



September 11, 2009

# REPORT

  
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## **FOUNDATION INVESTIGATION REPORT WHITE CLAY RIVER BRIDGE REPLACEMENT HIGHWAY 11, SITE NO. 47-005 TOWNSHIP OF MAISONVILLE, ONTARIO MINISTRY OF TRANSPORTATION, ONTARIO GWP 5239-06-00**

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**GEOCRES No.** 42A-77

**Report Number:** 07-1191-0008-WC

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## **1.0 INTRODUCTION**

Golder Associates Ltd. (Golder) has been retained by LEA Consulting Ltd. (LEA) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services for the detail design of the replacement of the structure carrying Highway 11 over White Clay River in the Township of Maisonville and Seseikinika (northwest of Kirkland Lake), Ontario.

The terms of reference for the scope of work are outlined in Golder's proposal P7-1191-0008, dated March 12, 2007. The work was carried out in accordance with the Quality Control Plan for this project dated September 18, 2007. The General Arrangement drawing for the bridge structure, dated May 2008, was provided to Golder by LEA in September 2008.

The purpose of this investigation is to establish the subsurface conditions at the proposed replacement structure and the approach embankments by borehole drilling, rock coring, in situ testing and laboratory testing on selected samples. The location of the investigated area is shown in plan in the Contract Drawings.

## **2.0 SITE DESCRIPTION**

The site is situated in the Township of Maisonville on Highway 11 crossing the White Clay River, approximately 18 km north of the junction with Highway 66. The existing road grade is about 2 m above the river water level. The surrounding land is mainly used for recreational activities, with grass and tree cover extending beyond the limits of the site. The banks adjacent to the river are vegetated with grass and small shrubs. A low-lying swampy area is present on the northwest side of the bridge, extending to Swan Lake Park Road. The river is about 40 m across at its narrowest at the existing crossing location where the north and south causeways have been extended some 40 m and 140 m into the river, respectively. On either side of the crossing, the river widens to about 250 m and then narrows toward the west. Approximately 1 km upstream of the river, a small lake is present. The river is mainly used for recreation and is an unregulated watercourse (i.e. it does not have a control dam).

The existing bridge was constructed in 1951 and has eight main spans with an overall deck length of 50.7 m. The current structure consists of a concrete deck with steel girders supported by concrete-timber hybrid pile caps on timber piles founded at an unknown depth. It is unknown if an earlier structure existed at the site prior to 1951 and details of any older foundations that may be present in the subsurface are not available. We understand that the existing bridge will be replaced with a new three-span structure approximately 54 m long.

The existing highway grade is at about Elevation 312.4 m and 312.3 m at the existing north and south bridge abutments with the grade increasing in elevation away from the bridge abutments. The water level in the river was measured at approximately Elevation 310.2 m in July 2008 and 310.1 m in October 2008.

## **3.0 INVESTIGATION PROCEDURES**

The fieldwork at the bridge site was carried out in four stages, with a total of twenty-three (23) boreholes advanced at the site. The borehole locations and groundwater surface elevations are shown on the Contract Drawings and noted on the respective Record of Borehole and Drillhole Sheets in Appendix A.

- Between July 7 and 23, 2008, thirteen (13) boreholes (WC-1 to WC-12 and WC-9a) were drilled for the proposed south and north abutments and approaches. Boreholes WC-1 and WC-11 were drilled on land using a CME 850 track-mounted drill rig supplied and operated by Landcore Drilling Inc. (Landcore) of Sudbury, Ontario. Boreholes WC-2 to WC-10 and WC-12 were drilled over water in the White Clay River using a D25 drill rig mounted on a modular raft supplied and operated by Walker Drilling Ltd. of Barrie, Ontario (Walker).



- On August 28, 2008, an additional one (1) borehole (WC-11a) was drilled on land near the north approach using portable equipment supplied by OGS Inc. of Ottawa, Ontario (OGS).
- Between October 25 and 28, 2008, a further six (6) boreholes (WC-5a, WC-11b, and WC-13 to WC 16) were drilled. Borehole WC-5a was drilled over water using raft-mounted portable equipment supplied and operated by OGS for the proposed south approach. Borehole WC-11b at the north approach and Boreholes WC-13 to WC-16 at the north embankment were drilled on land using portable equipment supplied and operated by OGS.
- On November 5 and 6, 2008, three (3) boreholes (WC-17 to WC-19) were drilled on land through the existing embankment using a CME55 truck-mounted drill supplied and operated by Walker.

The boreholes were advanced using either 108 mm inside diameter (I.D.) continuous flight hollow stem augers, NW casing and wash boring or portable equipment using BW casing and wash boring. Soil samples were obtained, where possible, continuously or at intervals of depth of about 0.75 m to 1.5 m, using a 50 mm outer diameter (O.D.) split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures (ASTM D1586-99). Shelby tube samples were taken in cohesive deposits at some borehole locations. In each borehole where hollow stem augers or NW Casing was used to advance the hole, N-vane shear tests were conducted in cohesive soils to assess the undrained shear strengths (ASTM D2573-01); in Boreholes WC-5a, WC-11a, WC-11b, WC-13, WC-14, WC-15 and WC-16, B-vanes were used inside the BW Casing. Rock core samples were obtained using an NQ size core barrel.

Boreholes WC-5a, WC-11a and WC-11b were advanced immediately adjacent to Boreholes WC 5, WC-11 and WC-11, respectively, to carry out additional field vane testing in, and/or to obtain Shelby Tube samples of the cohesive soil deposits.

The land-based boreholes were advanced to depths ranging from about 6.5 m to 16.5 m below the existing ground surface and the water-based boreholes were advanced to depths ranging from about 5.5 m to 27.4 m below the water surface at the time of drilling (including rock coring when carried out). Most of the boreholes were advanced to auger, casing, DCPT or sampler refusal (i.e. on inferred bedrock). However, four of the boreholes (WC-5, WC-9a, WC-11 and WC-19) were terminated after penetrating the cohesive deposit and prior to reaching refusal.

A minimum of 3 m of rock core was obtained from four of the boreholes drilled at this site at the proposed pier and abutment foundation units, namely Boreholes WC-6 to WC-9.

The groundwater conditions in the open boreholes were observed during the drilling operations. The water level readings are presented on the Record of Borehole sheets in Appendix A. The boreholes were backfilled with bentonite as per Ontario Regulation 903 (as amended by O. Reg. 372) upon completion of drilling.

In Boreholes WC-9 and WC-13, artesian water conditions were encountered. A seal consisting of granular bentonite (i.e. holeplug) was placed from the bottom of the borehole up to about 3.0 m in Borehole WC-9 and 5.0 m in Borehole WC-13 below the ground surface. Above this seal, the holes were backfilled with cuttings to ground surface to complete the abandonment of the boreholes.

Sediment control procedures as detailed in our Environmental Protection Plan were carried out to minimize sediment entering the river and/or disturbance of the river bottom. The soil cuttings from the land-based boreholes were used for backfill and also distributed in the vicinity of the boreholes. The wash water from the water-based boreholes was allowed to return to the river in a controlled manner; the cuttings from the water-based boreholes were used as backfill and distributed along the river banks.

Traffic protection was carried out for the boreholes drilled within the roadway in accordance with our Traffic Control Plan and MTO Book 7 Temporary Conditions Manual.



The fieldwork was supervised throughout by members of our engineering and technical staff who located the boreholes, arranged for the clearance of underground service locations, supervised the drilling and sampling operations, logged the boreholes, and examined and cared for the soil and rock core samples. The samples were identified in the field, placed in appropriate containers, labelled and transported to our Sudbury geotechnical laboratory where the samples underwent further visual examination and laboratory testing. Select Shelby tube samples were sent to our Mississauga laboratory for additional laboratory testing. All of the laboratory tests were carried out to MTO and/or ASTM Standards, as appropriate. Classification testing (water content, Atterberg limits and grain size distribution) was carried out on selected soil samples. A total of five one-dimensional consolidation (oedometer) tests were carried out on Shelby tube samples of the cohesive soil deposit from the boreholes. Uniaxial compressive strength (UCS) testing was carried out on selected specimens of the bedrock core recovered from the boreholes.

The locations of the proposed foundation elements were laid out in the field by Golder relative to the proposed centreline alignment staked in the field by LEA's subconsultant SRQ Geomatics Inc. (SRQ), based on the dimensions shown on the General Arrangement dated May 2008. Golder surveyed the ground surface elevation of the land-based boreholes once completed as well as the water surface elevation for the water-based boreholes. All borehole elevations were then referenced to LEA's centreline alignment survey. The ground surface and water surface elevations are referenced to geodetic datum. The northings and eastings in MTM NAD 83 were determined by plotting the station and offset of the boreholes (relative to the stakes) on the May 2008 General Arrangement and converting to the coordinate system.

## **4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS**

### **4.1 Regional Geology**

Published literature indicates that the site is located in the Abitibi Subprovince of the Superior Province. The bedrock geology forms part of the Huronian Supergroup which consists of conglomerate, sandstone, siltstone and agillite. (Geology of Ontario; OGS Special Volume 4)<sup>1</sup>. To the south of the site, the bedrock geology consists of granite-greenstone-gneiss terrane, generally with minor metasedimentary rock overlying the metavolcanic rock.

Based on terrain mapping by the Ontario Department of Lands and Forest<sup>2</sup>, the surficial soils in the vicinity of the site consist of lacustrine deposits comprising varved or massive clays, silts, fine sands and sands. The Ontario Geological Survey<sup>3</sup> (Map 5032) describes the subsurface soils in the vicinity of the site as outwashed plains compromised of gravels and sands, with peat swamps.

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<sup>1</sup> Geology of Ontario, 1991. Ontario Geological Survey, 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.

<sup>2</sup> Northern Ontario Engineering Geology Terrain Study, OGS Electronic Map Reference Number 5465.

<sup>3</sup> Northern Ontario Engineering Geology Terrain Study, OGS Electronic Map Reference Number 5032





## **4.2 Subsurface Conditions**

The detailed subsurface soil and groundwater conditions, as encountered in the boreholes advanced during this investigation, together with the results of the laboratory tests carried out on selected soil and rock samples, are presented on the attached Record of Borehole and Drillhole sheets in Appendix A. The stratigraphic boundaries shown on the Record of Borehole sheets are inferred from non-continuous sampling and observations of drilling progress and cuttings. These boundaries, therefore, represent transitions between soil types rather than exact planes of geological change. Further, subsurface conditions will vary between and beyond the borehole locations. The inferred soil stratigraphy based on the results of the boreholes is shown on the Contract Drawings.

In general, the subsoils at the structure site consist of peat, underlain by deposits of clayey silt to silty clay, silt, silt and sand to sand and gravel and cobbles and boulders. Within the existing embankment, the subsoils are generally comprised of sand embankment fill underlain by clayey silt to silty clay, silt and sand and gravel. The total thickness of overburden (including existing road fill at boreholes WC-17 to WC-19) is variable at the site, ranging from about 5.9 m to 17.4 m. The bedrock surface was confirmed by coring at four locations at depths ranging from 14.3 m to 17.4 m.

A more detailed description of the subsurface conditions encountered in the boreholes is provided in the following sections.

### **4.2.1 Topsoil**

Moist, brown to black sandy topsoil was encountered at ground surface in Boreholes WC-14 and WC-16 having a thickness of 0.3 m and 0.2 m, respectively. The ground surface at these boreholes is at Elevation 310.7 m and 311.1 m, respectively.

The natural water content measured on one sample of the topsoil is about 19 percent.

### **4.2.2 Pavement Structure**

In Boreholes WC-17 to WC-19 (drilled on the roadway surface), approximately 200 m to 240 m of asphalt was encountered overlying either 150 m of concrete (WC-17) or 250 m to 300 m of silty sand to sand and gravel road base fill. The ground surface at these boreholes is at Elevation 312.3 m.

### **4.2.3 Fill**

Fill was encountered in Boreholes WC-1, WC-14, WC-16, WC-17, WC-18 and WC-19. In Borehole WC-1 and Boreholes WC-16 through WC-19, the existing embankment fill consists of brown sand to sand and silt to sand and gravel containing trace to some silt, trace clay. Trace organics were noted in the fill in Borehole WC-1. In Borehole WC-14, the fill consists of a brown peat and grey silty clay. The fill was encountered at ground surface in Borehole WC-1, below the pavement structure in Boreholes WC-17 to WC-19 and below topsoil in Boreholes WC-14 and WC-16. The ground surface/top of fill ranges from about Elevation 310.4 m to 312.2 m and the fill ranges in thickness from about 0.6 m to 5.6 m. The bottom of the fill material was encountered up to 6.1 m below ground surface and the fill/native soil interface was encountered between Elevation 306.2 m and 310.1 m.

SPT 'N' values measured within the non-cohesive fill ranges from 4 to 51 blows per 0.3 m of penetration, indicating a very loose to very dense relative density. In Borehole WC-14, one SPT 'N' value within the cohesive fill was measured at 4 blows per 0.3 m of penetration, indicating a firm consistency. Grain size distributions of several samples of the fill are shown on Figures B-1 and B-2 in Appendix B for sand fill and sand and silt fill, respectively.



The natural water content measured on samples of the fill ranges between about 13 percent and 23 percent.

#### **4.2.4 Peat**

A 0.7 m to 3.1 m thick layer of wet, brown to black, very soft to soft peat containing trace sand was encountered underlying the fill in Boreholes WC-14 and WC-16, at the river bed in Boreholes WC-2 to WC-10 and WC-12 and at ground surface in Boreholes WC-11, WC-13 and WC-15. The top of the peat was encountered at depths up to 2.4 m below the ground surface or water surface at between Elevation 311.1 m and 307.8 m.

SPT 'N' values measured within the peat range from 0 (weight of hammer or rods) to 5 blows per 0.3 m of penetration. The higher 'N' values were measured at the north side (Boreholes WC-11 to WC-16) and at the extreme south side (Borehole WC-2) where the peat is considered to have a very soft to firm consistency. Elsewhere, such as in the river, the peat has a very soft consistency.

The natural water content measured on samples of the peat ranged between about 35 percent and 510 percent.

#### **4.2.5 Clayey Silt to Silty Clay**

Below the peat and/or fill in all boreholes excluding WC-1 and WC-2, a deposit of wet, grey, varved, clayey silt to silty clay was encountered. The surface of this deposit was encountered between Elevation 306.2 m and 310.2 m and ranged in thickness from 0.8 m to 9.1 m. Boreholes WC-5, WC-10 and WC-11 were terminated within the clayey silt to silty clay deposit and a dynamic cone was driven to refusal adjacent to Borehole WC-10.

SPT 'N' values measured within the clayey silt to silty clay range from 0 (i.e. weight of hammer or weight of rods) to 12 blows per 0.3 m of penetration suggesting a very soft to stiff consistency. In situ field vane testing carried out within this stratum measured undrained shear strengths ranging from about 13 kPa to 81 kPa, but typically ranging from about 15 kPa to 30 kPa, indicating a predominantly soft to firm consistency. One exception is below the existing embankment where the shear strengths typically ranged from 35 kPa to 50 kPa, indicating a predominantly firm to stiff consistency.

Atterberg limits testing carried out on several samples of the clayey silt to silty clay deposit indicate liquid limits ranging from about 26 percent to 62 percent and plastic limits ranging from about 16 percent to 24 percent, yielding plasticity indices ranging from about 6 percent to 39 percent. The results of the Atterberg limits testing are shown on the plasticity charts on Figures B-3a to B-3c for the clayey silt, clayey silt to silty clay and silty clay for clarity. The results indicate that the stratum ranges from a clayey silt of low plasticity to a silty clay of medium plasticity. The highest results were from the clay varves as shown on Figure B-3d which indicate the clay varves are of high plasticity.

The wide range of plasticity is indicative of the varved nature of the deposit. Where possible, Atterberg limits tests were carried out on samples from the Shelby tubes separated into the clay varved fraction and the 'siltier' varved fraction. The test results confirm that the clay varves are classified as a silty clay to clay of medium to high plasticity and the 'siltier' varves are a silt to clayey silt of low plasticity. It was not possible to separate the varves in some samples as they were too thin and, in these cases, the combined test results were within the range noted above.

In Borehole WC-19, a 1.5 m thick layer of silt was encountered beneath the fill and overlying the clayey silt to silty clay deposit at Elevation 308.0 m. The Atterberg limits testing indicates that the sample tested was non-plastic.

Grain size distribution tests were carried out on several samples of the clayey silt to silty clay deposit and the results are shown on Figures B-4a and B-4b.





The natural water content measured on select samples of this deposit ranges between 26 percent and 76 percent.

Five laboratory consolidation (oedometer) tests were carried out on specimens of the clayey silt to silty clay obtained from Boreholes WC-4, WC-8, WC-13, WC-17 and WC-18 and the test results are shown on Figures B-5, B-6, B-7, B-8, and B-9, respectively. The preconsolidation pressures ( $\sigma_p'$ ) were estimated from the Void Ratio versus logarithmic Pressure plots using the Casagrande method as well as from the Total Work versus Pressure plots. The relevant consolidation test results are summarized below.

<b>Borehole/ Sample Number</b>	<b>Elevation (m)</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>e_o</math></b>	<b><math>C_r</math></b>	<b><math>C_c</math></b>	<b><math>c_v^*</math> (cm<sup>2</sup>/s)</b>
WC-4/6	304.4	25	75	50	3.0	1.43	0.08	0.48	0.0240
WC-8/7	301.5	40	75	35	1.9	1.45	0.06	0.46	0.0088
WC-13/8	303.9	32	70	38	2.2	2.04	0.08	0.63	0.0039
WC-17/7	305.9	87	110	23	1.3	0.75	0.02	0.15	0.0410
WC-18/8	303.0	108	80	-28	0.7	1.25	0.05	0.31	0.0037

\*For stress range of approximately  $80 \leq \sigma_v' \leq 150$  kPa

where:  $\sigma_{vo}'$  effective overburden pressure in kPa

$\sigma_p'$  preconsolidation pressure in kPa

OCR overconsolidation ratio

$e_o$  initial void ratio

$C_c$  compression index (based on void ratio)

$C_r$  recompression index (based on void ratio)

$c_v$  coefficient of consolidation in cm<sup>2</sup>/s in the normally consolidated range

#### 4.2.6 Silt

Beneath the clayey silt to silty clay stratum in Boreholes WC-4, WC-5a, WC-9, WC-11b, WC-13, WC 15, WC-16, WC18 and WC-19, a deposit of silt was encountered. The top of this deposit was encountered from about Elevation 306.5 m to 298.5 m and the thickness ranges from about 0.3 m to 5.2 m.

SPT 'N' values measured within this deposit range from 0 (i.e. weight of rods) to 56 blows per 0.3 m of penetration, indicating a very loose to very dense relative density, typically loose to compact.

The test results of grain size distributions performed on several samples of the silt deposit are shown on Figure B-10.

The natural water content measured on samples of the silt ranged from about 12 percent to 72 percent.



#### **4.2.7 Silt and Sand to Sand and Gravel**

A deposit of grey silt and sand to sand and gravel was encountered underlying the peat/fill in Boreholes WC-1 and WC-2, below the clayey silt to silty clay in Boreholes WC-3, WC-14 and WC-17, below the silt in Boreholes WC-5a, WC-9, WC-13, WC15, WC-16, WC-18 and WC19 and below the cobbles and boulders in Borehole WC-6. The silt and sand to sand and gravel was noted to be grey to black in Boreholes WC-6 and WC-19. The deposit contained trace clay and/or trace to some silt and, in some boreholes, the presence of cobbles and boulders were inferred by grinding of augers or during the wash boring. The top of the deposit was encountered between Elevation 294.2 m and 310.0 m and the thickness ranges between 0.8 m and 5.6 m. Boreholes WC-14 and WC-19 were terminated within the silty sand to sand and gravel deposit.

SPT 'N' values measured within the deposit ranged from 8 to 74 blows per 0.3 m of penetration, indicating a loose to very dense relative density.

Grain size distributions on several samples of the silt and sand to silty sand and the sand, gravelly sand and sand and gravel are shown on Figures B-11a and B-11b in Appendix B, respectively.

The natural water content measured on samples of the silt and sand to sand and gravel range between 4 percent and 16 percent.

#### **4.2.8 Cobbles and Boulders**

In Boreholes WC-6 to WC-8, a 0.5 m to 2.6 m thick layer of cobbles and boulders was encountered generally above the bedrock surface. The surface of the cobbles and boulders ranges from Elevation 293.4 m to 297.2 m. In general, the cobbles and boulders were distinctly different from the bedrock below due to the rock fragment types and the presence of a sand and/or gravel matrix.

#### **4.2.9 Bedrock**

Bedrock was encountered and cored in Boreholes WC-6 to WC-9. The bedrock surface was inferred from auger, casing, dynamic cone or sampler refusal in all the remaining boreholes and dynamic cones except Boreholes WC-5, WC-9a, WC-11 and WC-19. The bedrock surface encountered in the boreholes ranged from Elevation 292.8 m to 305.9 m, and was encountered at depths ranging between 5.9 m and 17.4 m below ground or water surface, as presented in Table B-1 in Appendix B. In Boreholes WC-4, WC-11a and WC-12, the bedrock surface was inferred from resistance to dynamic cone penetration of greater than 50 blows per 0.3 m of penetration as well as adjacent boreholes.

Based on a review of the bedrock core samples, the bedrock at the site generally consists of grey, fine grained, moderately to slightly weathered siltstone, which is heavily jointed and fractured in the upper approximately 2.0 m to 3.5 m. In Boreholes WC-6 and WC-7, brownish red, fine to medium, fresh sandstone was encountered below the siltstone at Elevation 291.9 m and 289.5 m, respectively. In Borehole WC-7, a 0.8 m thick seam of sand and gravel was encountered below the siltstone cap rock at a depth of 17.9 m (Elevation 292.3 m).

The Rock Quality Designation (RQD) measured on the core samples ranged from 0 percent to 100 percent. This indicates rock mass of variable quality, ranging from very poor to excellent. The RQD values within the siltstone are generally between about 40 percent and 70 percent, indicating that the bedrock is of poor to fair quality. In the sandstone, RQD values of two rock core runs are 50 percent and 100 percent, indicating the bedrock is of fair to excellent quality. The Total Core Recovery (TCR) during bedrock coring was between 40 percent and 100 percent, generally increasing with depth.



