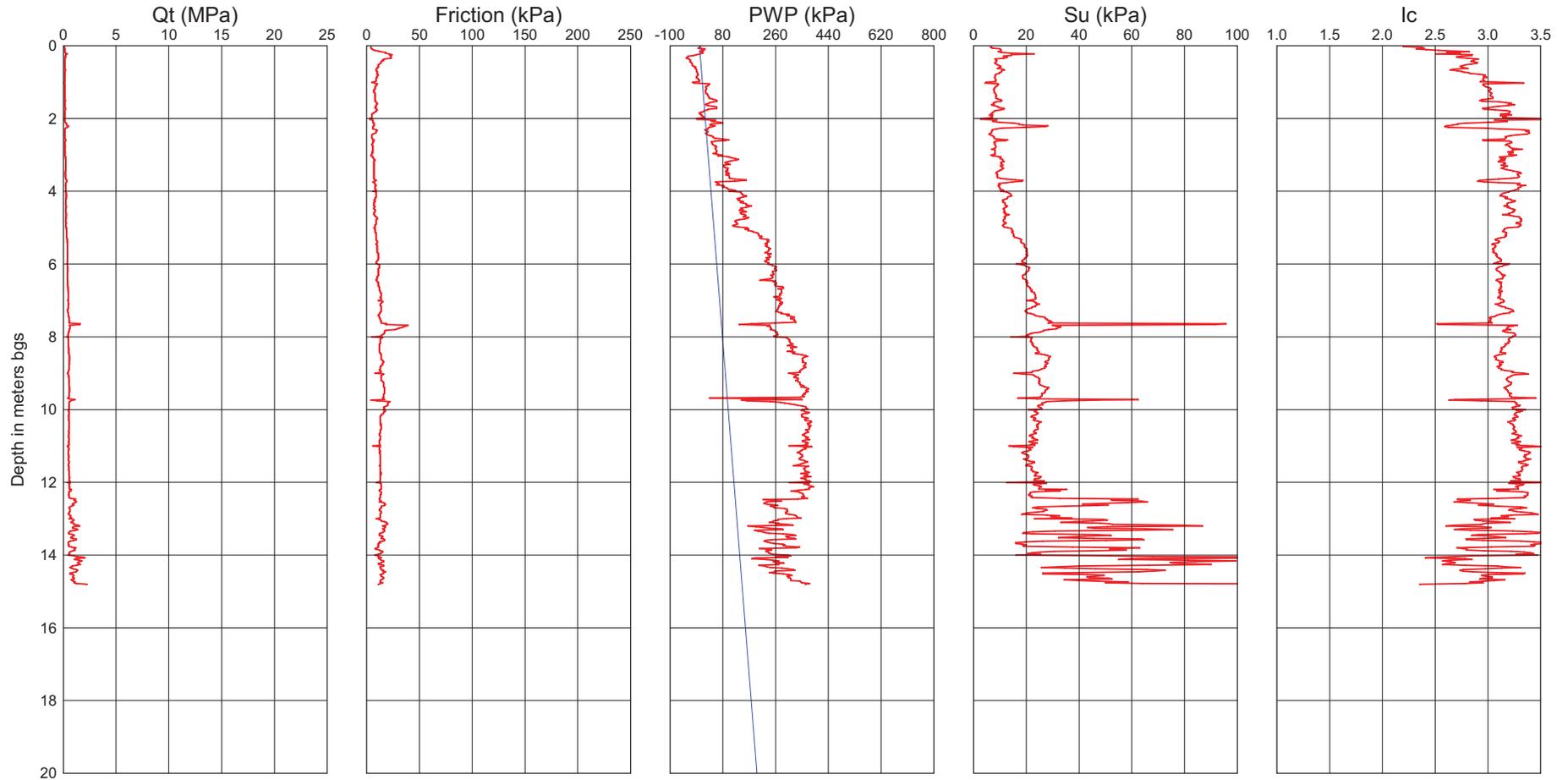
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT306-3

Test Date : March 10, 2009  
 Location : Highway 69 - STA 15+575 o/s 22 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 188.70  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

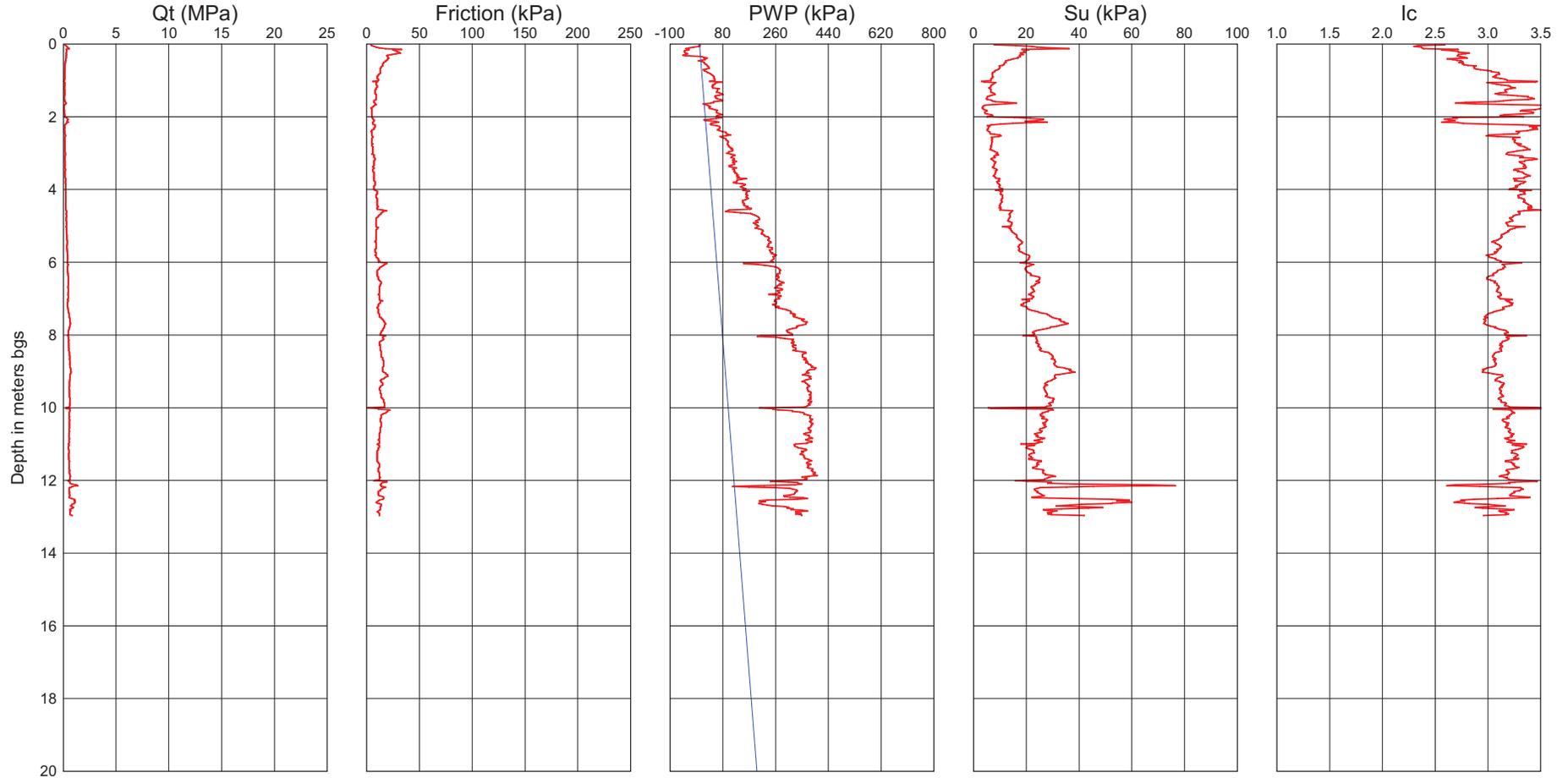
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT306-4

Test Date : March 11, 2009  
 Location : Highway 69 - STA 15+575 o/s 23 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 188.70  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

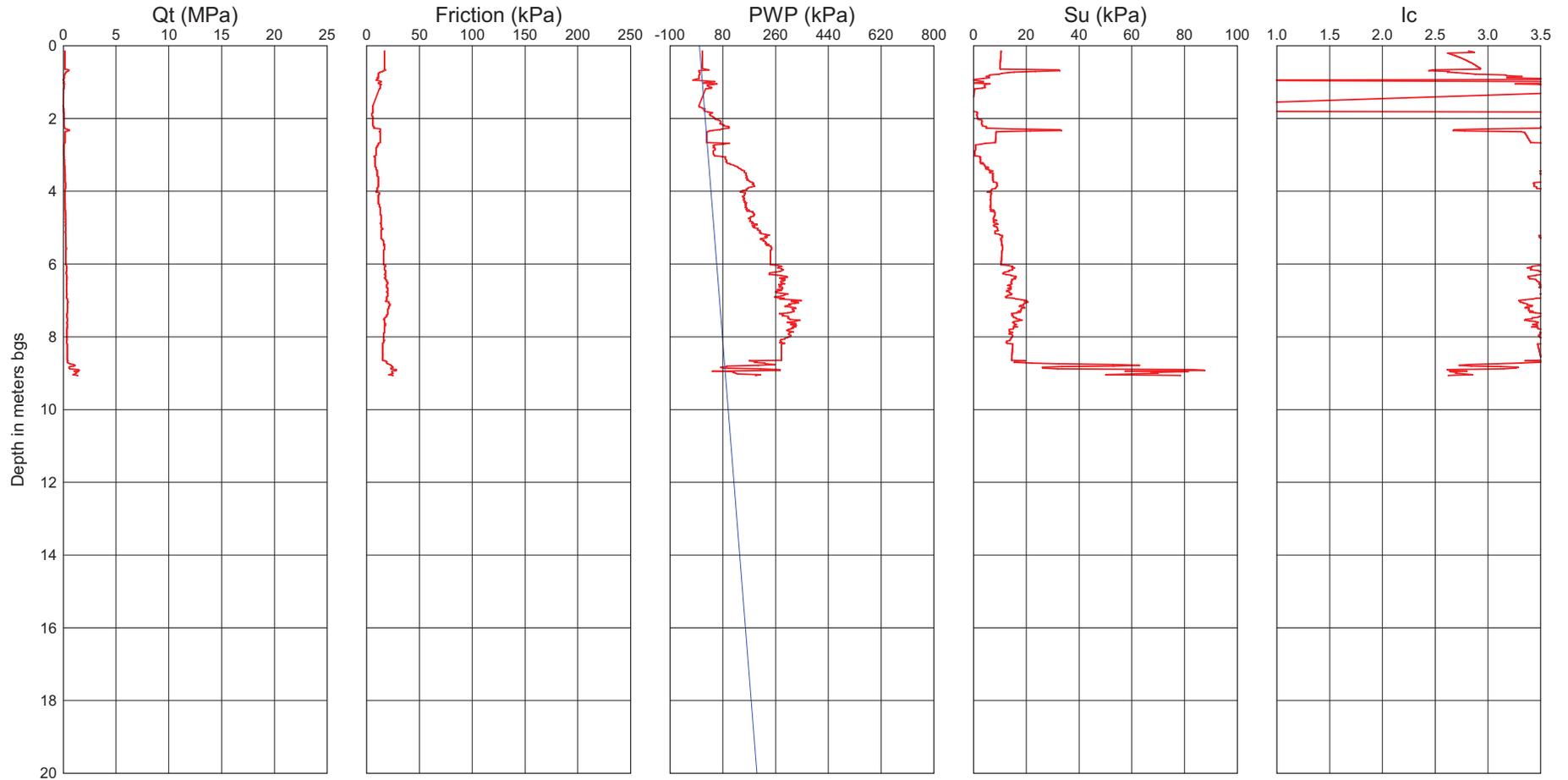
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT306-5

Test Date : March 18, 2009  
 Location : Highway 69 - STA 15+576 o/s 39 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 189.40  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

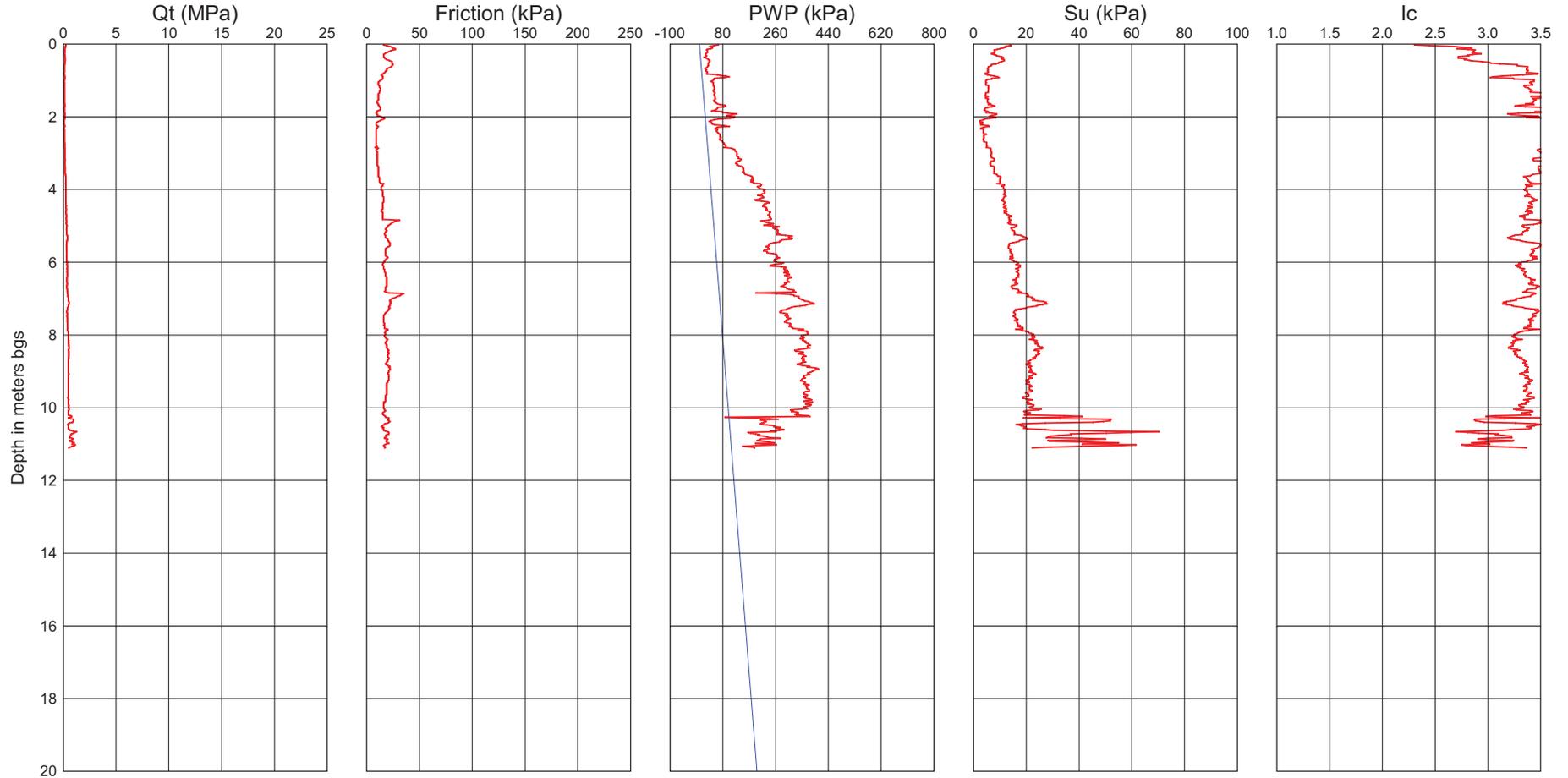
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT306-6

Test Date : March 19, 2009  
 Location : Highway 69 - STA 15+452 o/s 39 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 189.40  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$Su = (Qt - \sigma_v) / Nk$   
 $Nk = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

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

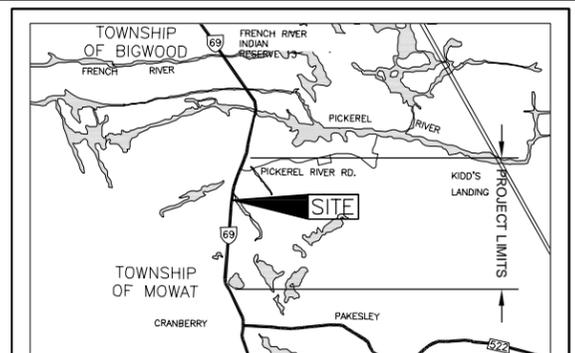
CONT No. GWP No. 5230-06-00



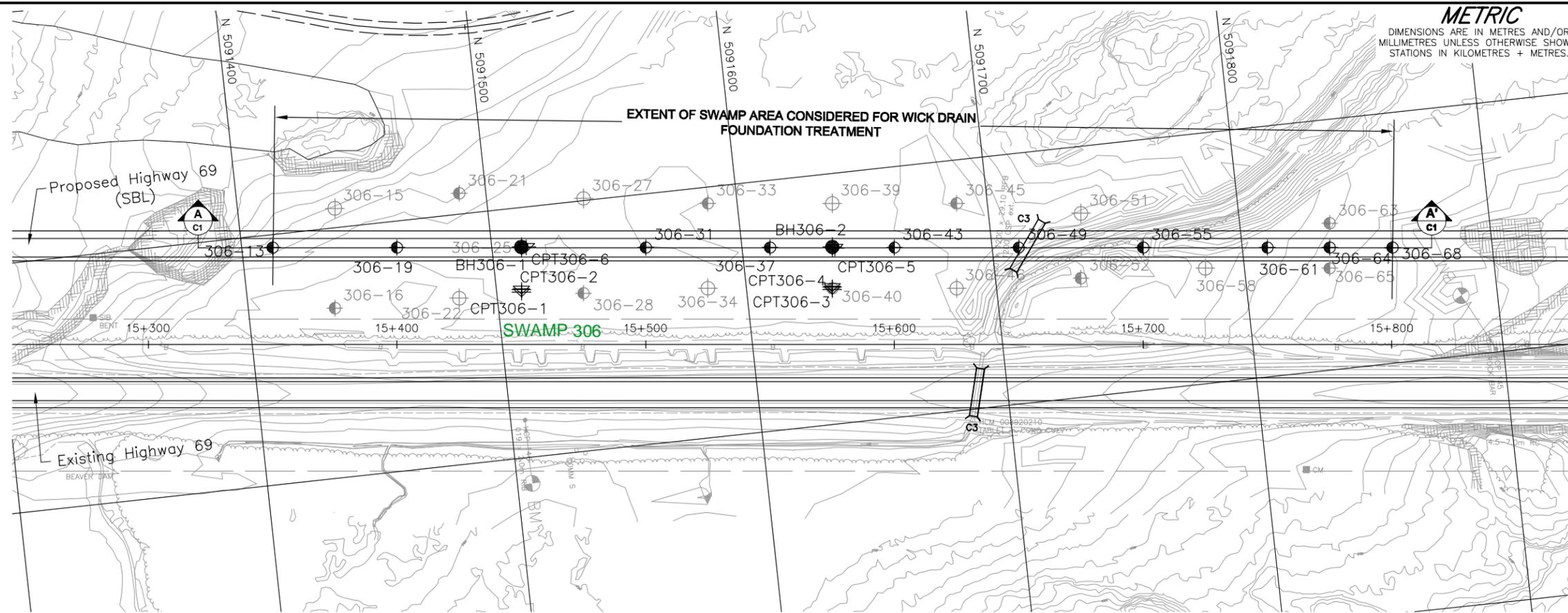
HIGHWAY 69 (SBL)  
STA 15+350 TO 15+800  
BOREHOLE LOCATION AND SOIL STRATA



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



KEY PLAN  
SCALE 800 0 800 m



PLAN SCALE  
20 0 20 40 m

**LEGEND**

- Borehole - Current Investigation
- ▽ CPT - Current Investigation
- ⊕ Borehole - Previous Investigation (Peto MacCallum Ltd.)
- ⊕ Dynamic Cone Penetration Test - Previous Investigation (Peto MacCallum Ltd.)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL observed during or upon completion of drilling
- R Refusal

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
BH306-1	189.4	5091511.8	221015.8
BH306-2	189.4	5091636.1	221029.3
CPT306-1	189.4	5091509.9	221033.7
CPT306-2	189.4	5091510.0	221032.7
CPT306-3	188.7	5091634.3	221046.2
CPT306-4	188.7	5091634.4	221045.2
CPT306-5	189.4	5091637.1	221029.4
CPT306-6	189.4	5091513.9	221016.0

**NOTES**

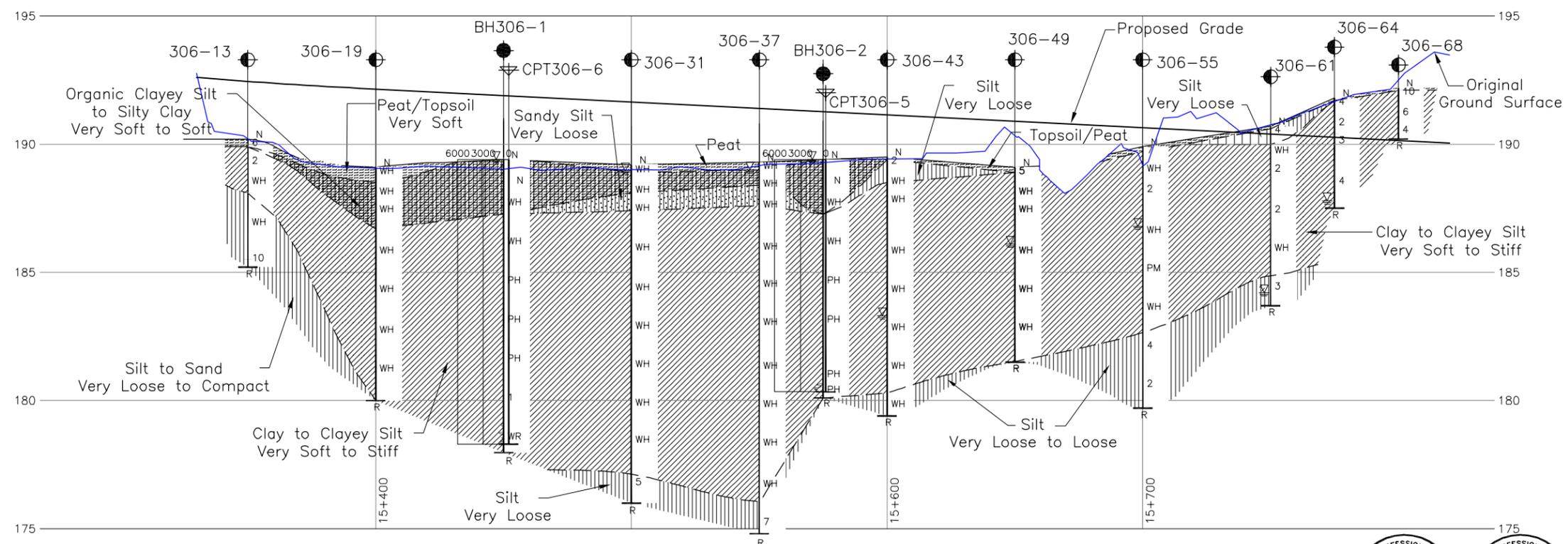
This drawing is for subsurface information only. The proposed structure details/works are shown for illustration purposes only and may not be consistent with the final design configuration as shown elsewhere in the Contracts Documents.

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 and Profile provided in digital format by MRC, drawing file's no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009. 1-6454\_Phase3-ML PROFILE-Mar 26-09.dwg, received Sept. 30, 2009.



**A-A' CENTRELINE PROFILE**  
C1  
20 HORIZONTAL SCALE  
0 20 40 m  
VERTICAL SCALE  
0 2 4 m

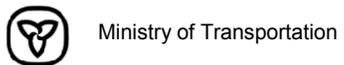
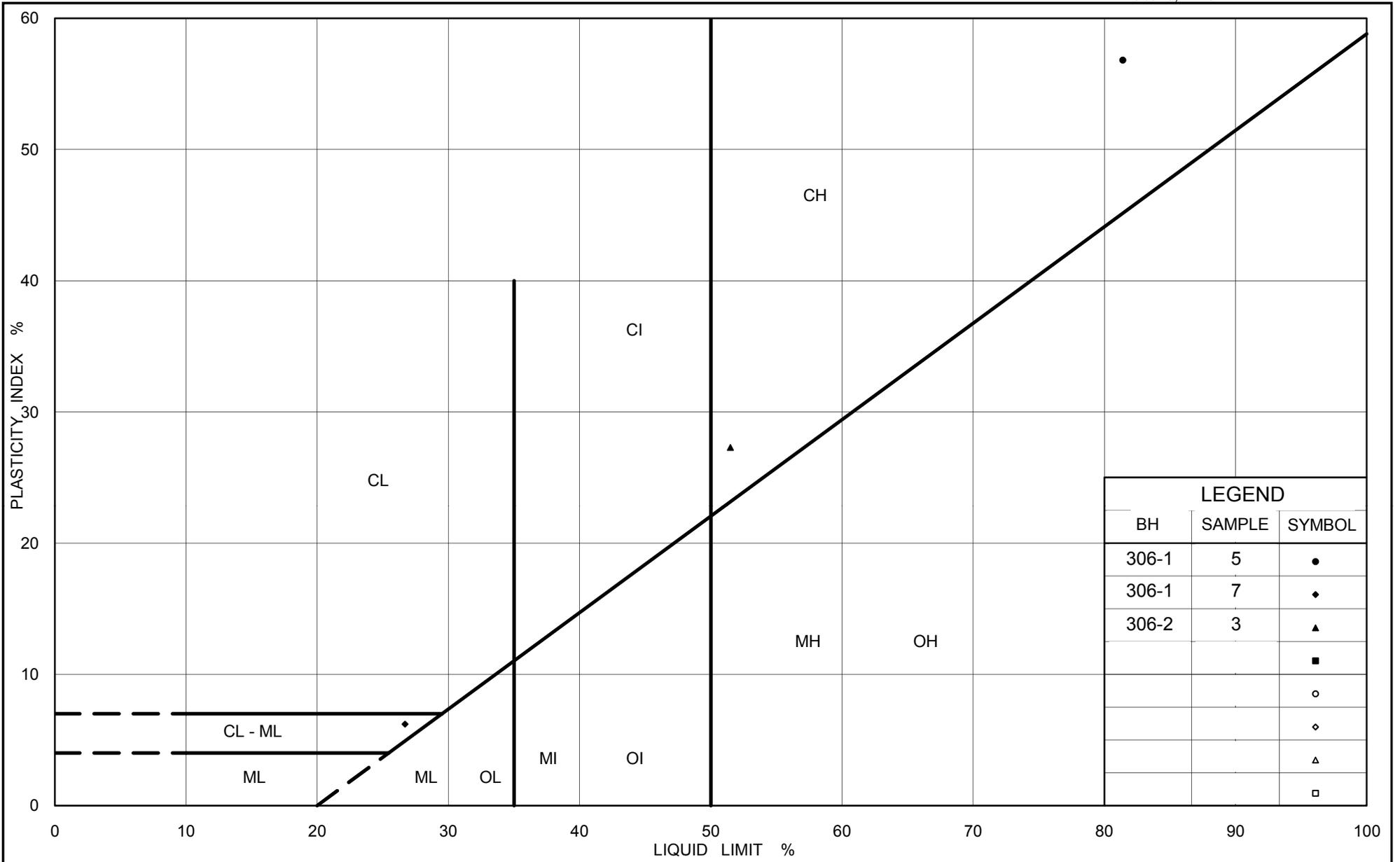


NO.	DATE	BY	REVISION

Geocres No. 41H-106

HWY. 69	PROJECT NO. 06-1111-025	DIST.
SUBM'D. MWK	CHKD. MWK	DATE: Feb. 2012
DRAWN: RJ/JFC	CHKD. VA	APPD. JPD/JMAC
		DWG. C1





Ontario

**PLASTICITY CHART**  
 Clay to Clayey Silt  
 Highway 69 (SBL) STA 15+350 to 15+800

Figure No. C.S306-2

Project No. 06-1111-025

Checked By: TVA

**CONSOLIDATION TEST SUMMARY**

Highway 69 (SBL) STA 15+350 to 15+800

**FIGURE C.S306-3**

Sheet 1 of 4

**SAMPLE IDENTIFICATION**

Project Number	06-1111-025	Sample Number	5
Borehole Number	306-1	Sample Depth, m	7.9

**TEST CONDITIONS**

Test Type	Standard	Load Duration, hr	24
Oedometer Number	6		
Date Started	04/19/2009		
Date Completed	06/11/2009		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	1.90	Unit Weight, kN/m <sup>3</sup>	14.87
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	8.12
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.76
Volume, cm <sup>3</sup>	59.86	Solids Height, cm	0.569
Water Content, %	83.02	Volume of Solids, cm <sup>3</sup>	17.96
Wet Mass, g	90.74	Volume of Voids, cm <sup>3</sup>	41.89
Dry Mass, g	49.58	Degree of Saturation, %	98.3

**TEST COMPUTATIONS**

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv. cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	1.896	2.332	1.896				
4.87	1.889	2.320	1.892	6	1.27E-01	7.69E-04	9.54E-06
9.58	1.883	2.309	1.886	17	4.44E-02	6.72E-04	2.92E-06
19.47	1.876	2.297	1.879	28	2.67E-02	3.79E-04	9.92E-07
38.76	1.859	2.267	1.867	22	3.36E-02	4.65E-04	1.53E-06
77.68	1.751	2.077	1.805	52	1.33E-02	1.46E-03	1.91E-06
155.14	1.455	1.557	1.603	585	9.31E-04	2.01E-03	1.84E-07
310.29	1.295	1.275	1.375	270	1.48E-03	5.44E-04	7.91E-08
620.45	1.164	1.045	1.229	208	1.54E-03	2.23E-04	3.36E-08
1241.21	1.062	0.866	1.113	146	1.80E-03	8.67E-05	1.53E-08
2481.81	0.970	0.704	1.016	52	4.21E-03	3.91E-05	1.61E-08
1241.21	0.986	0.732	0.978				
310.29	1.013	0.780	0.999				
77.68	1.056	0.855	1.034				
19.47	1.102	0.936	1.079				
4.87	1.135	0.994	1.118				

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.13	Unit Weight, kN/m <sup>3</sup>	18.86
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	13.57
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.76
Volume, cm <sup>3</sup>	35.83	Solids Height, cm	0.569
Water Content, %	39.01	Volume of Solids, cm <sup>3</sup>	17.96
Wet Mass, g	68.92	Volume of Voids, cm <sup>3</sup>	17.86
Dry Mass, g	49.58		

Prepared By: LH

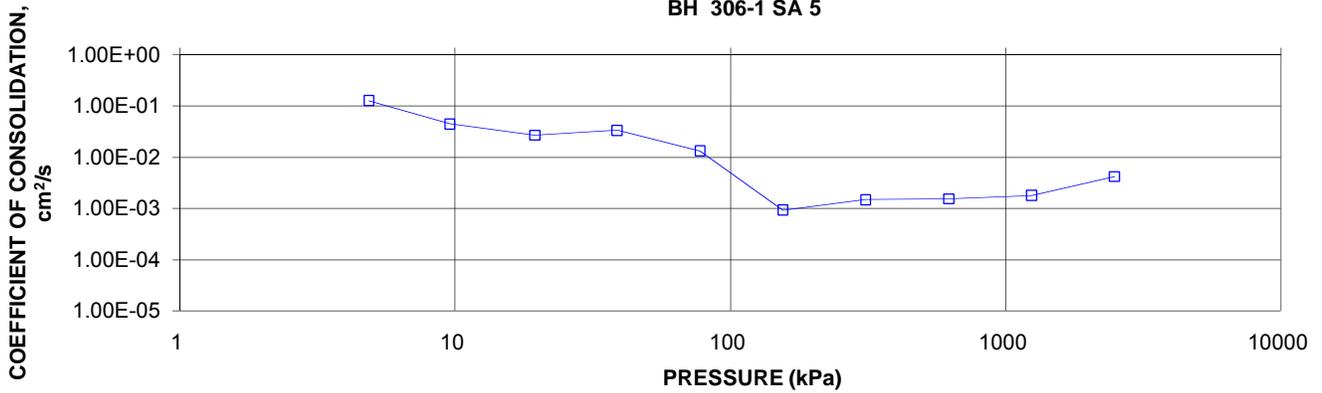
**Golder Associates**

Checked By: MM

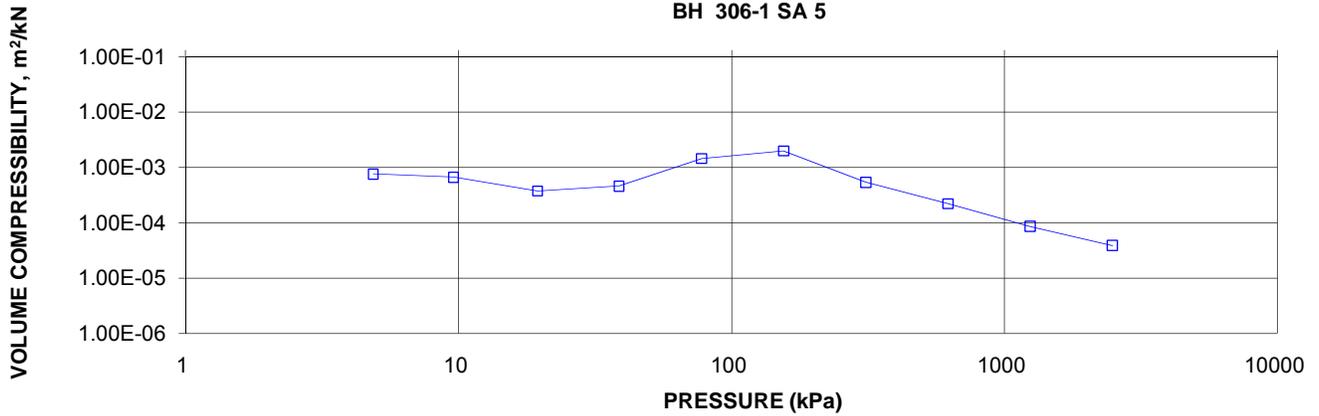
**CONSOLIDATION TEST SUMMARY**  
**Highway 69 (SBL) STA 15+350 to 15+800**