Laboratory UCS testing was carried out on eight core samples of the bedrock from Boreholes WC-6 to WC-9. The UCS results ranged between 41 MPa and 256 MPa, indicating medium strong to extremely strong rock. Typically, the higher values are for the sandstone. The depths and corresponding elevations of the tested samples and results of the UCS testing are presented in Table B-2.

#### **4.2.10 Groundwater Conditions**

The water levels were noted during and immediately after the drilling and coring operations in the boreholes. In general, the soil samples taken in the boreholes were noted to be moist to wet with free water evident within most of the non-cohesive materials. Due to the largely water-based drilling program, piezometers were not installed in the boreholes at this site.

In the boreholes advanced on land to the north of the river (i.e. Boreholes WC-11, WC-13 to WC-16), the water levels in the open boreholes were between 0 m and 0.5 m below the ground surface ranging between Elevation 310.2 m and 311.0 m, which is within 0.8 m of the river water level. In the boreholes drilled through the existing embankment (i.e. Boreholes WC-1, WC-17 to WC-19), the water level measured in the open borehole was between 2.1 m and 2.3 m below the ground surface ranging between Elevation 310.0 m and 310.2 m, or at approximately the river water level. The water levels measured in the open boreholes during and upon completion of drilling are summarized below:

<b>Location</b>	<b>Borehole</b>	<b>Depth to Groundwater below Existing Ground Surface (m)</b>	<b>River/Groundwater Elevation (m)</b>
Proposed South Approach	WC-1	2.1	310.1
	WC-2	0	310.2*
	WC-3	0	310.2*
	WC-4	0	310.2*
	WC-12	0	310.2*
	WC-5	0	310.2*
	WC-5a	0	310.1*
	WC-6	0	310.2*
River Channel	WC-7	0	310.2*
	WC-8	0	310.2*
Proposed North Approach	WC-9/9a	0	310.2*
	WC-10	0	310.2*
	WC-11/11a	0	310.2
	WC-11b	0	310.3
	WC-13	0	310.3
	WC-14	0.3	310.4
	WC-15	0.1	311.0
	WC-16	0.5	310.6
Existing South Approach	WC-17	2.3	310.0
	WC-18	2.2	310.1
Existing North Approach	WC-19	2.1	310.2

\* River water level



In Boreholes WC-9 and WC-13, artesian pressures were noted during drilling. In Borehole WC-9 (drilled from the water surface), water was observed to be flowing out of the casing, which had a stick-up of 0.6 m, while advancing the casing through the top of the silt deposit at a depth of 11.7 m (Elevation 298.5 m). After penetrating partially into the silt, the artesian conditions stopped. In Borehole WC-13 (drilled in the low-lying area adjacent to the north bank of the river), the water level was 0.3 m above the ground surface while removing the casing. These boreholes were sealed as discussed in Section 3.0.

The water level of White Clay River was measured at Elevation 310.2 m in July 2008 and at Elevation 310.1 m in October 2008. The high water level and normal water level elevations were not provided to us at the time of this report. The White Clay River is an unregulated watercourse. The 1 in 50 year storm water level is approximately Elevation 311.3 m. Groundwater and river water levels in the area are subject to seasonal fluctuations and to fluctuations after precipitation events and snowmelt.

## **5.0 CLOSURE**

The field personnel supervising the drilling program were Mr. Ed Savard and Mr. Evan Childerhose for the water and land-based boreholes advanced during the summer months, respectively. Mr. Indulis Dumpis and Mr. Tim Rancourt supervised the drilling program during the fall months. This report was prepared by Mr. Tim Rancourt, E.I.T., and the technical aspects were reviewed by Ms. Sarah E.M. Coyne, P.Eng., an Associate with Golder. A quality control review of the report was provided by Mr. Jorge Costa, P.Eng., Golder's Designated MTO Contact for this project.



## Report Signature Page

**GOLDER ASSOCIATES LTD.**

Timothy Rancourt, E.I.T.  
Geotechnical Group

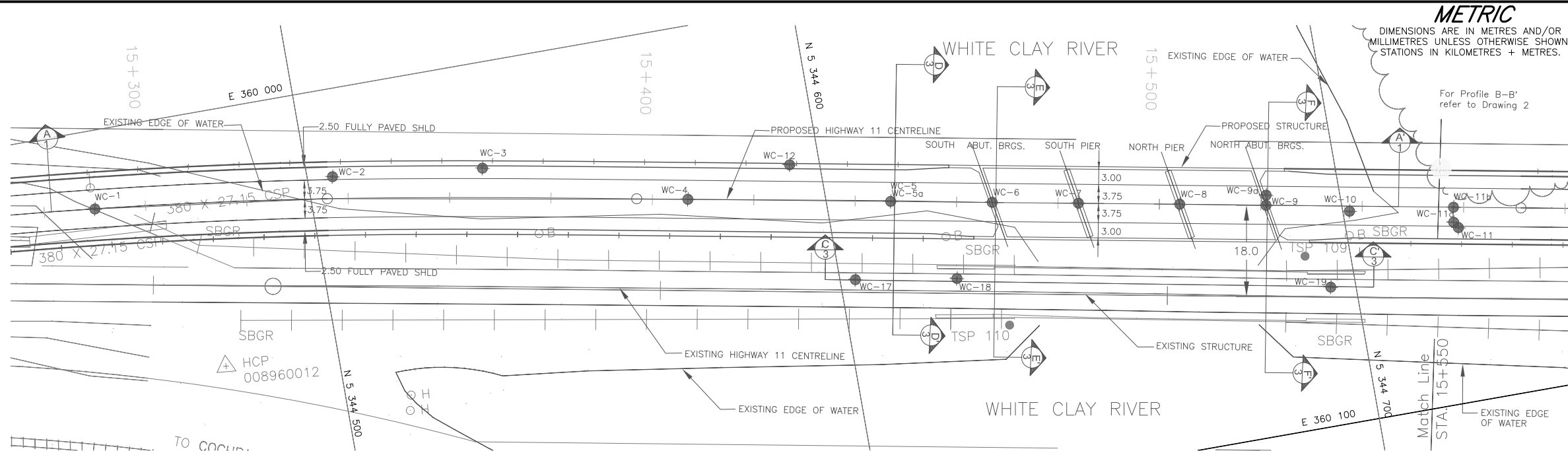


Sarah E.M. Coyne, P.Eng.  
Associate, Senior Geotechnical Engineer



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

TR/SEMC/AZ/JMAC/lb

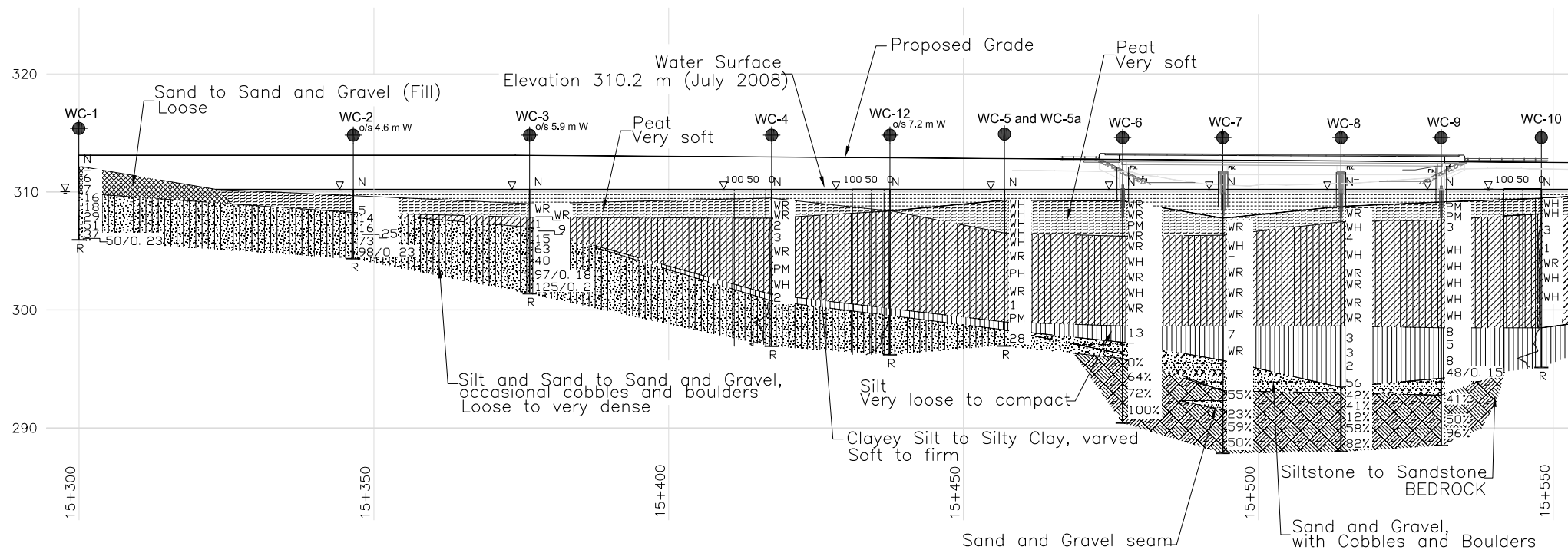


PLAN

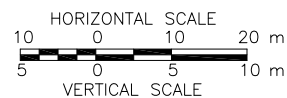


LEGEND

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



PROFILE A-A'



CONT No. 2011-5110  
WP No. 5239-06-00

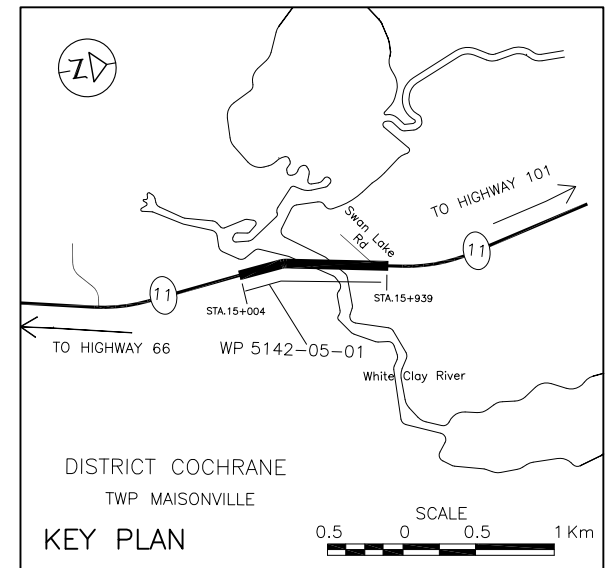
HIGHWAY 11 CROSSING  
WHITE CLAY RIVER  
STA 15+290 TO 15+535  
BOREHOLE LOCATION  
AND SOIL STRATA



SHEET  
49



Golder Associates Ltd.  
SUDBURY, ONTARIO, CANADA



No.	ELEVATION(m)	CO-ORDINATES	
		NORTHING	EASTING
WC-1	312.2	5344457.7	360015.3
WC-2	310.2	5344504.9	360017.2
WC-3	310.2	5344534.4	360020.7
WC-4	310.2	5344573.2	360033.8
WC-5	310.2	5344612.5	360041.1
WC-5a	310.1	5344612.5	360041.1
WC-6	310.2	5344632.2	360044.8
WC-7	310.2	5344648.9	360047.9
WC-8	310.2	5344668.6	360051.6
WC-9	310.2	5344685.3	360054.7
WC-9a	310.2	5344685.7	360052.7
WC-10	310.2	5344701.3	360058.8
WC-11	310.2	5344721.9	360065.7
WC-11a	310.2	5344721.1	360064.5
WC-11b	310.3	5344721.6	360061.5
WC-12	310.2	5344594.2	360030.6
WC-17	312.3	5344603.0	360055.1
WC-18	312.3	5344622.8	360058.4
WC-19	312.3	5344695.1	360072.8

## 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 provided in digital format by LEA, drawing file name 2007-032-White Clay-Recommended Plan.dwg dated May, 2008 and received September 9, 2008 and Key Plan.dwg received December, 2008.



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NO.	DATE	BY	REVISION						
Geocres No. 42A-77									
HWY. 11			PROJECT NO. 07-1191-0008					DIST.	
SUBM'D. AB		CHKD. AB		DATE: Nov 2009			SITE: 47-005		
DRAWN: MM		CHKD. SEMC		APPD. JMAC			DWG. 3		

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

CONT No. 2011-5110  
WP No. 5239-06-00

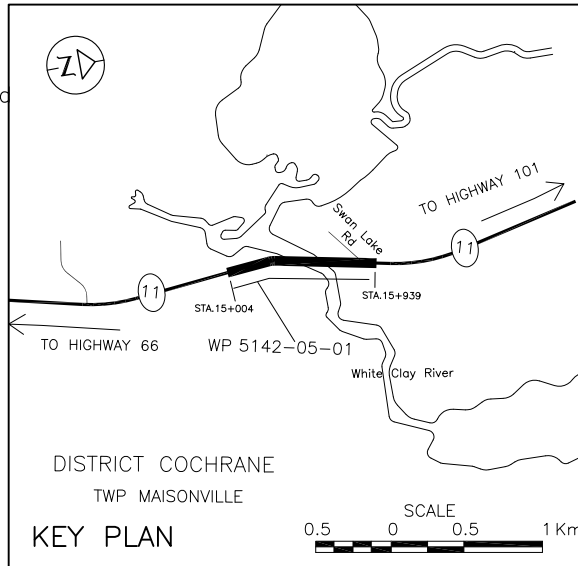


HIGHWAY 11 CROSSING  
WHITE CLAY RIVER  
SOIL STRATA

SHEET  
51



Golder Associates Ltd.  
SUDBURY, ONTARIO, CANADA



LEGEND

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

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.

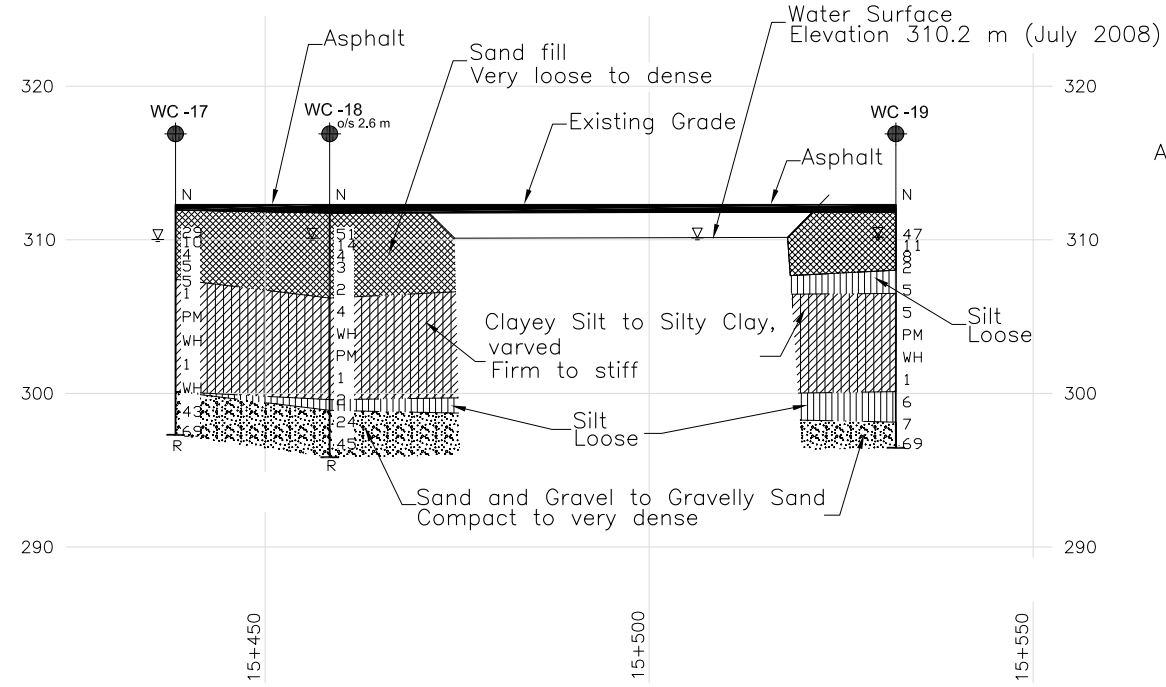
The boundaries between soil strata have been established only at borehole locations. Between Boreholes the boundaries are assumed from geological evidence.

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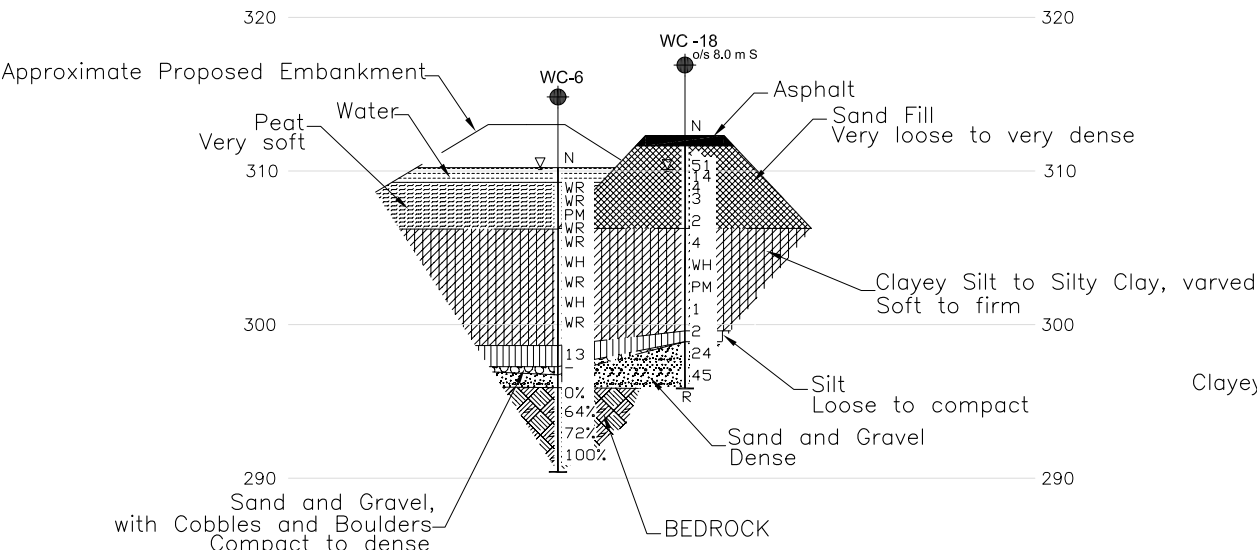
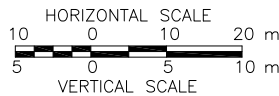
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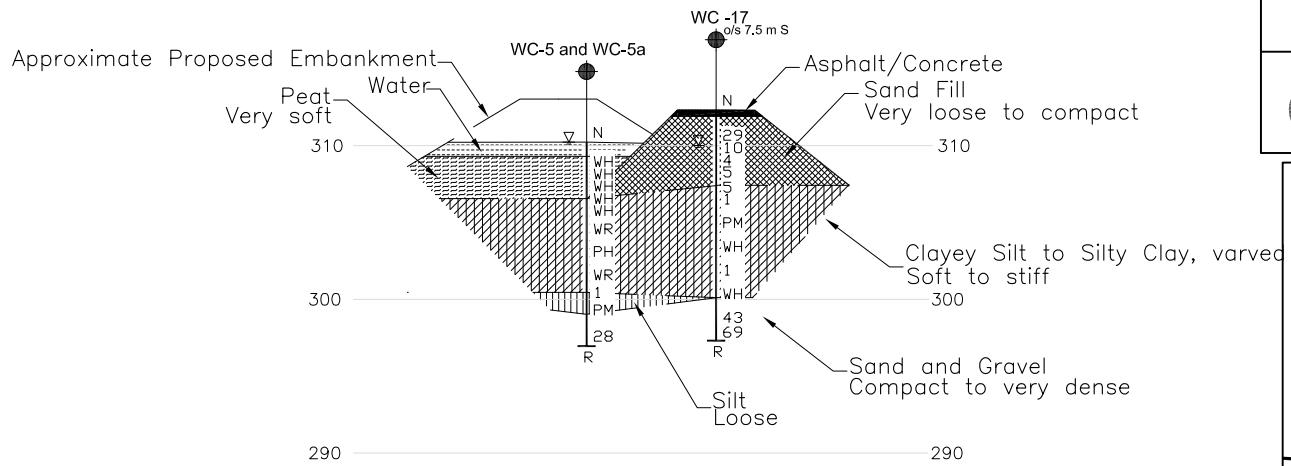
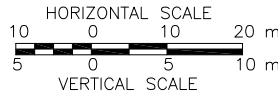
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DRAWN: MM	CHKD. SEMC	APPD. JMAC	DWG. 4



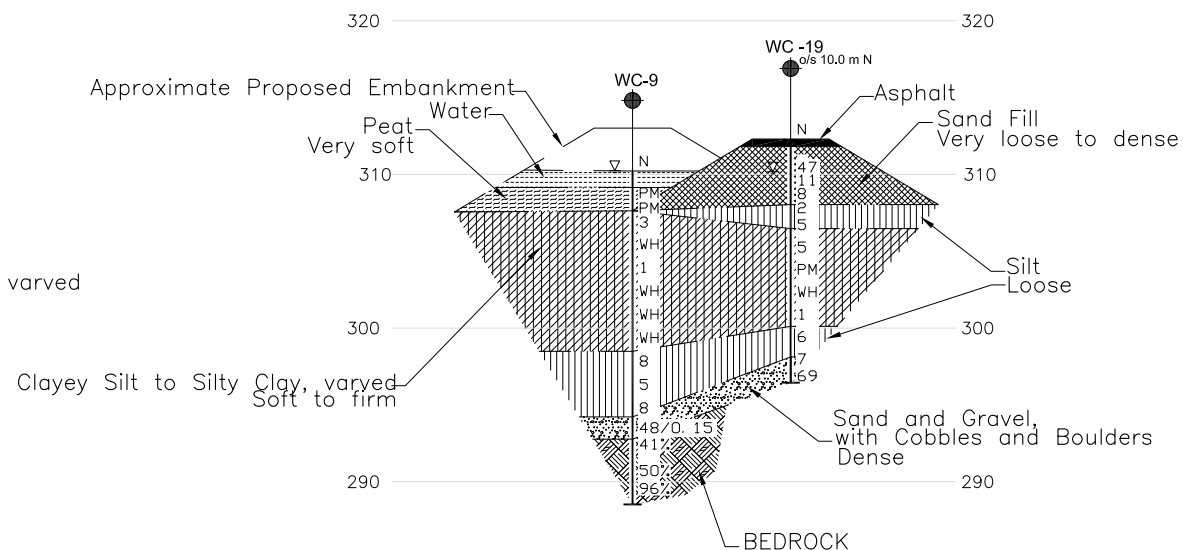
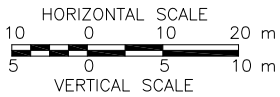
PROFILE C-C'



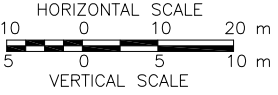
SECTION E-E'



SECTION D-D'



SECTION F-F'





# APPENDIX A

## RECORD OF BOREHOLES AND DRILLHOLES

## 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 or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time
F	factor of safety
V	volume
W	weight

### II. STRESS AND STRAIN

$\gamma$	shear strain
$\Delta$	change in, e.g. stress: $\Delta\sigma$
$\epsilon$	linear strain
$\epsilon_v$	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 x acceleration due to gravity).

#### (a) Index Properties (continued)

w	water content
$w_L$	liquid limit
$w_p$	plastic limit
$I_p$	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
$C_a$	coefficient of secondary consolidation
$m_v$	coefficient of volume change
$c_v$	coefficient of consolidation
$T_v$	time factor (vertical direction)
U	degree of consolidation
$\sigma'_p$	pre-consolidation pressure
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  $\tau = c' + \sigma' \tan \phi'$   
2 Shear strength = (Compressive strength)/2

## LIST OF ABBREVIATIONS

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

### I. SAMPLE TYPE

AS	Auger sample
BS	Block sample
CS	Chunk sample
SS	Split-spoon
DS	Denison type sample
FS	Foil sample
RC	Rock core
SC	Soil core
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

#### Piezcone Penetration Test (CPT)

An 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.

### III. SOIL DESCRIPTION

#### (a) Cohesionless Soils

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

#### (b) Cohesive Soils

#### Consistency

	$C_u, S_u$	
	kPa	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 <sub>p</sub>	plastic limit
w <sub>l</sub>	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 <sub>R</sub>	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.

# LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

## WEATHERING STATE

**Fresh:** no visible sign of weathering.

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

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

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

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

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

## BEDDING THICKNESS

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

## JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	> 3 m
Wide	1 - 3 m
Moderately close	0.3 - 1 m
Close	50 - 300 mm
Very close	< 50 mm

## GRAIN SIZE

Term	Size*
Very Coarse Grained	> 60 mm
Coarse Grained	2 - 60 mm
Medium Grained	60 microns - 2 mm
Fine Grained	2 - 60 microns
Very Fine Grained	< 2 microns

Note: \* Grains > 60 microns diameter are visible to the naked eye.

## CORE CONDITION

### Total Core Recovery

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

### Solid Core Recovery (SCR)

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

### Rock Quality Designation (RQD)

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

## DISCONTINUITY DATA

### Fracture Index

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

### Dip with Respect to (W.R.T.) Core Axis

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

### Description and Notes

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

### Abbreviations

B - Bedding	P - Polished
FO - Foliation/Schistosity	S - Slickensided
CL - Cleavage	SM - Smooth
SH - Shear Plane/Zone	R - Ridged/Rough
VN - Vein	ST - Stepped
F - Fault	PL - Planar
CO - Contact	FL - Flexured
J - Joint	UE - Uneven
FR - Fracture	W - Wavy
MF - Mechanical Fracture	C - Curved
- Parallel To	
⊥ - Perpendicular To	



PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-1				1 OF 1		METRIC							
W.P. 5239-06-00			LOCATION N 5344457.7 ; E 360015.3				ORIGINATED BY EC									
DIST HWY 11			BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers				COMPILED BY MM									
DATUM Geodetic			DATE July 10, 2008				CHECKED BY AB									
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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100								
312.2	GROUND SURFACE															
0.0	Sand, some gravel (FILL) Brown Moist		1	AS	-		312									
311.4																
0.8	Sand and gravel, trace silt and clay, containing organics (FILL) Loose Brown to black Moist		2	SS	6		311									
			3	SS	7											
310.0							310									
2.2	Gravelly SAND Compact Grey Wet		4	SS	16											25 56 (19)
			5	SS	18		309									
308.5																
3.7	SILT and SAND to Silty SAND, trace to some gravel, trace to some clay Compact to very dense Grey Wet		6	SS	29		308									
			7	SS	51		307									
			8	SS	37											8 43 42 7
306.0			9	SS	50/0.23		306									
6.2	End of Borehole Spoon Refusal (Hammer Bouncing)  Note:  1. Water level at a depth of 2.1 m below ground surface (Elev. 310.1 m) upon completion of drilling.															

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-2				1 OF 1		METRIC					
W.P. 5239-06-00			LOCATION N 5344504.9 ;E 360017.2				ORIGINATED BY EHS							
DIST HWY 11			BOREHOLE TYPE NW Casing, Wash Boring				COMPILED BY MM							
DATUM Geodetic			DATE July 22, 2008				CHECKED BY AB							
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 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED						
310.2 0.0	WATER SURFACE WATER						310							
309.4 0.8	PEAT, trace sand Very soft Brown Wet						309							
308.3 1.9	Silty SAND, some gravel, trace clay Compact to very dense Grey Wet  Occasional cobbles and boulders inferred from grinding of augers.		1	SS	5		308						165.5	
			2	SS	14		307							15 59 25 1
			3	SS	16		306							
			4	SS	25		305							
			5	SS	73									16 52 26 6
304.3 5.9	End of Borehole Spoon Refusal		6	SS	98/0.23									


MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-3			1 OF 1 METRIC													
W.P. 5239-06-00			LOCATION N 5344534.4 ;E 360020.7			ORIGINATED BY EHS													
DIST HWY 11			BOREHOLE TYPE NW Casing, Wash Boring			COMPILED BY MM													
DATUM Geodetic			DATE July 21, 2008			CHECKED BY AB													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			WATER CONTENT (%)			γ			GR SA SI CL		
310.2 0.0	WATER SURFACE WATER						310												
309.0 1.2	PEAT Very soft Brown Wet		1	SS	WR		309												
307.8 2.4	CLAYEY SILT to SILTY CLAY, trace sand, trace organics Very soft Grey Wet		2	SS	WR		308												
307.0 3.2	Silty SAND to SAND and GRAVEL, trace to some clay Loose to very dense Grey Wet		3	SS	1		307												
	Occasional cobbles and boulders inferred from grinding of augers.		4	SS	9		306												
			5	SS	15		305												
			6	SS	63		304												
			7	SS	40		303												
			8	SS	97/0.18		302												
301.4 8.8	End of Borehole Spoon Refusal		9	SS	125/0.2														

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-4			1 OF 1 METRIC												
W.P. 5239-06-00			LOCATION N 5344573.2 ;E 360033.8			ORIGINATED BY EHS												
DIST HWY 11			BOREHOLE TYPE NW Casing, Wash Boring			COMPILED BY MM												
DATUM Geodetic			DATE July 21, 2008			CHECKED BY AB												
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	10 20 30	W <sub>p</sub> W W <sub>L</sub>	γ	GR SA SI CL					
310.2 0.0	WATER SURFACE WATER						310											
309.5 0.7	PEAT Very soft Brown Wet		1	SS	WR		309											
307.8 2.4	CLAYEY SILT to SILTY CLAY, trace sand Soft to firm Grey Wet  Varved below 3.2 m depth.  Dark grey clay laminae 5 mm to 25 mm thick. Light grey silt laminae 5 mm to 10 mm thick.		2	SS	WR		308					170						
			3	SS	2		307								0	0	36	64
			4	SS	3		306											
			5	SS	WR		305	9 +	10 +									
			6	TO	PM		304					42 59	16.8					
			7	SS	WH		303											
301.3 8.9	SILT, trace to some clay, trace sand Very loose Grey Wet		8	SS	2		302	3 +	5 +									
300.8 9.4	End of Borehole						301								0	1	87	12
296.9 13.3	End of DCPT (50 Blows/0.15 m)  Note: 1. Dynamic Cone Penetration Test advanced 3.0 m north of Borehole No. WC-4.						297											

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT 07-1191-0008			<b>RECORD OF BOREHOLE No WC-5</b>				1 OF 1 <b>METRIC</b>					
W.P. 5239-06-00		LOCATION N 5344612.5 ;E 360041.1				ORIGINATED BY EHS						
DIST HWY 11		BOREHOLE TYPE NW Casing, Wash Boring				COMPILED BY MM						
DATUM Geodetic		DATE July 10, 2008				CHECKED BY AB						
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W <sub>P</sub> — W — W <sub>L</sub> WATER CONTENT (%) 10 20 30	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							
310.2 0.0	WATER SURFACE WATER						310					
309.3 0.9	PEAT, trace sand, trace gravel Very soft Brown Wet		1	SS	WH		309					
			2	SS	WH		308					
			3	SS	WH		307					
306.5 3.7	CLAYEY SILT to SILTY CLAY, varved Soft Grey Wet		4	SS	WH		306					
			5	SS	WH		305					
			6	SS	WR		304					
			7	TO	PH		303					
			8	SS	WR		302					
300.4 9.8	End of Borehole						301					

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-5a			1 OF 1 METRIC													
W.P. 5239-06-00			LOCATION N 5344612.5 ;E 360041.1			ORIGINATED BY ID													
DIST HWY 11			BOREHOLE TYPE BW Casing, Wash Boring, Portable equipment			COMPILED BY MM													
DATUM Geodetic			DATE October 24, 2008			CHECKED BY AB													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			WATER CONTENT (%)			γ			GR SA SI CL		
310.1	WATER SURFACE						310												
0.0	WATER						309												
309.0							308												
1.1	For soil stratigraphy refer to Record of Borehole WC-5.						307												
							306												
							305												
							304												
							303												
							302												
							301												
301.0	CLAYEY SILT to SILTY CLAY, varved Very soft to firm Grey Wet		1	SS	1		300												
298.9			2	TO	PM		299												
11.2	SILT Grey Wet						298												
298.2							297												
11.9	SAND and GRAVEL Compact Grey Wet		3	SS	28														
296.8																			
13.3	End of Borehole Casing Refusal																		

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM




PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-6			1 OF 2 METRIC													
W.P. 5239-06-00			LOCATION N 5344632.2 ; E 360044.8			ORIGINATED BY EHS													
DIST HWY 11			BOREHOLE TYPE NW Casing, Wash Boring			COMPILED BY MM													
DATUM Geodetic			DATE July 19 and 20, 2008			CHECKED BY AB													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			WATER CONTENT (%)			γ			GR SA SI CL		
310.2 0.0	WATER SURFACE WATER						310												
309.3 0.9	PEAT, trace sand Very soft Brown Wet		1	SS	WR		309												
			2	SS	WR		308												
			3	SS	WR		307												
			4	SS	WR		306												
306.2 4.0	CLAYEY SILT to SILTY CLAY, varved Soft to firm Grey Wet		5	SS	WR		305												
			6	SS	WH		304												
			7	TO	WR		303												
			8	SS	WH		302												
			9	SS	WR		301												
298.6 11.6	SILT, trace to some clay, occasional clay seams/layers Compact Grey Wet		10	SS	13		300												
297.2 13.0	BOULDER						299												
296.7 13.5	SAND and GRAVEL Black Wet		11	SC	REC 100%		298												
295.9 14.3			1	RC	REC 71%		297												
							296												

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

Continued Next Page

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






PROJECT <u>07-1191-0008</u>			<b>RECORD OF BOREHOLE No WC-6</b>				2 OF 2 <b>METRIC</b>										
W.P. <u>5239-06-00</u>		LOCATION <u>N 5344632.2 ;E 360044.8</u>		ORIGINATED BY <u>EHS</u>													
DIST <u>          </u> HWY <u>11</u>		BOREHOLE TYPE <u>NW Casing, Wash Boring</u>		COMPILED BY <u>MM</u>													
DATUM <u>Geodetic</u>		DATE <u>July 19 and 20, 2008</u>		CHECKED BY <u>AB</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  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
	--- CONTINUED FROM PREVIOUS PAGE ---																
	SILTSTONE to SANDSTONE (BEDROCK)		1	RC	REC 71%											RQD = 0%	
	Bedrock cored from 14.3 m to 19.8 m depth.		2	RC	REC 81%												RQD = 64%
	For coring details, refer to Record of Drillhole WC-6.		3	RC	REC 100%												RQD = 72%
			4	RC	REC 100%												RQD = 100%
290.4 19.8	End of Borehole																

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM



MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

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

PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-7				2 OF 2		METRIC						
W.P. 5239-06-00		LOCATION N 5344648.9 ;E 360047.9		ORIGINATED BY EHS											
DIST HWY 11		BOREHOLE TYPE NW Casing, Wash Boring		COMPILED BY MM											
DATUM Geodetic		DATE July 17 and 18, 2008		CHECKED BY AB											
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							
--- CONTINUED FROM PREVIOUS PAGE ---								20 40 60 80 100							
293.1	COBBLES and BOULDERS, containing sand and gravel						295								
17.1	SILTSTONE (BEDROCK)		1	RC	REC 100%		293								RQD = 55%
292.3	SAND and GRAVEL						292								
17.9															
291.5	SILTSTONE to SANDSTONE (BEDROCK)		2	RC	REC 100%		291								RQD = 23%
18.7	Bedrock cored from 18.7 m to 22.4 m depth.  For coring details, refer to Record of Drillhole WC-7.		3	RC	REC 100%		290								RQD = 59%
			4	RC	REC 100%		289								RQD = 50%
287.8							288								
22.4	End of Borehole														

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT: 07-1191-0008

## RECORD OF DRILLHOLE: WC-7

SHEET 1 OF 1

LOCATION: N 5344648.9 ; E 360047.9

DRILLING DATE: July 17 and 18, 2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE mm/rev	FLUSH	UN - Joint FLT - Fault SHR - Shear VN - Vein CJ - Conjugate	BD - Bedding FO - Foliation CO - Contact OR - Orthogonal CL - Cleavage	PL - Planar CU - Curved UN - Undulating ST - Stepped IR - Irregular	PO - Polished K - Slickensided SM - Smooth Ro - Rough MB - Mechanical Break	BR - Broken Rock  NOTE: For additional abbreviations refer to list of abbreviations & symbols	NOTES WATER LEVELS INSTRUMENTATION
18	NQ Coring July 18, 2008	Refer to Previous Page		293.10									
		SILTSTONE Fine grained Slightly to moderately weathered Very strong Grey		17.10	1		Grey 75					J, PL, SM J, ST, SM J, I, SM J, PL, SM J, I, SM J, ST, SM J, PL, SM	
		SAND and GRAVEL layer encountered between 17.9 m depth and 18.7 m depth.		292.30 17.90									
		SILTSTONE Heavily jointed and fractured with broken core zones from 18.7 m to 20.4 m depth and 20.6 m to 20.7 m depth.  Vertical joint between 19.2 m and 19.8 m depth.		291.50 18.70	2		Grey 75					BR	
												J, I, R J, PL, SM	
												J, I, R J, ST, SM J, I, R J, ST, R J, U, R J, ST, R J, I, R	UCS = 106 MPa
		SANDSTONE Fine to medium grained Slightly weathered Very strong Brownish red		289.50 20.70	3		Grey 75					J, I, R J, I, R J, U, R J, U, R J, U, R	
												J, I, R J, I, R J, U, R J, U, R	UCS = 188 MPa
		End of Drillhole		287.80 22.40	4		Grey 75						
19													
20													
21													
22													
23													
24													
25													
26													
27													

DEPTH SCALE

1 : 50



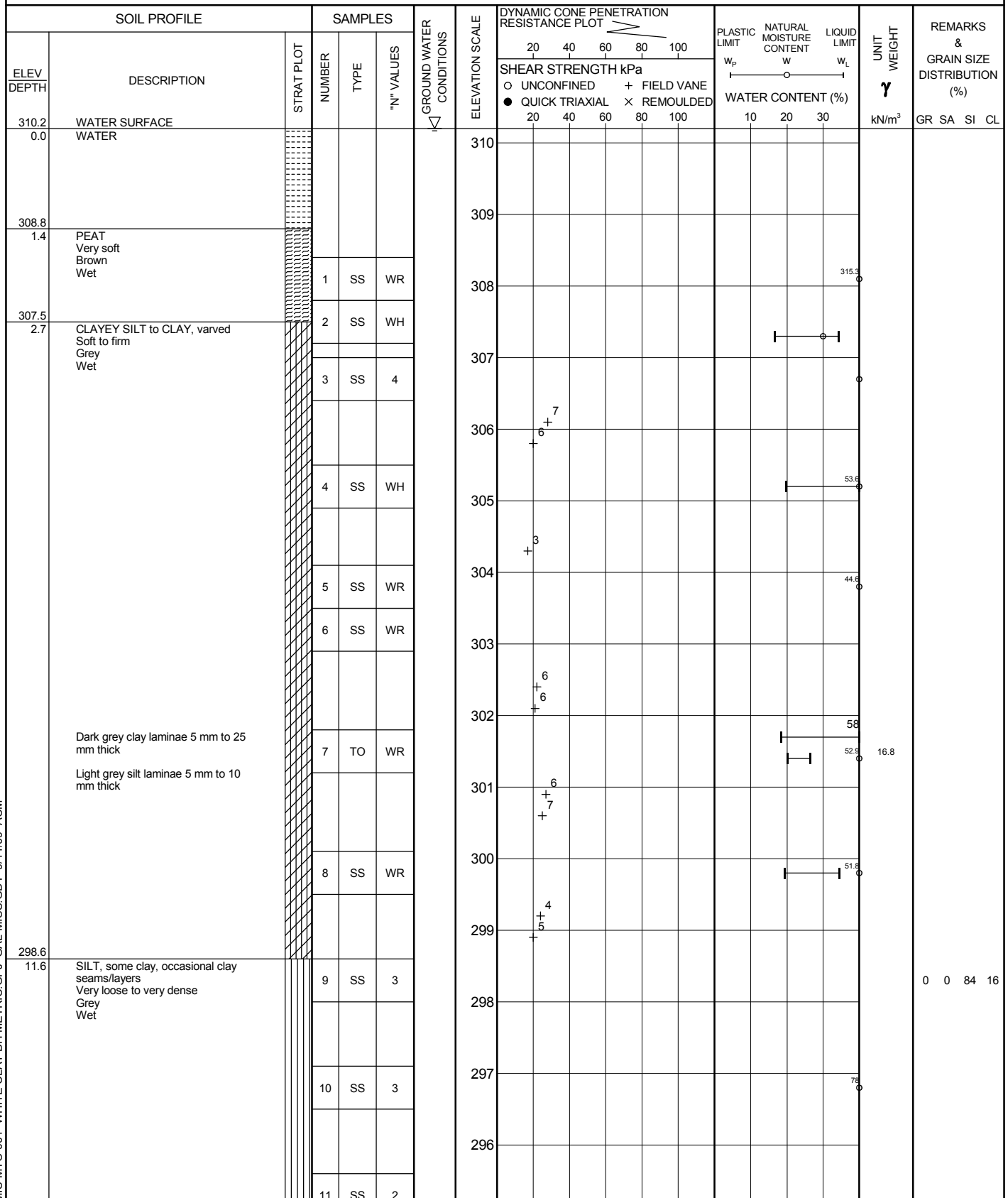
LOGGED: EHS

CHECKED: AB

MIS-RCK 004 WHITE CLAY BH METRIC GPJ GAL-MISS GDT 9/11/09 ACM



PROJECT <u>07-1191-0008</u>		<b>RECORD OF BOREHOLE No WC-8</b>		1 OF 2 <b>METRIC</b>	
W.P. <u>5239-06-00</u>	LOCATION <u>N 5344668.6 ; E 360051.6</u>	ORIGINATED BY <u>EHS</u>			
DIST <u>HWY 11</u>	BOREHOLE TYPE <u>NW Casing, Wash Boring</u>	COMPILED BY <u>MM</u>			
DATUM <u>Geodetic</u>	DATE <u>July 15 and 16, 2008</u>	CHECKED BY <u>AB</u>			



MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

Continued Next Page

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

PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-8				2 OF 2		METRIC						
W.P. 5239-06-00			LOCATION N 5344668.6 ; E 360051.6				ORIGINATED BY EHS								
DIST HWY 11			BOREHOLE TYPE NW Casing, Wash Boring				COMPILED BY MM								
DATUM Geodetic			DATE July 15 and 16, 2008				CHECKED BY AB								
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							
--- CONTINUED FROM PREVIOUS PAGE ---															
293.4	SILT, some clay, occasional clay seams/layers Very loose to very dense Grey Wet		12	SS	56		295								0 6 79 15
16.8	COBBLES and BOULDERS, with gravel						294								
292.9							293								RQD = 42%
17.3	SILTSTONE (BEDROCK)  Bedrock cored from 17.3 m to 22.2 m depth.  For coring details, refer to Record of Drillhole WC-8.		1	RC	REC 100%		292								RQD = 41%
			2	RC	REC 100%		291								RQD = 12%
			3	RC	REC 40%		290								RQD = 58%
			4	RC	REC 100%		289								RQD = 82%
			5	RC	REC 100%		288								
288.0	End of Borehole														
22.2															

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT: 07-1191-0008

## RECORD OF DRILLHOLE: WC-8

SHEET 1 OF 1

LOCATION: N 5344668.6 ; E 360051.6

DRILLING DATE: July 15 and 16, 2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE mm/rev	FLUSH	COLOUR % RETURN	UN - Joint FLT - Fault SHR- Shear VN - Vein CJ - Conjugate				BD- Bedding FO- Foliation CO- Contact OR- Orthogonal CL - Cleavage				PL - Planar CU- Curved UN- Undulating ST - Stepped IR - Irregular				PO- Polished K - Slickensided SM- Smooth Ro - Rough MB- Mechanical Break				BR - Broken Rock  NOTE: For additional abbreviations refer to list of abbreviations & symbols.	NOTES WATER LEVELS INSTRUMENTATION			
									RECOVERY				R.Q.D. %	FRACT. INDEX PER 0.3 m	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY K, cm/sec				Diametral Point Load Index (MPa)	RMC -Q' AVG.					
									TOTAL CORE %	SOLID CORE %	B Angle	DIP w.r.t. CORE AXIS			TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 10 10 10	10 10 10 10									
		Refer to Previous Page		292.90																									
	NQ Coring July 16, 2008	SILTSTONE Fine grained Moderately weathered Very strong to medium strong Grey  Heavily jointed and fractured with broken core zones from 17.3 m to 19.3 m depth.  Slightly weathered below 20.3 m depth.		17.30	1		Grey 50																						
18				2		Grey 50																							
19				3		Grey 50																							
20				4		Grey 50																							
21				5		Grey 50																							
22																													
					End of Drillhole		288.00																						
23				22.20																									
24																													
25																													
26																													
27																													