**FIGURE C.S306-3**  
**Sheet 2 of 4**

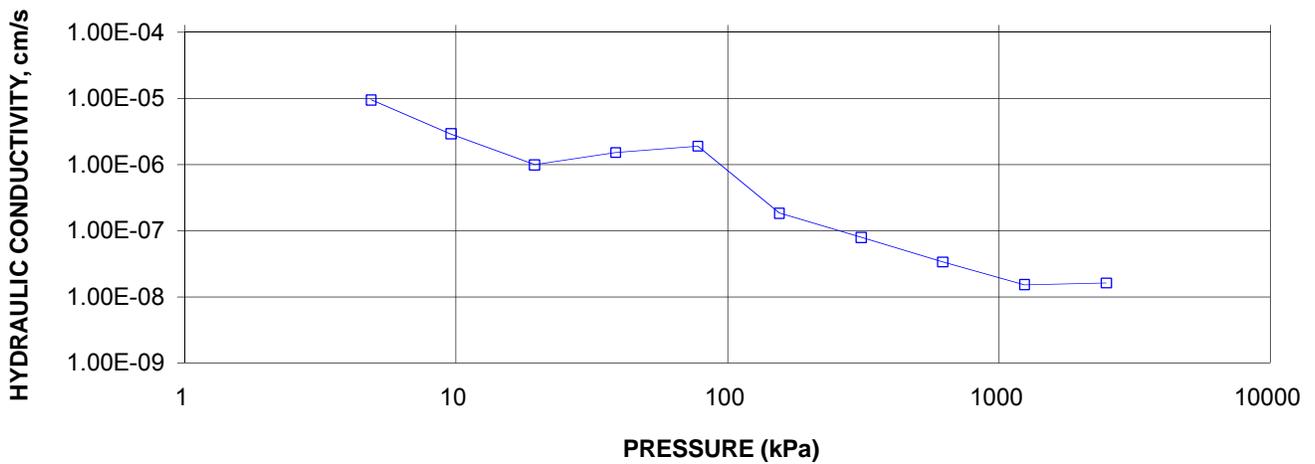
**CONSOLIDATION TEST**  
**CV cm<sup>2</sup>/s VS PRESSURE (kPa)**  
**BH 306-1 SA 5**



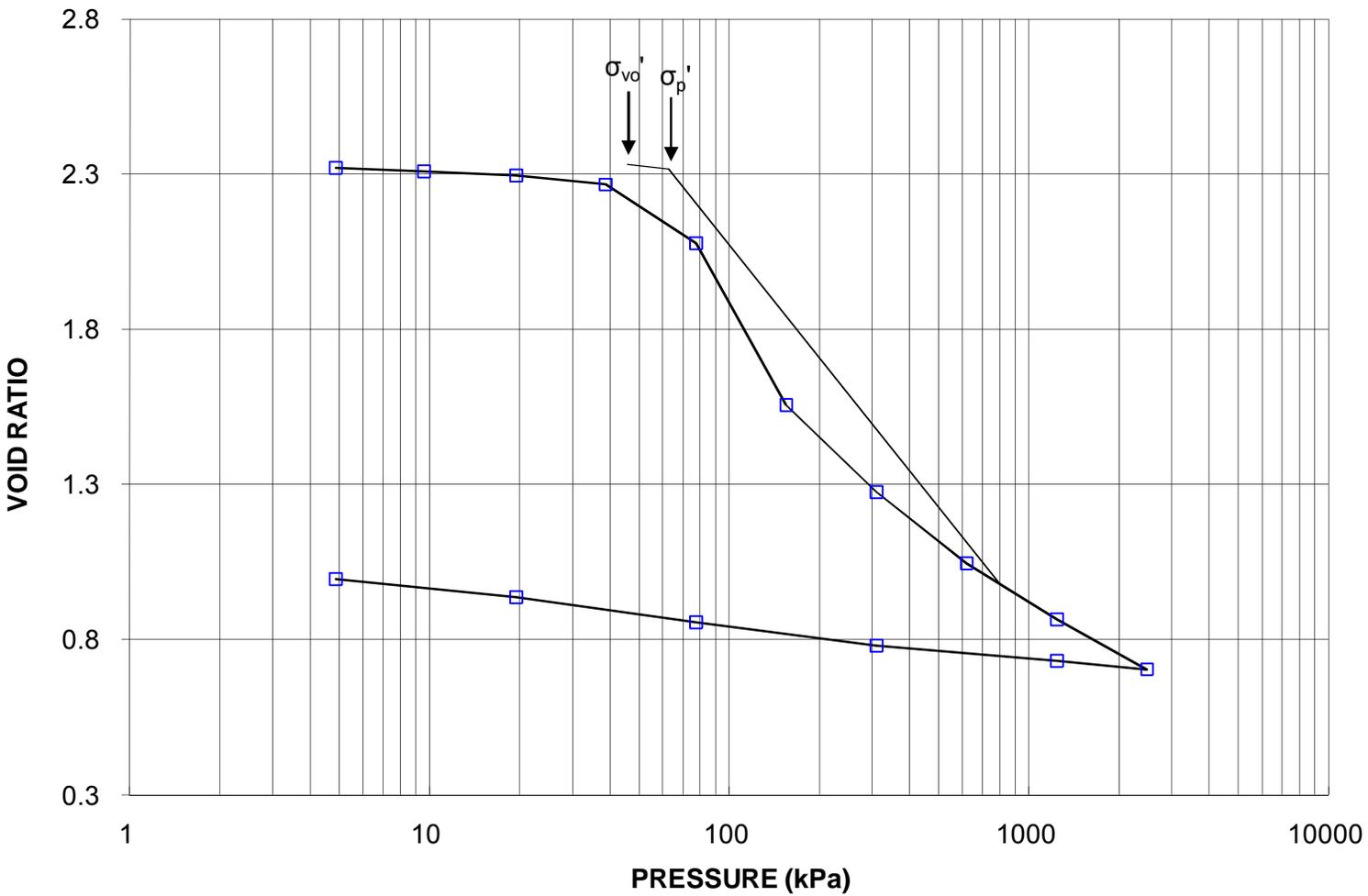
**CONSOLIDATION TEST**  
**MV m<sup>2</sup>/kN vs PRESSURE (kPa)**  
**BH 306-1 SA 5**



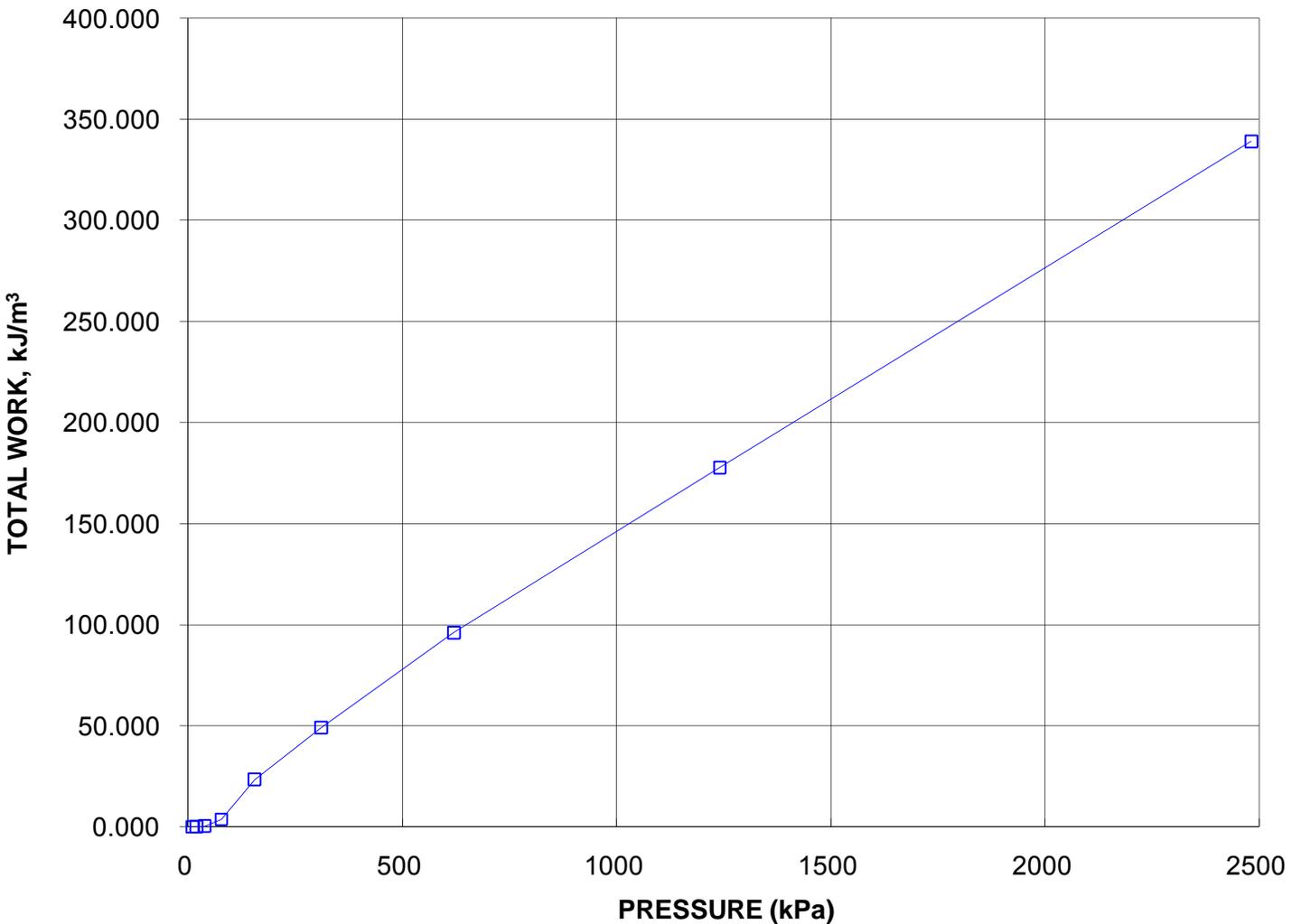
**CONSOLIDATION TEST**  
**HYDRAULIC CONDUCTIVITY vs PRESSURE**  
**BH 306-1 SA 5**



CONSOLIDATION TEST  
VOID RATIO vs PRESSURE  
BH 306-1 SA 5



CONSOLIDATION TEST  
TOTAL WORK, kJ/m<sup>3</sup> vs PRESSURE  
BH 306-1 SA 5



**CONSOLIDATION TEST SUMMARY**

Highway 69 (SBL) STA 15+350 to 15+800

**FIGURE C.S306-4**

Sheet 1 of 4

**SAMPLE IDENTIFICATION**

Project Number	06-1111-025	Sample Number	3
Borehole Number	306-2	Sample Depth, m	4.9

**TEST CONDITIONS**

Test Type	Standard	Load Duration, hr	24
Oedometer Number	1		
Date Started	05/26/2009		
Date Completed	06/15/2009		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	2.54	Unit Weight, kN/m <sup>3</sup>	14.45
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	7.33
Area, cm <sup>2</sup>	31.61	Specific Gravity, measured	2.75
Volume, cm <sup>3</sup>	80.38	Solids Height, cm	0.691
Water Content, %	97.09	Volume of Solids, cm <sup>3</sup>	21.85
Wet Mass, g	118.43	Volume of Voids, cm <sup>3</sup>	58.53
Dry Mass, g	60.09	Degree of Saturation, %	99.7

**TEST COMPUTATIONS**

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv. cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	2.543	2.679	2.543				
4.70	2.508	2.628	2.525	240	5.63E-03	2.94E-03	1.62E-06
9.56	2.484	2.593	2.496	142	9.30E-03	1.97E-03	1.79E-06
19.44	2.426	2.509	2.455	308	4.15E-03	2.30E-03	9.37E-07
38.76	2.310	2.341	2.368	432	2.75E-03	2.36E-03	6.37E-07
77.54	2.095	2.030	2.202	540	1.90E-03	2.18E-03	4.06E-07
154.86	1.859	1.689	1.977	699	1.19E-03	1.20E-03	1.39E-07
309.84	1.660	1.401	1.759	371	1.77E-03	5.05E-04	8.76E-08
619.54	1.512	1.187	1.586	72	7.40E-03	1.88E-04	1.37E-07
1240.32	1.380	0.996	1.446	44	1.01E-02	8.33E-05	8.22E-08
2488.11	1.268	0.834	1.324	47	7.90E-03	3.55E-05	2.75E-08
1240.32	1.274	0.844	1.271				
309.84	1.315	0.902	1.295				
77.54	1.360	0.968	1.337				
19.44	1.405	1.032	1.382				
4.70	1.435	1.076	1.420				

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.44	Unit Weight, kN/m <sup>3</sup>	18.18
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	12.99
Area, cm <sup>2</sup>	31.61	Specific Gravity, measured	2.75
Volume, cm <sup>3</sup>	45.37	Solids Height, cm	0.691
Water Content, %	40.01	Volume of Solids, cm <sup>3</sup>	21.85
Wet Mass, g	84.13	Volume of Voids, cm <sup>3</sup>	23.52
Dry Mass, g	60.09		

Prepared By: LH

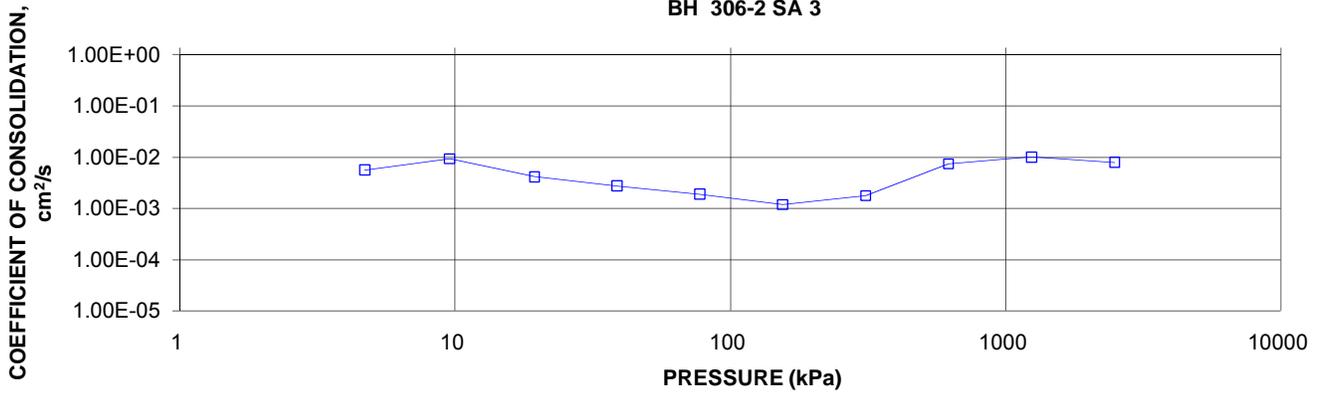
**Golder Associates**

Checked By: MM

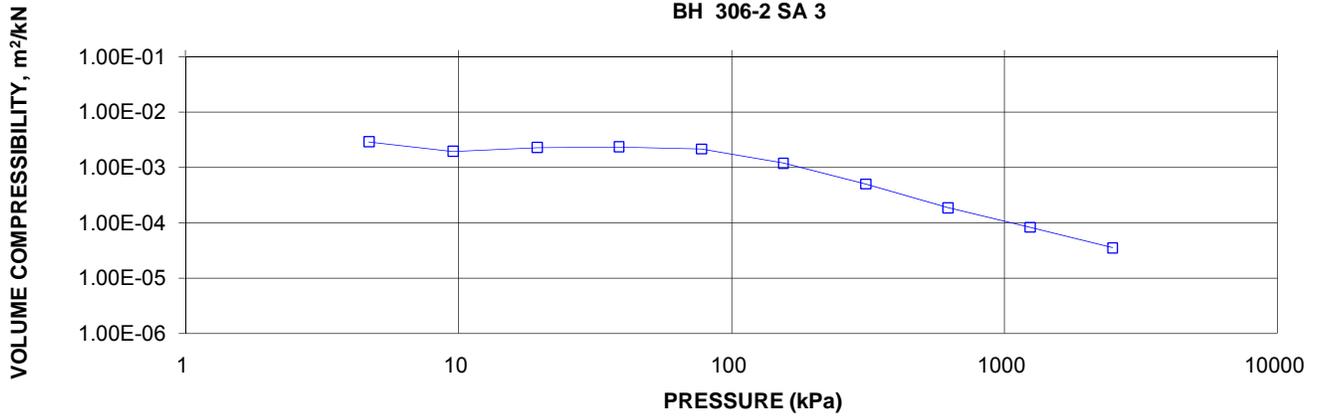
**CONSOLIDATION TEST SUMMARY**  
**Highway 69 (SBL) STA 15+350 to 15+800**

**FIGURE C.S306-4**  
**Sheet 2 of 4**

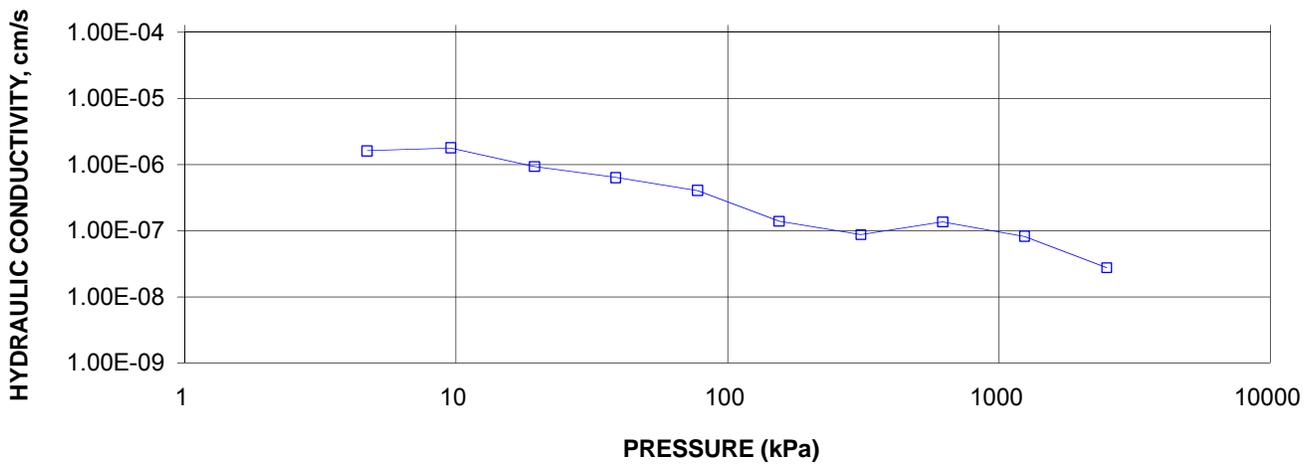
**CONSOLIDATION TEST**  
**CV cm<sup>2</sup>/s VS PRESSURE (kPa)**  
**BH 306-2 SA 3**

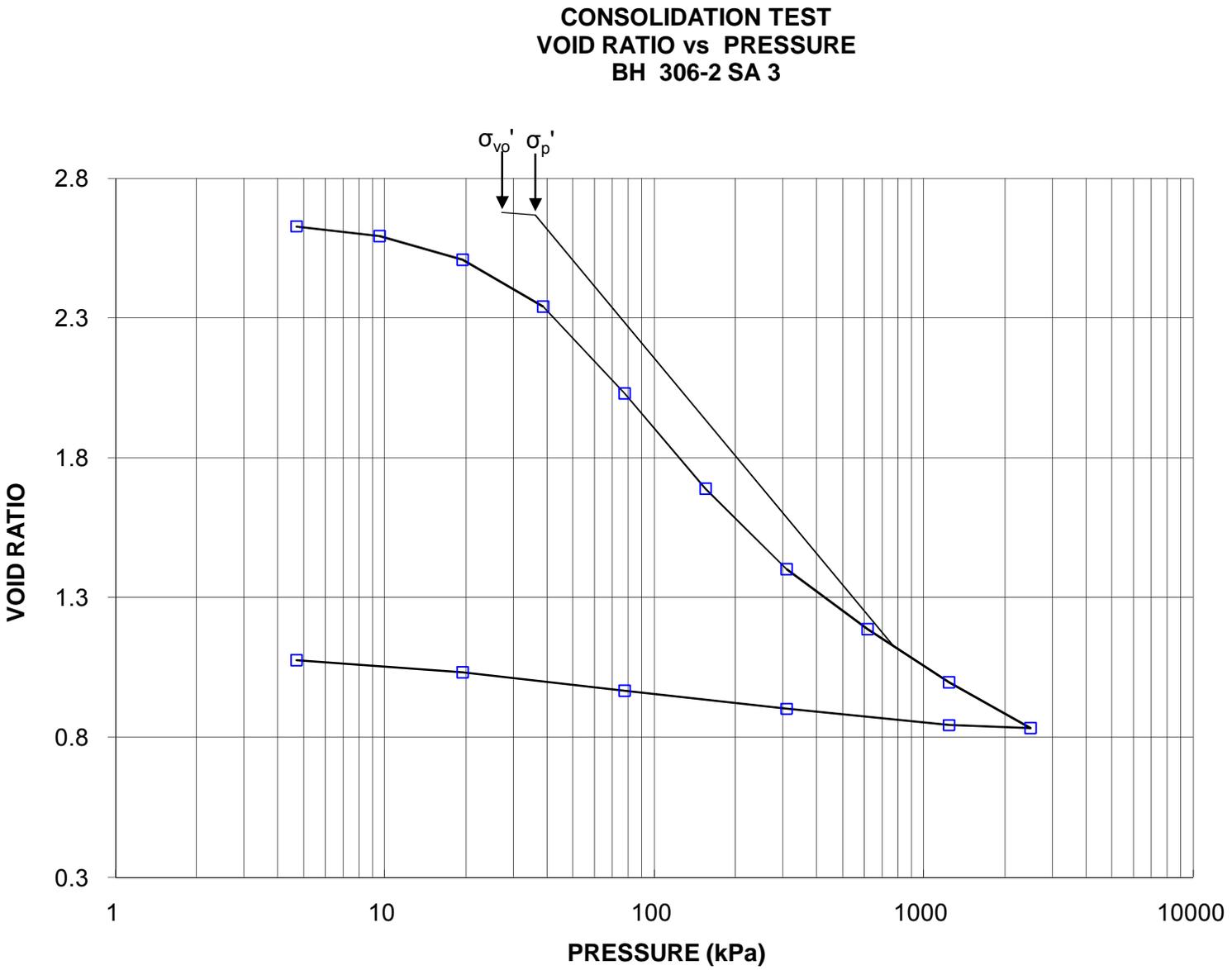


**CONSOLIDATION TEST**  
**MV m<sup>2</sup>/kN vs PRESSURE (kPa)**  
**BH 306-2 SA 3**

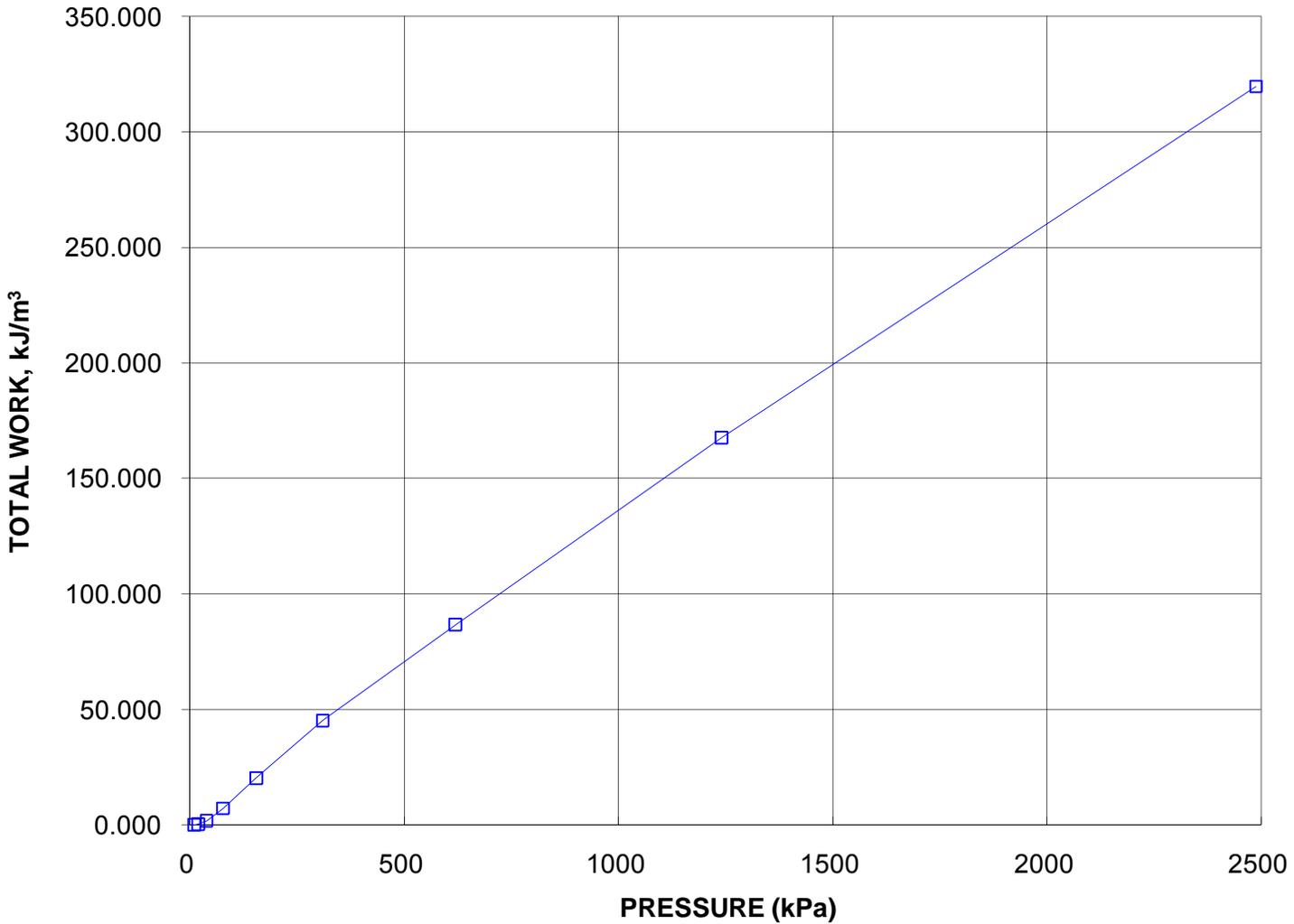


**CONSOLIDATION TEST**  
**HYDRAULIC CONDUCTIVITY vs PRESSURE**  
**BH 306-2 SA 3**





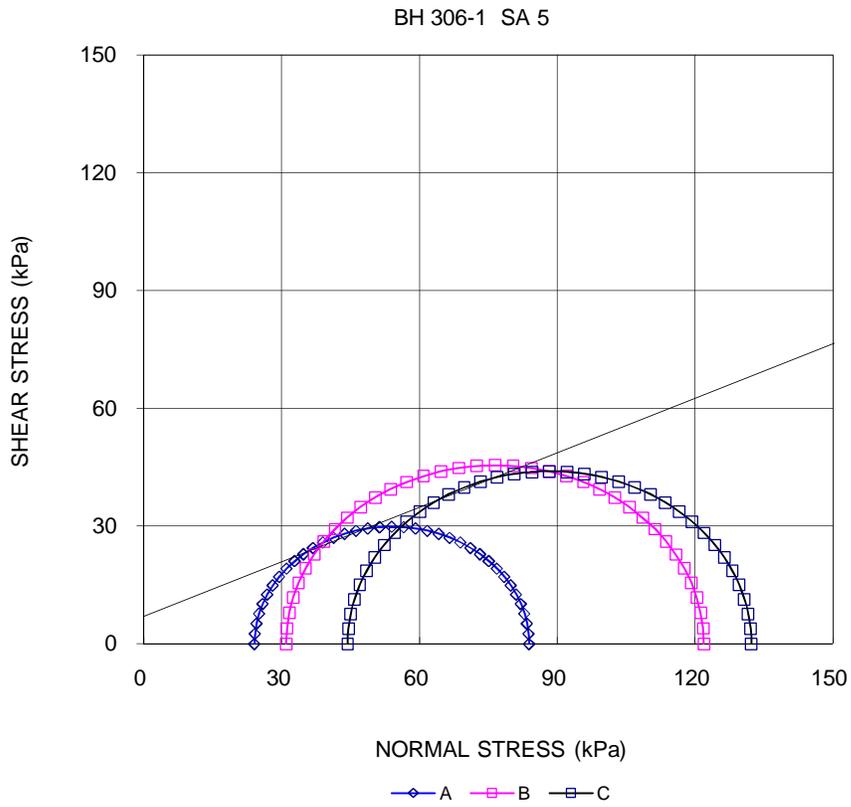
CONSOLIDATION TEST  
TOTAL WORK, kJ/m<sup>3</sup> vs PRESSURE  
BH 306-2 SA 3



**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE C.S306-5  
Sheet 1 of 4**

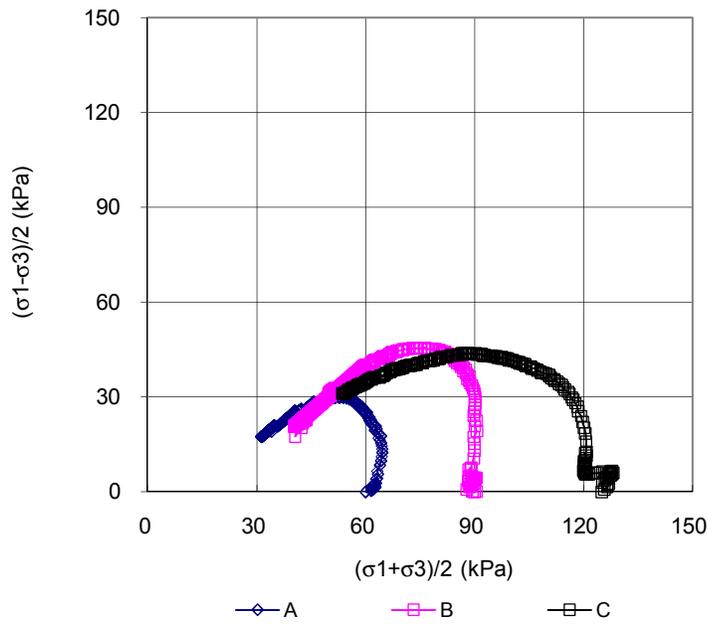
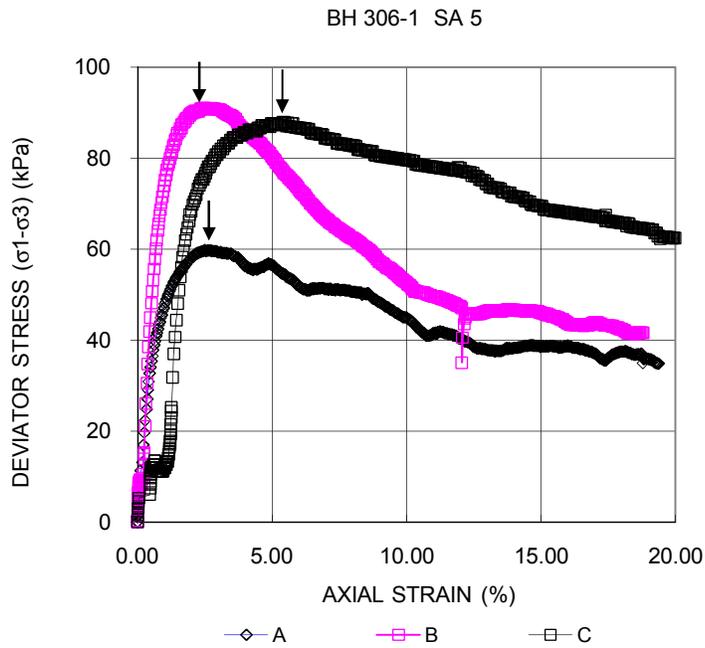
TEST STAGE	A	B	C
BOREHOLE NUMBER	306-1	306-1	306-1
SAMPLE	5	5	5
SPECIMEN DIAMETER, cm	5.07	5.07	5.02
SPECIMEN HEIGHT, cm	10.17	10.18	10.17
WATER CONTENT BEFORE CONSOLIDATION, %	85.1	87.1	89.2
CELL PRESSURE, $\sigma_3$ , kPa	195.0	365.0	470.0
BACK PRESSURE, kPa	135.0	275.0	345.0
PORE PRESSURE PARAMETER "B"	0.99	0.98	0.98
CONSOLIDATION PRESSURE, $\sigma_c$ , kPa	60.0	90.0	125.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	8.0	6.9	13.6
WATER CONTENT AFTER CONSOLIDATION, %	75.3	78.7	72.6
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, DAYS	2	2	2
WATER CONTENT AFTER TEST, %	80.7	82.3	71.1
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa	59.8	91.0	87.9
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %	2.5	2.4	5.4
MAX EFFECTIVE PRINCIPAL STRESS RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM	4.3	5.1	3.8
DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa	56.8	80.5	71.2
AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %	4.9	5.0	14.3
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM	0.60	0.65	0.92
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM	0.75	0.87	1.40
NATURAL WATER CONTENT, %	83.7	83.9	84.6
DRY DENSITY, Mg/m <sup>3</sup>	0.82	0.82	0.82
FILTER DRAINS USED, y/n	y	y	y
TEST NOTES:			
CHANGED RATE OF STRAIN, %/hr	-	-	-
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %	-	-	-
FAILURE PLANE NUMBER	1	1	1
ANGLE OF FAILURE, DEGREES	70	62	70
Date: 06/15/2009			Prepared By: MM
Project No. 06-1111-025	<b>Golder Associates</b>		Checked By: RO



Date: 06/15/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

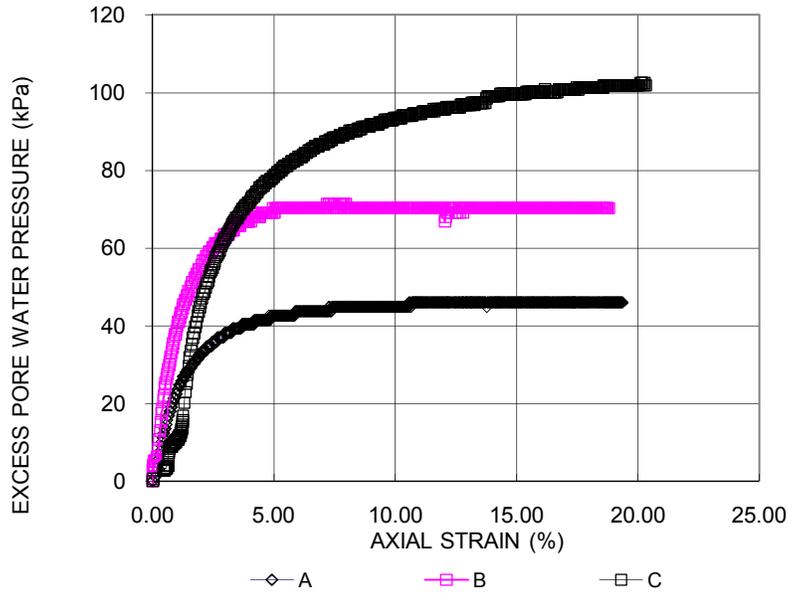
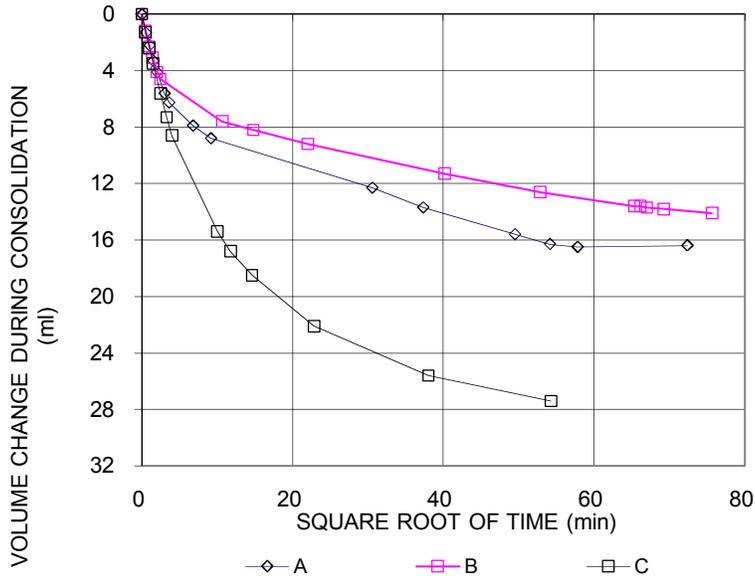


Date: 06/15/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

BH 306-1 SA 5



Date: 06/15/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

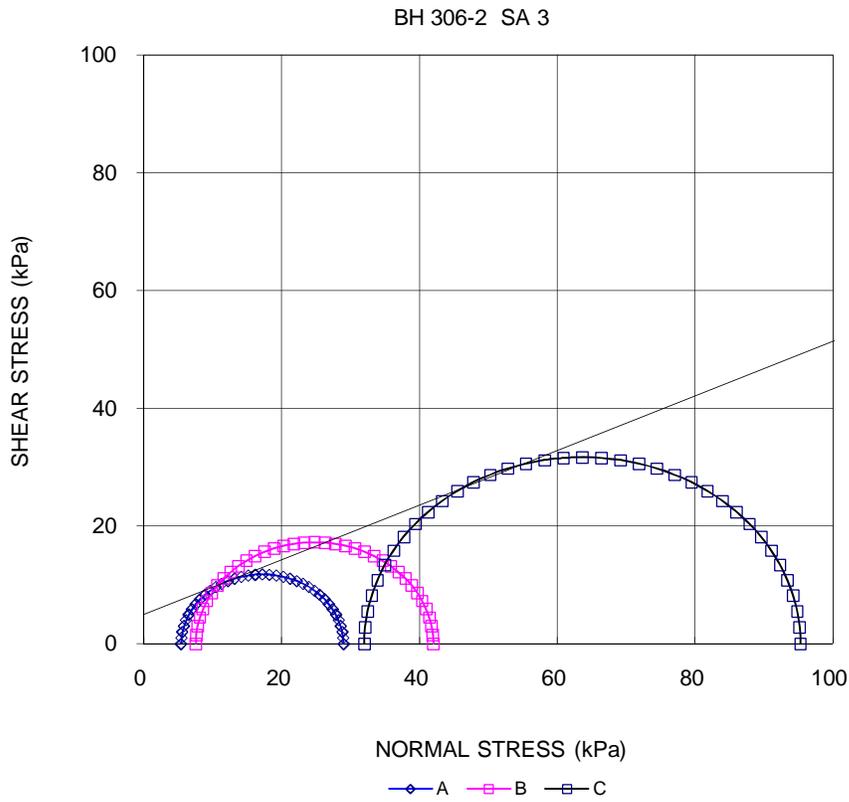
**FIGURE C.S306-6  
Sheet 1 of 4**

TEST STAGE	A	B	C
BOREHOLE NUMBER	306-2	306-2	306-2
SAMPLE	3	3	3
SPECIMEN DIAMETER, cm	5.10	5.13	5.06
SPECIMEN HEIGHT, cm	9.90	9.89	10.05
WATER CONTENT BEFORE CONSOLIDATION, %	92.1	93.5	98.2
CELL PRESSURE, $\sigma_3$ , kPa	155.0	170.0	215.0
BACK PRESSURE, kPa	135.0	135.0	135.0
PORE PRESSURE PARAMETER "B"	0.98	0.98	0.99
CONSOLIDATION PRESSURE, $\sigma_c$ , kPa	20.0	35.0	80.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	5.2	9.5	19.9
WATER CONTENT AFTER CONSOLIDATION, %	85.2	81.1	71.2
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, DAYS	2	2	2
WATER CONTENT AFTER TEST, %	84.9	81.2	71.4
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa	23.5	34.5	63.3
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %	6.0	4.9	4.4
MAX EFFECTIVE PRINCIPAL STRESS RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM	6.4	7.2	3.8
DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa	23.5	32.6	58.9
AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %	6.1	10.0	13.1
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM	0.62	0.80	0.76
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM	0.67	0.91	1.01
NATURAL WATER CONTENT, %	94.1	94.3	97.4
DRY DENSITY, Mg/m <sup>3</sup>	0.76	0.76	0.74
FILTER DRAINS USED, y/n	y	y	y
TEST NOTES:			
CHANGED RATE OF STRAIN, %/hr	-	-	-
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %	-	-	-
FAILURE PLANE NUMBER	1.0	1.0	-
ANGLE OF FAILURE, DEGREES	65.0	60.0	bulged

Date: 06/12/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

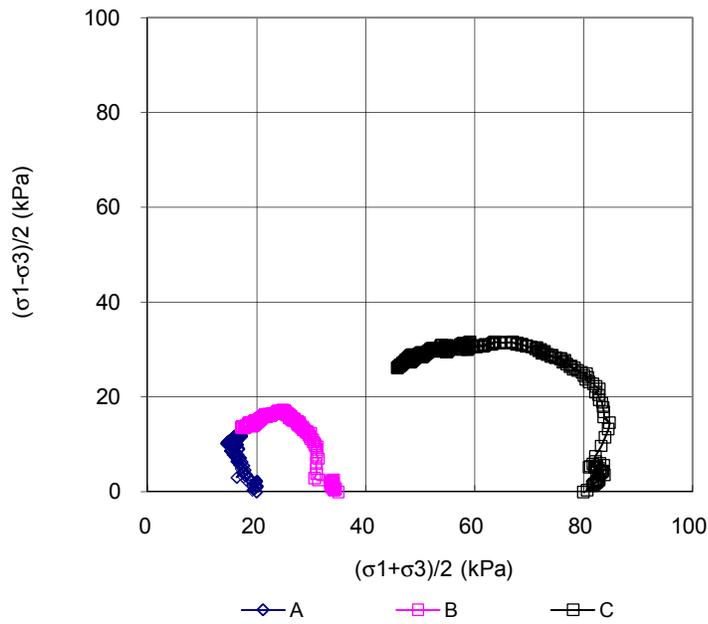
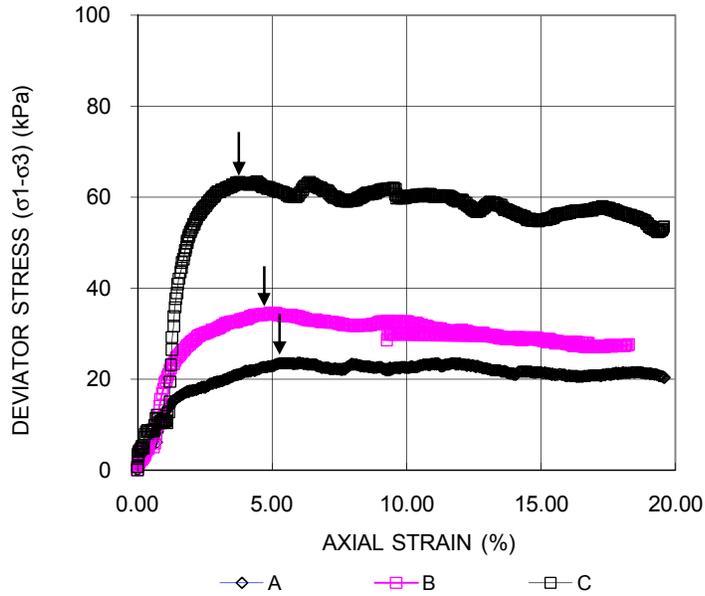


Date: 06/12/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

BH 306-2 SA 3

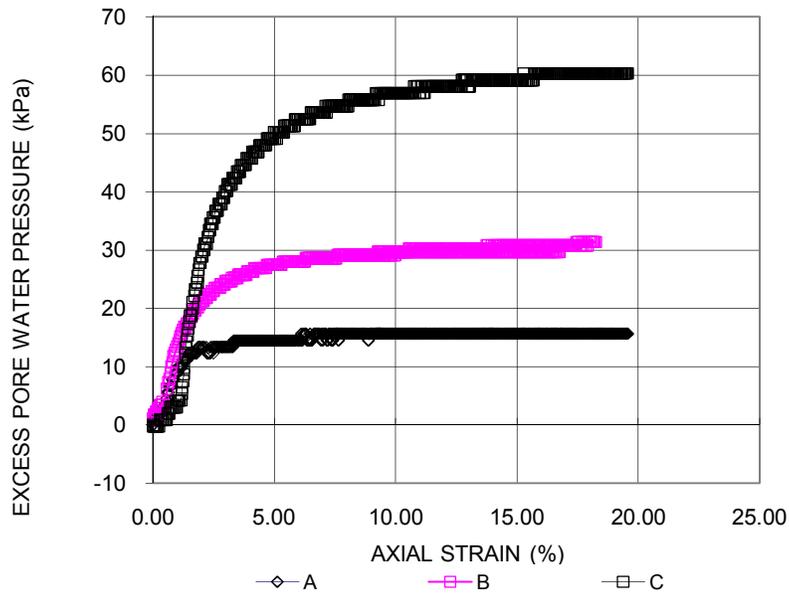
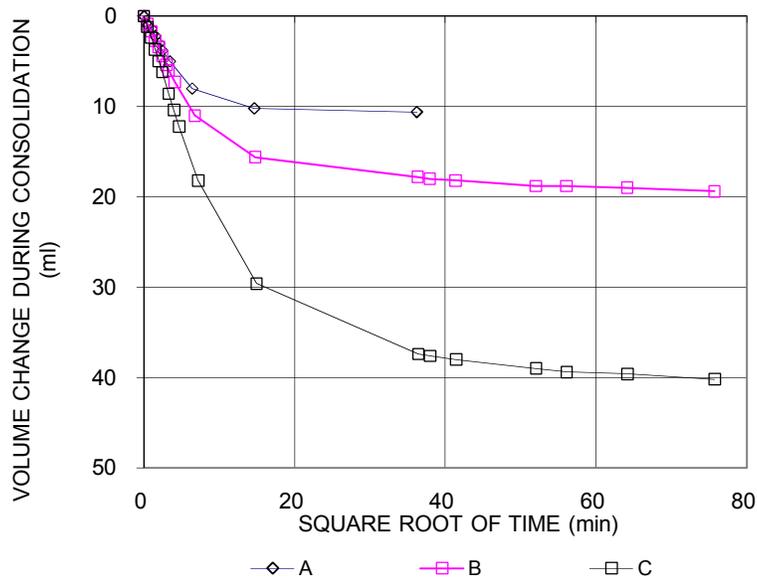


Date: 06/12/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO

BH 306-2 SA 3



Date: 06/12/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO



# **APPENDIX D**

**Highway 69 NBL – STA 14+425 to 14+500 (Swamp 307 SBL)**



PROJECT <u>06-1111-025</u>	<b>RECORD OF BOREHOLE No 307-1</b>	2 OF 2 <b>METRIC</b>
G.W.P. <u>5203-06-00</u>	LOCATION <u>N 5090527.6 ; E 220909.4</u>	ORIGINATED BY <u>MR</u>
DIST <u>                    </u> HWY <u>69</u>	BOREHOLE TYPE <u>108 mm O.D. Solid Stem Augers and NW Casing, Wash Boring</u>	COMPILED BY <u>MWK</u>
DATUM <u>Geodetic</u>	DATE <u>March 19, 2009</u>	CHECKED BY <u>VA</u>

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
176.3	--- CONTINUED FROM PREVIOUS PAGE ---  SILT, trace to some clay, trace sand Loose to compact Grey Wet		10	SS	13											
16.5	END OF BOREHOLE  A Dynamic Cone Penetration Test was carried out between depths of 16.5 m and 18.8 m.															
174.0	END OF DCPT  NOTES:  1. Water level in open borehole at ice surface (Elev. 192.8 m) upon completion of drilling.  2. An additional borehole was drilled 1 m east of Borehole 307-1 to obtain a Shelby tube sample between depths of 2.7 m and 3.2 m and to carry out insitu vane tests at depths of 3.5 m and 3.8 m.															
18.8																

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

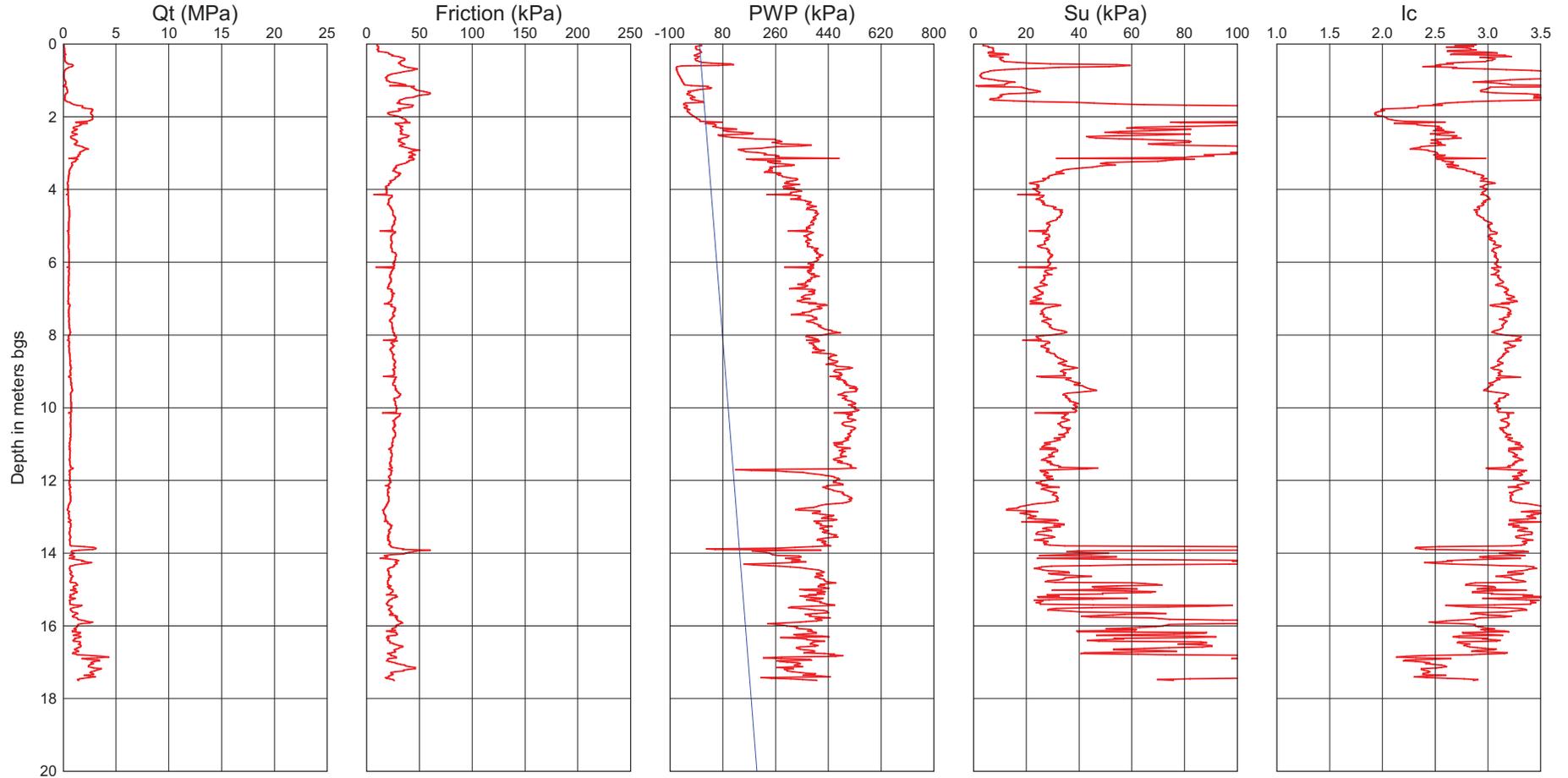
+<sup>3</sup>, X<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

# Cone Penetration Test - CPT307-1

Test Date : March 11, 2009  
 Location : Highway 69 - STA 15+460 o/s 23 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 192.80  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 15.5 \text{ kN/m}^3$

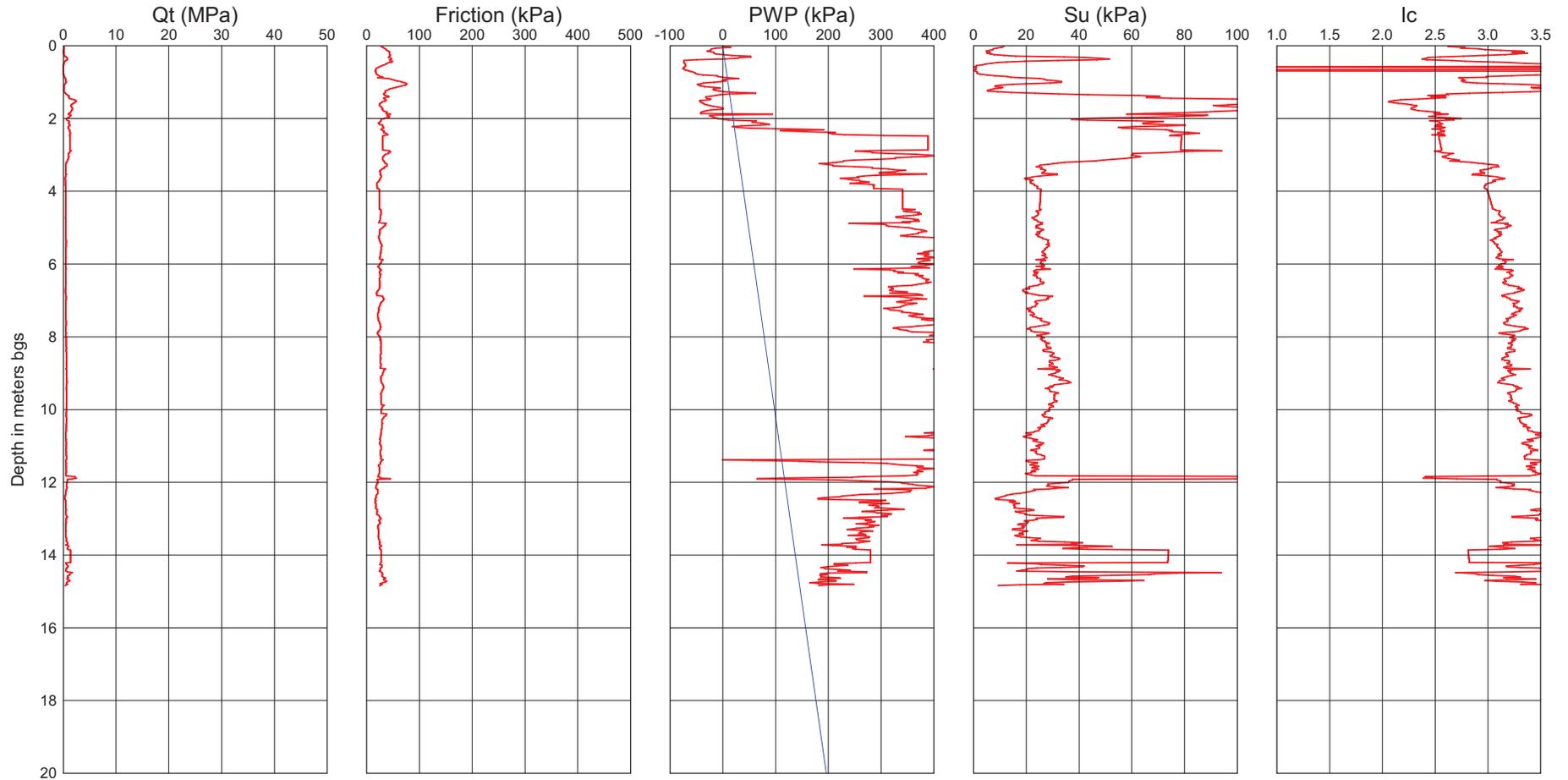
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT307-2

Test Date : 11//2/3/  
 Location : Highway 69 - STA 15+460 o/s 24 m Left

Operator : Golder Associates

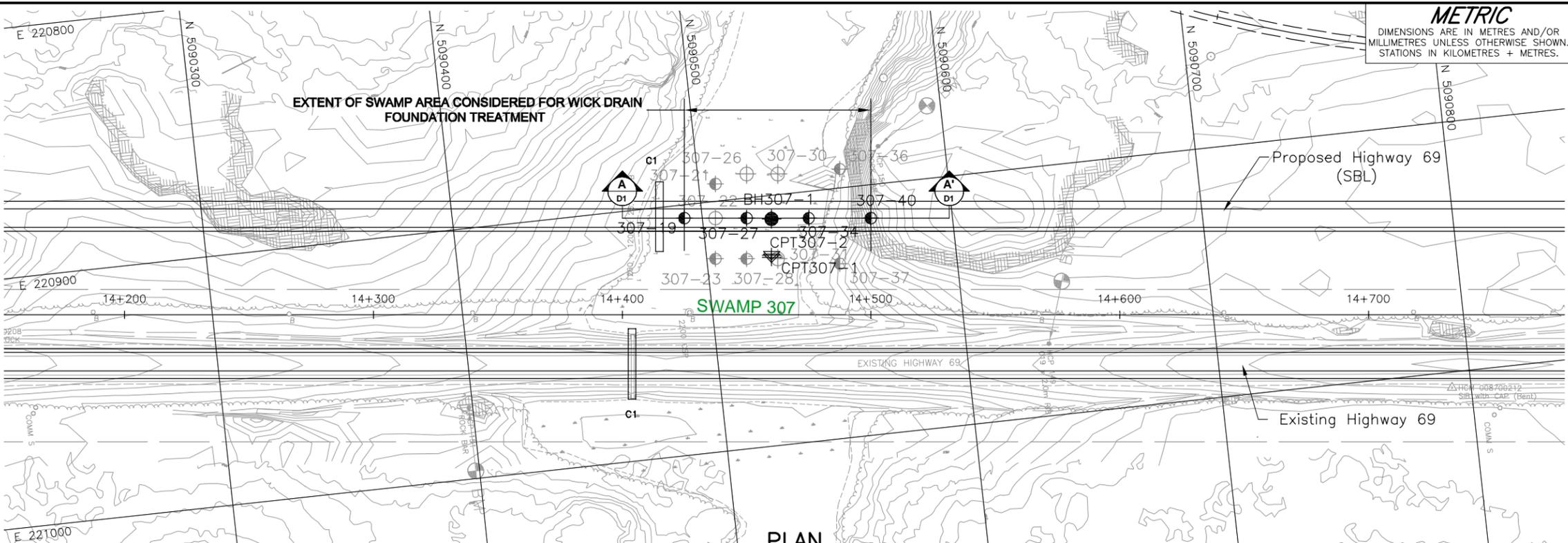
Ground Surf. Elev. : 192.80  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$Su = (Qt - \text{Sigma}V) / Nk$   
 $Nk = 15.5$   
 $\text{Gamma} = 15.5 \text{ kN/m}^3$

After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

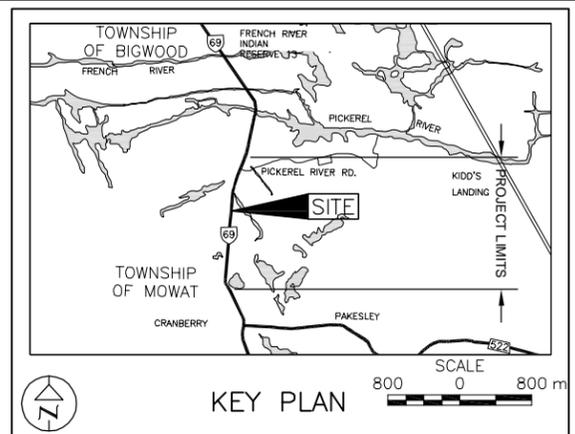


**METRIC**  
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

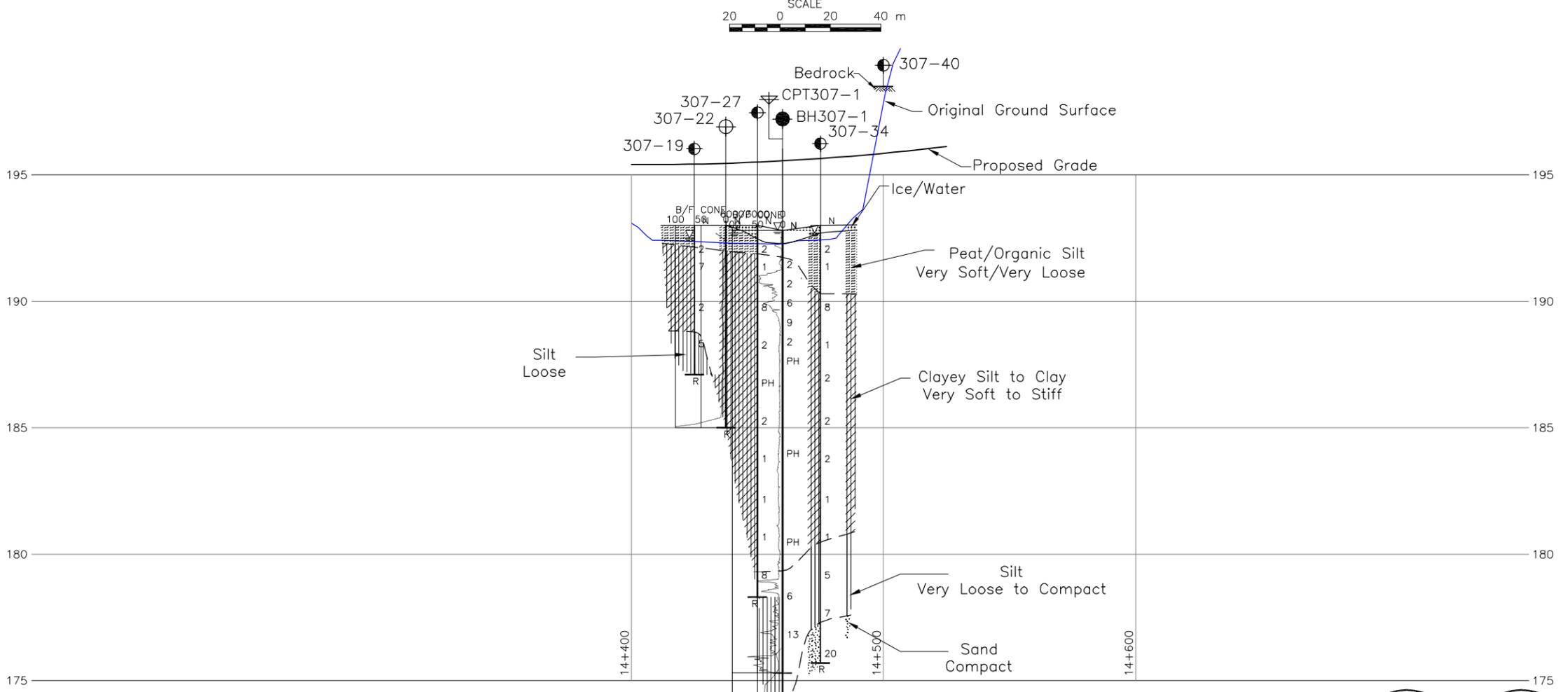
CONT No. GWP No. 5203-06-00  
HIGHWAY 69 (SBL)  
STA 14+425 TO 14+500  
BOREHOLE LOCATION AND SOIL STRATA



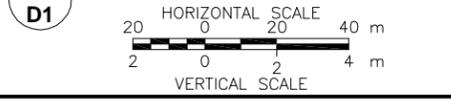
**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



**PLAN**



**A-A' CENTRELINE PROFILE**



**LEGEND**

- Borehole – Current Investigation
- ▽ CPT – Current Investigation
- ⊕ Borehole – Previous Investigation (Peto MacCallum Ltd.)
- ⊕ Dynamic Cone Penetration Test – Previous Investigation (Peto MacCallum Ltd.)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ≡ WL observed during or upon completion of drilling
- R Refusal

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
BH307-1	192.8	5090527.6	220909.4
CPT307-1	192.8	5090525.9	220924.8
CPT307-2	192.8	5090526.0	220923.8

**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**

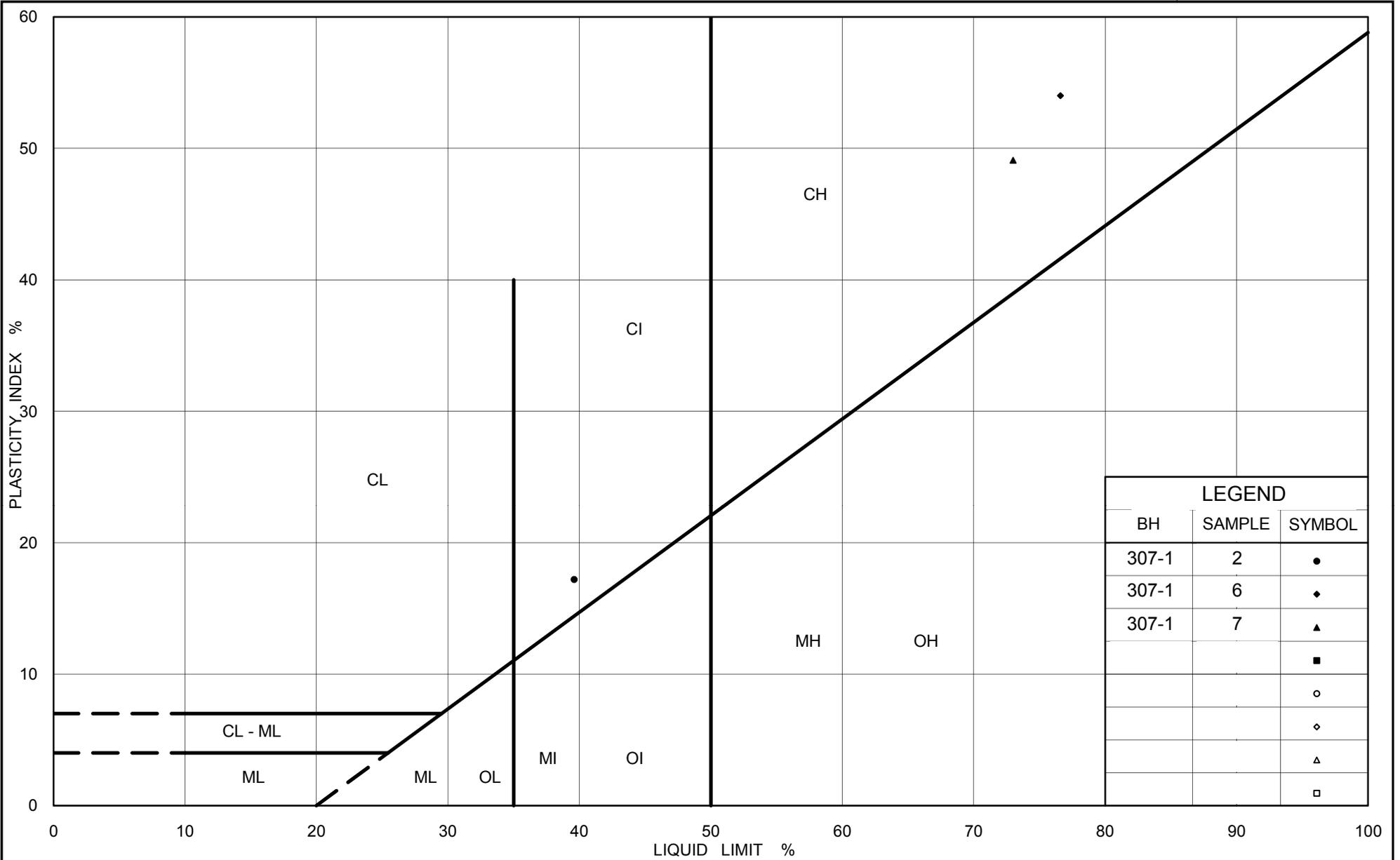
Base plans and Profile provided in digital format by MRC, drawing file's no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009. 1-6454\_ Phase3-ML PROFILE-Mar 26-09.dwg, received Sept. 30, 2009.