DEPTH SCALE

1 : 50



LOGGED: EHS

CHECKED: AB





MIS-RCK 004 WHITE CLAY BH METRIC GP J GAL-MISS GDT 9/11/09 ACM

PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-9			1 OF 2 METRIC											
W.P. 5239-06-00		LOCATION N 5344685.3 ; E 360054.7		ORIGINATED BY EHS													
DIST HWY 11		BOREHOLE TYPE NW Casing, Wash Boring		COMPILED BY MM													
DATUM Geodetic		DATE July 7 to 9, 2008		CHECKED BY AB													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)	10 20 30	γ	GR SA SI CL			
310.2 0.0	WATER SURFACE WATER						310										
309.1 1.1	PEAT Very soft Brown Wet		1	SS	PM		309						322.8				
307.6 2.6	CLAYEY SILT to SILTY CLAY, varved Soft to firm Grey Wet  Stiff above 4.0 m depth.		2	SS	PM		308										
			3	SS	3		307	9	5								
			4	SS	WH		306						55.8				
			5	SS	1		305	7	6								
			6	SS	WH		304	4	6				45.6	0 0 55 45			
			7	SS	WH		303						46.4				
			8	SS	WH		302	5									
			9	SS	8		301	8	4				48.5				
			10	SS	5		300						51				
298.5 11.7	SILT, trace to some clay, occasional clay seams/layers Loose Grey Wet						299	5	4								
							298										
							297							0 0 88 12			
							296										

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

Continued Next Page

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

PROJECT <u>07-1191-0008</u>			<b>RECORD OF BOREHOLE No WC-9</b>				2 OF 2 <b>METRIC</b>					
W.P. <u>5239-06-00</u>		LOCATION <u>N 5344685.3 ; E 360054.7</u>		ORIGINATED BY <u>EHS</u>								
DIST <u>HWY 11</u>		BOREHOLE TYPE <u>NW Casing, Wash Boring</u>		COMPILED BY <u>MM</u>								
DATUM <u>Geodetic</u>		DATE <u>July 7 to 9, 2008</u>		CHECKED BY <u>AB</u>								
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    × REMOULDED 20 40 60 80 100	PLASTIC LIMIT W <sub>P</sub> NATURAL MOISTURE CONTENT W LIQUID LIMIT W <sub>L</sub> WATER CONTENT (%) 10 20 30	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							
294.2	SILT, trace to some clay, occasional clay seams/layers Loose Grey Wet		11	SS	8		295					
16.0	SAND, trace silt, containing gravel, cobbles and boulders Very dense Grey Wet		12	SS	48/0.15		294					0 95 (5)
292.8	SILTSTONE (BEDROCK)  Bedrock cored from 17.4 m to 21.7 m depth.  For coring details, refer to Record of Drillhole WC-9.		1	RC	REC 60%		293					RQD = 41%
17.4			2	RC	REC 100%		292					RQD = 50%
			3	RC	REC 100%		291					
							290					
							289					RQD = 96%
288.5												
21.7	End of Borehole  Note:  1. On July 8, 2008, casing tip advanced to 11.7 m depth (Elev. 298.5 m) and with top of casing approximately 0.6 m above water (river) surface, water was flowing out of top of casing; when casing was advanced to 13 m depth (Elev. 297.2 m), water was not flowing out of casing.											

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT: 07-1191-0008

## RECORD OF DRILLHOLE: WC-9

SHEET 1 OF 1

LOCATION: N 5344685.3 ; E 360054.7

DRILLING DATE: July 7 to 9, 2008

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: D25

DRILLING CONTRACTOR: Walker Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE mm/rev	FLUSH	RECOVERY	R.Q.D.	FRACT. INDEX PER 0.3 m	B Angle	DIP w.r.t. CORE AXIS	DISCONTINUITY DATA	HYDRAULIC CONDUCTIVITY K, cm/sec	Diametral Point Load Index (MPa)	RMC "Q"	AVG.	NOTES WATER LEVELS INSTRUMENTATION
		Refer to Previous Page		292.80														
18	NO Coring July 9, 2008	SILTSTONE Fine grained Moderately to slightly weathered Very strong Grey  Heavily jointed and fractured with broken core zones from 18.5 m to 18.9 m depth and 19.1 m to 19.2 m depth and 19.4 m to 19.6 m depth.		17.40	1		Grey 50						J, ST, SM					
													J, ST, SM					
													J, ST, SM					
													J, ST, R					
													BR					
19													J, U, SM					
													J, ST, SM					
													BR					
													BR					
20					2		Grey 50						J, U, SM					
													J, ST, R					
													J, U, SM					
													J, ST, SM					
21					3		Grey 50						J, PL, SM					
													J, PL, SM					
													J, PL, SM					
22		End of Drillhole		288.50 21.70														
23																		
24																		
25																		
26																		
27																		

UCS = 180 MPa

UCS = 138 MPa

DEPTH SCALE


1 : 50



LOGGED: EHS

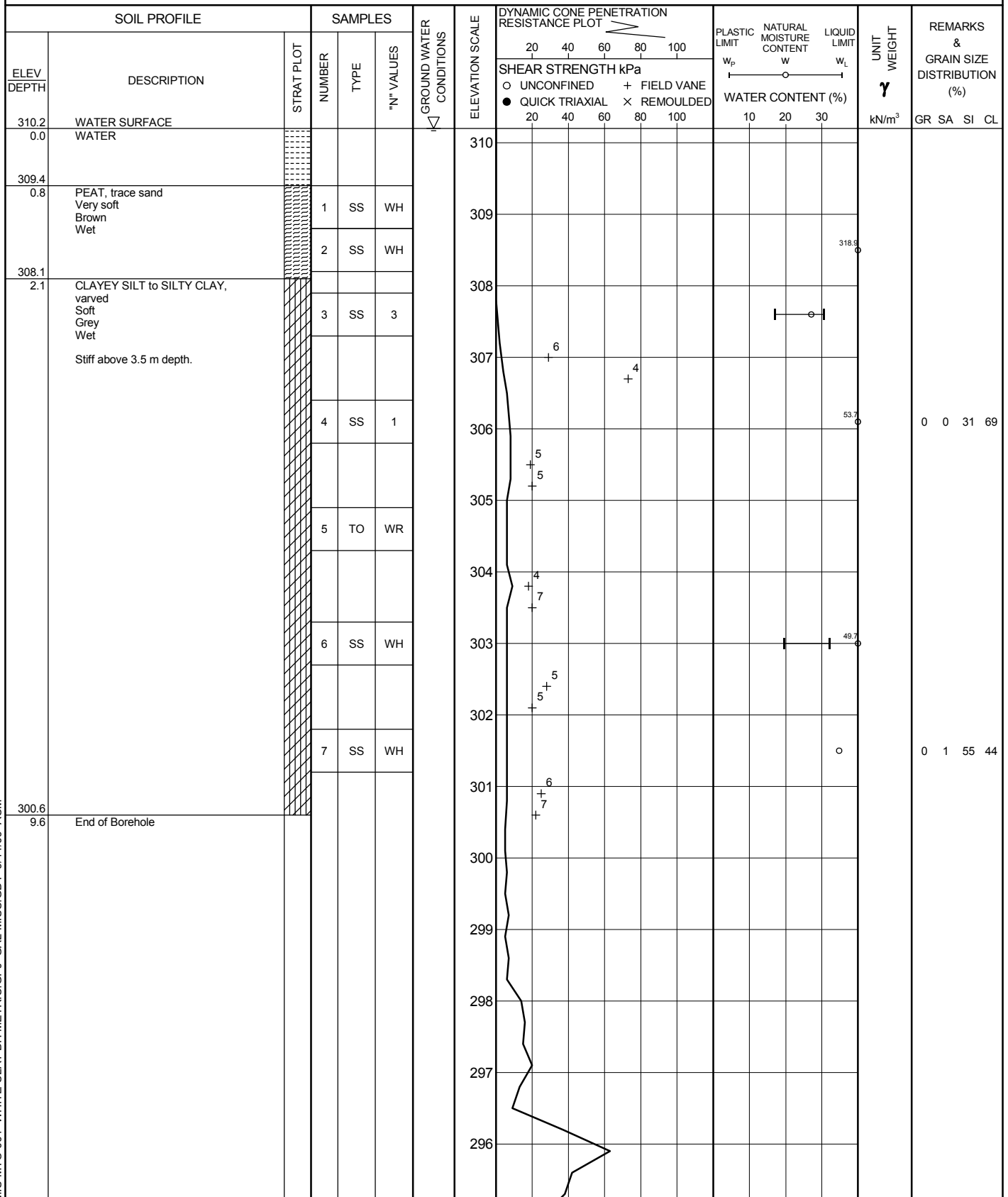
CHECKED: AB

MIS-RCK 004 WHITE CLAY BH METRIC.GPJ GAL-MISS GDT 9/11/09 ACM

PROJECT <u>07-1191-0008</u>			<b>RECORD OF BOREHOLE No WC-9a</b>			1 OF 1 <b>METRIC</b>													
W.P. <u>5239-06-00</u>			LOCATION <u>N 5344685.7 ;E 360052.7</u>			ORIGINATED BY <u>EHS</u>													
DIST <u>          </u> HWY <u>11</u>			BOREHOLE TYPE <u>NW Casing, Wash Boring</u>			COMPILED BY <u>MM</u>													
DATUM <u>Geodetic</u>			DATE <u>July 23, 2008</u>			CHECKED BY <u>AB</u>													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			WATER CONTENT (%)			γ			GR SA SI CL		
310.2 0.0	WATER SURFACE WATER						310												
309.3 0.9	For soil stratigraphy, refer to Record of Borehole WC-9.						309	+ 8											
							308	+ 4 + 3 + 3											
							307	+ 3 + 10 + 4											
							306	+ 5 + 6 + 4											
							305	+ 5 + 6 + 7 + 6											
304.7 5.5	End of Borehole																		

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT <u>07-1191-0008</u>		<b>RECORD OF BOREHOLE No WC-10</b>		1 OF 2 <b>METRIC</b>	
W.P. <u>5239-06-00</u>	LOCATION <u>N 5344701.3 ; E 360058.8</u>	ORIGINATED BY <u>EHS</u>			
DIST <u>HWY 11</u>	BOREHOLE TYPE <u>NW Casing, Wash Boring</u>	COMPILED BY <u>MM</u>			
DATUM <u>Geodetic</u>	DATE <u>July 7, 2008</u>	CHECKED BY <u>AB</u>			



MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

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

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



PROJECT <u>07-1191-0008</u>		<b>RECORD OF BOREHOLE No WC-10</b>		2 OF 2 <b>METRIC</b>	
W.P. <u>5239-06-00</u>	LOCATION <u>N 5344701.3 ;E 360058.8</u>	ORIGINATED BY <u>EHS</u>			
DIST <u>HWY 11</u>	BOREHOLE TYPE <u>NW Casing, Wash Boring</u>	COMPILED BY <u>MM</u>			
DATUM <u>Geodetic</u>	DATE <u>July 7, 2008</u>	CHECKED BY <u>AB</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  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	10
--- CONTINUED FROM PREVIOUS PAGE ---																		
295.1 15.1	End of DCPT Cone Refusal (Hammer Bouncing)  Note:  1. Dynamic Cone Penetration Test advanced about 2 m north and 1 m east of Borehole WC-10 on July 21, 2008.						295											

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT 07-1191-0008			<b>RECORD OF BOREHOLE No WC-11</b>				1 OF 1 <b>METRIC</b>						
W.P. 5239-06-00		LOCATION N 5344721.9 ; E 360065.7		ORIGINATED BY EC									
DIST HWY 11		BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers		COMPILED BY MM									
DATUM Geodetic		DATE July 10, 2008		CHECKED BY AB									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W <sub>p</sub> — W — W <sub>L</sub> WATER CONTENT (%)	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								
310.2 0.0	GROUND SURFACE PEAT, some sand Very soft Brown to black Wet		1	AS	-		310				58.3		
			2	SS	1			309					
			3	SS	WH			308				216.8	
308.0 2.2	CLAYEY SILT to SILTY CLAY Soft Grey Wet  Varved below 3.7 m depth.		4	SS	WH			308					
			5	TO	PH			307					
			6	SS	WH			306				52.6	0 0 32 68
			7	SS	WH			305				41.1	
			8	SS	WH			304					0 1 60 39
			9	SS	WH			303					
302.9 7.3	End of Borehole  Note: 1. Water level at ground surface (Elev. 310.2 m) upon completion of drilling.												

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT 07-1191-0008		<b>RECORD OF BOREHOLE No WC-11a</b>				1 OF 1 <b>METRIC</b>					
W.P. 5239-06-00		LOCATION N 5344721.1 ; E 360064.5				ORIGINATED BY TR					
DIST HWY 11		BOREHOLE TYPE Portable Equipment, 75 mm O.D. Hand Auger				COMPILED BY MM					
DATUM Geodetic		DATE August 28, 2008				CHECKED BY AB					
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT		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	GROUND WATER CONDITIONS	ELEVATION SCALE	W <sub>P</sub> W W <sub>L</sub>	WATER CONTENT (%)		
310.2 0.0	GROUND SURFACE For soil stratigraphy, refer to Record of Borehole WC-11.						310				
							309				
							308				
							307				
							306				
							305				
							304				
							303				
302.7 7.5	Start of DCPT						302				
							301				
							300				
							299				
298.2 12.0	End of DCPT (127 Blows/0.3 m)  Note:  1. Water level at ground surface (Elev. 310.2 m) upon completion of drilling.										

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-11b			1 OF 1 METRIC													
W.P. 5239-06-00			LOCATION N 5344721.6 ;E 360061.5			ORIGINATED BY ID													
DIST HWY 11			BOREHOLE TYPE BW Casing, Wash Boring, Portable equipment			COMPILED BY MM													
DATUM Geodetic			DATE October 25, 2008			CHECKED BY AB													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			WATER CONTENT (%)			γ			GR SA SI CL		
310.3	GROUND SURFACE																		
0.0	For soil stratigraphy, refer to Record of Borehole WC-11.																		
304.2	CLAYEY SILT to SILTY CLAY, varved Firm Grey Wet		1	SS	2														
6.1																			
			2	SS	1														
			3	SS	1														
299.6	SILT, trace clay, trace sand, trace gravel Loose Grey Wet		4	SS	62/0.18														
299.3	End of Borehole Spoon Refusal																		
11.0	Note: 1. Water level at ground surface (Elev. 310.3 m) upon completion of drilling.																		

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT <u>07-1191-0008</u>			<b>RECORD OF BOREHOLE No WC-12</b>			1 OF 1 <b>METRIC</b>					
W.P. <u>5239-06-00</u>			LOCATION <u>N 5344594.2 ; E 360030.6</u>			ORIGINATED BY <u>EHS</u>					
DIST <u>          </u> HWY <u>11</u>			BOREHOLE TYPE <u>NW Casing, Wash Boring</u>			COMPILED BY <u>MM</u>					
DATUM <u>Geodetic</u>			DATE <u>July 22, 2008</u>			CHECKED BY <u>AB</u>					
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W <sub>P</sub> — W — W <sub>L</sub> WATER CONTENT (%)	UNIT WEIGHT $\gamma$ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
310.2 0.0	WATER SURFACE WATER						310				
308.4 1.8							309				
							308	3 +			
							307	3 + 3 + 8 +			
							306	5 + 3 + 3 + 2 + 3 +			
							305	6 + 7 + 7 + 10 + 8 +			
							304	7 + 7 + 3 + 8 +			
							303	5 + 3 + 6 +			
							302	9 + 5 + 5 +			
300.8 9.4	Start of DCPT						301				
							300				
							299				
							298				
							297				
296.2 14.0	End of DCPT (64 Blows/0.3 m)										

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-13			1 OF 1 METRIC							
W.P. 5239-06-00			LOCATION N 5344762.9 ; E 360069.3			ORIGINATED BY ID							
DIST HWY 11			BOREHOLE TYPE BW Casing, Wash Boring, Portable equipment			COMPILED BY MM							
DATUM Geodetic			DATE October 26, 2008			CHECKED BY AB							
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT <div style="display: flex; justify-content: space-around; font-size: small;"> <span>20 40 60 80 100</span> </div>	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								
310.3 0.0	GROUND SURFACE		1	SS	1		310						
	PEAT Very soft Brown Wet		2	SS	1								
			3	SS	1		309						
308.3 2.0	CLAYEY SILT to SILTY CLAY, varved Soft to stiff Grey Wet		4	SS	2		308						0 19 45 36
			5	SS	7		307						
			6	SS	2		306						
			7	SS	2		305						0 0 59 41
			8	TO	PM		304					15.5	
301.8 8.5	SILT Grey Wet		9	SS	4		303						
301.0 9.3	Silty SAND to SAND and GRAVEL Compact to very dense Grey Wet		10	SS	20		302						
			11	SS	54		301						42 47 (11)
297.9 12.4	End of Borehole Spoon Refusal (Hammer Bouncing)  Note:  1. During casing removal, water level in casing was noted to be 0.3 m above ground surface.  2. Water level at ground surface (Elev. 310.3 m) upon completion of drilling.		12	SS	19/0.2		298						

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT 07-1191-0008		<b>RECORD OF BOREHOLE No WC-14</b>		1 OF 1 <b>METRIC</b>	
W.P. 5239-06-00	LOCATION N 5344802.1 ;E 360077.5	ORIGINATED BY ID			
DIST HWY 11	BOREHOLE TYPE BW Casing, Wash Boring, Portable equipment	COMPILED BY MM			
DATUM Geodetic	DATE October 27, 2008	CHECKED BY AB			

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 ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED						
310.7	GROUND SURFACE														
310.4	Peat (FILL) Very soft Brown Moist		1	SS	4										
310.1	Silty clay (FILL) Firm Grey Wet		2	SS	1										
309.3	PEAT Very soft Black Wet		3	SS	4										
308.4	CLAYEY SILT to SILTY CLAY, varved Firm to stiff Grey Wet		4	SS	8										
		5	SS	12											
		6	SS	4											
		7	SS	1											
		8	SS	1											
307.5															
306.5															
305.5															
304.5															
303.4															
303.4	SILT and SAND to SAND and GRAVEL, trace clay Loose to very dense Grey Wet		10	SS	8										
302.5															
301.5															
300.9			11	SS	73										
300.9	End of Borehole Casing Refusal														
9.8	Note:  1. Water level at a depth of 0.3 m below ground surface (Elev. 310.4 m) upon completion of drilling.														

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

<b>PROJECT</b> 07-1191-0008		<b>RECORD OF BOREHOLE No WC-15</b>		1 OF 1 <b>METRIC</b>	
W.P. 5239-06-00		LOCATION N 5344840.9 ;E 360087.1		ORIGINATED BY ID	
DIST HWY 11		BOREHOLE TYPE BW Casing, Wash Boring, Portable equipment		COMPILED BY MM	
DATUM Geodetic		DATE October 27 and 28, 2008		CHECKED BY AB	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL LIMIT   MOISTURE   CONTENT   LIQUID LIMIT			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	20   40   60   80   100	W <sub>p</sub> W   W <sub>L</sub>	WATER CONTENT (%)				
								SHEAR STRENGTH kPa ○ UNCONFINED   + FIELD VANE ● QUICK TRIAXIAL   × REMOULDED							
311.1	GROUND SURFACE						311								
0.0	PEAT Soft Brown Wet		1	SS	3										
310.2	CLAYEY SILT to SILTY CLAY, varved Soft to stiff Grey Wet		2	SS	4			310							
0.9			3	SS	12										0   2   37   61
			4	SS	8										
			5	SS	8										
			6	SS	1										
306.5	SILT, some clay Very loose Grey Wet		7	SS	1		307								
4.6														0   0   88   12	
305.3	SAND and GRAVEL Dense Grey Wet						306								
5.8			8	SS	38		305								
304.0	End of Borehole Casing Refusal  Note:  1. Water level at a depth of 0.1 m below ground surface (Elev. 311.0 m) upon completion of drilling.						304								
7.1															

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM



PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-16			1 OF 1 METRIC													
W.P. 5239-06-00			LOCATION N 5344879.5 ; E 360097.4			ORIGINATED BY ID													
DIST HWY 11			BOREHOLE TYPE BW Casing, Wash Boring, Portable equipment			COMPILED BY MM													
DATUM Geodetic			DATE October 28, 2008			CHECKED BY AB													
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED			WATER CONTENT (%)			γ			GR SA SI CL		
311.1	GROUND SURFACE							20 40 60 80 100											
0.0	TOPSOIL																		
0.2	Brown		1	SS	3													9 40 31 20	
	Sand and silt, some clay, trace to some gravel (FILL)																		
	Loose		2	SS	5														
310.0	Brown																		
1.1	Wet																		
	PEAT		3	SS	3														
309.3	Soft																		
1.8	Brown																		
	Wet																		
	CLAYEY SILT to SILTY CLAY, trace sand, varved		4	SS	11													0 5 63 32	
	Firm to stiff																		
	Grey																		
	Wet		5	SS	2														
			6	SS	1														
305.0																			
6.1	SILT, trace sand		7	SS	12														
	Compact																		
	Grey																		
	Wet																		
303.2																			
7.9	SAND and GRAVEL, some silt, trace clay		8	SS	19													44 36 (20)	
	Compact																		
	Grey																		
	Wet																		
301.7			9	SS	74/0.15														
9.4	End of Borehole																		
	Spoon Refusal																		
	Note:																		
	1. Water level at a depth of 0.5 m below ground surface (Elev. 310.6 m) upon completion of drilling.																		