NO.	DATE	BY	REVISION

Geocres No. 41H-106

HWY: 69	PROJECT NO. 06-1111-025	DIST.
SUBM'D. MWK	CHKD. MWK	DATE: Feb. 2012
DRAWN: RJ/JFC	CHKD. VA	APPD. JPD/JMAC
		DWG. D1



Ministry of Transportation

Ontario

**PLASTICITY CHART**  
 Clayey Silt to Clay  
 Highway 69 (SBL) STA 14+425 to 14+500

Figure No. D.S307-1

Project No. 06-1111-025

Checked By: TVA

**CONSOLIDATION TEST SUMMARY**

Highway 69 (SBL) STA 14+425 to 14+500

**FIGURE D.S307-2**

Sheet 1 of 4

**SAMPLE IDENTIFICATION**

Project Number	06-1111-025	Sample Number	6
Borehole Number	307-1	Sample Depth, m	5.3

**TEST CONDITIONS**

Test Type	Standard	Load Duration, hr	24
Oedometer Number	3		
Date Started	06/02/2009		
Date Completed	06/27/2009		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	2.54	Unit Weight, kN/m <sup>3</sup>	14.92
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m <sup>3</sup>	8.35
Area, cm <sup>2</sup>	31.62	Specific Gravity, measured	2.71
Volume, cm <sup>3</sup>	80.28	Solids Height, cm	0.797
Water Content, %	78.83	Volume of Solids, cm <sup>3</sup>	25.21
Wet Mass, g	122.18	Volume of Voids, cm <sup>3</sup>	55.07
Dry Mass, g	68.32	Degree of Saturation, %	97.8

**TEST COMPUTATIONS**

Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv. cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	2.539	2.184	2.539				
4.70	2.531	2.174	2.535	2	6.81E-01	7.12E-04	4.75E-05
9.55	2.526	2.168	2.528	4	3.39E-01	4.06E-04	1.35E-05
19.44	2.516	2.155	2.521	11	1.22E-01	3.98E-04	4.78E-06
38.75	2.495	2.129	2.505	9	1.48E-01	4.20E-04	6.09E-06
77.50	2.455	2.079	2.475	34	3.82E-02	4.06E-04	1.52E-06
154.93	2.252	1.824	2.353	19	6.18E-02	1.03E-03	6.26E-06
309.82	1.895	1.376	2.073	371	2.46E-03	9.09E-04	2.19E-07
620.03	1.677	1.103	1.786	315	2.15E-03	2.77E-04	5.82E-08
1239.80	1.508	0.891	1.592	240	2.24E-03	1.08E-04	2.36E-08
2478.18	1.375	0.724	1.441	93	4.73E-03	4.23E-05	1.96E-08
1239.80	1.383	0.734	1.379				
309.82	1.430	0.794	1.406				
77.50	1.487	0.865	1.458				
19.44	1.533	0.923	1.510				
4.70	1.561	0.958	1.547				

Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.56	Unit Weight, kN/m <sup>3</sup>	18.80
Sample Diameter, cm	6.35	Dry Unit Weight, kN/m <sup>3</sup>	13.57
Area, cm <sup>2</sup>	31.62	Specific Gravity, measured	2.71
Volume, cm <sup>3</sup>	49.37	Solids Height, cm	0.797
Water Content, %	38.57	Volume of Solids, cm <sup>3</sup>	25.21
Wet Mass, g	94.67	Volume of Voids, cm <sup>3</sup>	24.16
Dry Mass, g	68.32		

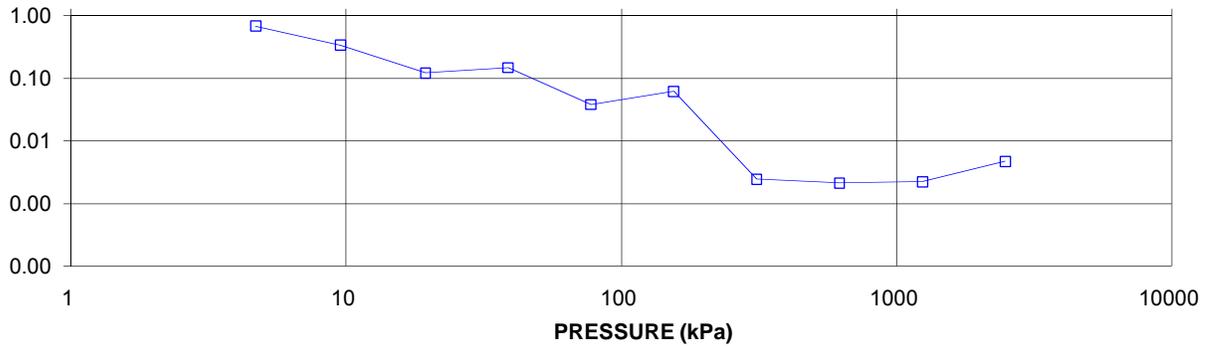
Prepared By: LH

**Golder Associates**

Checked By: MM

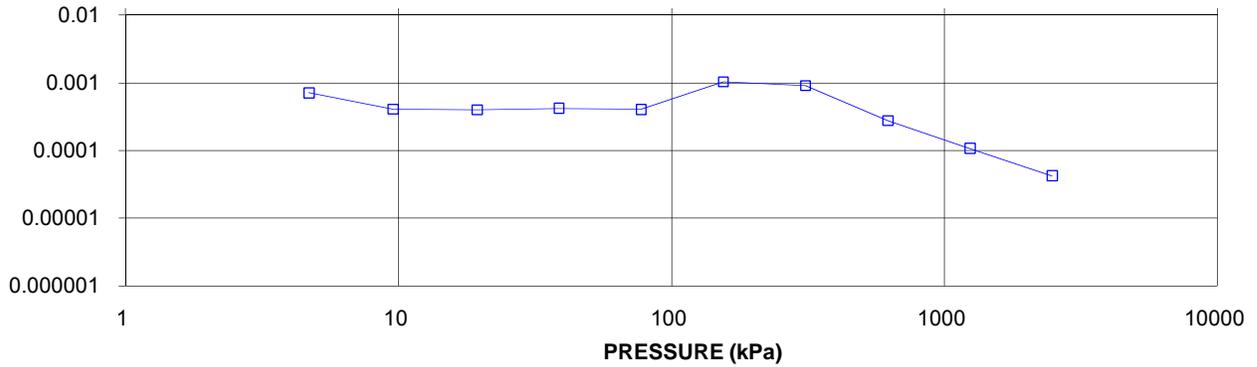
COEFFICIENT OF CONSOLIDATION,  
 $cm^2/s$

**CONSOLIDATION TEST**  
**CV  $cm^2/s$  VS PRESSURE (kPa)**  
**BH 307-1 SA 6**



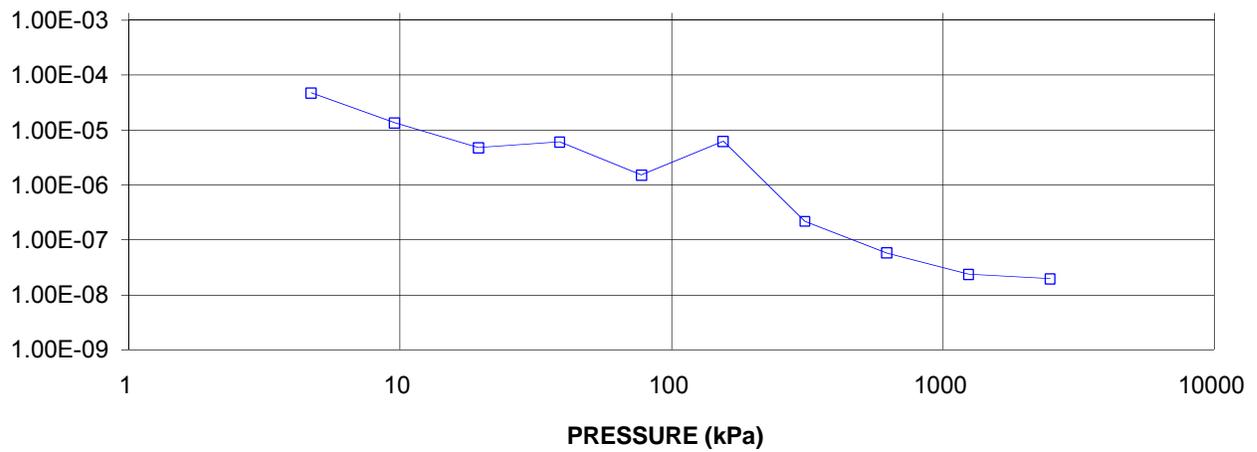
VOLUME COMPRESSIBILITY,  $m^2/kN$

**CONSOLIDATION TEST**  
**MV  $m^2/kN$  vs PRESSURE (kPa)**  
**BH 307-1 SA 6**

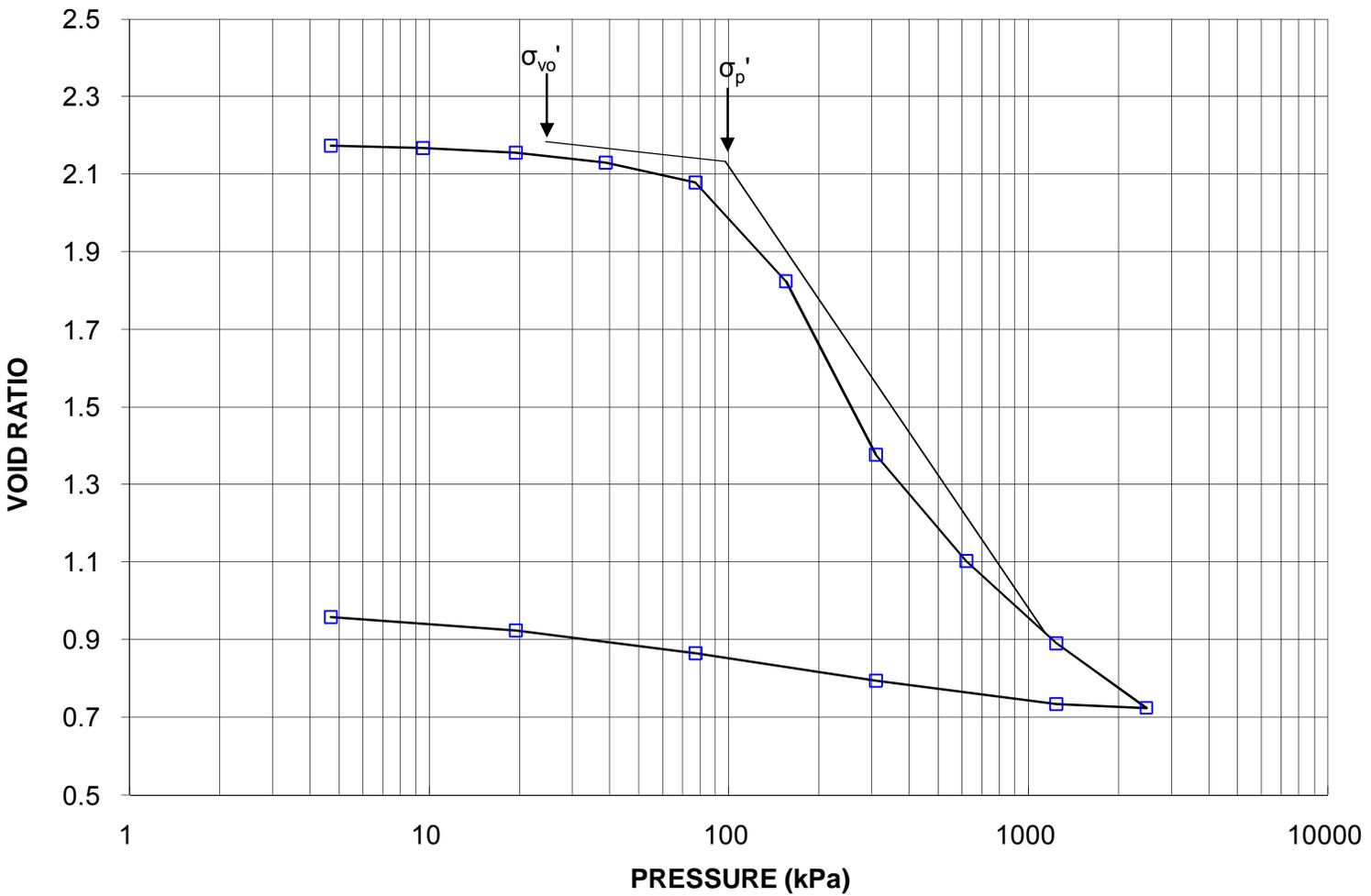


HYDRAULIC CONDUCTIVITY,  $cm/s$

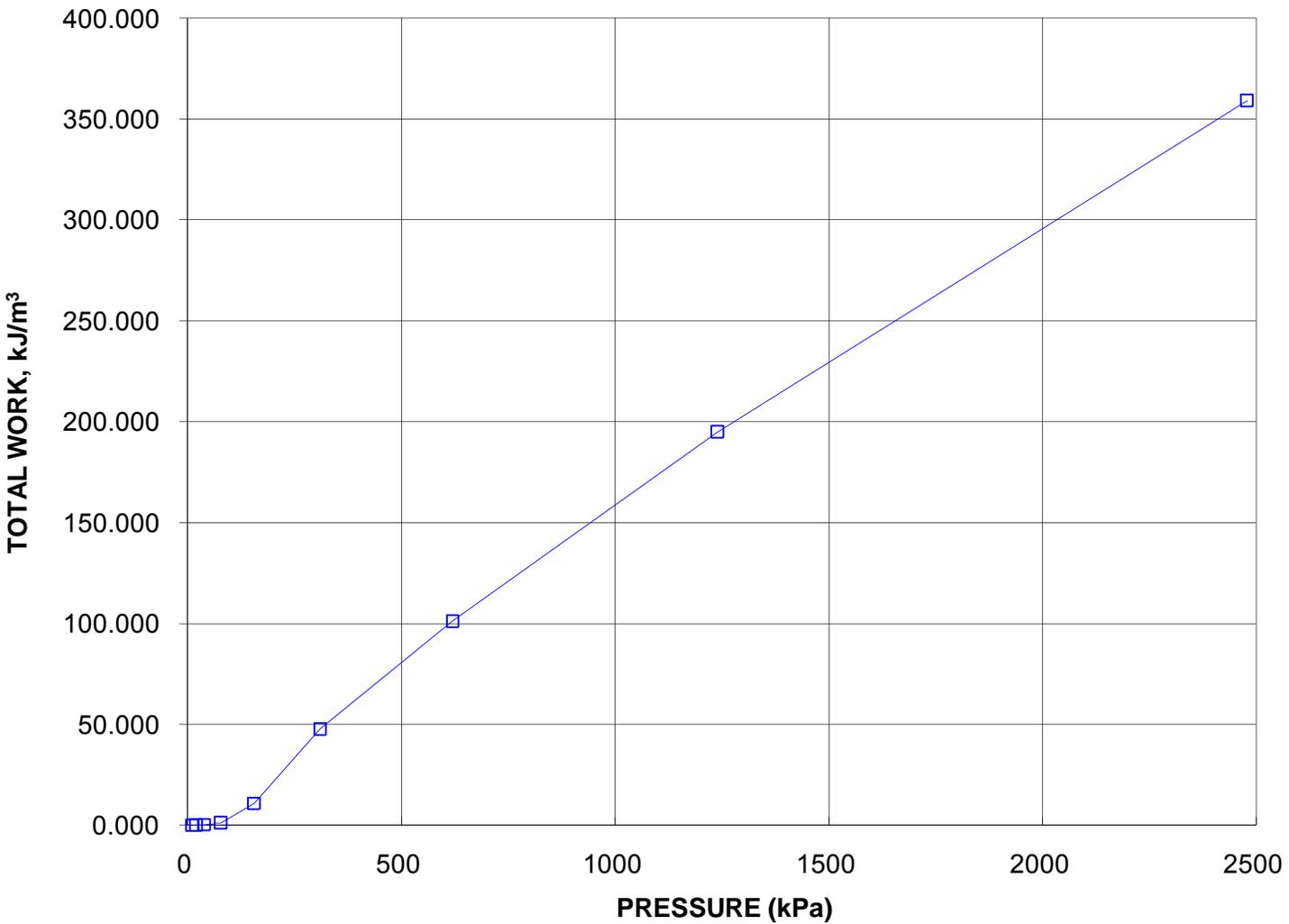
**CONSOLIDATION TEST**  
**HYDRAULIC CONDUCTIVITY vs PRESSURE**  
**BH 307-1 SA 6**



CONSOLIDATION TEST  
VOID RATIO vs PRESSURE  
BH 307-1 SA 6



CONSOLIDATION TEST  
TOTAL WORK, kJ/m<sup>3</sup> vs PRESSURE  
BH 307-1 SA 6



**CONSOLIDATION TEST SUMMARY**

Highway 69 (SBL) STA 14+425 to 14+500

**FIGURE D.S307-3**

Sheet 1 of 4

**SAMPLE IDENTIFICATION**

Project Number	06-1111-025	Sample Number	7
Borehole Number	307-1	Sample Depth, m	8.9

**TEST CONDITIONS**

Test Type	Standard	Load Duration, hr	24
Oedometer Number	6		
Date Started	06/17/2009		
Date Completed	07/07/2009		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	1.90	Unit Weight, kN/m <sup>3</sup>	15.21
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	9.24
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.76
Volume, cm <sup>3</sup>	59.86	Solids Height, cm	0.647
Water Content, %	64.60	Volume of Solids, cm <sup>3</sup>	20.43
Wet Mass, g	92.82	Volume of Voids, cm <sup>3</sup>	39.42
Dry Mass, g	56.39	Degree of Saturation, %	92.4

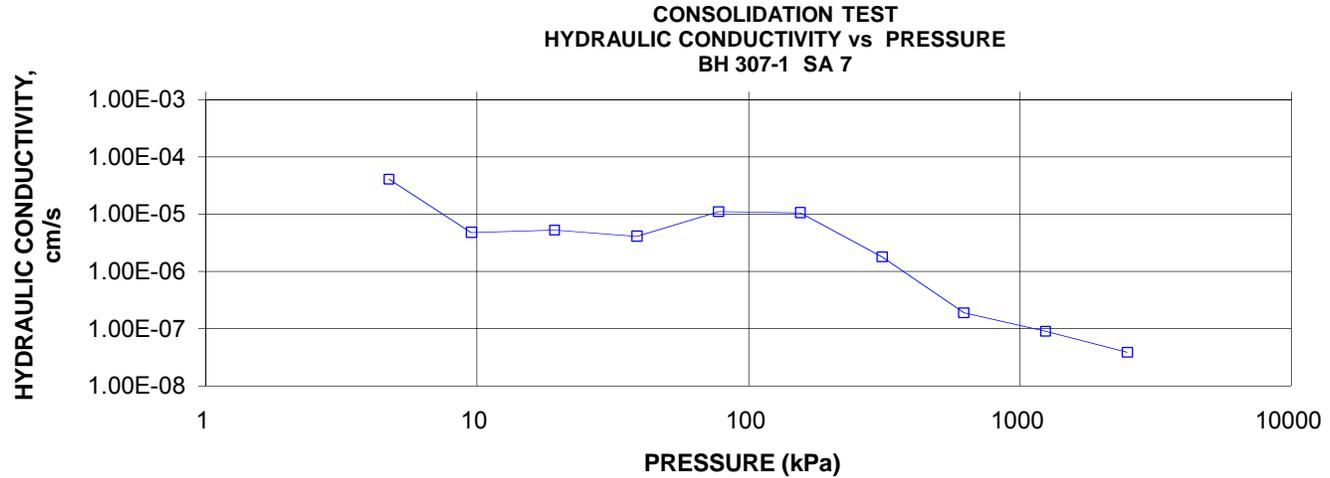
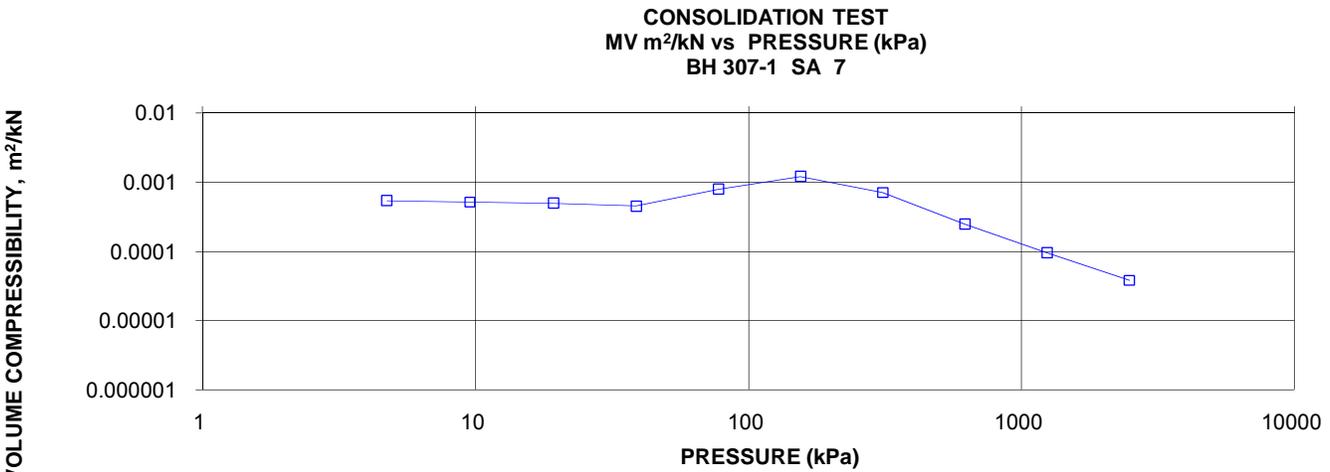
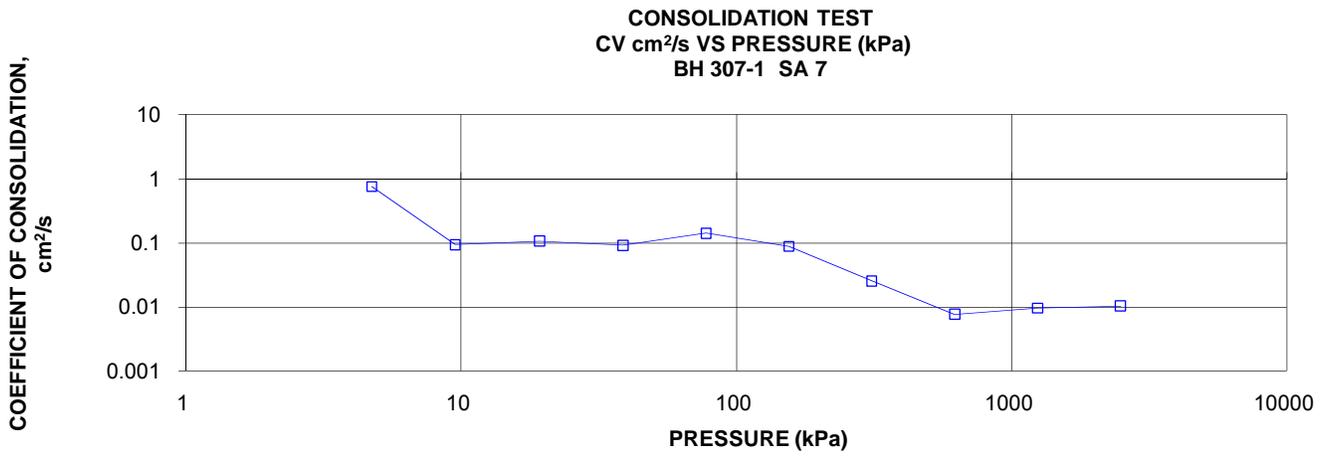
**TEST COMPUTATIONS**

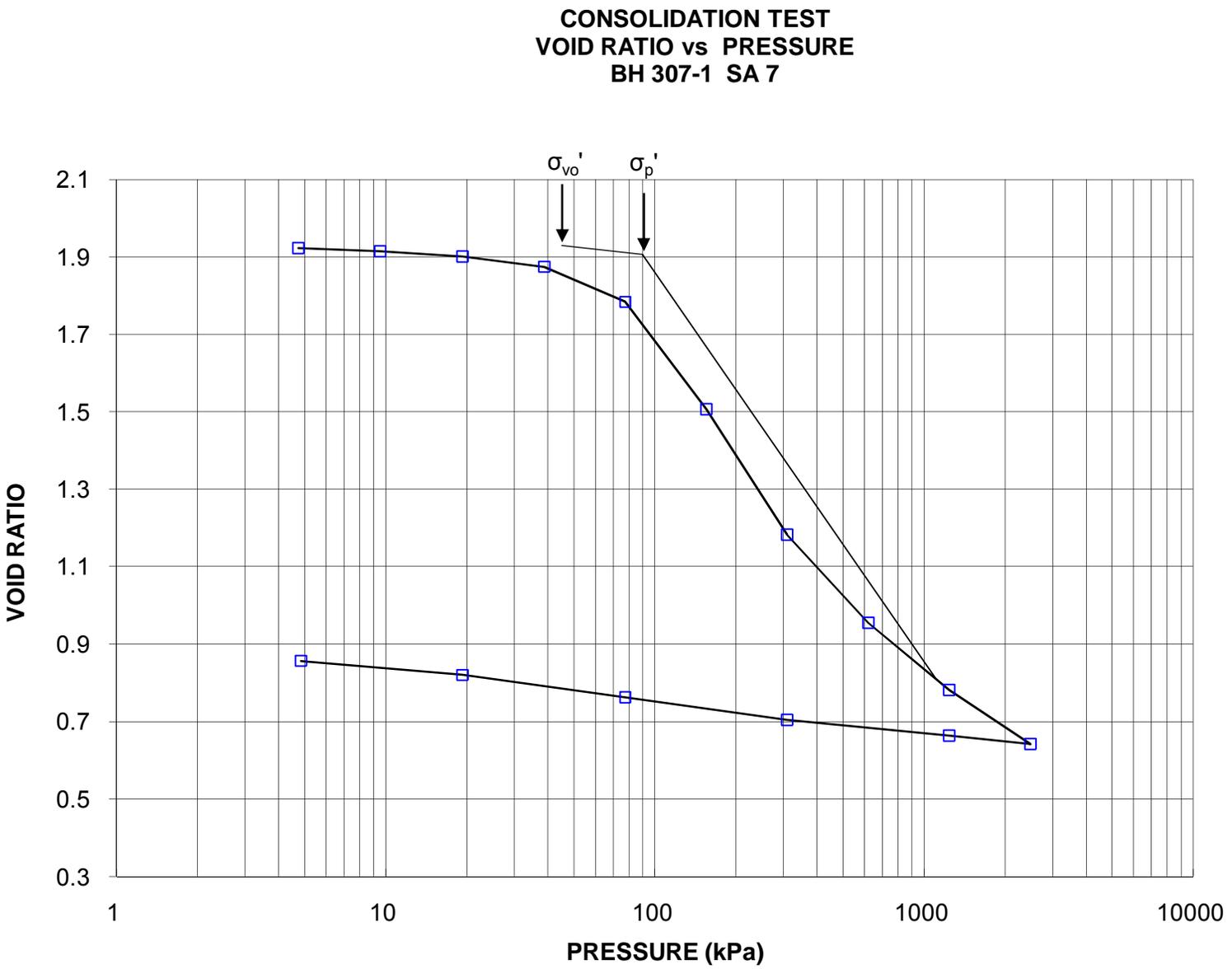
Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	cv. cm <sup>2</sup> /s	mv m <sup>2</sup> /kN	k cm/s
0.00	1.896	1.930	1.896				
4.74	1.891	1.922	1.894	1	7.60E-01	5.45E-04	4.06E-05
9.53	1.886	1.915	1.889	8	9.45E-02	5.18E-04	4.79E-06
19.31	1.877	1.900	1.882	7	1.07E-01	5.02E-04	5.27E-06
38.80	1.860	1.874	1.869	8	9.25E-02	4.55E-04	4.12E-06
77.62	1.802	1.784	1.831	5	1.42E-01	7.98E-04	1.11E-05
155.17	1.622	1.507	1.712	7	8.88E-02	1.22E-03	1.06E-05
310.23	1.413	1.183	1.518	19	2.57E-02	7.13E-04	1.80E-06
620.78	1.266	0.955	1.339	49	7.76E-03	2.50E-04	1.90E-07
1241.11	1.153	0.781	1.209	32	9.69E-03	9.57E-05	9.09E-08
2481.69	1.063	0.642	1.108	25	1.04E-02	3.83E-05	3.90E-08
1241.11	1.077	0.664	1.070				
310.23	1.103	0.704	1.090				
77.62	1.140	0.762	1.122				
19.31	1.178	0.820	1.159				
4.84	1.202	0.857	1.190				

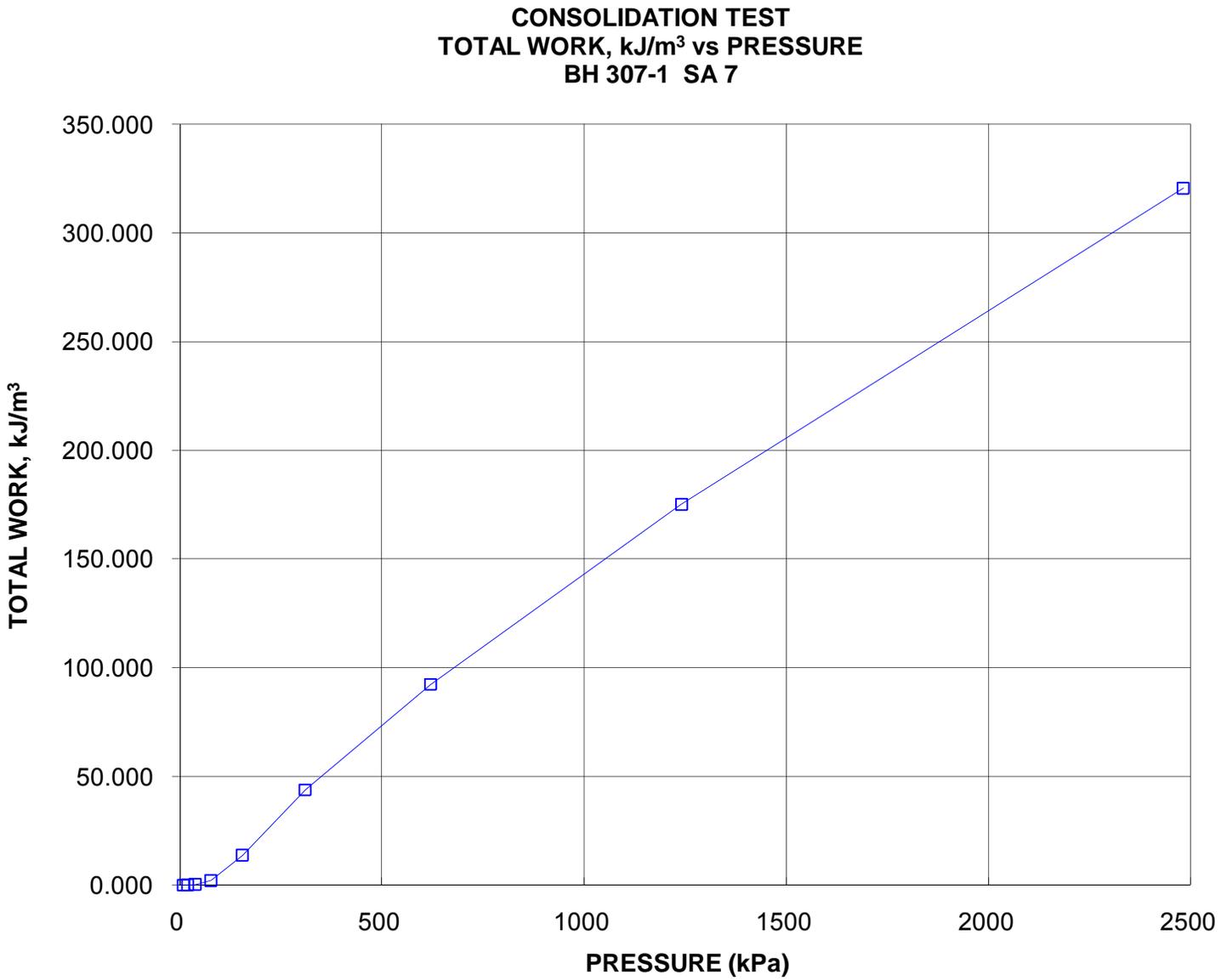
Note:

k calculated using cv based on t<sub>90</sub> values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.20	Unit Weight, kN/m <sup>3</sup>	19.61
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	14.58
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.76
Volume, cm <sup>3</sup>	37.93	Solids Height, cm	0.647
Water Content, %	34.49	Volume of Solids, cm <sup>3</sup>	20.43
Wet Mass, g	75.84	Volume of Voids, cm <sup>3</sup>	17.50
Dry Mass, g	56.39		







**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

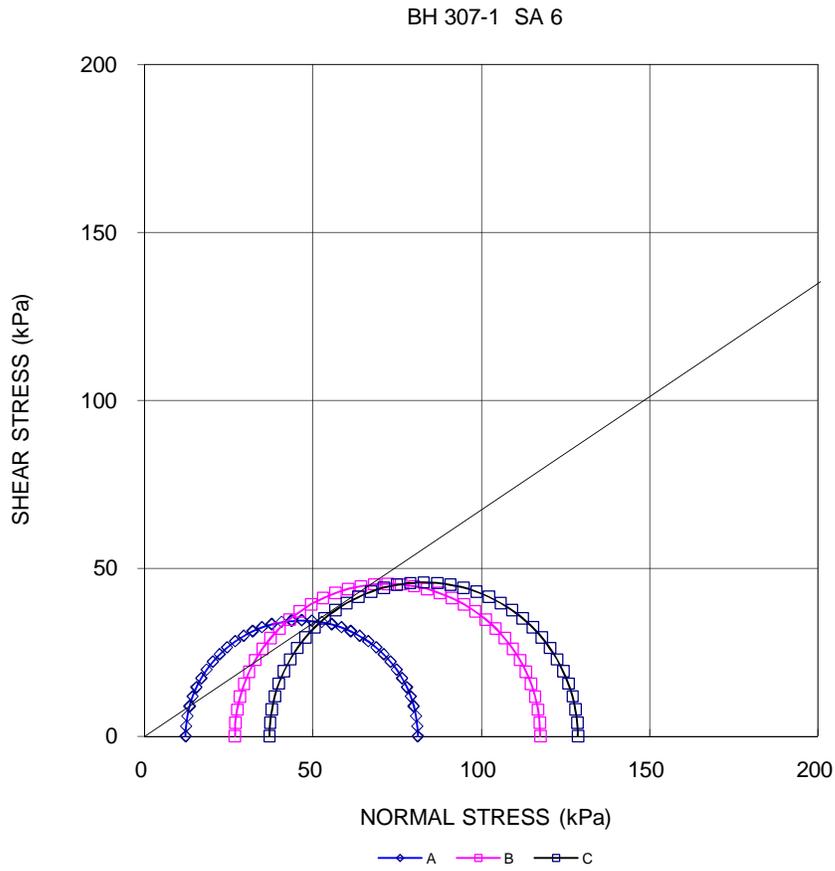
**FIGURE D.S307-4  
Sheet 1 of 4**

TEST STAGE	A	B	C
BOREHOLE NUMBER	307-1	307-1	307-1
SAMPLE	6	6	6
SPECIMEN DIAMETER, cm	5.05	5.01	5.03
SPECIMEN HEIGHT, cm	10.16	10.17	10.15
WATER CONTENT BEFORE CONSOLIDATION, %	76.5	77.6	76.7
CELL PRESSURE, $\sigma_3$ , kPa	450.0	560.0	595.0
BACK PRESSURE, kPa	415.0	485.0	485.0
PORE PRESSURE PARAMETER "B"	0.98	0.97	0.96
CONSOLIDATION PRESSURE, $\sigma_c$ , kPa	35.0	75.0	110.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	1.6	2.5	11.9
WATER CONTENT AFTER CONSOLIDATION, %	74.7	74.7	63.3
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, DAYS	2	2	2
WATER CONTENT AFTER TEST, %	75.8	76.2	69.4
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa	69.0	90.8	91.6
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %	1.2	1.3	4.1
MAX EFFECTIVE PRINCIPAL STRESS RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM	6.7	5.9	4.1
DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa	69.0	81.8	80.1
AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %	1.2	3.1	10.4
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ MAXIMUM	0.33	0.53	0.80
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 / \sigma_3)$ MAXIMUM	0.33	0.71	1.05
NATURAL WATER CONTENT, %	73.2	75.3	73.8
DRY DENSITY, Mg/m <sup>3</sup>	0.90	0.88	0.89
FILTER DRAINS USED, y/n	y	y	y
TEST NOTES:			
CHANGED RATE OF STRAIN, %/hr	-	-	-
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %	-	-	-
FAILURE PLANE NUMBER	1.0	1.0	-
ANGLE OF FAILURE, DEGREES	55.0	60.0	bulged

Date: 06/17/2009  
Project No. 06-1111-025

**Golder Associates**

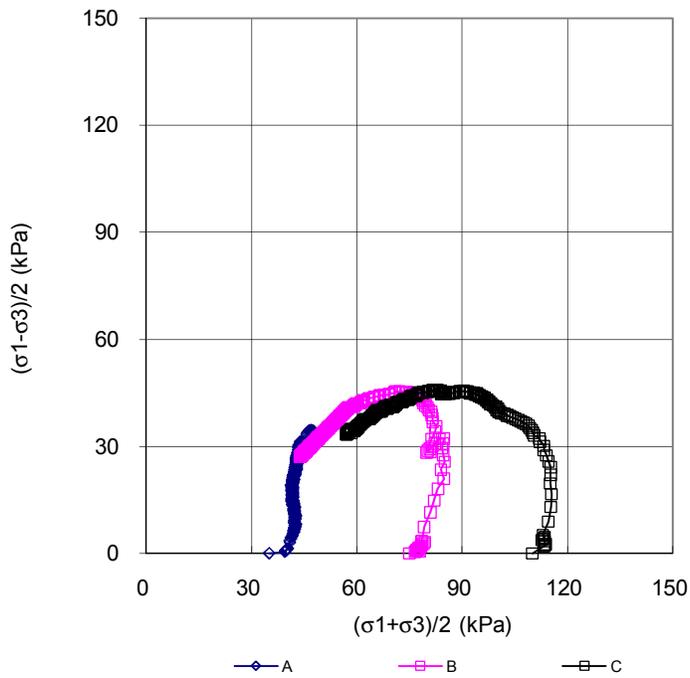
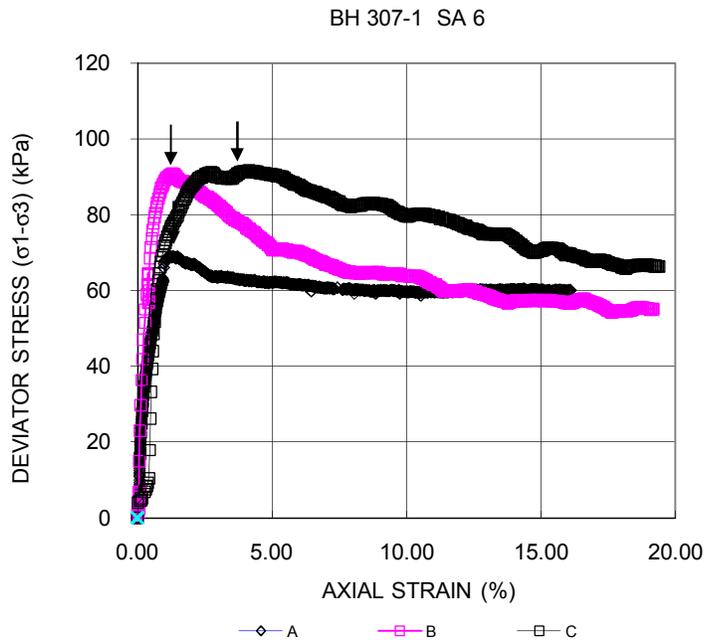
Prepared By: MM  
Checked By: RO



Date: 06/17/2009  
Project No. 06-1111-025

**Golder Associates**

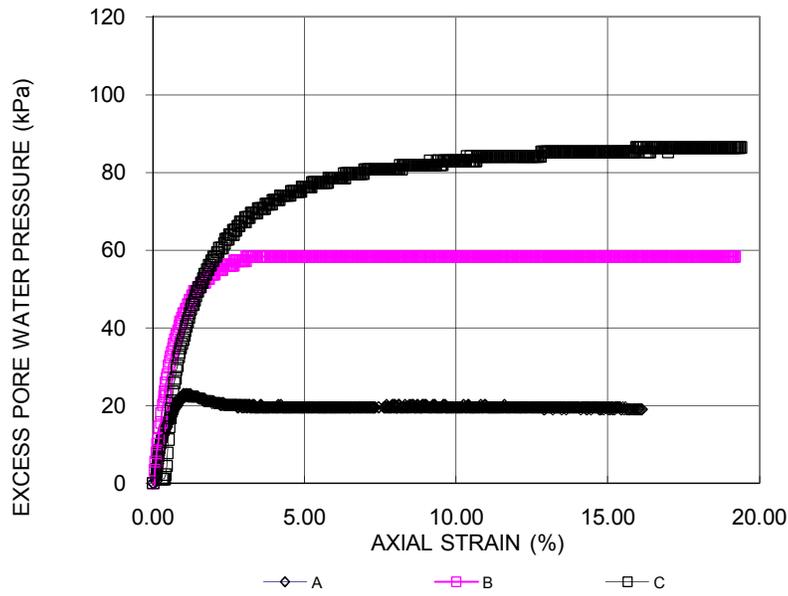
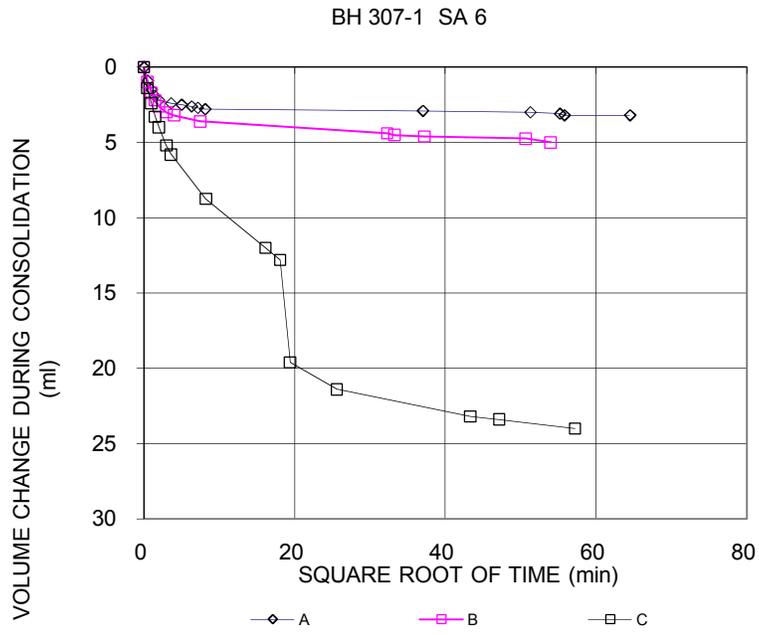
Prepared By: MM  
Checked By: RO



Date: 06/17/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: MM  
Checked By: RO



Date: 06/17/2009  
Project No. 06-1111-025

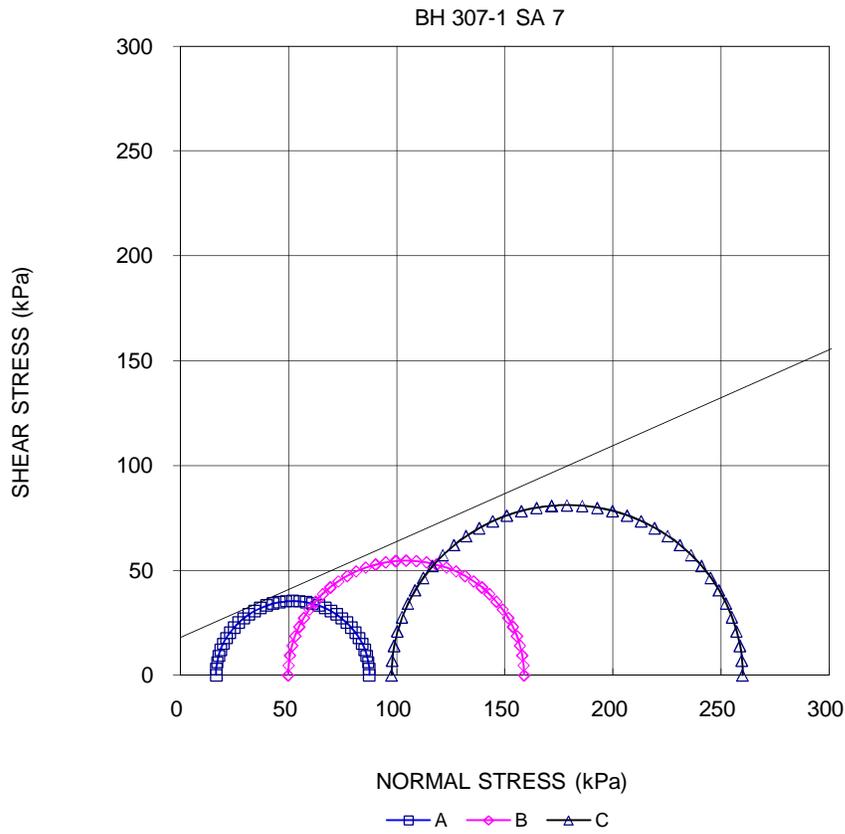
**Golder Associates**

Prepared By: MM  
Checked By: RO

**CONSOLIDATED UNDRAINED TRIAXIAL  
WITH PORE PRESSURE MEASUREMENTS**

**FIGURE D.S307-5  
Sheet 1 of 4**

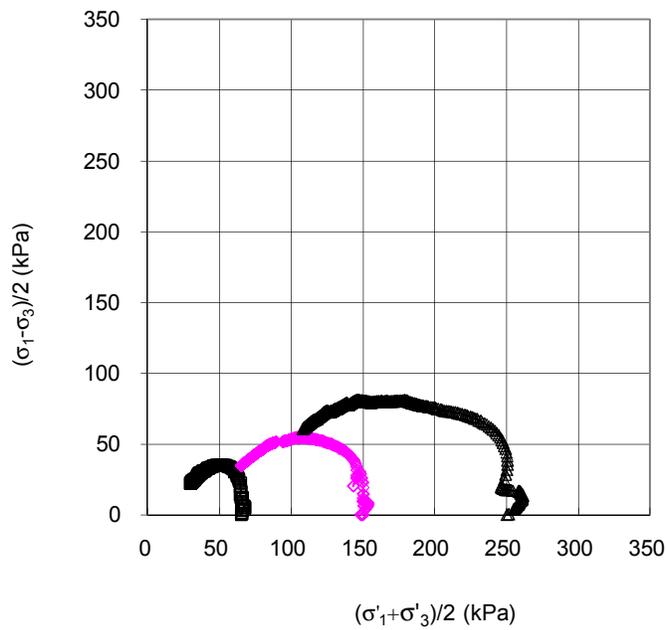
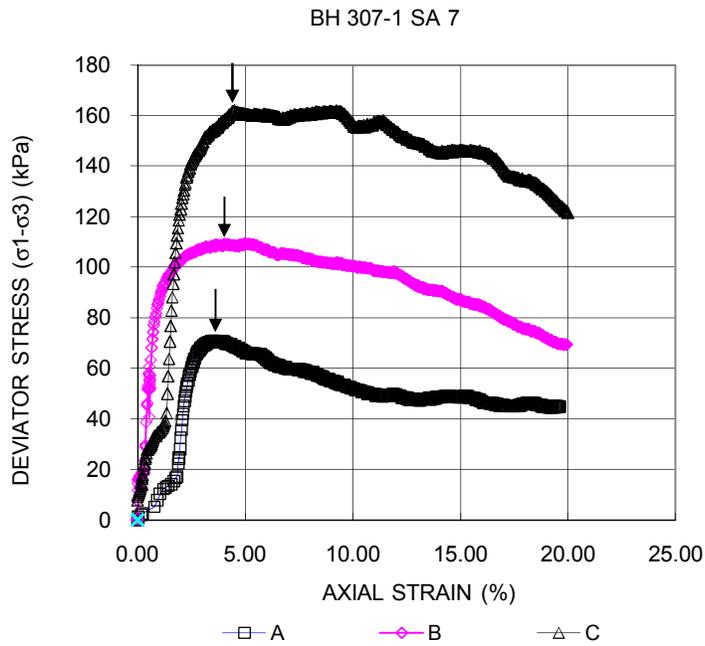
TEST STAGE	A	B	C
BOREHOLE NUMBER	307-1	307-1	307-1
SAMPLE	7	7	7
SPECIMEN DIAMETER, cm	5.00	5.02	5.03
SPECIMEN HEIGHT, cm	10.15	10.10	10.05
WATER CONTENT BEFORE CONSOLIDATION, %	75.5	81.1	71.5
CELL PRESSURE, $\sigma_3$ , kPa	550.0	565.0	385.0
BACK PRESSURE, kPa	485.0	415.0	135.0
PORE PRESSURE PARAMETER "B"	0.92	0.96	0.96
CONSOLIDATION PRESSURE, $\sigma_c$ , kPa	65.0	150.0	250.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	2.5	12.8	28.6
WATER CONTENT AFTER CONSOLIDATION, %	72.7	66.5	40.5
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, DAYS	2	2	2
WATER CONTENT AFTER TEST, %	71.5	63.7	49.9
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$ , kPa	70.8	109.2	162.3
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ MAXIMUM, %	3.4	5.0	4.5
MAX EFFECTIVE PRINCIPAL STRESS RATIO, $(\sigma_1 / \sigma_3)$ MAXIMUM	10.2	3.9	3.9
DEVIATOR STRESS AT $(\sigma_1 / \sigma_3)$ MAXIMUM, kPa	59.4	98.2	145.8
AXIAL STRAIN AT $(\sigma_1 / \sigma_3)$ MAXIMUM, %	7.6	11.9	15.7
PORE PRESSURE PARAMETER, Af, at $(\sigma_1 - \sigma_3)$ MAXIMUM	0.68	0.92	0.94
PORE PRESSURE PARAMETER, Af, at $(\sigma_1 / \sigma_3)$ MAXIMUM	0.99	1.18	1.36
NATURAL WATER CONTENT, %	71.4	76.2	70.2
DRY DENSITY, Mg/m <sup>3</sup>	0.91	0.88	0.93
FILTER DRAINS USED, y/n	y	y	y
TEST NOTES:			
CHANGED RATE OF STRAIN, %/hr	-	-	-
AXIAL STRAIN WHERE RATE OF STRAIN WAS CHANGED, %	-	-	-
FAILURE PLANE NUMBER	1.0	1.0	1.0
ANGLE OF FAILURE, DEGREES	70 <sup>0</sup>	65 <sup>0</sup>	70 <sup>0</sup>
Date: 07/13/2009			Prepared By: LH
Project No. 06-1111-025	<b>Golder Associates</b>		Checked By: MM

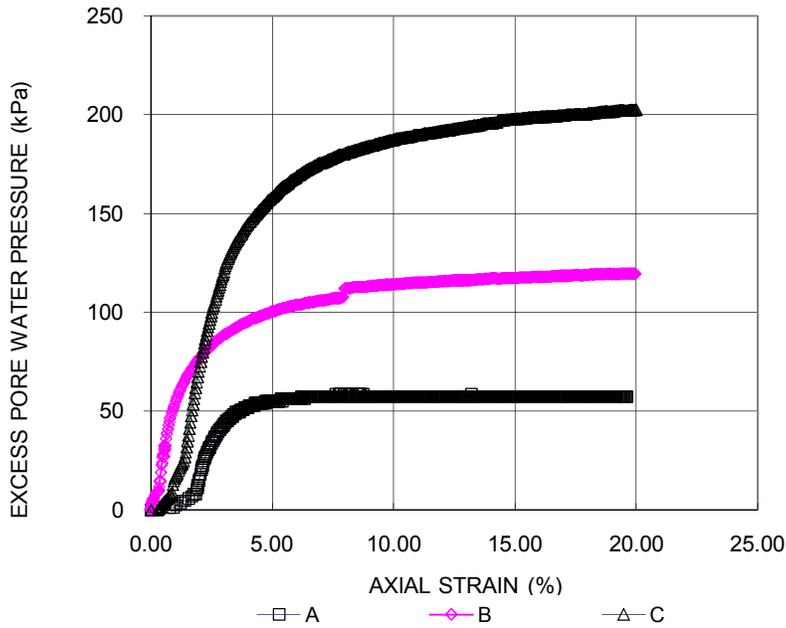
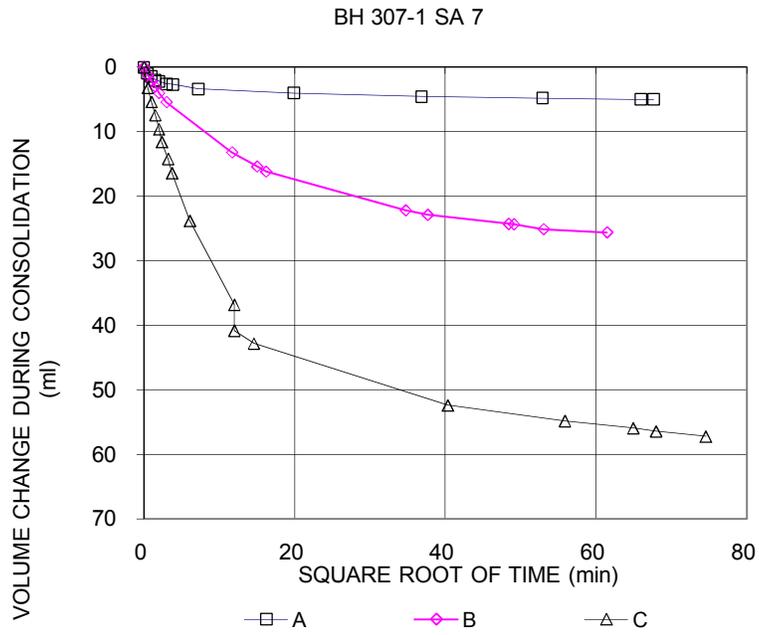


Date: 07/13/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: LH  
Checked By: MM





Date: 07/13/2009  
Project No. 06-1111-025

**Golder Associates**

Prepared By: LH  
Checked By: MM



# **APPENDIX E**

**Highway 69 SBL – STA 13+160 to 13+450 (Swamp 310 SBL)**

PROJECT <u>06-1111-025</u>	<b>RECORD OF BOREHOLE No 310-1</b>	1 OF 1 <b>METRIC</b>
G.W.P. <u>5203-06-00</u>	LOCATION <u>N 5089349.4 ; E 220782.8</u>	ORIGINATED BY <u>MWK</u>
DIST <u>                    </u> HWY <u>69</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>MWK</u>
DATUM <u>Geodetic</u>	DATE <u>March 17, 2009</u>	CHECKED BY <u>VA</u>

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
194.6	GROUND SURFACE															
0.0	PEAT (Fibrous) Very soft Dark brown Wet															
192.5			1	AS	WH									820.2		OC = 90.3%
2.1	CLAY, trace silt, containing organics Very soft Grey Wet															
			2	SS	WH									106		
			3	TO	PH									97.3		
			4	TO	PH									73		
187.3	END OF BOREHOLE AUGER REFUSAL															
7.3	NOTES:  1. Water level in open borehole at ground surface (Elev. 194.6 m) upon completion of drilling.  2. An additional borehole was drilled adjacent to Borehole 310-1 to obtain a Shelby tube sample between depths of 5.2 m and 5.8 m.															

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

PROJECT <u>06-1111-025</u>	<b>RECORD OF BOREHOLE No 310-2</b>	1 OF 1 <b>METRIC</b>
G.W.P. <u>5203-06-00</u>	LOCATION <u>N 5089449.9 ; E 220792.8</u>	ORIGINATED BY <u>MWK</u>
DIST <u>                    </u> HWY <u>69</u>	BOREHOLE TYPE <u>108 mm I.D. Continuous Flight Hollow Stem Augers</u>	COMPILED BY <u>MWK</u>
DATUM <u>Geodetic</u>	DATE <u>March 17, 2009</u>	CHECKED BY <u>VA</u>

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20 40 60 80 100	○ UNCONFINED	+	FIELD VANE							
						20 40 60 80 100	● QUICK TRIAXIAL	×	REMOULDED							
							WATER CONTENT (%)									
							20 40 60 80 100				10 20 30					
194.6 0.0	GROUND SURFACE PEAT (Fibrous) Very soft Black Wet															
			1	SS	WH											
191.6 3.1	PEAT (Amorphous) Very soft Brown Wet		2	SS	WH									573.4		OC = 42.4%
			3	SS	WH											
189.7 4.9	CLAY, trace silt Very soft Grey Wet		4	TO	PH											
			5	TO	PH									89.9		
			6	TO	PH									68.8		
			7	TO	PH									78.8		
186.1 8.5	CLAYEY SILT Firm Grey Wet		8	SS	5											
184.7 9.9	END OF BOREHOLE AUGER REFUSAL  NOTE: 1. Water level in open borehole at ground surface (Elev. 194.6 m) upon completion of drilling.															