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-17			1 OF 2 METRIC											
W.P. 5239-06-00			LOCATION N 5344603.0 ; E 360055.1			ORIGINATED BY ID											
DIST HWY 11			BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers			COMPILED BY MM											
DATUM Geodetic			DATE November 5, 2008			CHECKED BY AB											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>	WATER CONTENT (%)	10 20 30	γ	GR SA SI CL			
312.3	GROUND SURFACE																
0.0	ASPHALT (200 mm) over																
311.9	CONCRETE (150 mm)																
0.4	Sand, trace gravel, trace silt (FILL) Very loose to compact Brown Moist to wet		1	SS	29		312										
			2	SS	10		311							2 93 (5)			
			3	SS	4		310										
			4	SS	5		309										
			5	SS	5		308							3 94 (3)			
307.4	CLAYEY SILT to SILTY CLAY, varved Firm to stiff Grey Wet		6	SS	1		307										
4.9	Dark grey clay laminae 2 mm to 5 mm thick.  Light grey silt laminae 2 mm to 5 mm thick.		7	TO	PM		306						19.4				
			8	SS	WH		305										
			9	SS	1		304										
			10	SS	WH		303										
300.1	SAND and GRAVEL, some silt, trace to some clay Dense to very dense Grey Wet		11	SS	43		302										
12.2			12	SS	69		301										
297.3							300							42 34 18 6			

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

Continued Next Page

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

PROJECT <u>07-1191-0008</u>			<b>RECORD OF BOREHOLE No WC-17</b>				2 OF 2 <b>METRIC</b>					
W.P. <u>5239-06-00</u>		LOCATION <u>N 5344603.0 ;E 360055.1</u>		ORIGINATED BY <u>ID</u>								
DIST <u>          </u> HWY <u>11</u>		BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers</u>		COMPILED BY <u>MM</u>								
DATUM <u>Geodetic</u>		DATE <u>November 5, 2008</u>		CHECKED BY <u>AB</u>								
SOIL PROFILE			SAMPLES			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	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	W <sub>p</sub> W W <sub>L</sub>			10 20 30
15.0	End of Borehole Auger Refusal  Note:  1. Water level at a depth of 2.3 m below ground surface (Elev. 310.0 m) upon completion of drilling.							SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100				


MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-18			1 OF 2 METRIC											
W.P. 5239-06-00			LOCATION N 5344622.8 ; E 360058.4			ORIGINATED BY ID											
DIST HWY 11			BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers			COMPILED BY MM											
DATUM Geodetic			DATE November 5, 2008			CHECKED BY AB											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	20 40 60 80 100	20 40 60 80 100	W <sub>P</sub> W W <sub>L</sub>	WATER CONTENT (%)	10 20 30	γ	GR SA SI CL			
312.3	GROUND SURFACE																
0.0	ASPHALT (240 mm) over crushed sand and gravel (300 mm) (FILL)						312										
311.8							311										
0.5	Sand, trace gravel, trace to some silt (FILL) Very loose to very dense Brown to grey Moist to wet		1	SS	51		310										
			2	SS	14		309										
			3	SS	4		308										
			4	SS	3		307										
			5	SS	2		306										
306.2			6	SS	4		305										
6.1	CLAYEY SILT to SILTY CLAY, varved Firm Grey Wet		7	SS	WH		304										
			8	TO	PM		303										
	Dark grey clay laminae 7 mm to 30 mm thick.  Light grey silt laminae 5 mm to 10 mm thick.		9	SS	1		302										
			10	SS	2		301										
299.6							300										
12.7	SILT Grey Wet						299										
298.9							298										
13.4	Gravelly SAND, trace to some silt Compact to dense Grey Moist to wet		11	SS	24												

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

Continued Next Page

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

PROJECT 07-1191-0008			RECORD OF BOREHOLE No WC-18				2 OF 2		METRIC							
W.P. 5239-06-00			LOCATION N 5344622.8 ;E 360058.4				ORIGINATED BY ID									
DIST HWY 11			BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers				COMPILED BY MM									
DATUM Geodetic			DATE November 5, 2008				CHECKED BY AB									
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								
	--- CONTINUED FROM PREVIOUS PAGE ---															
295.8	Gravelly SAND, trace to some silt Compact to dense Grey Moist to wet		12	SS	45		297									
16.5	End of Borehole Auger Refusal						296									
	Note: 1. Water level at a depth of 2.2 m below ground surface (Elev. 310.1 m) upon completion of drilling. 2. Approximately 1.0 m of heave was noted inside augers at 6.0 m depth.															

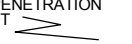

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

PROJECT 07-1191-0008			<b>RECORD OF BOREHOLE No WC-19</b>			1 OF 2 <b>METRIC</b>					
W.P. 5239-06-00			LOCATION N 5344695.1 ; E 360072.8			ORIGINATED BY ID					
DIST HWY 11			BOREHOLE TYPE 108 mm I.D. Hollow Stem Augers			COMPILED BY MM					
DATUM Geodetic			DATE November 6, 2008			CHECKED BY AB					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100	PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W <sub>P</sub> — W — W <sub>L</sub> WATER CONTENT (%) 10 20 30	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						
312.3	GROUND SURFACE										
0.0	ASPHALT (230 mm) over crushed sand and gravel (250 mm) (FILL)						312				
311.8											
0.5	Sand, trace gravel, trace to some silt (FILL) Very loose to dense Brown to grey Moist		1	SS	47		311				
			2	SS	11						
			3	SS	8		310				
			4	SS	2		309				
308.0							308				
4.3	SILT, containing organics Loose Brown to black Wet		5	SS	5		307				
306.5											
5.8	CLAYEY SILT to SILTY CLAY Firm Grey Wet		6	SS	5		306				
							305				
	Dark grey clay laminae 5 mm to 10 mm thick.		7	TO	PM		304				
	Light grey silt laminae 5 mm to 10 mm thick.						303				
			8	SS	WH		302				
							301				
			9	SS	1		300				
300.1							299				
12.2	SILT, some clay, trace sand Loose Grey Wet		10	SS	6		298				
298.1											
14.2	SAND and GRAVEL Very dense Grey to black Wet		11	SS	7						

MIS-MTO 001 WHITE CLAY BH METRIC.GPJ GAL-MISS.GDT 9/11/09 ACM

Continued Next Page

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

PROJECT <u>07-1191-0008</u>			<b>RECORD OF BOREHOLE No WC-19</b>				2 OF 2 <b>METRIC</b>					
W.P. <u>5239-06-00</u>			LOCATION <u>N 5344695.1 ;E 360072.8</u>				ORIGINATED BY <u>ID</u>					
DIST <u>          </u> HWY <u>11</u>			BOREHOLE TYPE <u>108 mm I.D. Hollow Stem Augers</u>				COMPILED BY <u>MM</u>					
DATUM <u>Geodetic</u>			DATE <u>November 6, 2008</u>				CHECKED BY <u>AB</u>					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT  SHEAR STRENGTH kPa ○ UNCONFINED    + FIELD VANE ● QUICK TRIAXIAL    × REMOULDED 20 40 60 80 100	PLASTIC LIMIT w <sub>p</sub> NATURAL MOISTURE CONTENT w LIQUID LIMIT w <sub>L</sub> WATER CONTENT (%) 10 20 30	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							
296.5	--- CONTINUED FROM PREVIOUS PAGE --- SAND and GRAVEL Very dense Grey to black Wet		12	SS	69		297					
15.8	End of Borehole  Note:  1. Water level at a depth of 2.1 m below ground surface (Elev. 310.2 m) upon completion of drilling.											



# **APPENDIX B**

## **LABORATORY TEST RESULTS**



**TABLE B-1  
REFUSAL/BEDROCK ELEVATIONS  
WHITE CLAY RIVER BRIDGE REPLACEMENT  
GWP 5239-06-00, SITE NO. 47-005  
HIGHWAY 11, TOWNSHIP OF MAISONVILLE**

<b>Borehole</b>	<b>Depth to Refusal/Bedrock Surface (m)</b>	<b>Refusal/Bedrock Surface Elevation (m)</b>	<b>Comments</b>
WC-1	6.2	306.0	Split-Spoon Refusal
WC-2	5.9	304.3	Split-Spoon Refusal
WC-3	8.8	301.4	Split-Spoon Refusal
WC-4*	13.3	296.9	End of DCPT >50 blows/0.3m
WC-5	Refusal not encountered; borehole terminated above bedrock surface		
WC-5a	13.3	296.8	Casing Refusal
WC-6	14.3	295.9	Bedrock Cored
WC-7	17.1	293.1	Bedrock Cored
WC-8	17.3	292.9	Bedrock Cored
WC-9	17.4	292.8	Bedrock Cored
WC-9a	Refusal not encountered; borehole advanced for field vane testing		
WC-10	15.1	295.1	DCPT Refusal
WC-11	Refusal not encountered; borehole terminated above bedrock surface		
WC-11a*	12.0	298.2	End of DCPT >50 blows/0.3m
WC-11b	11.0	299.3	Split-Spoon Refusal
WC-12*	14.0	296.2	End of DCPT >50 blows/0.3m
WC-13	12.4	297.9	Split-Spoon Refusal
WC-14	9.8	300.9	Casing Refusal
WC-15	7.1	304.0	Casing Refusal
WC-16	9.4	301.7	Split-Spoon Refusal
WC-17	15.0	297.3	Auger Refusal
WC-18	16.5	295.8	Auger Refusal
WC-19	Refusal not encountered; borehole terminated above bedrock surface		

\* Bedrock surface inferred from resistance to dynamic cone penetration >50 blows/0.3 m and based on information from the adjacent boreholes.

Compiled by: TR  
Checked by: SEMC  
Reviewed by: JMAC

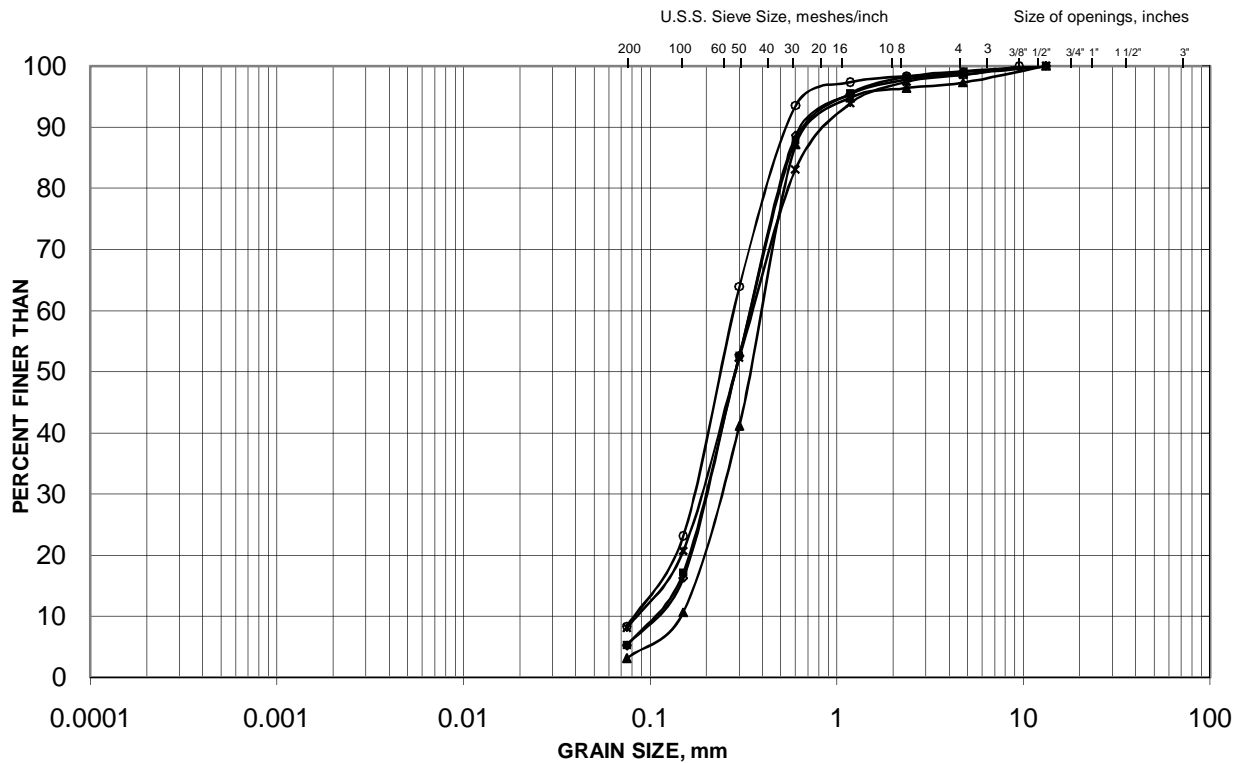
**TABLE B-2**  
**UNIAXIAL COMPRESSIVE STRENGTH TEST RESULTS**  
**WHITE CLAY RIVER BRIDGE REPLACEMENT**  
**GWP 5239-06-00, SITE NO. 47-005**  
**HIGHWAY 11, TOWNSHIP OF MAISONVILLE**

<b>Borehole Number</b>	<b>Sample Depth (m)</b>	<b>Sample Elevation (m)</b>	<b>Rock Type</b>	<b>Core Diameter (mm)</b>	<b>Uniaxial Compressive Strength (MPa)</b>
WC-6	17.2	293.0	Siltstone	47	68
WC-6	19.3	290.9	Sandstone	48	256
WC-7	20.3	289.9	Siltstone	48	106
WC-7	22.3	287.9	Sandstone	48	188
WC-8	19.6	290.6	Siltstone	47	132
WC-8	22.1	288.1	Siltstone	47	41
WC-9	20.2	290.0	Siltstone	47	180
WC-9	21.3	288.9	Siltstone	47	138

Compiled by: TR  
Checked by: SEMC  
Reviewed by: JMAC

# GRAIN SIZE DISTRIBUTION Sand (FILL)

**FIGURE  
B-1**



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
—■—	WC-17	2	310.4
—▲—	WC-17	5	308.1
—✱—	WC-18	1	311.2
—◆—	WC-18	3	309.7
—○—	WC-19	2	310.5

Project Number: 07-1191-0008

Checked By: SEMC

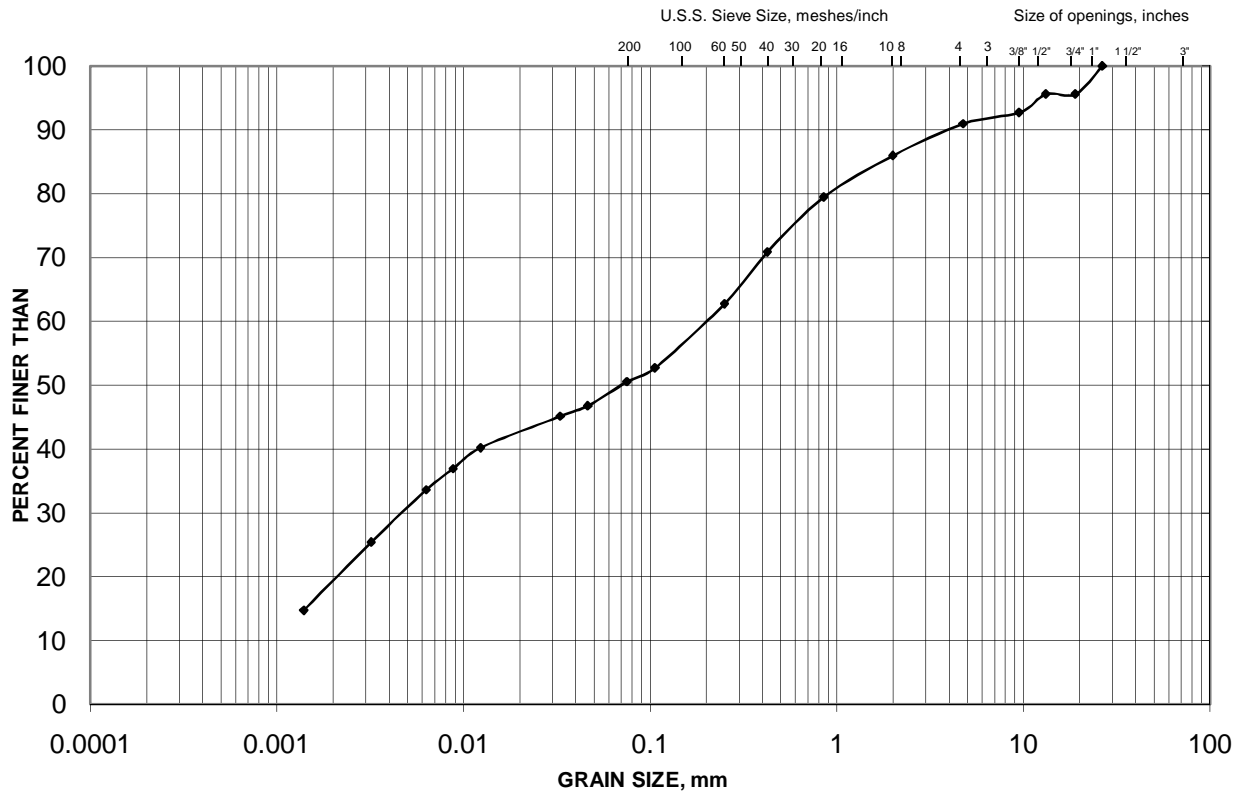
**Golder Associates**

Date: September 2009

# GRAIN SIZE DISTRIBUTION

## Sand and Silt (FILL)

**FIGURE**  
**B-2**



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

### LEGEND

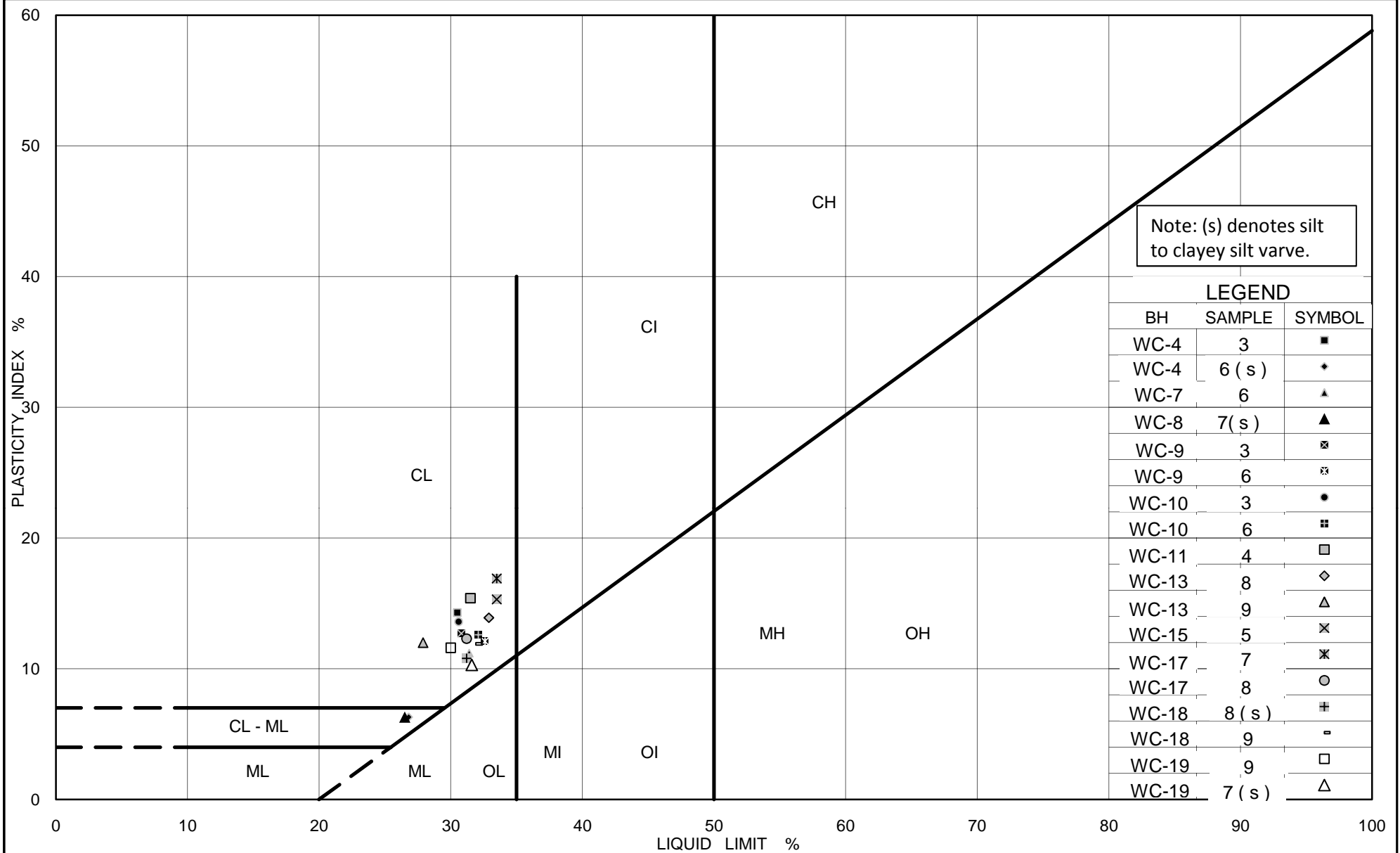
SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
—●—	WC16	1	310.7