GTA-MTO 001 06-1111-025.GPJ GAL-MISS.GDT 1/27/12 SAC

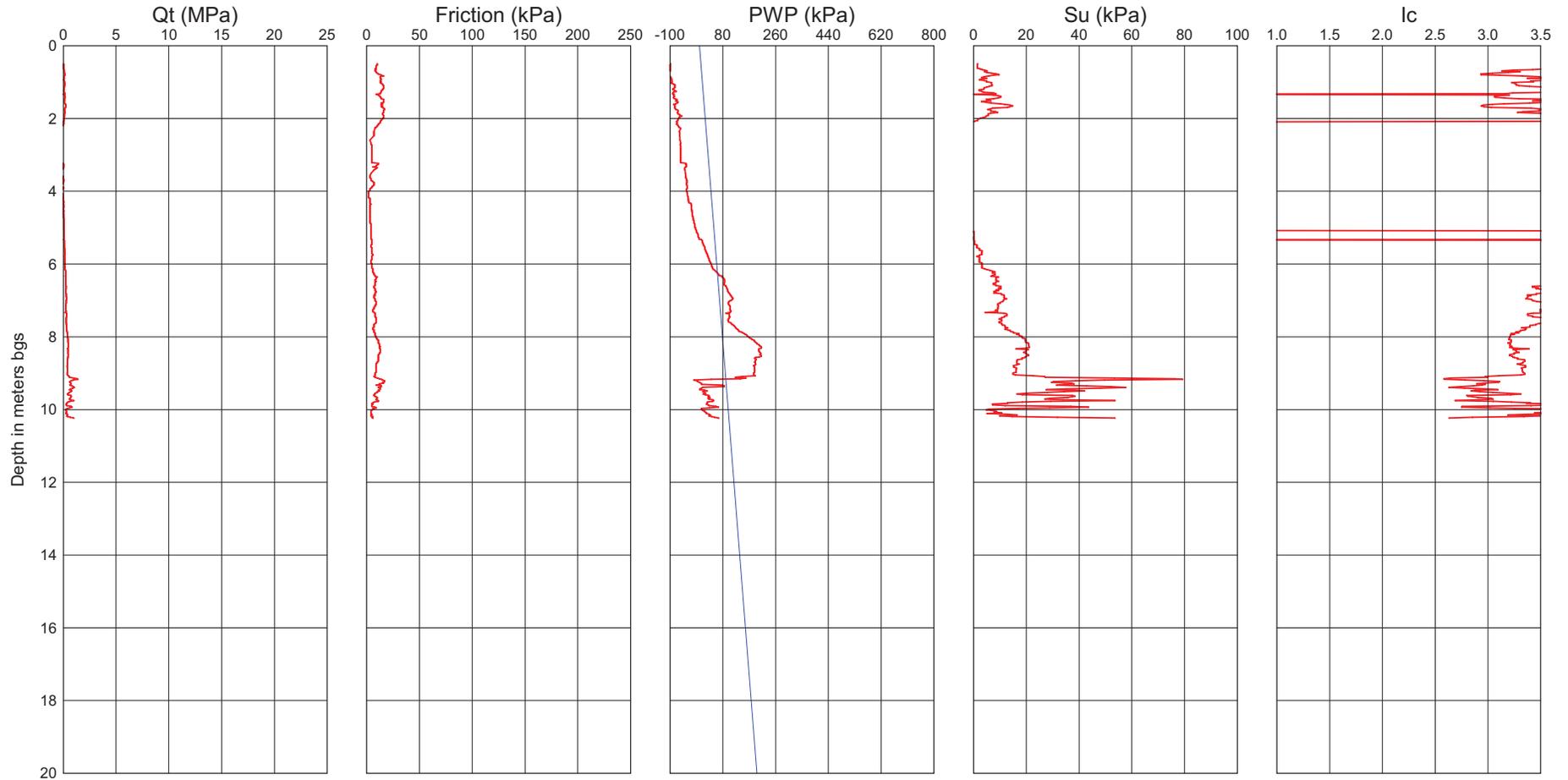
+<sup>3</sup>, ×<sup>3</sup>: Numbers refer to Sensitivity      ○ 3% STRAIN AT FAILURE

# Cone Penetration Test - CPT310-1

Test Date : March 16, 2009  
 Location : Highway 69 - STA 13+377 o/s 39 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 194.60  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$Su = (Qt - \text{Sigma}V) / Nk$   
 $Nk = 15.5$   
 $\text{Gamma} = 16 \text{ kN/m}^3$

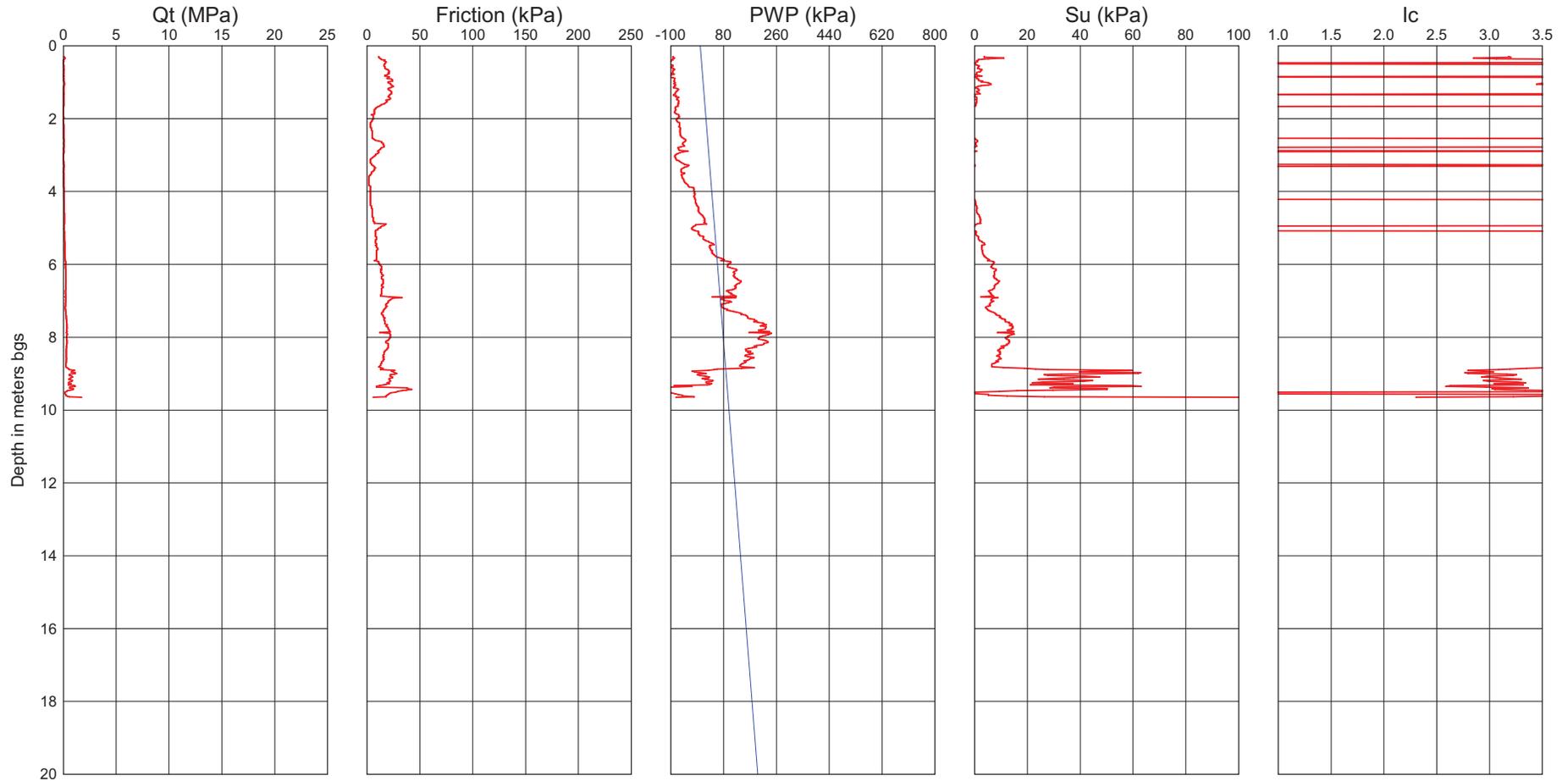
After Robertson and (Fear) Wride (1998)  
 $Ic < 1.31$  - Gravelly sands  
 $1.31 < Ic < 2.05$  - Clean to silty sand  
 $2.05 < Ic < 2.60$  - Silty sand to sandy silt  
 $2.60 < Ic < 2.95$  - Clayey silt to silty clay  
 $2.95 < Ic < 3.60$  - Clays

# Cone Penetration Test - CPT310-2

Test Date : March 16, 2009  
 Location : Highway 69 - STA 13+377 o/s 38 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 194.60  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

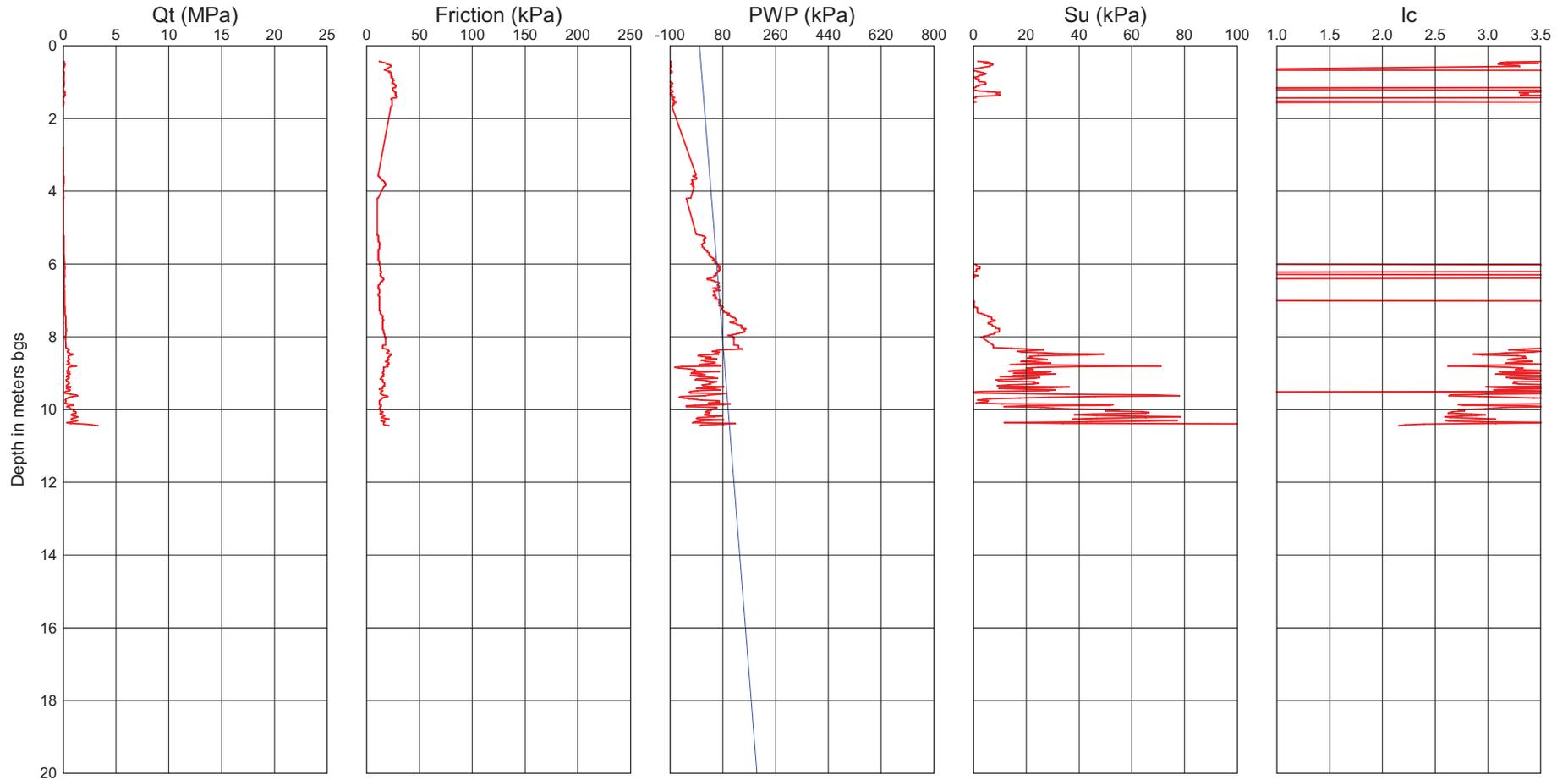
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT310-3

Test Date : March 16, 2009  
 Location : Highway 69 - STA 13+275 o/s 39 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 194.60  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

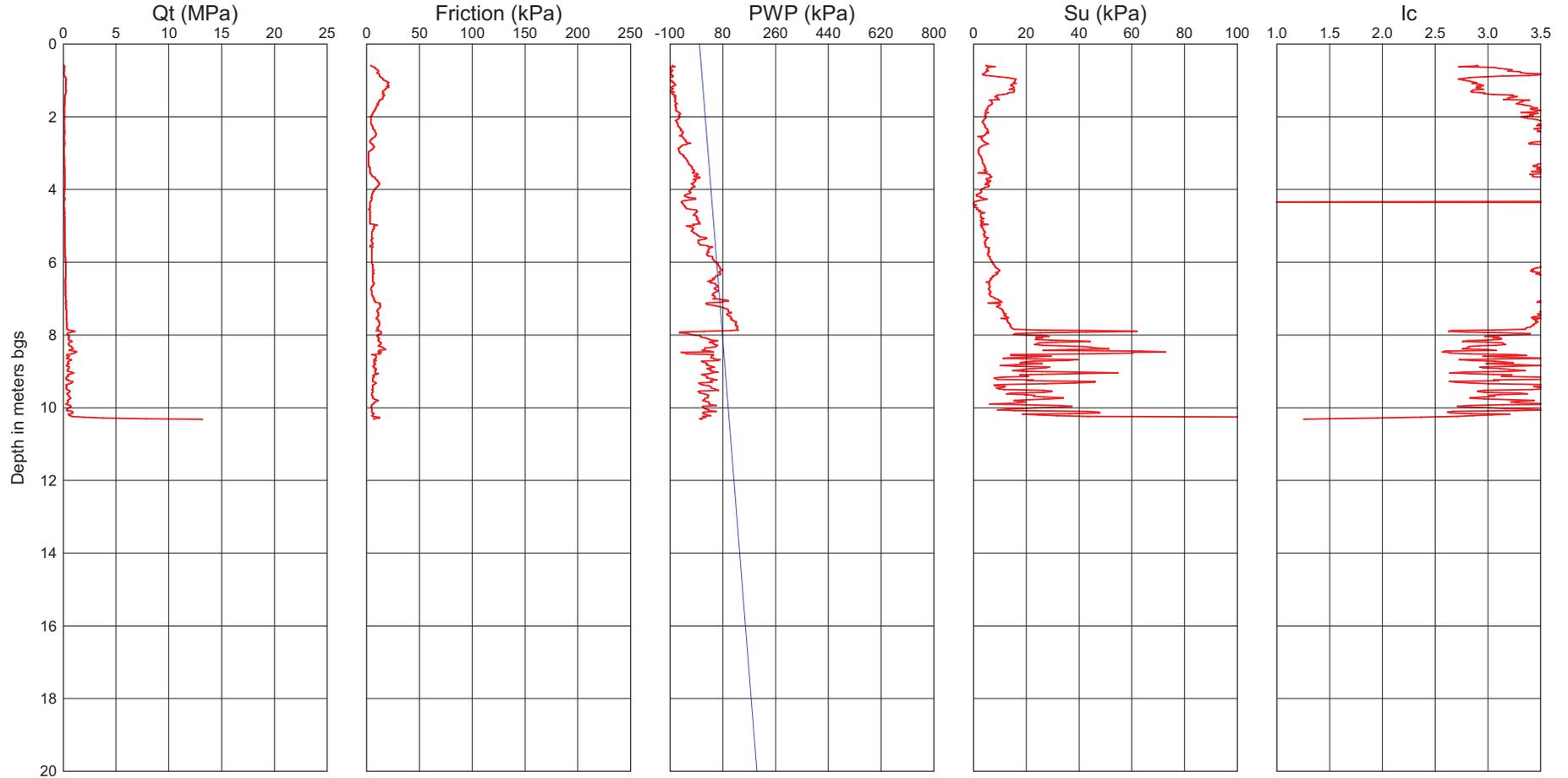
After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

# Cone Penetration Test - CPT310-4

Test Date : March 16, 2009  
 Location : Highway 69 - STA 13+275 o/s 38 m Left

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 194.60  
 Water Table Depth : 0.00



Qt normalized for  
 unequal end area effects

$S_u = (Q_t - \sigma_v) / N_k$   
 $N_k = 15.5$   
 $\gamma = 16 \text{ kN/m}^3$

After Robertson and (Fear) Wride (1998)  
 $I_c < 1.31$  - Gravelly sands  
 $1.31 < I_c < 2.05$  - Clean to silty sand  
 $2.05 < I_c < 2.60$  - Silty sand to sandy silt  
 $2.60 < I_c < 2.95$  - Clayey silt to silty clay  
 $2.95 < I_c < 3.60$  - Clays

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

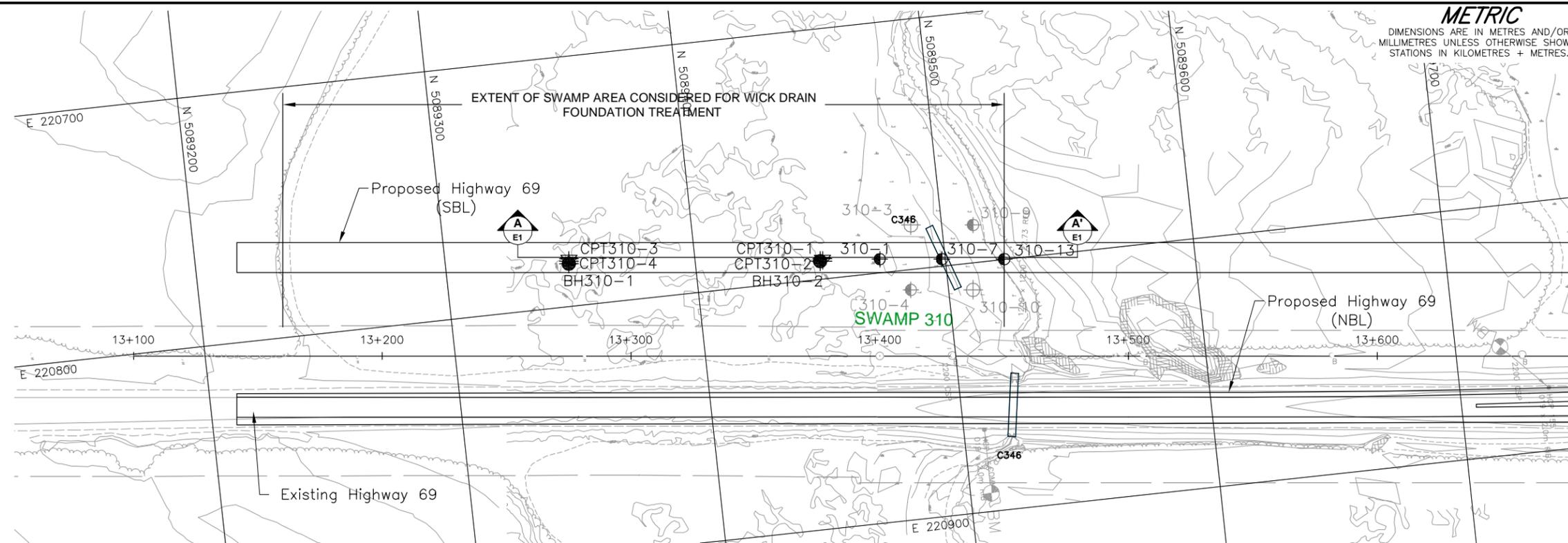
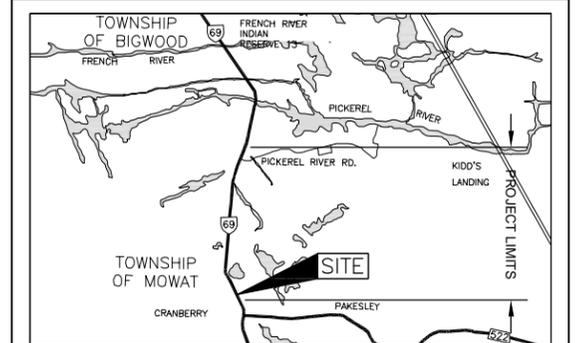
CONT No. GWP No. 5203-06-00



HIGHWAY 69 (SBL)  
STA 13+160 TO 13+450  
BOREHOLE LOCATION AND SOIL STRATA



**Golder Associates Ltd.**  
MISSISSAUGA, ONTARIO, CANADA



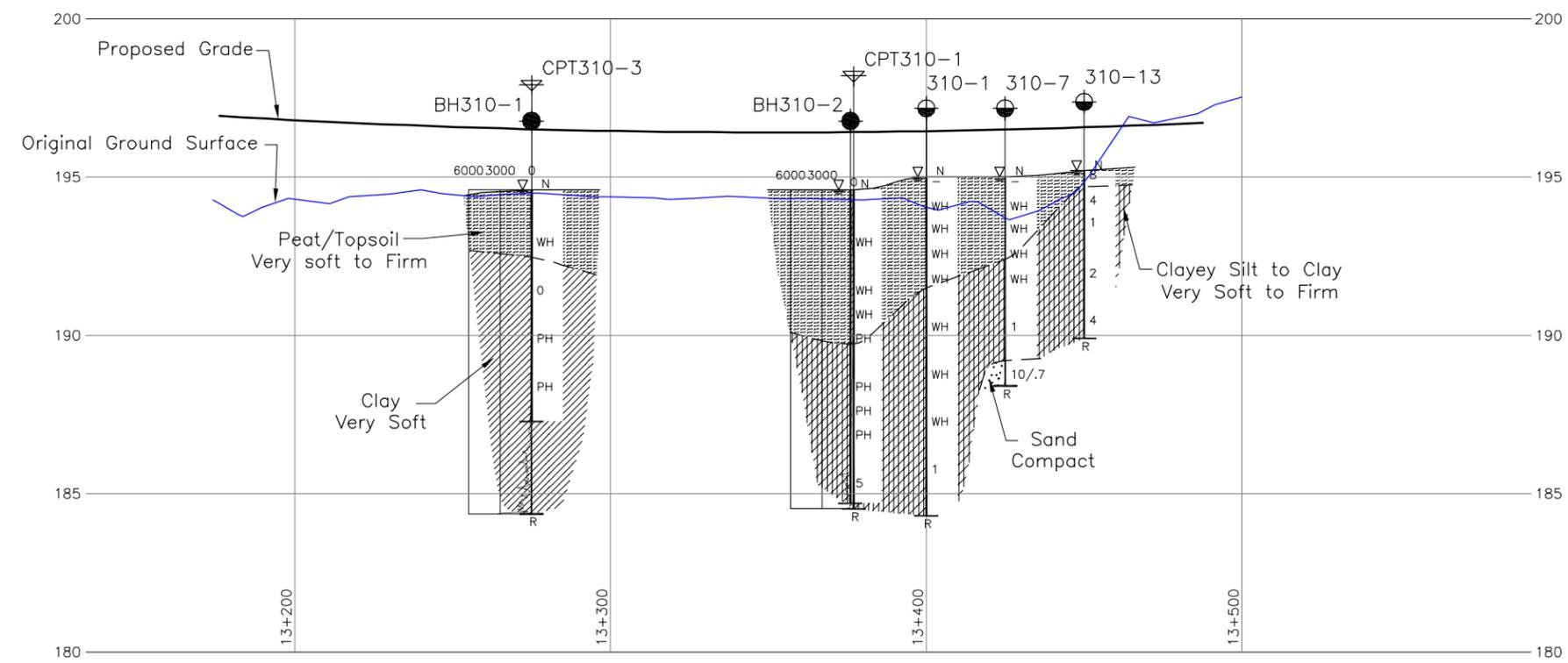
**PLAN**  
SCALE  
0 20 40 m

**KEY PLAN**  
SCALE  
0 800 800 m

**LEGEND**

- Borehole - Current Investigation
- ▽ CPT - Current Investigation
- ⊕ Borehole - Previous Investigation (Peto MacCallum Ltd.)
- ⊕ Dynamic Cone Penetration Test - Previous Investigation (Peto MacCallum Ltd.)
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 j/blow)
- ▽ WL observed during or upon completion of drilling
- R Refusal

No.	ELEVATION	CO-ORDINATES	
		NORTHING	EASTING
BH310-1	194.6	5089349.4	220782.8
BH310-2	194.6	5089449.9	220792.8
CPT310-1	194.6	5089451.0	220791.9
CPT310-2	194.6	5089450.9	220792.9
CPT310-3	194.6	5089349.6	220780.9
CPT310-4	194.6	5089349.5	220781.9



**A-A' CENTRELINE PROFILE**  
E1  
HORIZONTAL SCALE  
0 20 40 m  
VERTICAL SCALE  
0 2 4 m

**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.

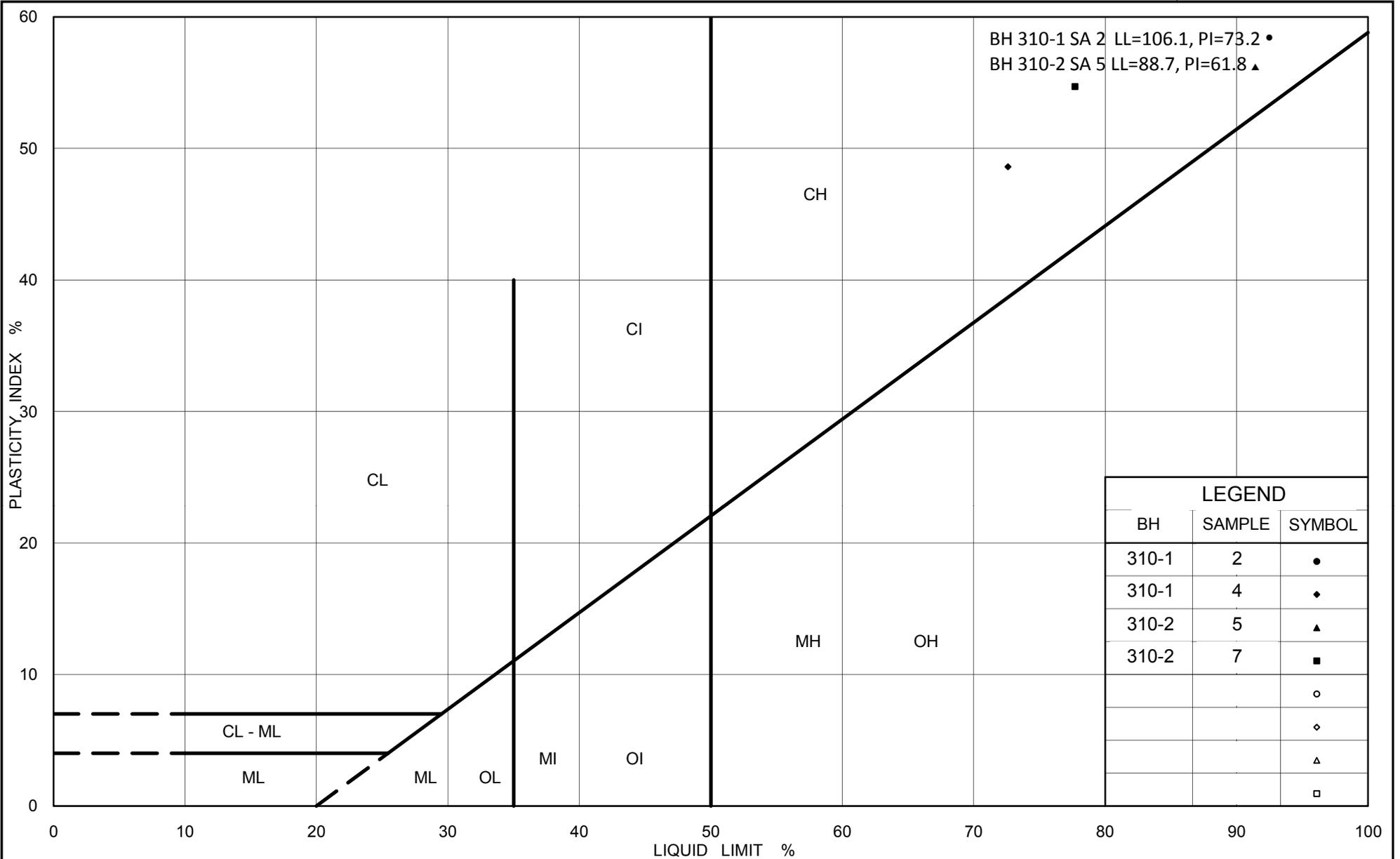
The complete foundation investigation and design report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section GC 2.01 of OPS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

**REFERENCE**

Base plans provided in digital format by MRC, drawing file no. PHASE 3 Plan 090211 - Golder.dwg, received February 11, 2009 and drawing file no. 6454 Phase 3 Mainline Plan 091110.dwg, received November 10, 2009.

NO.	DATE	BY	REVISION
Geocres No. 41H-106			
HWY. 69		PROJECT NO. 06-1111-025 DIST.	
SUBM'D. MWK	CHKD. MWK	DATE: Feb. 2012	SITE:
DRAWN: RJ	CHKD. VA	APPD. JPD/JMAC	DWG. E1





Ministry of Transportation

Ontario

**PLASTICITY CHART**  
 Clay  
 Highway 69 (SBL) STA 13+160 to 13+450

Figure No. E.S310-1

Project No. 06-1111-025

Checked By: TVA



# **APPENDIX F**

## **Investigation by Others**

**RECORD OF BOREHOLE No 302-19**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+700, o/s 19.0m Lt. CL Med. ORIGINATED BY V.M.M.  
 DIST 54 HWY 69 BOREHOLE TYPE Power Augering COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 22, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	20			40	60	80	100	20					
189.0	Top of Ice																
0.0	Ice					KL*											
0.2	Water																
188.2																	
0.8	End of borehole Refusal on probable bedrock																
	* 2007 02 22																
	∇ Water level observed during drilling																

RECORD OF BOREHOLE No 302-20 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+700, o/s 18.8m Rt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 28, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
188.9	Top of Ice															
0.0	Ice															
0.2	Peat, coarse fibrous Dark brown		1	AS	-											
187.8			2	SS	3											
1.1	Clayey silt, organics Firm Dark Moist grey		3	SS	4											
186.2																
2.7	Silty sand Loose Grey Wet		4	SS	4/15cm											
185.6																
3.3	End of borehole Refusal on probable bedrock															
	* Borehole dry upon completion of drilling															

RECORD OF BOREHOLE No 302-21 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+725, o/s 44.5m Lt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 01, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
189.0	Ground Surface																	
0.0	Peat, coarse fibrous Dark brown		1	SS	1													
188.5	Silt with sand, trace clay Loose Grey Wet		2	SS	8	188												0 24 67 9
0.5	trace gravel																	
187.0	Compact		3	SS	17													
2.0	End of borehole Refusal on probable bedrock					187												

**RECORD OF BOREHOLE No 302-23** 1 of 2 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+725, o/s 43.3m Rt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 01, 2007 CHECKED BY G.D.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
188.0	Ground Surface																	
0.0	Peat, coarse fibrous Dark brown		1	SS	28													0.5m frozen
0.1	Sandy silt, trace clay organics Compact Dark brown Wet		2	SS	15													
186.5	Mottled grey/brown																	
1.5	Sand, trace silt Compact Brown Wet		3	SS	15													
184.9	Silty sand Very loose Brown Wet		4	SS	1													
183.7	Clayey silt, varved Soft to Grey Wet firm		5	SS	1													
180.7	Silt some clay, trace sand Very loose Grey Wet to loose		6	SS	2													0 2 82 16
176.1	trace clay, sand seams		7	SS	4													
175.2	Silty sand Very loose Grey Wet		8	SS	5													
175.2	End of borehole Probable silty sand Very loose to compact		9	SS	1													
12.8																		

Cont'd

**RECORD OF BOREHOLE No 302-23 2 of 2 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+725, o/s 43.3m Rt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 01, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
173.0																	
172.0																	
16.0	End of dynamic cone penetration test Refusal on probable bedrock Samples 6 to 9 : 'N' - values affected by hydraulic disturbance  * 2007 03 01  ▽ Water level observed during drilling  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																





**RECORD OF BOREHOLE No 302-25      2 of 2      METRIC**

G.W.P. 5203-06-00      LOCATION Hwy 69 (New), Sta. 17+750, o/s 18.8m Rt. CL Med.      ORIGINATED BY T.X.  
 DIST 54      HWY 69      BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test      COMPILED BY N.S.B.  
 DATUM Geodetic      DATE March 02, 2007      CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
173.5							20	40	60	80	100						
173.3																	
15.2	End of dynamic cone penetration test Refusal on probable bedrock  *    2007   03   02  ▽    Water level observed during drilling ▼    Water level measured after drilling  WH** Denotes penetration due to weight of hammer and rods  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																



**RECORD OF BOREHOLE No 302-27 2 of 2 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+775 CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 03, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
174.0	Probable silt Very loose to loose																	
172.8							173											
16.2	End of dynamic cone penetration test Refusal on probable bedrock																	
	* 2007 03 03																	
	▽ Water level observed during drilling																	
	▼ Water level measured after drilling																	
	WH** Denotes penetration due to weight of hammer and rods																	
	C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																	

RECORD OF BOREHOLE No 302-29 1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+800, o/s 18.8m Lt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 04, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									WATER CONTENT (%)	
						20	40	60	80	100	20	40	60		GR SA SI CL			
189.0	Ground Surface																	
0.0	Peat, coarse fibrous	[Strat Plot]	1	SS	13													
0.1	Silt trace clay, trace sand organics and rootlets																	
	Compact Dark Moist to loose brown to wet		2	SS	4													
187.5	Sandy silt, trace clay																	
1.5	Loose Mottled Wet brown/grey		3	SS	5													
186.4	Sand trace silt, trace gravel																	
2.6	Compact Brown Wet		4	SS	19													
			5	SS	15										2	67	26	5
183.4	Silty clay, trace sand layers of clayey silt																	
5.6	Firm Grey Wet		6	SS	1													
			7	TW	-										0	1	63	36
			8	SS	WH**													
			9	SS	1													
177.9	Silt some clay, trace sand																	
11.1	Very loose Grey Wet to loose																	
			10	SS	7										0	4	85	11
	sand seams																	
174.7	End of borehole																	
14.3																		

Cont'd

RECORD OF BOREHOLE No 302-29

2 of 2

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+800, o/s 18.8m Lt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 04, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER + CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
174.0	Probable silt Loose to compact																
170.4																	
18.6	End of dynamic cone penetration test																
	* Borehole dry upon completion of drilling																
	WH** Denotes penetration due to weight of hammer and rods																
	C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																



RECORD OF BOREHOLE No 302-30 2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+800, o/s 18.8m Rt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 28 and March 01, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
173.0																
172.2			11	SS	3											
15.8	End of borehole Probable sandy silt Loose					172										
168.5						171										
19.5	End of dynamic cone penetration test					170										
	* 2007 02 28 and 2007 03 01 ▽ Water level observed during drilling					169										

RECORD OF BOREHOLE No 302-31

1 of 2

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+825, o/s 40.5m Lt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 06, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
189.5	Ground Surface															
0.0	Peat, coarse fibrous Dark brown		1	SS	7										0.5m frozen	
0.1	Silt trace sand, trace clay															
	Loose to Mottled Moist very loose grey/ brown		2	SS	3											
			3	SS	4											
186.2	Sandy silt, trace clay		4	SS	6											
3.3	Loose Grey Wet															
184.8	Silty sand		5	SS	7											
4.7	Loose Grey Wet															
183.7	Silty clay, varved		6	SS	WH**											
5.8	Firm Grey Wet															
	layers of silt		7	SS	1											
			8	SS	WH											
179.5	Clayey silt		9	SS	3											
10.0	Firm Grey Wet															
178.1	Silt some clay, trace sand		10	SS	4											
11.4	Very loose Grey Wet															
	layers of sandy silt		11	SS	5											
175.2	End of borehole															
14.3																

Cont'd

+<sup>7</sup>, X<sup>5</sup>: Numbers refer to  
Sensitivity

20  
15-O-5  
10  
(%) STRAIN AT FAILURE

RECORD OF BOREHOLE No 302-31 2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+825, o/s 40.5m Lt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 06, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
174.5	Probable silt Loose to compact																
169.7																	
19.8	End of dynamic cone penetration test																
	* Borehole dry upon completion of drilling																
	WH** Denotes penetration due to weight of hammer and rods																
	C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																



RECORD OF BOREHOLE No 302-32 2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+825 CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 19 and March 07, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						WATER CONTENT (%)	20
173.4	Probable silt Loose to compact																		
168.6	End of dynamic cone penetration test																		
19.8	Sample 11' N'- value affected by hydraulic disturbance  * 2007 03 07  ▽ Water level observed during drilling ▼ Water level measured after drilling  WH** Denotes penetration due to weight of hammer and rods  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																		

RECORD OF BOREHOLE No 302-33 1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+825, o/s 35.4m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 20, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20					
186.5	Ground Surface												
0.0	Peat, coarse fibrous Dark brown		1	AS	-								0.3m frozen
0.3	Organic clayey silt Very soft Dark Wet brown		2	SS	1						106	Org. 5.4%	
			3	SS	1						98		
183.9	Silty clay trace sand, trace gravel Stiff to Grey Wet firm		4	SS	WH								
2.6				FV									
			5	SS	2								0 1 47 52
	thin layers of silt			FV									
			6	SS	1								
				FV									
	layers of silt		7	SS	1								
				FV									
			8	SS	8								
176.4	Silt trace clay, trace sand Compact Grey Wet		9	SS	11								0 5 89 6
10.1	some to with sand Loose												
			10	SS	6								0 20 77 3
173.7	End of borehole Probable silt Loose to compact												
12.8													

Cont'd

+<sup>7</sup>, X<sup>5</sup>: Numbers refer to Sensitivity  
 20  
 15—○—5 (% STRAIN AT FAILURE  
 10

RECORD OF BOREHOLE No 302-33 2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+825, o/s 35.4m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 20, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							
					20	40	60	80	100								
171.5																	
167.9																	
18.6	End of dynamic cone penetration test  Sample 11: 'N' value affected by hydraulic disturbance  * 2007 02 20  ▽ Water level observed during drilling ▼ Water level measured after drilling  WH** Denotes penetration due to weight of hammer and rods  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																

**RECORD OF BOREHOLE No 302-34** 1 of 2 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+850, o/s 18.8m Lt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 05, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100					
188.4	Ground Surface														
0.0	Peat, coarse fibrous Dark brown		1	SS	22										0.5m frozen
0.1	Sandy silt, trace clay organics, rootlets														
	Compact Dark brown Moist		2	SS	14										
	Mottled brown														
186.5			3	SS	12										
1.9	Sand, trace silt														
	Compact Brown Moist to loose														
	Grey		4	SS	6										
183.7															
4.7	Silty clay, varved		5	SS	1										
	Firm Grey Wet														
	layers of silt		6	SS	1										
				FV											
			7	SS	WH**										
				FV											
			8	SS	2										
			9	SS	1										
176.0															
12.4	Silt trace clay, trace sand		10	SS	6										
	Loose to Grey Wet very loose														
			11	SS	WH										0 7 89 4
174.1															
14.3	End of borehole														

Cont'd

**RECORD OF BOREHOLE No 302-34      2 of 2      METRIC**

G.W.P. 5203-06-00      LOCATION Hwy 69 (New), Sta. 17+850, o/s 18.8m Lt. CL Med.      ORIGINATED BY T.X.  
 DIST 54      HWY 69      BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test      COMPILED BY N.S.B.  
 DATUM Geodetic      DATE March 05, 2007      CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			'N' VALUES	SHEAR STRENGTH kPa								
							20	40	60	80	100					
173.4	Probable silt Very loose to compact						20	40	60	80	100					
168.6	End of dynamic cone penetration test															
19.8	Sample 11: 'N' - value affected by hydraulic disturbance															
	*    2007 03 05															
	∇    Water level observed during drilling															
	▼    Water level measured after drilling															
	■    Penetrometer test															
	WH** Denotes penetration due to weight of hammer and rods															
	C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers															

RECORD OF BOREHOLE No 302-35 1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+850, o/s 18.8m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 19, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		GR SA SI CL	
186.5	Ground Surface															
0.0	Peat, coarse fibrous Dark brown		1	AS	-											0.2m frozen
0.3	Organic silty clay trace sand		2	SS	1											
	Soft Dark brown Wet															
	roots		3	SS	21											
184.3	Clayey silt, trace sand															
2.2	Stiff to Grey Wet firm		4	SS	3											
			5	SS	4											
				FV												
	thin layers of silt															
			6	SS	5											
				FV												
			7	SS	3											
				FV												
			8	SS	1											
				FV												
			9	SS	5											
176.6	Silt trace clay, trace sand															
9.9	Loose to Grey Wet very loose		10	SS	7											0 5 86 9
	some sand															
			11	SS	WR**											0 20 78 2
173.7	End of borehole															
12.8	Probable silt															
	Very loose to loose															

Cont'd

RECORD OF BOREHOLE No 302-35 2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+850, o/s 18.8m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 19, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
171.5																	
170.0																	
16.5	End of dynamic cone penetration test Refusal on probable bedrock  * 2007 02 19 ▽ Water level observed during drilling ▼ Water level measured after drilling WR** Denotes penetration due to weight of rods only C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																

RECORD OF BOREHOLE No 302-37 1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+875 CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 19, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		
186.5	Ground Surface														
0.0	Peat, coarse fibrous Dark brown		1	SS	10									Org. 94.8%	
185.4			2	SS	WH**										
1.1	Silt, some clay sand seams Very loose Grey Wet		3	SS	2						H				0 19 70 11
183.6			4	SS	1										
2.9	Silty clay, trace sand thin layers of clayey silt Firm Grey Wet			FV			5								
			5	SS	WH										0 1 59 40
				FV			5								
	layers of sandy silt		6	SS	1										
			7	SS	WH										
177.3			8	SS	4										0 1 90 9
9.2	Silt trace clay, trace sand Loose Grey Wet		9	SS	6										
	sand seams														
174.7			10	SS	WH										0 63 36 1
11.8	Silty sand, trace clay Very loose Grey Wet														
173.7															
12.8	End of borehole Probable silty sand Very loose to compact														

Cont'd

+<sup>7</sup>, X<sup>5</sup>: Numbers refer to Sensitivity  
 20  
 15—○—5 (% STRAIN AT FAILURE)  
 10

RECORD OF BOREHOLE No 302-37

2 of 2

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+875 CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 19, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa												
171.5					○ UNCONFINED	+	FIELD VANE				WATER CONTENT (%)						
					● QUICK TRIAXIAL	×	LAB VANE	20	40	60	80	100	20	40	60		
168.2																	
18.3	End of dynamic cone penetration test  Sample 10: 'N'- value affected by hydraulic disturbance  * 2007 02 19  ▽ Water level observed during drilling  ▼ Water level measured after drilling  WH** Denotes penetration due to weight of hammer and rods  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																

RECORD OF BOREHOLE No 302-39 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+900, o/s 18.8m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 18, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		GR SA SI CL
186.5	Ground Surface														
0.0	Peat, coarse fibrous Dark brown		1	AS	-										0.2m frozen
0.3	Clayey silt, trace sand sandy silt layers														
185.6	Firm Grey Wet Sand and silt trace clay		2	SS	4										
0.9	Loose to Grey Wet compact		3	SS	11										0 53 44 3
184.2	Silty clay, trace sand Stiff to Grey Wet firm		4	SS	2										
2.3				FV											
			5	SS	3										0 1 62 37
				FV											
	thin layers of silt		6	SS	2										
				FV											
			7	SS	1										
				FV											
177.7	Silt some clay, trace sand thin layers of clayey silt		8	SS	5										0 1 86 13
8.8	Loose Grey Wet														
175.2	Sand and silt, trace clay Loose Grey Wet		9	SS	7										
11.3															
173.7			10	SS	6										0 50 48 2
12.8	End of borehole														
	* 2007 02 18														
	∇ Water level observed during drilling														
	▼ Water level measured after drilling														

RECORD OF BOREHOLE No 302-40 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+900, o/s 18.8m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 19, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20	40
186.5	Ground Surface																		
0.0	Peat, coarse fibrous		1	AS	-													0.5m frozen	
	fine fibrous																		
	amorphous			2	SS	WH**								135					Org. 10.2%
184.4	Silty clay, trace sand		3	SS	WH														
2.1	Soft to Grey Wet firm			4	SS	WH													
				5	SS	1													0 1 43 56
					FV														
				6	SS	WH													
					FV														
	thin layers of silt			7	SS	1													
					FV														
				8	SS	4													
					FV														
177.7	Silt trace clay, trace sand thin layers of clayey silt		9	SS	6													0 3 90 7	
8.8	Loose to Grey Wet compact			10	SS	18													
175.1	End of borehole																		
11.4	Refusal on probable bedrock																		



**RECORD OF BOREHOLE No 302-41      2 of 2      METRIC**

G.W.P. 5203-06-00      LOCATION Hwy 69 (New), Sta. 17+925, o/s 34.8m Lt. CL Med.      ORIGINATED BY F.P.  
 DIST 54      HWY 69      BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test      COMPILED BY N.S.B.  
 DATUM Geodetic      DATE February 18, 2007      CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
171.7																
169.5																
17.2	End of dynamic cone penetration test Refusal on probable bedrock  *    2007   02   18  ▽    Water level observed during drilling ▼    Water level measured after drilling  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers															

RECORD OF BOREHOLE No 302-43

1 of 1

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+925, o/s 34.8m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 17, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
186.5	Ground Surface															
0.0	Peat, coarse fibrous Dark brown		1	AS	-											
0.2	Organic silt															
	Very loose Dark Wet brown		2	SS	WH**											
184.4			3	SS	WH											
184.4	Silty clay															
2.1	Soft to firm Brown Wet															
			4	SS	1											
			5	SS	WH											
180.4	Silt, trace clay thin layers of clayey silt		6	SS	3											
6.1	Very loose Grey Wet to loose															
	layers of silty sand															
	Compact		7	SS	17											
178.0																
8.5	End of borehole Refusal on probable bedrock															

RECORD OF BOREHOLE No 302-44 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+950, o/s 18.8m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 17, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		'N' VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100					
186.5	Ground Surface														
0.0	Peat, coarse fibrous Dark brown		1	AS	-										0.3m frozen
0.3	Organic silt, trace clay														
	Very loose Dark Wet brown		2	SS	WH**								108		
	thin layers of silty sand														
			3	SS	WH								128		
184.4	Clayey silt, trace sand														
2.1	Firm Grey Wet														
			4	SS	1										
	thin layers of silt														
			5	TW	PM										0 1 72 27
			6	TW	PH										
			7	SS	6										
178.9	Silt trace clay, trace sand		8	SS	6										0 6 84 10
7.6	Loose Grey Wet														
177.8	Sandy silt, trace clay														
8.7	Very loose Grey Wet														
176.8	End of borehole		9	SS	WR										0 32 66 2
9.7	Probable sandy silt														
	Very loose to loose														
174.8	End of dynamic cone penetration test														
11.7	Refusal on probable bedrock									120/20cm					
	* 2007 02 17														
	∇ Water level observed during drilling														
	▼ Water level measured after drilling														
	WH** Denotes penetration due to weight of hammer and rods														
	WR Denotes penetration due to weight of rods only														
	C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers														

RECORD OF BOREHOLE No 302-45 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+950, o/s 18.8m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 16, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
186.5	Ground Surface																	
0.0	Peat, fine fibrous Dark brown		1	AS	-													
0.3	Organic silty clay																	
185.9																		
0.6	Silty clay, trace sand Soft Grey Wet		2	SS	WH**													0 4 53 43
			3	SS	WH													
	thin layers of silt				FV													
			4	SS	1													
	layered with silt				FV													
	Firm		5	SS	4													
180.7	Sandy silt, trace clay Very loose Grey Wet		6	SS	WR													0 37 59 4
179.8	End of borehole Probable sandy silt																	
6.7	Very loose to compact																	
178.7	End of dynamic cone penetration test Refusal on probable bedrock																	
7.8	Sample 6: 'N'- value affected by hydraulic disturbance  * 2007 02 16  ▽ Water level observed during drilling ▼ Water level measured after drilling  WH** Denotes penetration due to weight of hammer and rods WR Denotes penetration due to weight of rods  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																	





RECORD OF BOREHOLE No 302-49 2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+000, o/s 18.8m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 14, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							
					○ UNCONFINED	+	FIELD VANE										
					● QUICK TRIAXIAL	×	LAB VANE	20	40	60	80	100	20	40	60		
171.5																	
167.7																	
18.8	End of dynamic cone penetration test Refusal on probable bedrock  * 2007 02 14 ▽ Water level observed during drilling ▼ Water level measured after drilling WH** Denotes penetration due to weight of hammer and rods  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																



RECORD OF BOREHOLE No 302-51 1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+025, o/s 34.0m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 16, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		GR SA SI CL	
186.5	Ground Surface															
0.0	Peat, coarse fibrous Dark brown		1	SS	5											
0.3	Clayey silt, trace sand layers of silty sand															
185.6	Firm Mottled Moist grey/brown		2	SS	7											
0.9	Silty sand															
	Loose to Grey Wet compact		3	SS	13											
184.1	Clayey silt, trace sand															
2.4	Firm Grey Wet															
			4	SS	2											
				FV												
			5	SS	1											
				FV												
	thin layers of silt															
			6	SS	2											
				FV												
			7	SS	5											
				FV												
177.7	Silt trace sand, trace clay															
8.8	Loose to Grey Wet very loose		8	SS	7										0 6 85 9	
			9	SS	WR**											
175.2	End of borehole															
11.3	Probable silt															
	Loose to compact															

Cont'd

RECORD OF BOREHOLE No 302-51 2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+025, o/s 34.0m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 16, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT	PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	ELEVATION SCALE							
171.5							20 40 60 80 100					
166.7							20 40 60 80 100					
19.8	End of dynamic cone penetration test  Sample 9: 'N'- value affected by hydraulic disturbance  * 2007 02 16  ∇ Water level observed during drilling ▼ Water level measured after drilling  WR** Denotes penetration due to weight of rods  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers											

RECORD OF BOREHOLE No 302-53 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+025, o/s 34.1m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 13, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		GR SA SI CL	
186.5	Ground Surface															
0.0	Peat, fine fibrous Dark brown		1	AS	-										0.5m frozen	
185.9																
0.6	Clayey silt, organics Soft to Grey Wet firm		2	SS	WH**											
			3	SS	1											
				FV												
	thin layers of silt		4	SS	WH											
				FV												
			5	SS	WH											
				FV												
180.7																
5.8	Silt trace clay, trace sand thin layers of clayey silt Loose Grey Wet		6	SS	4											
			7	SS	5											
178.0																
8.5	Sand, with silt Very loose Grey Wet		8	SS	WH											
176.8																
9.7	End of borehole Probable sand Very loose to compact															
173.8																
12.7	End of dynamic cone penetration test * 2007 02 13 ▽ Water level observed during drilling ▽ Water level measured after drilling WH** Denotes penetration due to weight of hammer and rods C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers														Refusal on probable bedrock  Sample 8: "N"- value affected by hydraulic disturbance	

RECORD OF BOREHOLE No 302-54 1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+050, o/s 18.8m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 14, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
186.5	Ground Surface															
0.0	Peat, fine fibrous Dark brown		1	AS	-											
186.0	Organic silt Very loose Dark Wet grey															
0.5																
185.6	Clayey silt, trace sand Firm Grey Wet		2	SS	WH**											
0.9																
			3	SS	WH											
	thin layers of silt		4	SS	WH											
	thin layers of silt		5	SS	WH											
			6	SS	1											
179.2	Silt trace clay, trace sand thin layers of sandy silt		7	SS	7											
7.3																
			8	SS	7											
176.8	End of borehole Probable silt Loose to compact															
9.7																

Cont'd

RECORD OF BOREHOLE No 302-54 2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+050, o/s 18.8m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 14, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							
					20	40	60	80	100	20	40	60					
171.5																	
167.3																	
19.2	End of dynamic cone penetration test  * 2007 02 14  ▽ Water level observed during drilling ▼ Water level measured after drilling  WH** Denotes penetration due to weight of hammer and rods  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																



RECORD OF BOREHOLE No 302-55 2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+050, o/s 18.8m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 13, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							
171.5							20	40	60	80	100						
167.3																	
19.2	End of dynamic cone penetration test Sample 8: 'N' - value affected by hydraulic disturbance  * 2007 02 13  ▽ Water level observed during drilling ▼ Water level measured after drilling  WH** Denotes penetration due to weight of hammer and rods  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																



RECORD OF BOREHOLE No 302-57

2 of 2

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+075 CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 15, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	20			40	60	80	100						
171.5																	
169.7																	
16.8	End of dynamic cone penetration test  Sample 9: 'N'- value affected by hydraulic disturbance  * 2007 02 15  ▽ Water level observed during drilling ▼ Water level measured after drilling  WH** Denotes penetration due to weight of hammer and rods WR*** Denotes penetration due to weight of rods only  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																





**RECORD OF BOREHOLE No 302-60 2 of 2 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+100, o/s 18.8m Rt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 17, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
171.5																	
171.3																	
15.2	End of dynamic cone penetration test  Sample 8: 'N'- value affected by hydraulic disturbance  * 2007 02 17  ▽ Water level observed during drilling  WH** Denotes penetration due to weight of hammer and rods WR*** Denotes penetration due to weight of rods only  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																



**RECORD OF BOREHOLE No 302-63**

2 of 2

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+125, o/s 44.5m Rt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 18, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	20			40	60	80	100	20					
171.5	* 2007 02 18  ▽ Water level observed during drilling ▼ Water level measured after drilling  WH** Denotes penetration due to weight of hammer and rods WR Denotes penetration due to weight of rods  C.F.H.S.A. - Denotes Continuous Flight Hollow Stem Augers																



RECORD OF BOREHOLE No 302-65 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+150, o/s 18.8m Rt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A. and Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 20, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60			
186.5	Top of Ice															
0.0	Ice and snow															
0.2	Peat, fine fibrous	[Strat Plot]	1	AS	-											
0.3	Dark brown Organic silty clay															
185.0	Very soft Dark grey Wet grey		2	SS	WH**									Org. 5.5%	0 3 64 33	
185.0	Clayey silt, trace sand		3	SS	WH											
1.5	Firm Grey Wet															
	layers of silt			FV												
			4	SS	2											
				FV												
			5	SS	4											
181.4	Silt, trace clay															
5.1	Loose to Grey Wet compact															
			6	SS	22											
179.3	Sand and silt, trace clay															
7.2	Very loose Grey Wet															
178.3	End of borehole															
8.2	Probable sand and silt															
	Loose to compact															
174.3	End of dynamic cone penetration test															
12.2																

Sample 7: 'N'- value affected by hydraulic disturbance

RECORD OF PENETRATION TEST No 302-22

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+725 CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 01, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
189.0 0.0	Ground Surface Probable peat Probable silt/silty sand Loose to compact  Probable clayey silt Firm to stiff  Probable silt compact															
179.7 9.3	End of dynamic cone penetration test Refusal on probable bedrock															120/15cm

RECORD OF PENETRATION TEST No 302-26

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+775, o/s 34.1m Lt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 03, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
189.0 0.0	Ground Surface Probable peat Probable silt/silty sand Very loose to compact						20	40	60	80	100					
	Probable clayey silt Firm to stiff						188									
	Probable silt/silty sand Compact						187									
							186									
							185									
							184									
							183									
							182									
180.8 8.2	End of dynamic cone penetration test Refusal on probable bedrock						181									



RECORD OF PENETRATION TEST No 302-28

2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+775, o/s 34.1m Rt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 03, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
173.2	Probable silt/ silty sand Compact						20	40	60	80	100					
							20	40	60	80	100					
168.4	End of dynamic cone penetration test															
19.8																

RECORD OF PENETRATION TEST No 302-36

1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+875, o/s 34.1m Lt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 04, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
188.5 0.0	Ground Surface Probable peat						20 40 60 80 100						GR SA SI CL
	probable sandy silt/sand Loose to compact						20 40 60 80 100						
	Probable clayey silt Firm						20 40 60 80 100						
	Probable silt Compact						20 40 60 80 100						
	Cont'd						20 40 60 80 100						

**RECORD OF PENETRATION TEST No 302-36**

2 of 2 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+875, o/s 34.1m Lt. CL Med. ORIGINATED BY T.X.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 04, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	20			40	60	80	100						
173.5	Probable silt Compact																
168.7 19.8	End of dynamic cone penetration test																

RECORD OF PENETRATION TEST No 302-38

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+875, o/s 35.4m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 19, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
186.5 0.0	Ground Surface Probable peat						20	40	60	80	100	20	40	60	kN/m <sup>3</sup>	GR SA SI CL
	Probable silty clay Soft to firm															
	Probable silt Loose to compact															
173.7 12.8	End of dynamic cone penetration test															

RECORD OF PENETRATION TEST No 302-42

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+925 CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 17, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		GR SA SI CL	
186.5 0.0	Ground Surface Probable peat  Probable organic silt Very loose  Probable clayey silt Firm															
178.1 8.4	End of dynamic cone penetration test Refusal on probable bedrock									120/15cm						

RECORD OF PENETRATION TEST No 302-46

1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 New), Sta. 17+975, o/s 34.1m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 16, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
186.5 0.0	Ground Surface Probable peat  Probable clayey silt Soft to firm															
						186										
						185										
						184										
						183										
						182										
						181										
						180										
	Probable silt Loose to compact					179										
						178										
						177										
						176										
						175										
						174										
						173										
						172										
171.5	Cont'd															

RECORD OF PENETRATION TEST No 302-46

2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 New), Sta. 17+975, o/s 34.1m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 16, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa												
171.5 15.0	End of dynamic cone penetration test  Refusal on probable bedrock																

RECORD OF PENETRATION TEST No 302-48

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 17+975, o/s 34.1m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 12, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		GR SA SI CL	
186.5 0.0	Ground Surface Probable peat  Probable organic silt Very loose  Probable clay Soft															
178.0 8.5	End of dynamic cone penetration test Refusal on probable bedrock									120/2cm						



**RECORD OF PENETRATION TEST No 302-52      2 of 2      METRIC**

G.W.P. 5203-06-00      LOCATION Hwy 69 (New), Sta. 18+025 CL Med.      ORIGINATED BY F.P.  
 DIST 54      HWY 69      BOREHOLE TYPE Dynamic Cone Penetration Test      COMPILED BY N.S.B.  
 DATUM Geodetic      DATE February 13, 2007      CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
171.5																		
171.3																		
15.2	End of dynamic cone penetration test																	

RECORD OF PENETRATION TEST No 302-56

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+075, o/s 44.5m Lt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 16, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
186.8 0.0	Ground Surface Probable peat  Probable silty clay Firm to stiff															
176.1 10.7	End of dynamic cone penetration test Refusal on probable bedrock															

RECORD OF PENETRATION TEST No 302-58

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 18+075, o/s 44.5m Rt. CL Med. ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 15, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
186.5 0.0	Ground Surface Probable peat Probable organic silt Probable silty clay Soft to firm						20	40	60	80	100	20	40	60		
175.8 10.7	End of dynamic cone penetration test															





RECORD OF BOREHOLE No 305-9

1 of 1

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+075, o/s 58.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 06, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER + CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
188.1	Ground Surface															
0.0	Peat, fine fibrous Dark brown		1	SS	10											
0.3	Silt with sand, trace clay															
187.4																
0.7	Loose Brown Moist Clayey silt, trace sand		2	SS	4											
	Firm Brown Moist															
185.9			3	SS	2											
185.9	End of borehole															
2.2	Refusal on probable bedrock															
	* Borehole dry upon completion of drilling															





RECORD OF BOREHOLE No 305-16 2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+125, o/s 20.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 07, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
172.5	Grey		11	SS	WH											
	Layers of silt															
	Brown/grey		12	SS	4											
	varved		13	SS	1											
167.1																
20.4	End of borehole Refusal on probable bedrock															

\* 2007 03 07  
 ▽ Water level observed during drilling  
 ▼ Water level measured after drilling  
 WH\*\* Denotes penetration due to weight of hammer and rods  
 WR\*\*\* Denotes penetration due to weight of rods only

RECORD OF BOREHOLE No 305-19

1 of 2

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+150, o/s 38.8m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 10 and 11, 2008 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
187.5	Top of Ice															
0.0	Ice															
186.9	Peat, fine fibrous Dark brown		1	SS	WH**											
			2	SS	WH											
185.4	Silty clay organics Very soft Grey Wet to soft		3	SS	WH											
			4	SS	2											
183.9	Sand, trace silt Loose to Grey Wet very loose		5	SS	5											
			6	SS	4											0 97 (3)
			7	SS	3											
180.4	Silt some sand, some clay Very loose Grey Wet		8	SS	1											0 18 71 11
178.7	Clay, trace sand Firm to Grey Wet stiff		9	SS	WH											
				FV												
			10	SS	WH											0 1 38 61
				FV												
			11	SS	3											
				FV												
			12	SS	WR***											
				FV												
172.5																

RECORD OF BOREHOLE No 305-19 2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+150, o/s 38.8m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 10 and 11, 2008 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60			
172.5 15.0			13	TW	PM											
			14	SS	WR											
				FV					5							
			15	SS	WH											
				FV					4							
167.0 20.5	Silty clay, trace sand Firm Grey Wet		16	SS	WR											
				FV					5							
163.2 24.3	Silt, trace clay trace sand, trace gravel Loose Grey Wet		17	SS	4										1 5 88 6	
161.3 26.2	End of borehole Refusal on probable bedrock															

RECORD OF BOREHOLE No 305-21 1 of 3 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+175, o/s 58.5m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 12 and 14, 2008 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
187.5	Top of Ice															
0.0	Ice															
186.9	Peat, fine fibrous Dark brown		1	SS	WR**											
			2	SS	WR											
			3	SS	WR											
184.6	Silty clay															
184.1	Soft Grey Wet		4	SS	2											
184.1	Sand, trace silt Loose Grey Wet															
3.4			5	SS	9											
			6	SS	7											
180.3	Clayey silt, trace sand Firm Grey Wet		7	SS	1											
7.2				FV												
178.5	Clay, trace sand Firm Grey Wet		8	TW	PH											
9.0																
			9	SS	WH***											
				FV												
			10	SS	WH											
				FV												
			11	SS	WR											
				FV												

Cont'd

+<sup>7</sup>, X<sup>5</sup>: Numbers refer to Sensitivity  
 20  
 15—○—5 (% STRAIN AT FAILURE)  
 10

RECORD OF BOREHOLE No 305-21 2 of 3 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+175, o/s 58.5m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 12 and 14, 2008 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
						20 40 60 80 100	20 40 60 80 100	20 40 60				GR SA SI CL	
172.5	silt seams stiff		12	SS	6		5						
				FV									
	trace gravel		13	SS	WH								
				FV									
	silt and sand seams very stiff		14	SS	1							0 3 41 56	
				FV			7						
167.7	Clayey silt silt layers Stiff Grey Wet		15	SS	2								
				FV									
164.5	Silt some clay, trace sand Very loose Grey Wet		16	SS	2							0 2 86 12	
162.2	End of borehole Probable silt Loose to compact												

Cont'd

RECORD OF BOREHOLE No 305-21

3 of 3

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+175, o/s 58.5m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 12 and 14, 2008 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
157.5																
155.9																
31.6	End of dynamic cone penetration test Refusal on probable bedrock  * 2008 03 12/14 ▽ Water level observed during drilling ▼ Water level measured after drilling WR** Penetration due to the rods only WH*** Denotes penetration due to weight of hammer and rods C.F.H.S.A. Denotes Continuous Flight Hollow Stem Augers															

RECORD OF BOREHOLE No 305-25

1 of 3

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+200, o/s 38.8m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 15, 2008 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		GR SA SI CL	
187.5	Top of Ice															
0.0	Ice															
187.2																
0.4	Peat, fine fibrous Dark brown		1	SS	WR**											
			2	SS	WR											508
184.8			3	SS	WH***											131
2.7	Organic clayey silt Very soft Grey Wet		4	SS	WR											130
183.5			5	SS	4											
4.0	Sand, some silt Loose Grey Wet		6	SS	5											
			7	SS	4											
180.2			8	SS	5											
7.3	Silty clay sand seams Firm to stiff Grey Wet		9	SS	WH											
				FV												
			10	SS	WH											
				FV												
	silt seams		11	SS	1											
				FV												
			12	SS	2											
				FV												

Cont'd



RECORD OF BOREHOLE No 305-25

3 of 3

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+200, o/s 38.8m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 15, 2008 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						W <sub>p</sub>
157.5																		
155.8																		
31.7	End of dynamic cone penetration test																	
	* 2007 03 15																	
	∇ Water level observed during drilling																	
	▼ Water level measured after drilling																	
	WR** Penetration due to the rods only																	
	WH*** Denotes penetration due to weight of hammer and rods																	
	C.F.H.S.A. Denotes Continuous Flight Hollow Stem Augers																	



**RECORD OF BOREHOLE No 305-28 2 of 2 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+225, o/s 20.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 09 and 10, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
172.5			11	SS	WH											
	layers of silt															
170.6			12	SS	5/15cm											
16.9	End of borehole Refusal on probable bedrock  Sample 12: Sampler bouncing  * 2007 03 09/10  ▽ Water level observed during drilling ▼ Water level measured after drilling  WH** Denotes penetration due to weight of hammer and rods															





RECORD OF BOREHOLE No 305-33 1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+275, o/s 60.5m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 16 and 17, 2008 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
187.5	Top of Ice															
0.0	Ice															
186.9	Water															
0.6																
186.0	Peat		1	SS	WR**											
1.5																
184.8	Organic clayey silt		2	SS	WH***									126		
2.7	Very soft Grey/ brown Wet															
			3	SS	WH											
	sand seams		4	SS	1									101		
182.9	Clayey silt silty sand seams		5	SS	WH											
4.6	Very soft Grey Wet															
181.4	Silt trace sand, trace clay		6	SS	1										0 9 82 9	
6.1	Very loose Grey Wet															
180.2	Silty clay, trace sand sandy silt seams		7	SS	WH											
7.3	Firm to Grey Wet stiff															
				FV												
			8	SS	WH										0 1 57 42	
	trace gravel		9	SS	WH											
				FV												
			10	SS	WR											
				FV												
			11	SS	WH											
				FV												
172.5																

RECORD OF BOREHOLE No 305-33

2 of 2

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+275, o/s 60.5m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 16 and 17, 2008 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		GR SA SI CL	
172.5 15.0	some sand silty sand seams		12	SS	WH											
	trace gravel sand seams		13	SS	WH											
	trace sand		14	SS	2											
168.3 19.2	End of borehole Probable silty clay Firm															
166.8 20.7	Probable silt Loose to compact															
163.7 23.8	End of dynamic cone penetration test															

RECORD OF BOREHOLE No 305-37 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+300, o/s 38.8m Lt. CL Med. ORIGINATED BY N.L.B.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 08, 2007 CHECKED BY G.D.