Project Number: 07-1191-0008

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Date: September 2009



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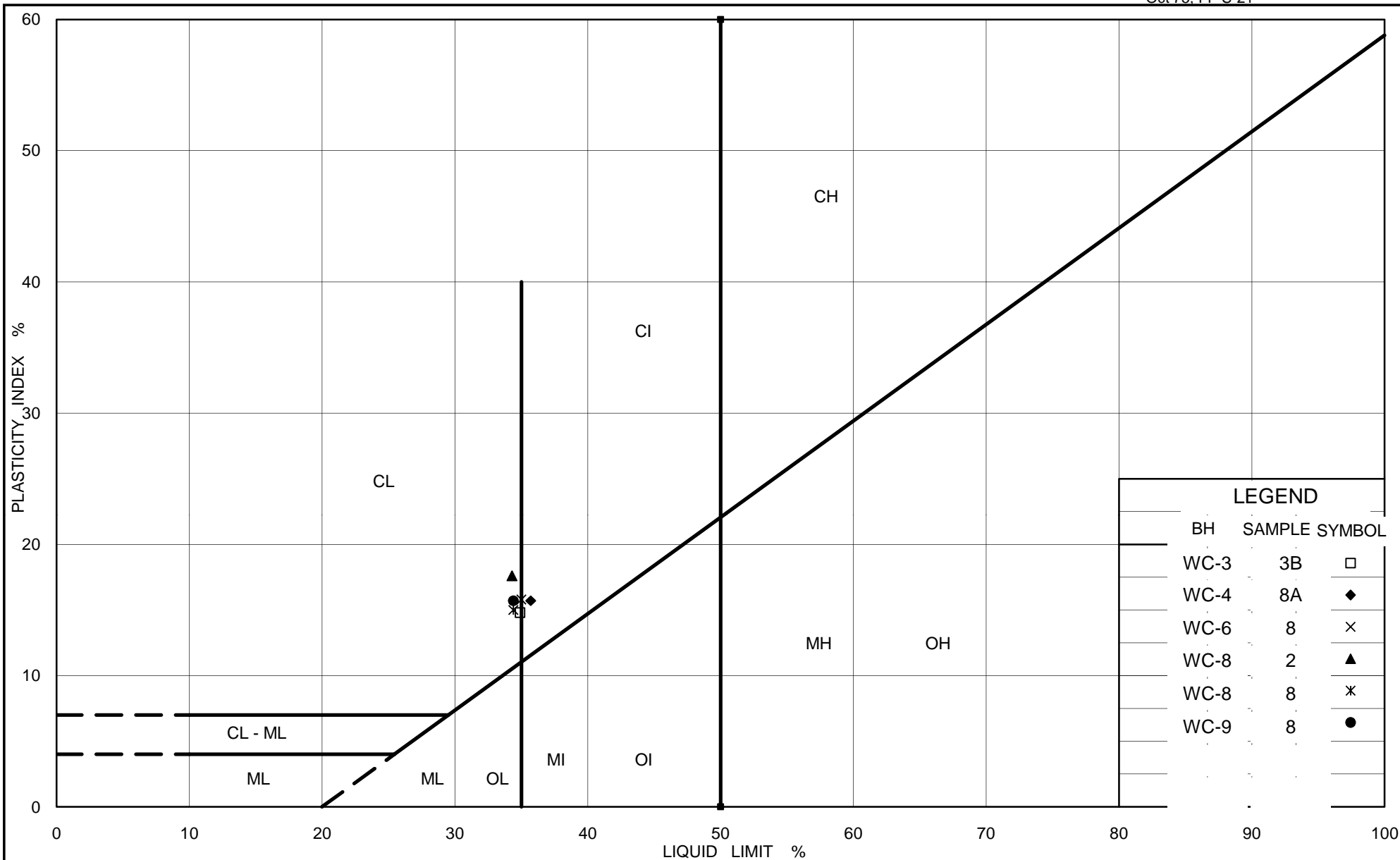
Ontario

# PLASTICITY CHART Clayey Silt

FIG No. B-3a

Project No. 07-1191-0008

Checked by: SEMC



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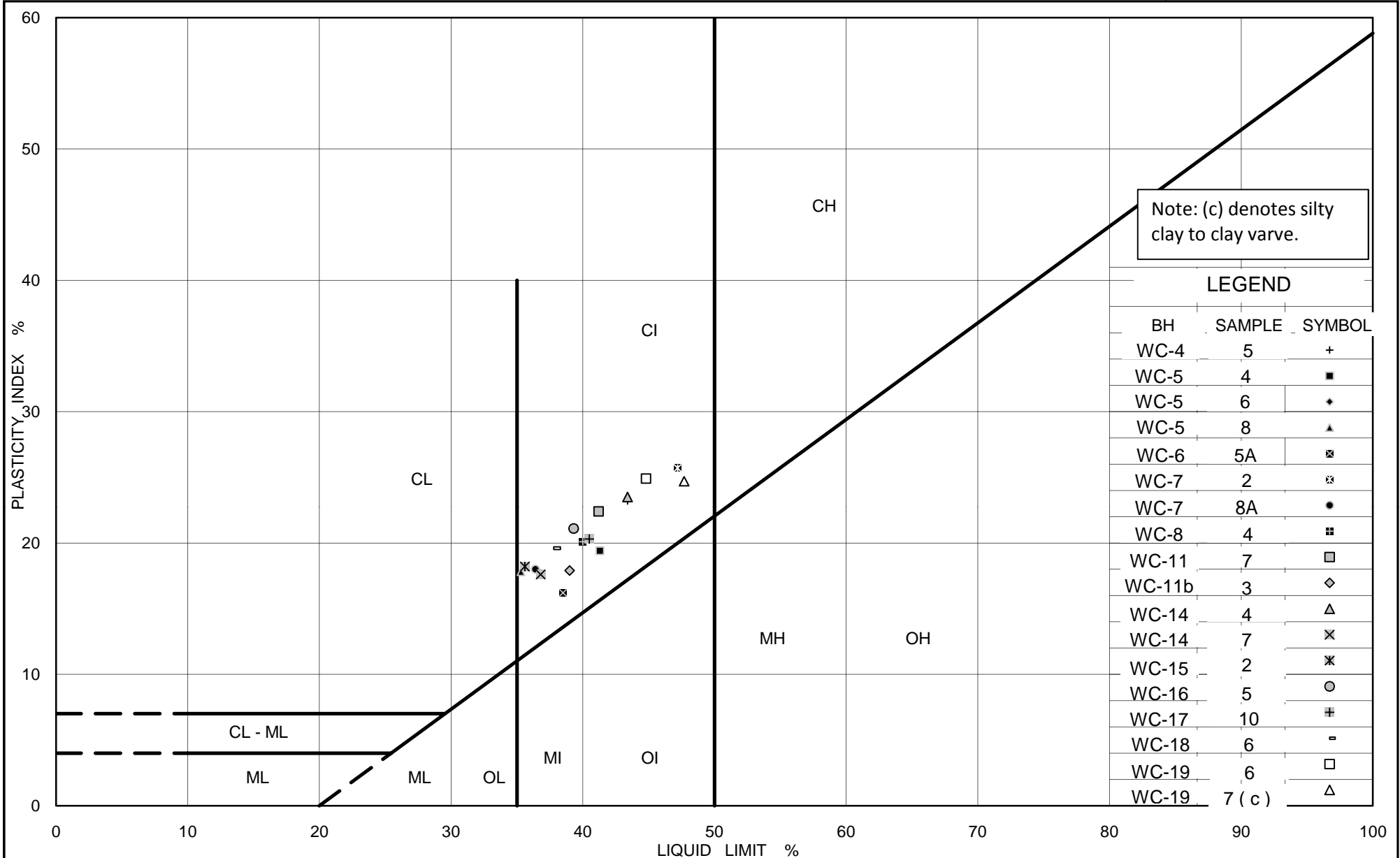
Ontario

# PLASTICITY CHART Clayey Silt to Silty Clay

Figure B-3b

Project No. 07-1191-0008

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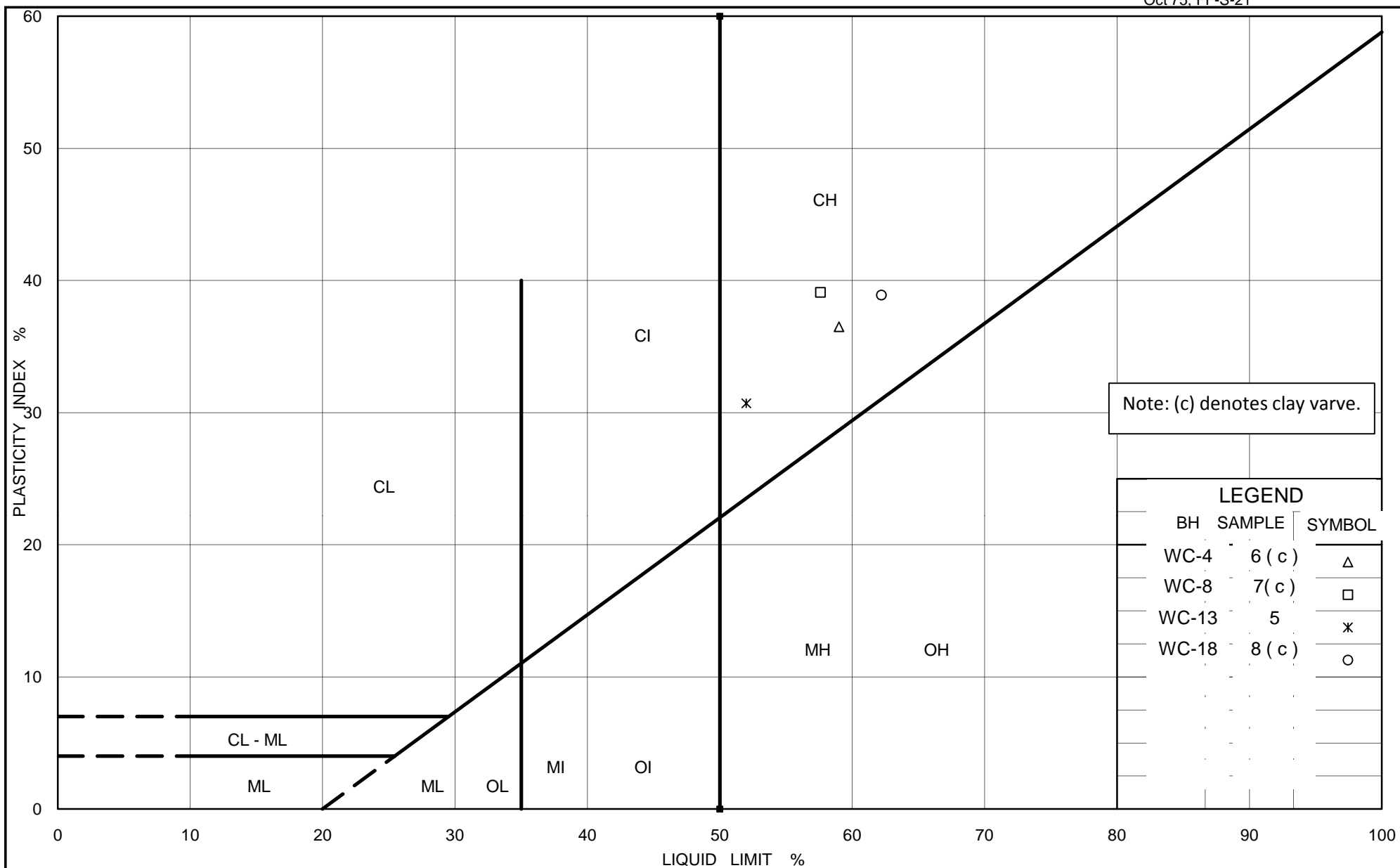
Ontario

# PLASTICITY CHART Silty Clay

FIG No. B-3c

Project No. 07-1191-0008

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## PLASTICITY CHART Clay Varves

Figure B-3d

Project No. 07-1191-0008

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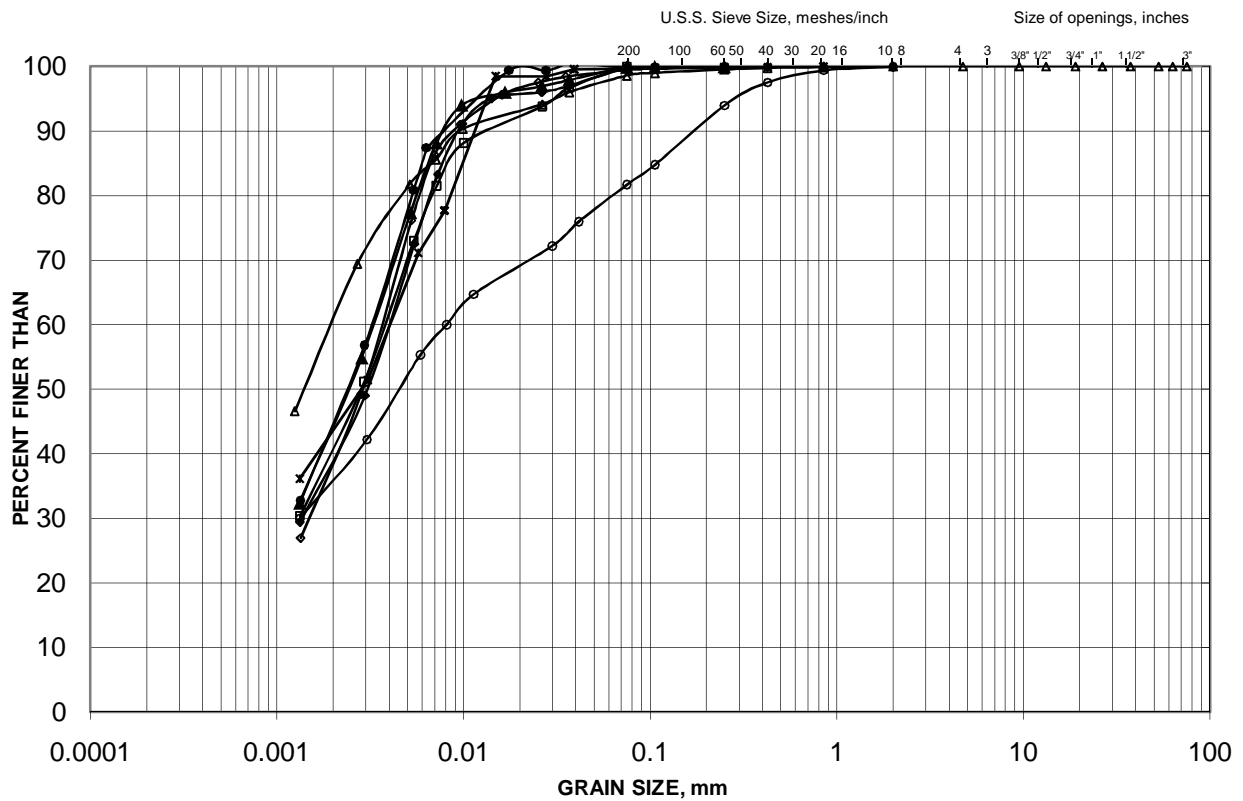










# GRAIN SIZE DISTRIBUTION

Clayey Silt

FIGURE

B-4a



SILT AND CLAY SIZES				FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED				SAND SIZE			GRAVEL SIZE		
LEGEND	SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)					
		WC-3	3	307.6					
		WC-7	3	304.2					
		WC-9	5	304.2					
		WC-10	7	301.5					
		WC-11	8	303.8					
		WC-13	4b	308.0					
		WC-13	7	305.4					
		WC-16	4	308.6					

Project Number: 07-1191-0008

Checked By: SEMC

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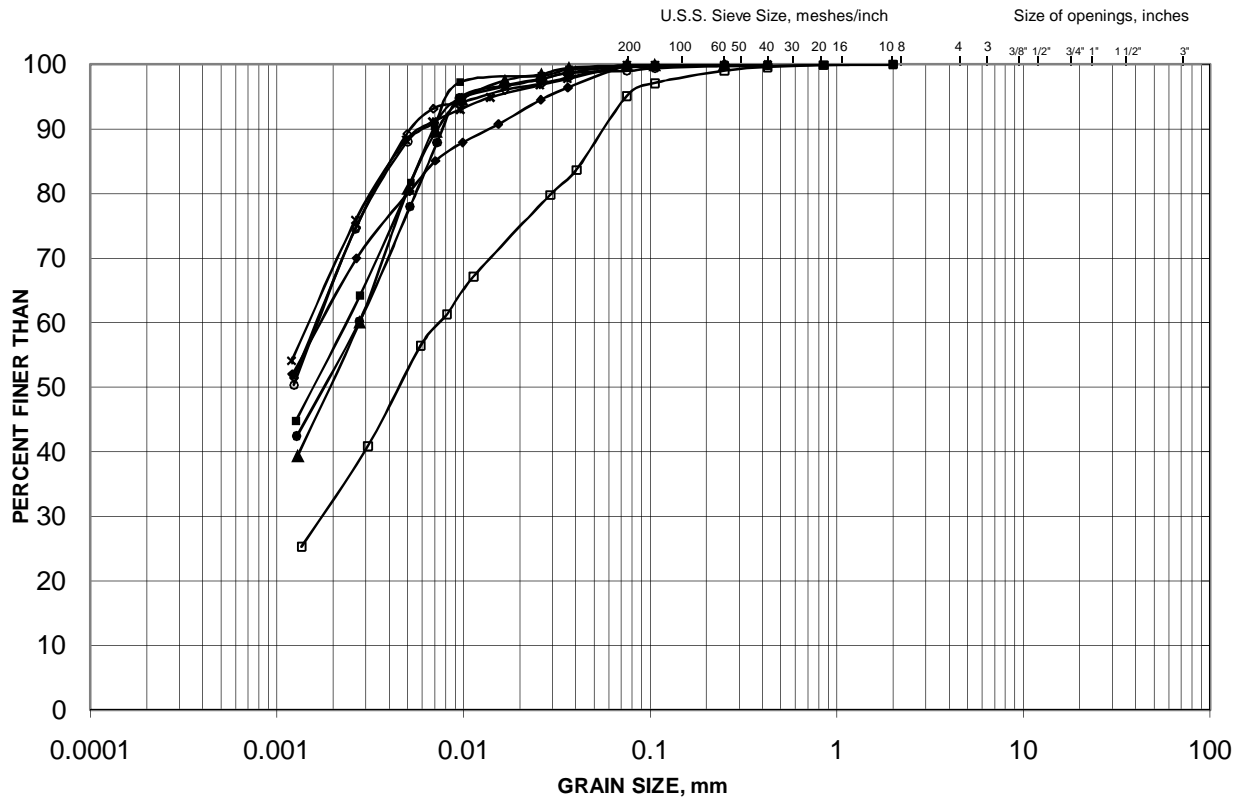
Date: September 2009

# GRAIN SIZE DISTRIBUTION

Silty Clay

FIGURE

B-4b



SILT AND CLAY SIZES				FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED				SAND SIZE			GRAVEL SIZE		
LEGEND	SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)					
	—●—	WC-4	4	306.7					
	—●—	WC-5	8	301.6					
	—■—	WC-5a	1	300.7					
	—▲—	WC-6	6	304.4					
	—✕—	WC-10	4	306.1					
	—●—	WC-11	6	306.2					
	—○—	WC-14	5	308.0					
	—□—	WC-15	3	309.6					

Project Number: 07-1191-0008

Checked By: SEMC

**Golder Associates**

Date: September 2009

# OEDOMETER CONSOLIDATION SUMMARY

**Figure B-5**

Page 1 of 4

## SAMPLE IDENTIFICATION

Project Number	07-1191-0008	Sample Number	6
Borehole Number	WC-4	Sample Depth, m	5.5-6.1

## TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	12		
Date Started	08/13/2008		
Date Completed	09/06/2008		

## SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.55	Unit Weight, kN/m <sup>3</sup>	16.82
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m <sup>3</sup>	11.06
Area, cm <sup>2</sup>	31.47	Specific Gravity, measured	2.74
Volume, cm <sup>3</sup>	80.25	Solids Height, cm	1.050
Water Content, %	52.06	Volume of Solids, cm <sup>3</sup>	33.04
Wet Mass, g	137.66	Volume of Voids, cm <sup>3</sup>	47.21
Dry Mass, g	90.53	Degree of Saturation, %	99.8

## 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	2.550	1.429	2.550				
4.88	2.539	1.418	2.545	9	1.53E-01	8.84E-04	1.32E-05
9.61	2.532	1.412	2.536	24	5.68E-02	5.80E-04	3.23E-06
19.62	2.520	1.400	2.526	41	3.30E-02	4.70E-04	1.52E-06
39.13	2.497	1.378	2.509	17	7.85E-02	4.62E-04	3.56E-06
77.92	2.456	1.339	2.477	32	4.06E-02	4.14E-04	1.65E-06
155.63	2.231	1.125	2.344	112	1.04E-02	1.14E-03	1.16E-06
311.28	2.022	0.926	2.127	60	1.60E-02	5.27E-04	8.25E-07
622.00	1.895	0.805	1.959	276	2.95E-03	1.60E-04	4.63E-08
1244.88	1.789	0.704	1.842	240	3.00E-03	6.67E-05	1.96E-08
2489.90	1.695	0.614	1.742	66	9.75E-03	2.96E-05	2.83E-08
1244.88	1.707	0.626	1.701				
311.28	1.741	0.658	1.724				
77.92	1.779	0.694	1.760				
19.62	1.816	0.730	1.798				
4.88	1.849	0.761	1.833				

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

## SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.85	Unit Weight, kN/m <sup>3</sup>	20.06
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m <sup>3</sup>	15.26
Area, cm <sup>2</sup>	31.47	Specific Gravity, measured	2.74
Volume, cm <sup>3</sup>	58.19	Solids Height, cm	1.050
Water Content, %	31.50	Volume of Solids, cm <sup>3</sup>	33.04
Wet Mass, g	119.05	Volume of Voids, cm <sup>3</sup>	25.15
Dry Mass, g	90.53		