ELEV DEPTH	SOIL PROFILE DESCRIPTION	STRAT PLOT	SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
			NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
187.5	Ground Surface																
0.0	Peat, fine fibrous Dark brown Wet																
186.9	Organic clay																
0.6	Soft Grey Moist		1	SS	1								o				
186.6	Silt, trace clay																
0.9	Very loose Grey Wet layers of silty clay		2	SS	1								o				
184.8	Clayey silt, trace sand																
2.7	Soft to firm Grey/brown Wet layers of silt		3	SS	WH**												0 5 66 29
182.0	Silt, trace clay thin layers of silty clay																
5.5	Very loose Grey Wet		5	SS	WH								o				
180.5	Clay, varved layers of silt																
7.0	Soft Grey/brown Wet		6	SS	WH												
175.0	no layers																
174.7	layers of silt		8	SS	WH												
174.4																	
175.0																	
12.5	Silt, trace clay		9	SS	WH								o				
174.7	Very loose Grey Wet																
12.8	Sand, trace silt																
174.4	Very loose Grey Wet		10	AS	-												
13.1	End of borehole Refusal on probable bedrock																

WH\*\* denotes penetration due to weight of hammer and rods

**RECORD OF BOREHOLE No 305-39**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 16+325, o/s 50.5m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE Excavator COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 26, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS +	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
191.5	Ground Surface																
0.0	Topsoil																
190.9	End of borehole						191										
0.6	Refusal on probable bedrock																
	* Borehole dry upon completion of drilling																

**RECORD OF BOREHOLE No 305-40**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 16+325, o/s 28.5m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 26, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	20			40	60	80	100	WATER CONTENT (%)					
191.2	Ground Surface																
0.0	Bedrock at surface																
	* Borehole dry																

**RECORD OF BOREHOLE No 305-43 1 of 1 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+350, o/s 38.8m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE Excavator COMPILED BY N.S.B.  
 DATUM Geodetic DATE February 26, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100					
192.1	Ground Surface																
0.0	Topsoil						192										
0.3	Silt some sand, trace clay																
191.0	Light brown Moist																
1.1	End of borehole Refusal on probable bedrock						191										
	* Borehole dry upon completion of Drilling																



RECORD OF PENETRATION TEST No 305-15

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+125, o/s 58.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 05, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
187.5	Top of Ice																	
0.0	Ice Water																	
	Probable peat																	
	Probable organic clayey silt																	
	Probable silty sand																	
	Very loose to loose																	
	Probable clay																	
	Soft																	
177.9	End of dynamic cone penetration test																	
9.6	Refusal on probable bedrock																	





**RECORD OF PENETRATION TEST No 305-27**

1 of 2 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+225, o/s 58.5m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 15, 2008 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa									
						20 40 60 80 100	○ UNCONFINED	+ FIELD VANE									
						20 40 60 80 100	● QUICK TRIAXIAL	× LAB VANE									
							WATER CONTENT (%)										
187.5 0.0	Top of Ice																
	Ice																
	Water					187											
	Probable peat					186											
						185											
						184											
	Probable sand Very loose					183											
						182											
						181											
						180											
	Probable silty clay Soft to firm					179											
						178											
						177											
						176											
						175											
						174											
						173											

Cont'd

RECORD OF PENETRATION TEST No 305-27

2 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+225, o/s 58.5m Lt. CL Med. ORIGINATED BY W.L.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 15, 2008 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
172.5	Probable silty clay Firm						20 40 60 80 100					GR SA SI CL	
	Probable clayey silt Firm to stiff						20 40 60 80 100						
	Probable silt Compact to dense						20 40 60 80 100						
161.6 25.9	End of dynamic cone penetration test												

RECORD OF PENETRATION TEST No 305-34

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 16+275, o/s 18.5m Lt. CL Med. ORIGINATED BY N.L.B.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 09, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
187.5 0.0	Ground Surface Probable peat ----- Probable silt Loose															
176.5 11.0	End of dynamic cone penetration test Refusal on probable bedrock															

MOT\_DCPT R2004 SWAMP 305-MAR 13.GPJ ON\_MOT.GDT 12/14/2007 7:18:09 PM  
 +, X<sup>5</sup>: Numbers refer to Sensitivity 20  
 15-O-5 (% STRAIN AT FAILURE  
 10

**RECORD OF BOREHOLE No 306-13 1 of 1 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+350, o/s 38.8m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 10, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
190.2	Ground Surface															
0.0	Topsoil		1	SS	6											
0.3	Clayey silt, trace sand Firm to soft Brown Moist to wet layers of silt and silty clay		2	SS	2											
188.1			3	SS	WH**											
188.1	Silt, trace clay Soft to firm Brown Wet to grey															
187			4	SS	WH											
186				FV												
185.5																
185.2	Sand some gravel, trace silt Compact Grey Wet		5	SS	10											
185.2	End of borehole Refusal on probable bedrock															
5.0																

\* Borehole dry on completion of drilling  
 WH\*\* denotes penetration due to weight of rods and hammer



**RECORD OF BOREHOLE No 306-16 2 of 2 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+375, o/s 14.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 10, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS *	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
174.0	brown layering		13	SS	3											0 9 83 8
172.2						173										
16.8	End of borehole Refusal on probable bedrock															
	* Borehole dry on completion of drilling WH** denotes penetration due to weight of rods and hammer															



RECORD OF BOREHOLE No 306-21 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+425, o/s 60.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 12, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT	NATURAL MOISTURE CONTENT	LIQUID LIMIT	UNIT WEIGHT $\gamma$	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	W <sub>p</sub>
190.2	Ground Surface																	
0.0	Topsoil																	
0.1	Clayey silt, trace sand layers of silt and silty clay		1	SS	4													
	Firm Brown/grey Moist to wet		2	SS	3													
188.8																		
1.4	Silty clay, trace sand																	
	Firm Brown Wet		3	SS	WH**													
187.3																		
2.9	Clay, trace sand thin layers of silt																	
	Firm Grey Moist to wet		4	SS	WH													0 1 37 62
185.6																		
4.6	End of borehole Refusal on probable bedrock																	

\* Borehole dry on completion of drilling  
 WH\*\* denotes penetration due to weight of rods and hammer





**RECORD OF BOREHOLE No 306-28      2 of 2      METRIC**

G.W.P. 5203-06-00      LOCATION Hwy 69 (New), Sta. 15+475, o/s 20.5m Lt. CL Med.      ORIGINATED BY M.R.  
 DIST 54      HWY 69      BOREHOLE TYPE Continuous Flight Hollow Stem Augers      COMPILED BY G.D.  
 DATUM Geodetic      DATE November 13, 2006      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
174.2																
15.0	Sandy silt		12	SS	7	174										
173.7	Loose Grey Wet															
15.5	End of borehole Refusal on probable bedrock															
	* 2006 11 13 ▼ Water level measured after drilling WH** denotes penetration due to weight of rods and hammer															



RECORD OF BOREHOLE No 306-33

1 of 2

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+525, o/s 56.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 14, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)							
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20						40	60	80	100	20	40	60
189.2	Ground Surface																			
0.0	Peat, fine fibrous Dark brown		1	SS	WH**															
0.3	Organic clay, trace sand layers of clayey silt																			
	Very soft Olive Wet brown		2	SS	WH								87				0	1	71	28
187.8																				
1.4	Sandy silt																			
187.4	Very loose Grey Wet Clay, trace sand		3	SS	WH								85							
1.8	Very soft Grey Wet to firm				FV															
	layers of silt																			
			4	SS	WH															
					FV															
	brown layering																			
			5	SS	WH															
					FV															
			6	SS	WH															
					FV															
			7	SS	WH															
					FV															
			8	SS	WH															
					FV															
			9	SS	WH															
					FV															
			10	SS	WH															
					FV															
			11	SS	WH															
174.2																				

**RECORD OF BOREHOLE No 306-33 2 of 2 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+525, o/s 56.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 14, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
174.2	Silt some clay, trace sand Very loose Grey Wet		12	SS	WH											0 1 84 15
172.0			13	SS	WH											
172.0	Sandy silt, with gravel Very loose Grey Wet															
171.2																
18.0	End of borehole Refusal on probable bedrock															

\* 2006 11 14  
 Water level observed during drilling  
 Water level measured after drilling  
 WH\*\* denotes penetration due to weight of rods and hammer

RECORD OF BOREHOLE No 306-37

1 of 2

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+550, o/s 38.8m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 15, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
189.3	Ground Surface																	
0.0	Peat, fine fibrous Dark brown		1	SS	WH**													
0.3	Organic silty clay trace sand																	
188.4	Very soft Brown Wet		2	SS	WH													
0.9	Silt trace sand, trace clay																	
187.6	Very loose Brown Wet		3	SS	WH													
1.7	Clay, trace sand layers of silt																	
	Soft to Grey Wet firm				FV													
			4	SS	WH													
					FV													
	brown layering																	
			5	SS	WH													
					FV													
			6	SS	WH													
					FV													
			7	SS	WH													
					FV													
			8	SS	WH													
					FV													
			9	SS	WH													
					FV													
			10	SS	WH													
					FV													
175.9	Silt, trace clay																	
13.4	Loose Grey Wet		11	SS	7													
174.8																		
14.5	End of borehole Refusal on probable bedrock																	

**RECORD OF BOREHOLE No 306-37 2 of 2 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+550, o/s 38.8m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 15, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							
174.3							20	40	60	80	100						
	* 2006 11 15 ▽ Water level observed during drilling ▼ Water level measured after drilling WH** denotes penetration due to weight of rods and hammer																







RECORD OF BOREHOLE No 306-49 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+650, o/s 38.8m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 21, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
189.1	Ground Surface																	
0.0	Topsoil																	
0.2	Silty clay, trace sand layers of silt and clayey silt		1	SS	5													
	Firm Brown Moist to wet		2	SS	WH**													
			3	SS	WH													
					FV													
186.4	Clay, trace sand																	
2.7	Firm Grey Moist to wet		4	SS	WH													
					FV													
	brown layering																	
			5	SS	WH													
	thin layers of silt																	
			6	SS	WH													
181.5	End of borehole																	
7.6	Refusal on probable bedrock																	

RECORD OF BOREHOLE No 306-52 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+675, o/s 26.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 07, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100					
189.8	Ground Surface														
0.0	Topsoil														
0.2	Silty clay, trace sand thin layers of silt		1	SS	6										
	Firm Brown Wet		2	SS	WH**										
			3	SS	WH										
				FV											
187.1	Clay, trace sand														
2.7	Soft to firm Reddish brown/grey Wet		4	SS	WH									93	0 1 31 68
				FV											
			5	SS	WH										
	thin layers of silt			FV											
184.0	Clayey silt, trace sand														
5.8	Firm Grey Wet		6	SS	WH										
				FV											
			7	SS	WH										0 2 76 22
181.4	Silt, some clay trace sand, trace gravel thin layers of silty clay														
8.4	Very loose Grey Wet to loose		8	SS	4										1 1 85 13
179.0	End of borehole														
10.8	Refusal on probable bedrock														

RECORD OF BOREHOLE No 306-55 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+700, o/s 38.8m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 08, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
189.9	Ground Surface															
0.0	Peat, amorphous Dark brown		1	SS	7											
0.2	Clayey silt, trace sand thin layers of silt and silty clay		2	SS	WH**											
	Firm Brown Wet		3	SS	2										0 3 78 19	
				FV												
187.2	Clay		4	SS	WH											
2.7	Soft to firm Brown/ grey Moist			FV												
			5	TW	PM										0 0 49 51	
				FV												
	thin layers of silt		6	SS	WH											
				FV												
182.7	Silt some clay, trace sand layers of clay		7	SS	4										0 7 81 12	
7.2	Loose to Brown/ Wet very loose grey															
			8	SS	2											
179.7	End of borehole															
10.2	Refusal on probable bedrock															

RECORD OF BOREHOLE No 306-61 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+750, o/s 38.8m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 08, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100						
190.7	Ground Surface															
0.0	Topsoil															
0.1	Sandy silt, trace clay		1	SS	4											
190.0	Loose Brown Wet Clayey silt, some sand															
0.7	Firm Brown Wet thin layers of silty clay		2	SS	WH**										0 19 66 15	
			3	SS	2											
188.1	Silty clay, trace sand															
2.6	Firm Brown Wet thin layers of silt Grey		4	SS	2										0 1 48 51	
185.1	Silt, some sand thin layers of silty clay															
5.6	Very loose Grey Moist to wet sandy, trace gravel		6	SS	3										5 22 62 11	
183.7	End of borehole Refusal on probable bedrock															
7.0																

**RECORD OF BOREHOLE No 306-63 1 of 1 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+775, o/s 48.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 09, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER + CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100
											○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × LAB VANE			WATER CONTENT (%)			
191.6	Ground Surface																
0.0	Topsoil																
0.1	Clayey silt with to trace sand layers of silt and silty clay		1	SS	4												
	Stiff to Brown Moist firm		2	SS	4												
			3	SS	2											0 1 70 29	
189.2	End of borehole																
2.4	Refusal on probable bedrock																

\* Borehole dry on completion of drilling  
 ■ Penetrometer test

RECORD OF BOREHOLE No 306-64

1 of 1

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+775, o/s 38.8m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 08, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
191.8	Ground Surface															
0.0	Topsoil															
0.1	Clayey silt, trace sand thin layers of silt and silty clay		1	SS	4											
	Firm Brown Moist		2	SS	2	191										
190.4																
1.4	Silty clay, trace sand thin layers of clayey silt		3	SS	3	190										
	Firm Brown Moist															
			4	SS	4	189										
						188										
187.5																
4.3	End of borehole Refusal on probable bedrock															

\* 2006 11 08  
 ▼ Water level measured  
 after drilling  
 ■ Penetrometer test



**RECORD OF BOREHOLE No 306-68 1 of 1 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+800, o/s 38.8m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY G.D.  
 DATUM Geodetic DATE November 09, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
192.2	Ground Surface															
0.0	Topsoil															
0.1	Silty clay, trace sand thin layers of clayey silt		1	SS	10											
	Stiff to Brown Moist firm thin layers of silt		2	SS	6											
			3	SS	4											
190.2	End of borehole															
2.0	Refusal on probable bedrock															
	* Borehole dry on completion of drilling															

RECORD OF PENETRATION TEST No 306-15

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+375, o/s 54.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY G.D.  
 DATUM Geodetic DATE November 10, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
191.2	Ground Surface															
0.0	Probable peat					191										
	Probable silty clay															
190.1	Soft to firm															
1.1	End of dynamic cone penetration test															
	Refusal on probable bedrock															

RECORD OF PENETRATION TEST No 306-22

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+425, o/s 18.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY G.D.  
 DATUM Geodetic DATE November 12, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
188.9 0.0	Ground Surface Probable peat Probable organic silty clay Soft to firm															
	Probable clay Very soft to firm															
	probable clayey silt Soft															
176.7 12.2	End of dynamic cone penetration test Refusal on probable bedrock															

**RECORD OF PENETRATION TEST No 306-27**

1 of 1 **METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+475, o/s 58.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY G.D.  
 DATUM Geodetic DATE November 12, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
189.2 0.0	Ground Surface Probable peat Probable organic silty clay Soft						20	40	60	80	100					
	Probable silty clay Soft to firm															
179.2 10.0	End of dynamic cone penetration test Refusal on probable bedrock															



**RECORD OF PENETRATION TEST No 306-34**      2 of 2      **METRIC**

G.W.P. 5203-06-00      LOCATION Hwy 69 (New), Sta. 15+525, o/s 22.5m Lt. CL Med.      ORIGINATED BY M.R.  
 DIST 54      HWY 69      BOREHOLE TYPE Dynamic Cone Penetration Test      COMPILED BY G.D.  
 DATUM Geodetic      DATE November 15, 2006      CHECKED BY C.N.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
174.1	Probable silt Loose to compact																
171.6							120/13cm										
17.5	End of dynamic cone penetration test Refusal on probable bedrock																

RECORD OF PENETRATION TEST No 306-39

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+575, o/s 56.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY G.D.  
 DATUM Geodetic DATE November 15, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
189.2 0.0	Ground Surface Probable peat Probable organic clayey silt Soft Probable clay Soft to firm															
178.2 11.0	End of dynamic cone penetration test Refusal on probable bedrock															

RECORD OF PENETRATION TEST No 306-46

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+625, o/s 22.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY G.D.  
 DATUM Geodetic DATE November 20, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		GR SA SI CL	
189.6 0.0	Ground Surface Probable peat Probable silty clay Soft															
	Probable clay Soft to firm															
	Probable silt Loose															
178.8 10.8	End of dynamic cone penetration test Refusal on probable bedrock									120/13cm						

RECORD OF PENETRATION TEST No 306-51

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+675, o/s 52.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY G.D.  
 DATUM Geodetic DATE November 21, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
190.2 0.0	Ground Surface Probable <u>topsoil</u> — Probable silty clay Firm															
184.2 6.0	End of dynamic cone penetration test Refusal on probable bedrock															

RECORD OF PENETRATION TEST No 306-58

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69 (New), Sta. 15+725, o/s 30.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY G.D.  
 DATUM Geodetic DATE November 08, 2006 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
190.0 0.0	Ground Surface Probable <u>topsoil</u> Probable clayey silt Soft to firm						20	40	60	80	100					
	Probable clay Firm															
	layers of silt															
181.0 9.0	End of dynamic cone penetration test Refusal on probable bedrock															

RECORD OF BOREHOLE No 307-19 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+425, o/s 38.8m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 02 and March 05, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100	20	40	60		GR SA SI CL	
193.0	Ground Surface															
0.0	Peat, fine fibrous															
0.2	Dark brown															
192.0	Organic silt trace sand, trace gravel															
1.0	Very loose Brown Wet		1	SS	2											
	Clayey silt trace sand, trace gravel layers of silt															
	Soft to firm Grey Moist to wet		2	SS	7										1 8 70 21	
			3	SS	2											
188.8	Silt some clay, trace sand															
4.2	Loose Grey Wet		4	SS	5										0 7 82 11	
187.1	End of borehole															
5.9	Refusal on probable bedrock															



RECORD OF BOREHOLE No 307-23 1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+437.5, o/s 22.5m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 03, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	SHEAR STRENGTH kPa
											○ UNCONFINED	+	FIELD VANE					
											● QUICK TRIAXIAL	×	LAB VANE					
											WATER CONTENT (%)							
											20	40	60					
193.0	Ground Surface																	
0.0	Organic silt Very soft Dark to soft grey Wet																	0.3m frozen
			1	SS	1													
			2	SS	2													
191.0	Silt, trace clay Very loose Grey to loose Wet																	
2.0																		
			3	SS	6													
189.2	Clayey silt, trace sand Firm Grey Wet																	
3.8			4	SS	3													
				FV														
			5	SS	1													
				FV														
			6	SS	1													
				FV														
184.2	End of borehole Refusal on probable bedrock																	
8.8																		

**RECORD OF BOREHOLE No 307-27 1 of 2 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+450, o/s 38.8m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 04, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
193.0 0.0	Top of Ice Ice/Snow																	
0.3	Peat, fine fibrous Dark brown Wet																	
191.9 1.1	Clayey silt, trace sand peat inclusions to 2.2m Very soft Grey Wet to soft		1	SS	2													
			2	SS	1													
	Firm to stiff																	
188.9 4.1	Silty clay, trace sand Firm to Grey Wet soft		3	SS	8													0 1 80 19
			4	SS	2													
				FV														
			5	TW	PH													16.5 1 1 53 46
185.8 7.2	Clay Firm Grey Wet		6	SS	2													
				FV														
			7	SS	1													0 0 37 63
				FV														
			8	SS	1													
				FV														
			9	SS	1													
				FV														
179.3 13.7	Silt some clay, trace sand Loose Grey Wet		10	SS	8													0 2 86 12
178.3 14.7	End of borehole																	

**RECORD OF BOREHOLE No 307-27      2 of 2      METRIC**

G.W.P. 5203-06-00      LOCATION Hwy 69(New), Sta. 14+450, o/s 38.8m Lt. CL Med.      ORIGINATED BY N.R.  
 DIST 54      HWY 69      BOREHOLE TYPE Continuous Flight Hollow Stem Augers      COMPILED BY N.S.B.  
 DATUM Geodetic      DATE March 04, 2007      CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	20			40	60	80	100	20					
178.0	Refusal on probable bedrock																
	* 2007 03 04																
	▽ Water level observed during drilling																
	▼ Water level measured after drilling																

RECORD OF BOREHOLE No 307-28 1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+450, o/s 22.5m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 06, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
193.0 0.0	Top of Ice Ice/Snow																	
0.3	Peat, fine fibrous Dark brown																	
192.1 0.9	Organic silt Soft Dark brown Wet		1	SS	2													
191.1 1.9	Silt, trace clay trace sand, organics Very loose Grey Wet to loose		2	SS	1													
188.3 4.7	Clay, trace sand thin layers of silty clay Firm Grey Wet		4	SS	1													0 1 47 52
				FV														
			5	SS	2													
				FV														
			6	SS	2													0 1 37 62
				FV														
			7	SS	2													
				FV														
			8	SS	2													
				FV														
181.2 11.8	Silt some clay, trace sand Very loose Grey Wet to loose		9	SS	4													0 1 84 15

Cont'd

**RECORD OF BOREHOLE No 307-28 2 of 2 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+450, o/s 22.5m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 06, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	20			40	60	80	100						
178.0																	
177.7																	
15.3	End of borehole Refusal on probable bedrock  Samples 5 and 6: Combined for lab testing  * 2007 03 06  ▽ Water level observed during drilling  ▼ Water level measured after drilling																

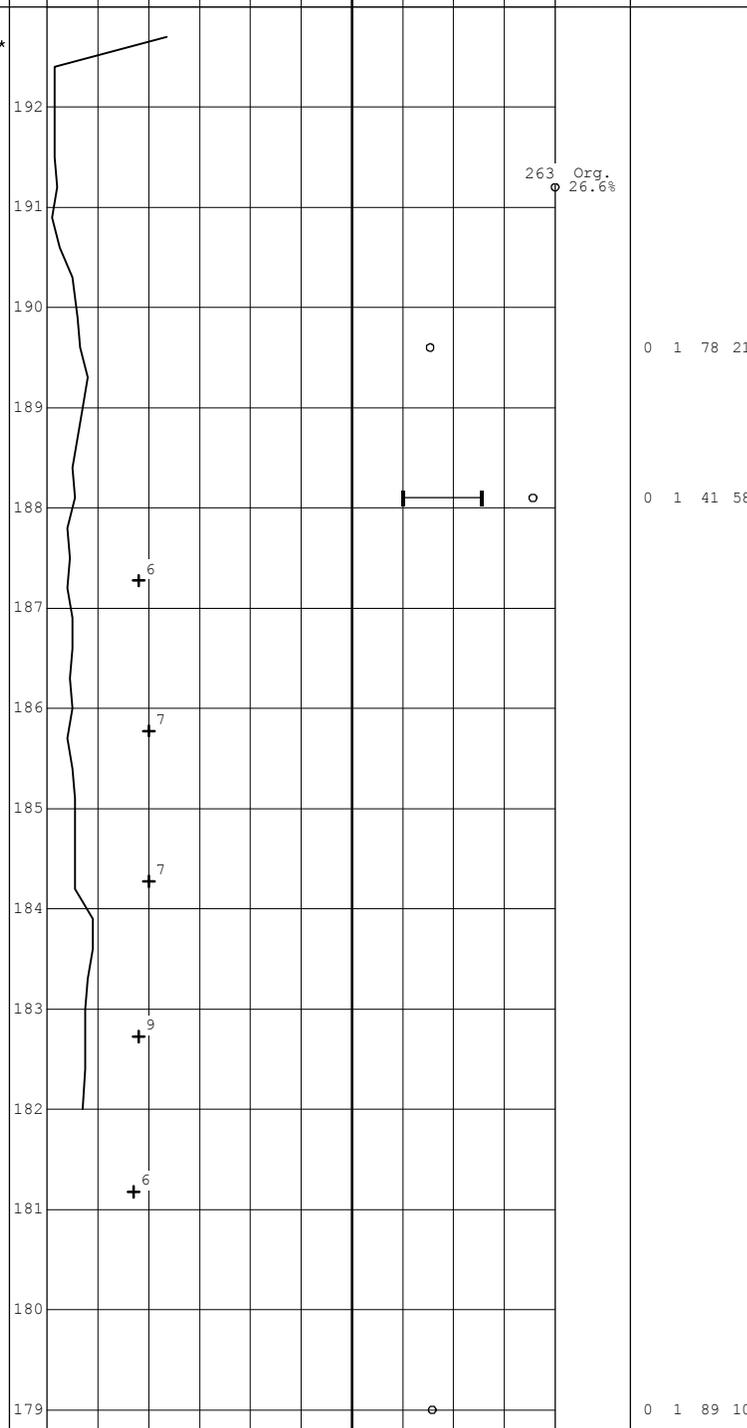
RECORD OF BOREHOLE No 307-34

1 of 2

METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+475, o/s 38.8m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 02 and March 05, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20					
193.0	Top of Ice												
0.0	Ice/Snow												
0.3	Peat, fine fibrous trace gravel Dark brown		1	SS	2								
			2	SS	1								
190.3	Clayey silt, trace sand Firm to Grey Wet stiff		3	SS	8								0 1 78 21
188.4	Clay, trace sand Firm Grey Wet		4	SS	1								0 1 41 58
4.6	fissured Blueish grey			FV									
			5	SS	2								
				FV									
			6	SS	2								
				FV									
			7	SS	2								
				FV									
			8	SS	1								
				FV									
180.5	Silt, trace to some clay trace sand Loose Grey Wet		9	SS	1								
12.5				FV									
			10	SS	5								0 1 89 10
178.0													



**RECORD OF BOREHOLE No 307-34      2 of 2      METRIC**

G.W.P. 5203-06-00      LOCATION Hwy 69(New), Sta. 14+475, o/s 38.8m Lt. CL Med.      ORIGINATED BY N.R.  
 DIST 54      HWY 69      BOREHOLE TYPE C.F.H.S.A + Dynamic Cone Penetration Test      COMPILED BY N.S.B.  
 DATUM Geodetic      DATE March 02 and March 05, 2007      CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
178.0 15.0	thin sand layers		11	SS	7											
177.1 15.9	Sand with gravel, trace silt Compact    Brown    Wet															
175.7 17.3	End of borehole Refusal on probable bedrock  Samples 4 and 5: Combined for lab testing  *    2007   03   05  ▽    Water level observed during drilling  ▼    Water level measured after drilling  C.F.H.S.A - Denotes Continuous Flight Hollow Stem Augers		12	SS	20									27 71	(2)	

**RECORD OF BOREHOLE No 307-36**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+487.5, o/s 58.5m Lt. CL Med. ORIGINATED BY M.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 29, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	20			40	60	80	100	WATER CONTENT (%)					
193.0	Ground Surface																
0.0	Bedrock at surface																
	* Borehole dry																



**RECORD OF BOREHOLE No 307-37 2 of 2 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+487.5, o/s 20.5m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 01, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)							
							20	40	60	80	100						
178.4	* 2007 03 01 ∇ Water level observed during drilling WH** Denotes penetration due to weight of hammer and rods																

**RECORD OF BOREHOLE No 307-40**

1 of 1

**METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+500, o/s 38.8m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Manual Probing COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 29, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES				GROUND WATER * CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT NUMBER	TYPE	"N" VALUES	20			40	60	80	100	WATER CONTENT (%)					
198.5	Ground Surface																
0.0	Bedrock at surface																
	* Borehole dry																

RECORD OF PENETRATION TEST No 307-22

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+437.5, o/s 38.8m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Hollow Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 05, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV. DEPTH	DESCRIPTION	STRAT. PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
193.0 0.0	Ground Surface Probable organic silt															GR SA SI CL
	----- Probable clayey silt Soft to firm															0.3m frozen
185.0 8.0	End of dynamic cone penetration test Refusal on probable bedrock															

RECORD OF PENETRATION TEST No 307-26

1 of 2 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+450, o/s 56.5m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 06, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
193.0	Ground Surface															
0.0	Probable peat															0.3m frozen
	Probable silt Loose to compact															
	Probable clayey silt/clay Firm to stiff															
	Probable silt Compact															
178.0	Cont'd															

RECORD OF PENETRATION TEST No 307-30

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+462.5, o/s 56.5m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 02, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
193.0 0.0	Ground Surface Probable peat															0.3m frozen
	----- Probable clayey silt Soft to stiff															
	----- Probable silt Compact															
181.1 11.9	End of dynamic cone penetration test															

RECORD OF PENETRATION TEST No 307-31

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 14+462.5, o/s 22.5m Lt. CL Med. ORIGINATED BY N.R.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 02, 2007 CHECKED BY G.D.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20					
193.0 0.0	Ground Surface Probable peat												0.2m frozen
	Probable clayey silt Firm to stiff												
	Probable silt some clay, trace sand Compact												
179.0 14.0	End of dynamic cone penetration test												



**RECORD OF BOREHOLE No 310-4**      1 of 1      **METRIC**

G.W.P. 5203-06-00      LOCATION Hwy 69(New), Sta. 13+412.5, o/s 26.5m Lt. CL median      ORIGINATED BY F.P.  
 DIST 54      HWY 69      BOREHOLE TYPE Continuous Flight Solid Stem Augers      COMPILED BY N.S.B.  
 DATUM Geodetic      DATE March 05, 2007      CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100					
195.0	Ground Surface														
0.0	Peat, coarse fibrous Dark brown fine fibrous		1	AS	-										0.5m frozen
			2	SS	WH**								626		Org. 56.3%
			3	SS	WH								988		
	amorphous layers of organic silty clay		4	SS	WH								184		
191.9															
3.1	Silty clay, organics layers of organic silty clay, seashells to 4.5m		5	SS	WH								94		
	Very soft Grey Wet to firm			FV											
	trace sand varved		6	SS	WH										1 1 51 47
				FV											
			7	SS	WH										
				FV											
			8	SS	WH										0 1 54 45
				FV											
	cobbles		9	SS	10/5cm										
185.4															
9.6	End of borehole Refusal on probable bedrock														
	Sample 9: sampler bouncing														
	* 2007 03 05														
	▽ Water level observed during drilling														
	▼ Water level measured after drilling														
	WH** Denotes penetration due to weight of hammer and rods														

**RECORD OF BOREHOLE No 310-7 1 of 1 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+425, o/s 38.8m Lt. CL median ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 04, 2007 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE		"N" VALUES	SHEAR STRENGTH kPa								
						20	40	60	80	100					
195.0	Ground Surface														
0.0	Peat, coarse fibrous Dark brown		1	AS	-										0.5m frozen
			2	SS	WH**								944		
	amorphous layers of organic silty clay		3	SS	WH								89		
192.4			4	SS	WH										
2.6	Clayey silt organics to 3.1m														
	Very soft Grey Wet to soft varved		5	SS	WH										0 0 68 32
				FV											
			6	SS	1										
				FV											
189.2															
5.8	Sand trace to some silt trace gravel, cobbles														
			7	SS	10/7cm										2 87 (11)
188.4	Compact Grey Wet														
6.6	End of borehole Refusal on probable bedrock														
	Sample 7: sampler bouncing														
	* 2007 03 04														
	▽ Water level observed during drilling														
	▼ Water level measured after drilling														
	WH** Denotes penetration due to weight of hammer and rods														

**RECORD OF BOREHOLE No 310-9 1 of 1 METRIC**

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+437.5, o/s 52.5m Lt. CL median ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Continuous Flight Solid Stem Augers COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 05, 2007 CHECKED BY C.N.

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40	60	80	100						20
195.0	Top of Ice/snow																	
0.0	Ice/Snow					↓*												
0.3	Peat, coarse fibrous Dark brown fine fibrous		1	AS	-	↓*												
			2	SS	WH**													
193.5																		
1.5	Silty clay organics to 3.0m varved Firm Grey Moist to wet		3	SS	2													
	layers of silt																	
			4	SS	2													
			5	TW	PH													
190.1	layers of sandy silt trace gravel, cobbles		6	SS	10/10cm													
4.9	End of borehole																	
	Refusal on probable bedrock																	
	Sample 6: Sampler bouncing																	
	* 2007 03 05																	
	∇ Water level observed during drilling																	
	▼ Water level measured after drilling																	
	WH** Denotes penetration due to weight of hammer and rods																	



RECORD OF PENETRATION TEST No 310-3

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+412.5, o/s 52.5m Lt. CL median ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 05, 2007 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80						100	20
195.0 0.0	Ground Surface Probable peat																	
	Probable silty clay Very soft to soft																	0.5m frozen
186.3 8.7	End of dynamic cone penetration test Refusal on probable bedrock									120/15cm								

RECORD OF PENETRATION TEST No 310-10

1 of 1 METRIC

G.W.P. 5203-06-00 LOCATION Hwy 69(New), Sta. 13+437.5, o/s 26.5m Lt. CL median ORIGINATED BY F.P.  
 DIST 54 HWY 69 BOREHOLE TYPE Dynamic Cone Penetration Test COMPILED BY N.S.B.  
 DATUM Geodetic DATE March 05, 2007 CHECKED BY C.N.

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	20	40	60	80					
195.0 0.0	Ground Surface Probable peat															
	Probable silty clay Very soft to soft															
190.0 5.0	End of dynamic cone penetration test Refusal on probable bedrock															

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