Prepared By: LFG

**Golder Associates**

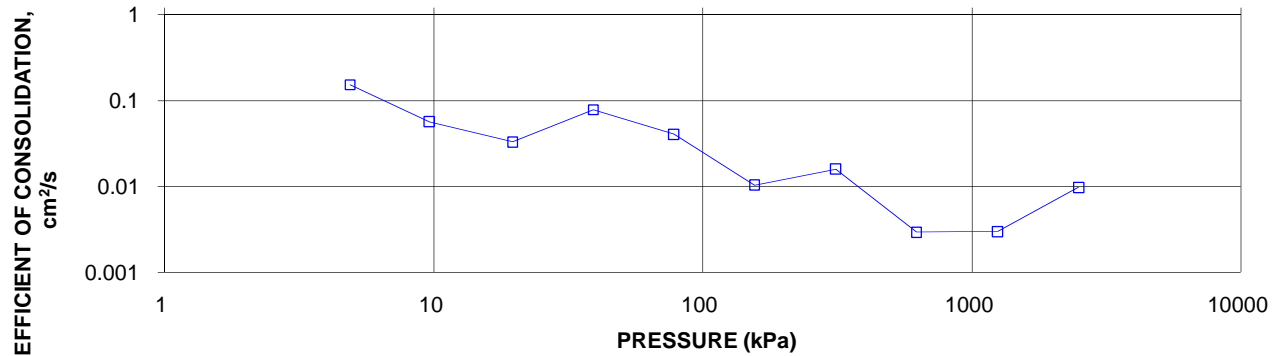
Checked By: MM

# OEDOMETER CONSOLIDATION SUMMARY

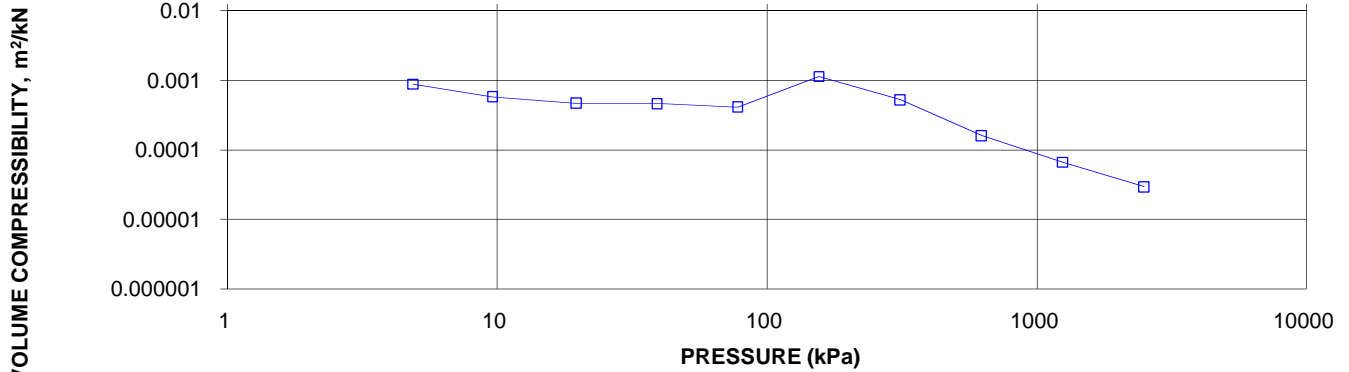
Figure B-5

Page 2 of 4

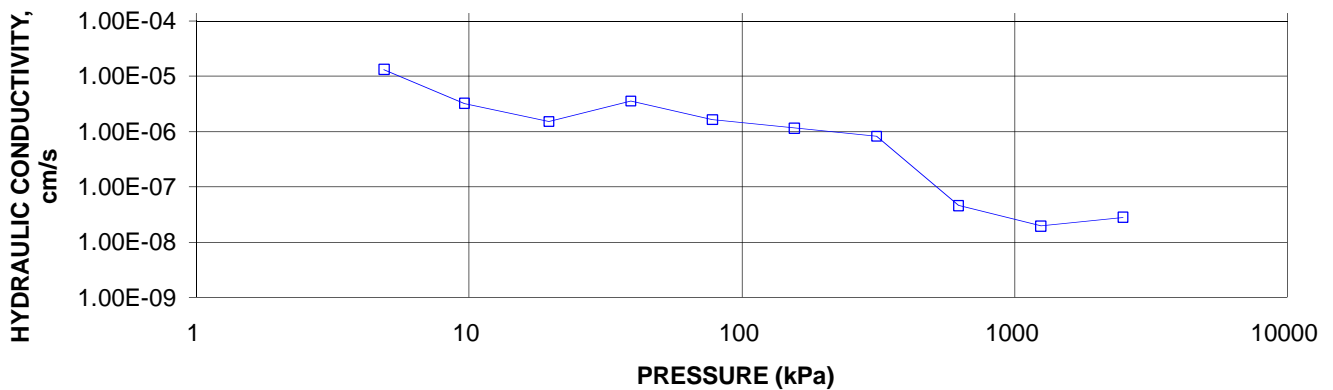
CONSOLIDATION TEST  
CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
BH WC-4 SA 6



CONSOLIDATION TEST  
MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
BH WC-4 SA 6



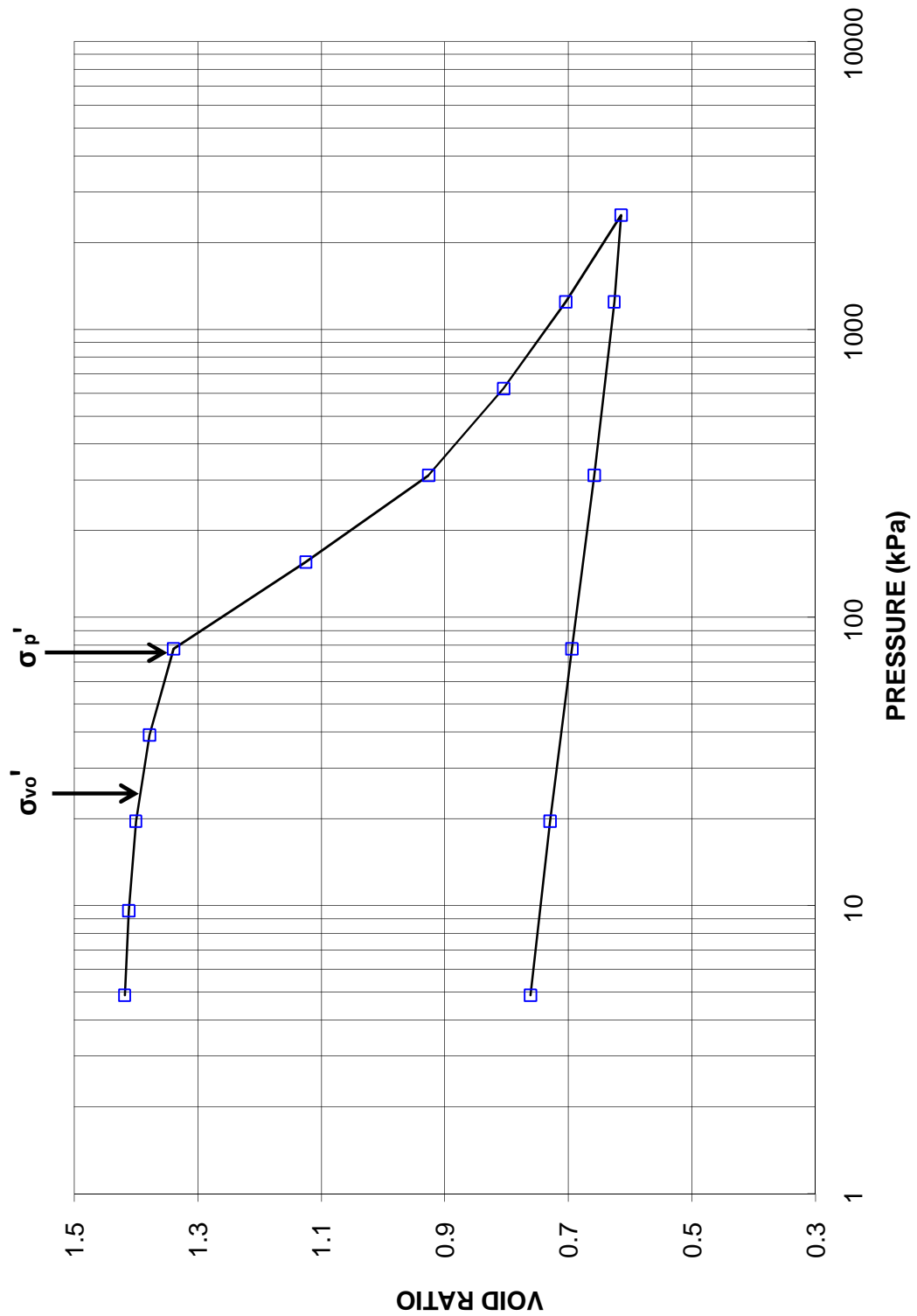
CONSOLIDATION TEST  
HYDRAULIC CONDUCTIVITY vs PRESSURE  
BH WC-4 SA 6



**CONSOLIDATION TEST  
VOID RATIO VS. LOG PRESSURE**

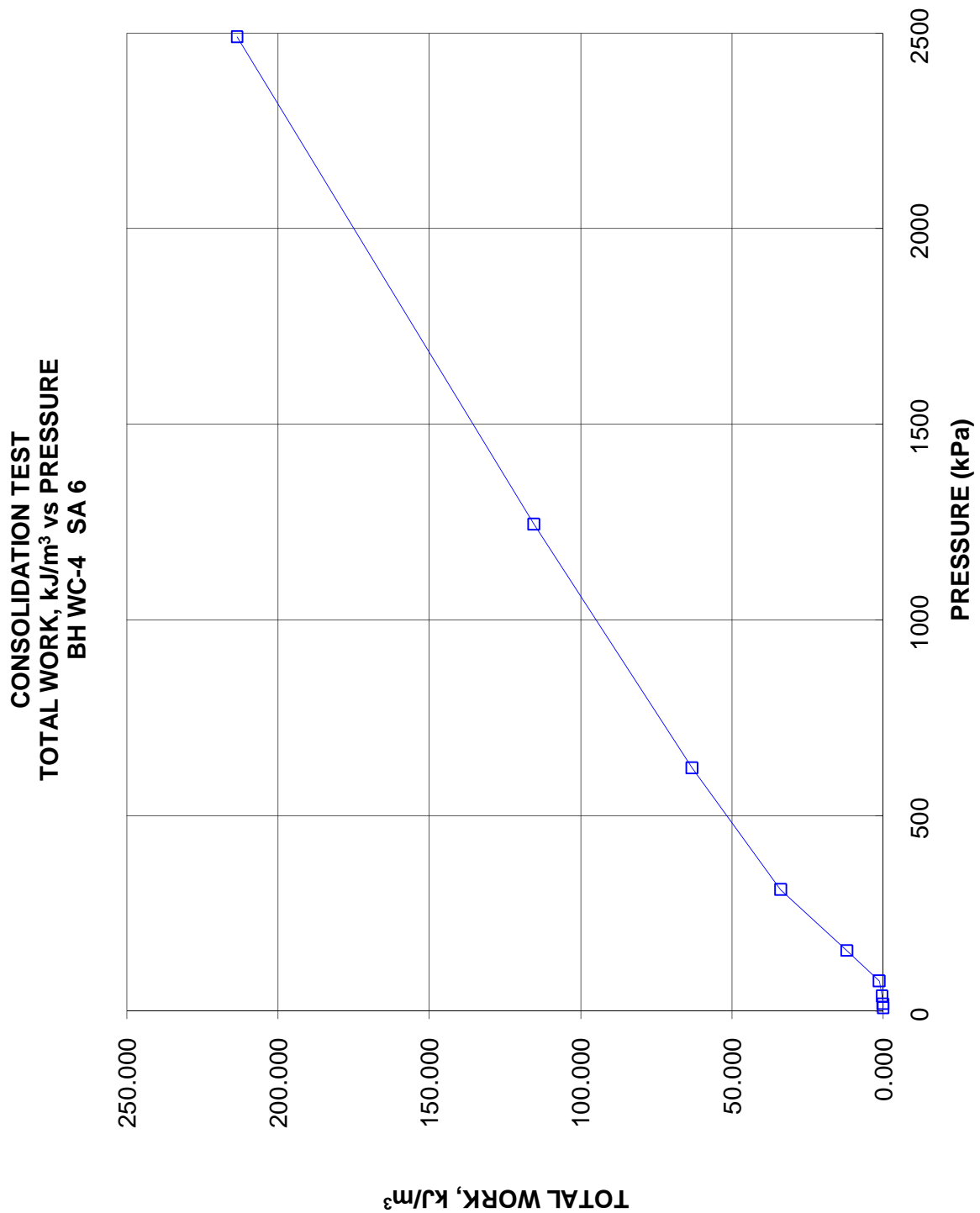
**FIGURE B-5**  
Page 3 of 4

**CONSOLIDATION TEST  
VOID RATIO vs PRESSURE  
BH WC-4 SA 6**



**CONSOLIDATION TEST  
TOTAL WORK VS. PRESSURE**

**FIGURE B-5**  
Page 4 of 4



# OEDOMETER CONSOLIDATION SUMMARY

**Figure B-6**

Page 1 of 4

## SAMPLE IDENTIFICATION

Project Number	07-1191-0008	Sample Number	7
Borehole Number	WC-8	Sample Depth, m	8.4-9.0

## TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	11		
Date Started	08/13/2008		
Date Completed	09/05/2008		

## SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m <sup>3</sup>	16.84
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	11.02
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.75
Volume, cm <sup>3</sup>	80.16	Solids Height, cm	1.037
Water Content, %	52.88	Volume of Solids, cm <sup>3</sup>	32.75
Wet Mass, g	137.68	Volume of Voids, cm <sup>3</sup>	47.41
Dry Mass, g	90.06	Degree of Saturation, %	100.5

## 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	1.448	2.539				
4.84	2.512	1.422	2.526	32	4.23E-02	2.20E-03	9.10E-06
9.56	2.502	1.412	2.507	32	4.16E-02	8.34E-04	3.40E-06
19.34	2.485	1.395	2.494	75	1.76E-02	6.85E-04	1.18E-06
38.80	2.458	1.369	2.472	60	2.16E-02	5.46E-04	1.16E-06
77.62	2.407	1.320	2.433	108	1.16E-02	5.17E-04	5.89E-07
155.17	2.174	1.096	2.291	679	1.64E-03	1.18E-03	1.90E-07
310.34	1.999	0.927	2.087	891	1.04E-03	4.44E-04	4.51E-08
619.90	1.879	0.811	1.939	329	2.42E-03	1.53E-04	3.62E-08
1239.81	1.780	0.716	1.830	190	3.73E-03	6.29E-05	2.30E-08
2480.18	1.692	0.631	1.736	175	3.65E-03	2.79E-05	1.00E-08
1239.81	1.699	0.638	1.696				
310.34	1.724	0.662	1.712				
77.62	1.757	0.694	1.741				
19.34	1.792	0.727	1.775				
4.84	1.819	0.753	1.806				

Note:  
k calculated using cv based on  $t_{90}$  values.

## SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.82	Unit Weight, kN/m <sup>3</sup>	19.98
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	15.38
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.75
Volume, cm <sup>3</sup>	57.43	Solids Height, cm	1.037
Water Content, %	29.91	Volume of Solids, cm <sup>3</sup>	32.75
Wet Mass, g	117.00	Volume of Voids, cm <sup>3</sup>	24.68
Dry Mass, g	90.06		

Prepared By: LFG

**Golder Associates**

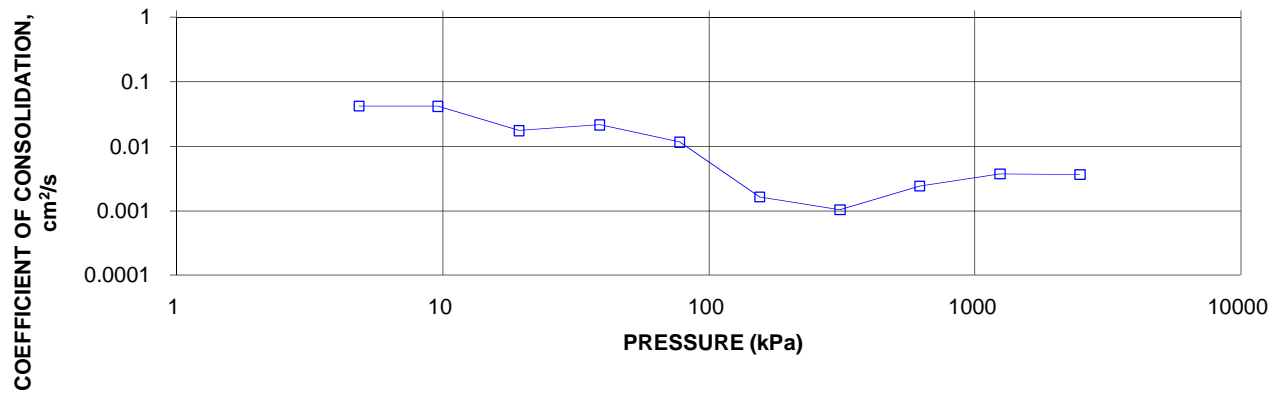
Checked By: MM

# OEDOMETER CONSOLIDATION SUMMARY

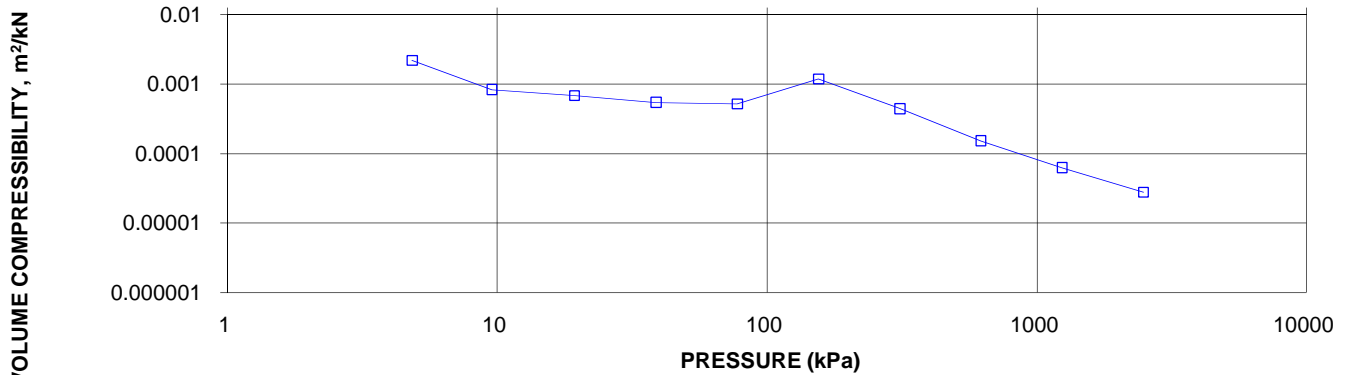
Figure B-6

Page 2 of 4

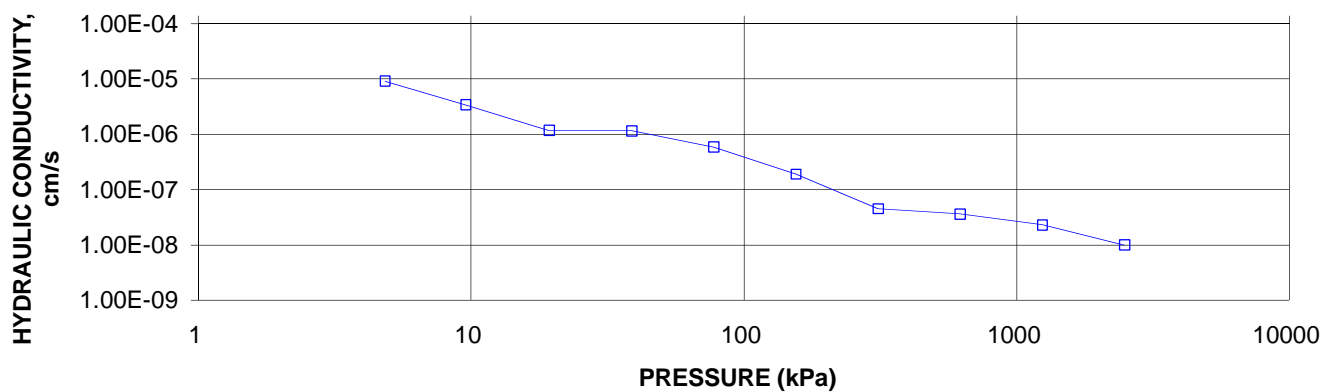
CONSOLIDATION TEST  
CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
BH WC-8 SA 7



CONSOLIDATION TEST  
MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
BH WC-8 SA 7



CONSOLIDATION TEST  
HYDRAULIC CONDUCTIVITY vs PRESSURE  
BH WC-8 SA 7

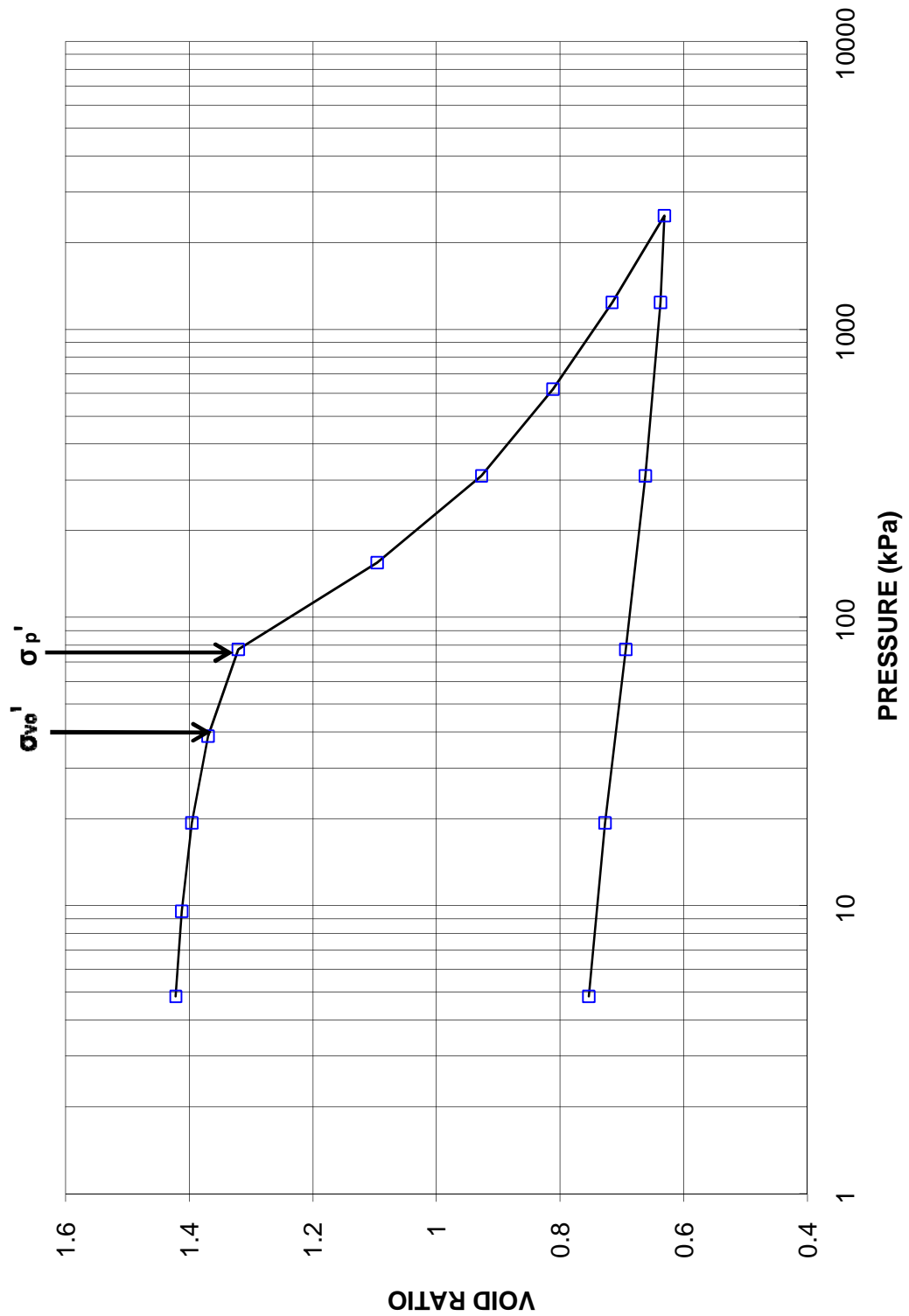




**CONSOLIDATION TEST  
VOID RATIO VS. LOG PRESSURE**

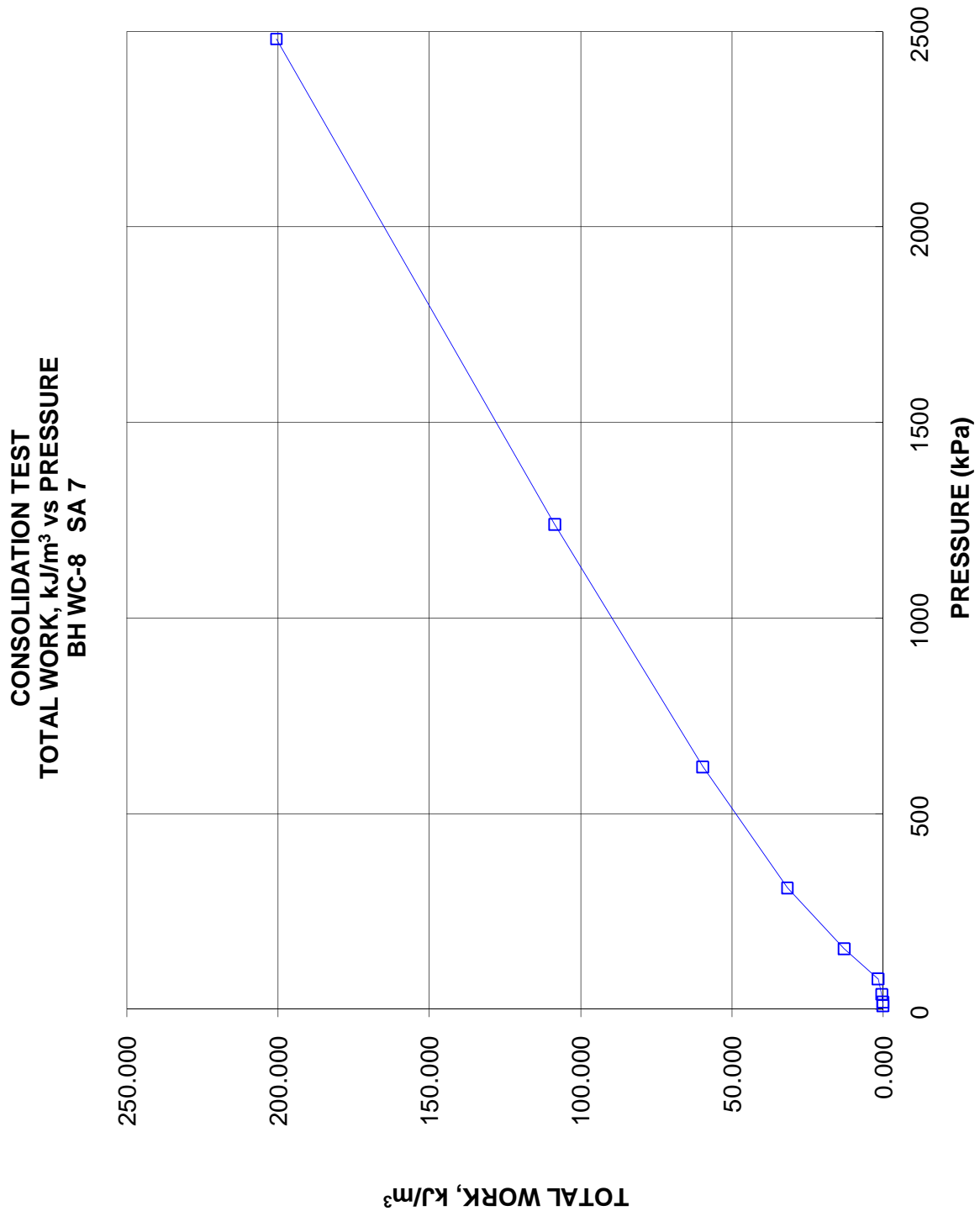
**FIGURE B-6**  
Page 3 of 4

**CONSOLIDATION TEST  
VOID RATIO vs PRESSURE  
BH WC-8 SA 7**



**CONSOLIDATION TEST  
TOTAL WORK VS. PRESSURE**

**FIGURE B-6**  
Page 4 of 4



**OEDOMETER CONSOLIDATION SUMMARY****Figure B-7**

Page 1 of 4

**SAMPLE IDENTIFICATION**

Project Number	07-1191-0008	Sample Number	8
Borehole Number	WC-13	Sample Depth, m	6.1-6.7

**TEST CONDITIONS**

Test Type	Standard	Load Duration, hr	24
Oedometer Number	9		
Date Started	12/12/2008		
Date Completed	12/31/2008		

**SAMPLE DIMENSIONS AND PROPERTIES - INITIAL**

Sample Height, cm	1.25	Unit Weight, kN/m <sup>3</sup>	15.48
Sample Diameter, cm	4.97	Dry Unit Weight, kN/m <sup>3</sup>	8.84
Area, cm <sup>2</sup>	19.40	Specific Gravity, measured	2.74
Volume, cm <sup>3</sup>	24.31	Solids Height, cm	0.412
Water Content, %	75.08	Volume of Solids, cm <sup>3</sup>	8.00
Wet Mass, g	38.36	Volume of Voids, cm <sup>3</sup>	16.31
Dry Mass, g	21.91	Degree of Saturation, %	100.8

**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	1.253	2.040	1.253				
4.95	1.245	2.021	1.249	19	1.74E-02	1.29E-03	2.20E-06
9.91	1.242	2.012	1.243	69	4.75E-03	5.63E-04	2.62E-07
19.79	1.231	1.987	1.236	60	5.40E-03	8.48E-04	4.49E-07
39.59	1.215	1.948	1.223	21	1.51E-02	6.45E-04	9.54E-07
80.00	1.145	1.778	1.180	39	7.57E-03	1.38E-03	1.03E-06
160.00	0.942	1.284	1.043	803	2.87E-04	2.03E-03	5.72E-08
320.00	0.844	1.048	0.893	386	4.38E-04	4.86E-04	2.09E-08
640.00	0.769	0.866	0.807	165	8.36E-04	1.87E-04	1.53E-08
1280.00	0.707	0.715	0.738	41	2.82E-03	7.73E-05	2.13E-08
2559.95	0.653	0.584	0.680	60	1.63E-03	3.37E-05	5.39E-09
1280.00	0.661	0.604	0.657				
320.00	0.686	0.663	0.673				
80.00	0.712	0.726	0.699				
19.79	0.733	0.778	0.722				
4.95	0.746	0.810	0.740				

Note:

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

Sample Height, cm	0.75	Unit Weight, kN/m <sup>3</sup>	20.28
Sample Diameter, cm	4.97	Dry Unit Weight, kN/m <sup>3</sup>	14.85
Area, cm <sup>2</sup>	19.40	Specific Gravity, measured	2.74
Volume, cm <sup>3</sup>	14.47	Solids Height, cm	0.412
Water Content, %	36.60	Volume of Solids, cm <sup>3</sup>	8.00
Wet Mass, g	29.93	Volume of Voids, cm <sup>3</sup>	6.48
Dry Mass, g	21.91		

Prepared By: LFG

**Golder Associates**

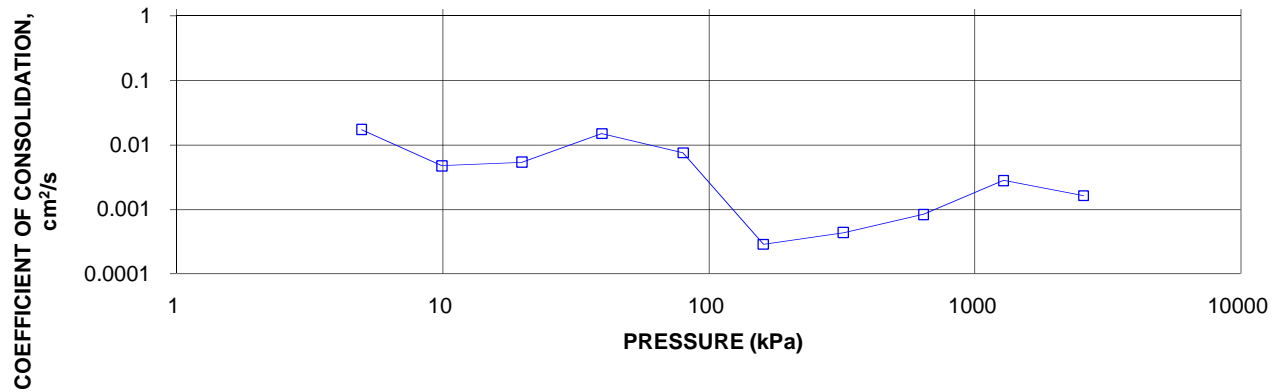
Checked By: MM

# OEDOMETER CONSOLIDATION SUMMARY

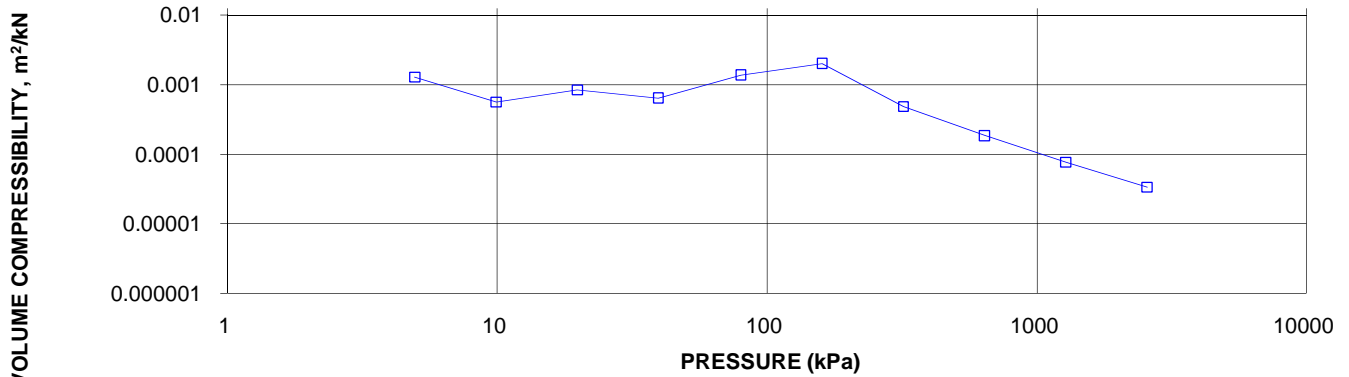
Figure B-7

Page 2 of 4

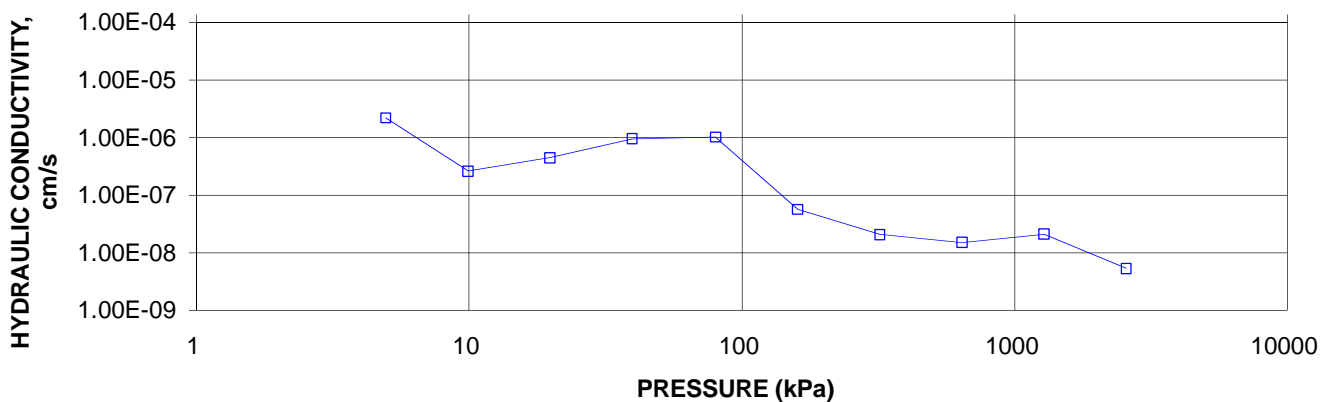
CONSOLIDATION TEST  
CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
BH WC-13 SA 8



CONSOLIDATION TEST  
MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
BH WC-13 SA 8



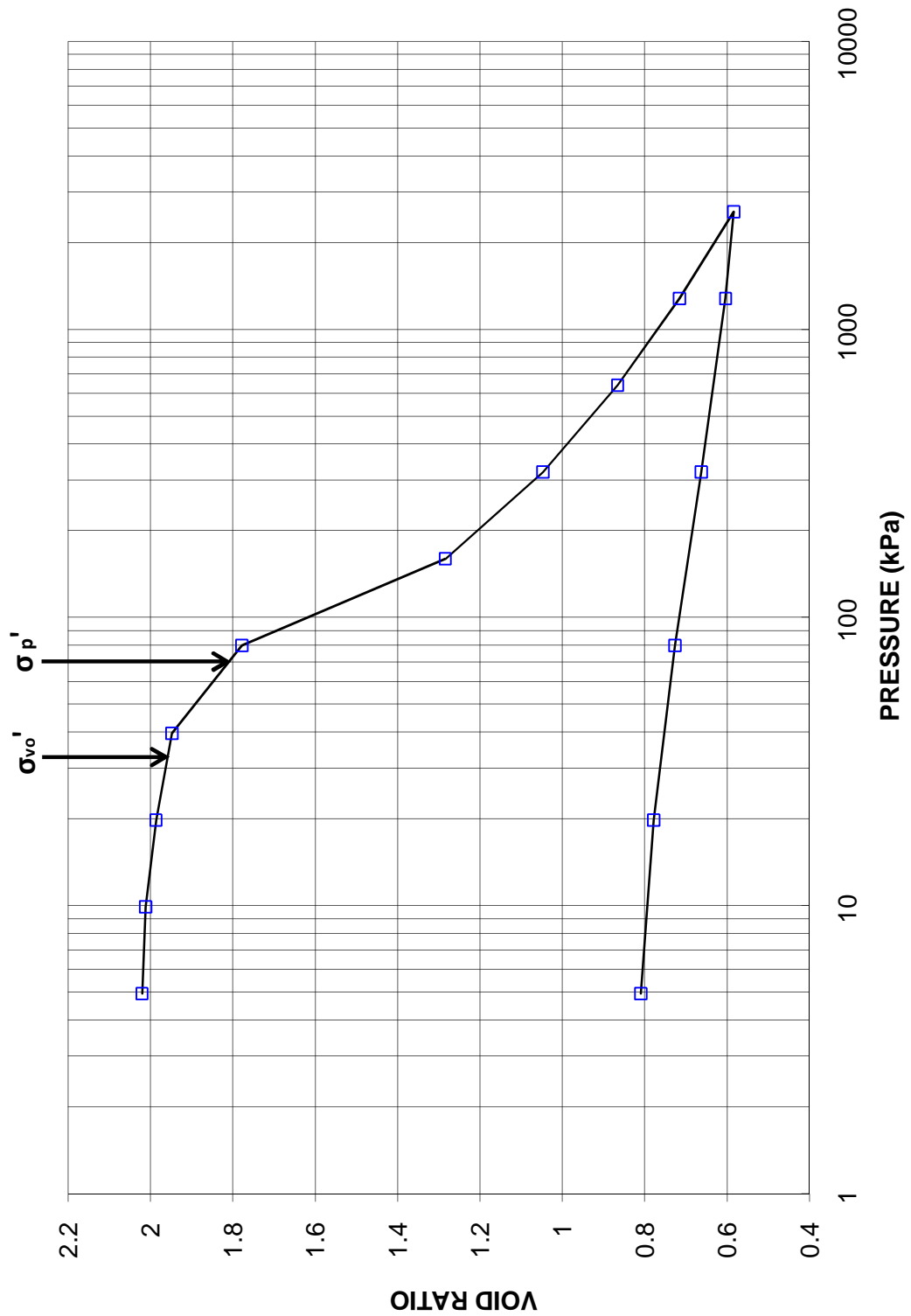
CONSOLIDATION TEST  
HYDRAULIC CONDUCTIVITY vs PRESSURE  
BH WC-13 SA 8



**CONSOLIDATION TEST  
VOID RATIO VS. LOG PRESSURE**

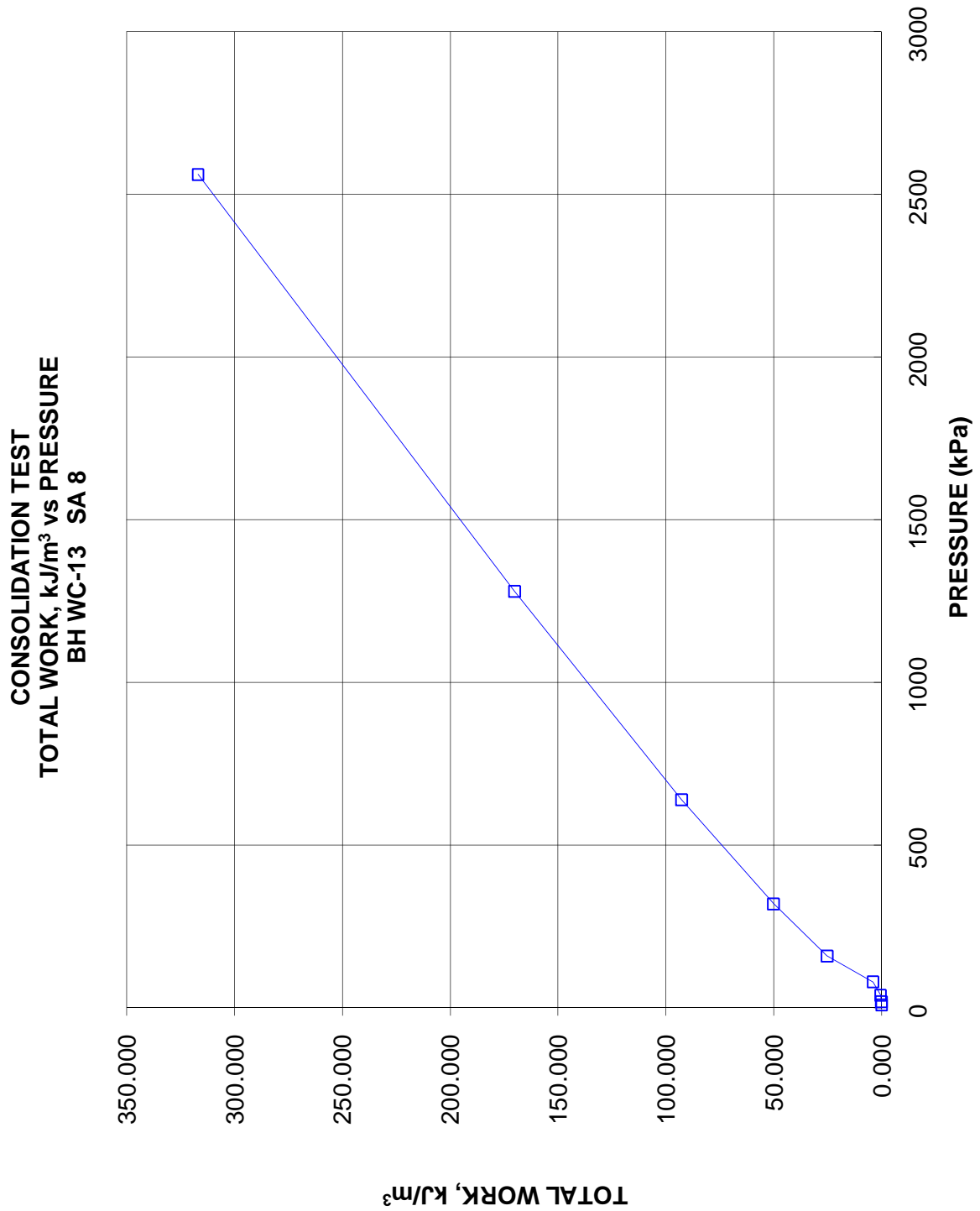
**FIGURE B-7**  
Page 3 of 4

**CONSOLIDATION TEST  
VOID RATIO vs PRESSURE  
BH WC-13 SA 8**



**CONSOLIDATION TEST  
TOTAL WORK VS. PRESSURE**

**FIGURE B-7**  
Page 4 of 4



# OEDOMETER CONSOLIDATION SUMMARY

**Figure B-8**

Page 1 of 4

## SAMPLE IDENTIFICATION

Project Number	07-1191-0008	Sample Number	7
Borehole Number	WC-17	Sample Depth, m	6.1-6.7

## TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	2		
Date Started	11/24/2008		
Date Completed	12/16/2008		

## SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m <sup>3</sup>	19.43
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	15.32
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.74
Volume, cm <sup>3</sup>	80.28	Solids Height, cm	1.450
Water Content, %	26.88	Volume of Solids, cm <sup>3</sup>	45.76
Wet Mass, g	159.10	Volume of Voids, cm <sup>3</sup>	34.52
Dry Mass, g	125.39	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	0.754	2.543				
4.71	2.533	0.747	2.538	97	1.41E-02	8.35E-04	1.15E-06
9.58	2.529	0.744	2.531	120	1.13E-02	3.55E-04	3.94E-07
19.34	2.518	0.737	2.523	175	7.71E-03	4.47E-04	3.38E-07
38.80	2.502	0.726	2.510	120	1.11E-02	3.19E-04	3.48E-07
77.76	2.479	0.710	2.490	32	4.11E-02	2.34E-04	9.43E-07
155.06	2.439	0.683	2.459	32	4.01E-02	2.01E-04	7.89E-07
310.21	2.388	0.647	2.413	37	3.34E-02	1.31E-04	4.27E-07
619.37	2.324	0.603	2.356	32	3.68E-02	8.03E-05	2.89E-07
1240.78	2.259	0.558	2.291	15	7.42E-02	4.17E-05	3.03E-07
2481.24	2.191	0.512	2.225	40	2.62E-02	2.13E-05	5.48E-08
1240.78	2.194	0.513	2.192				
310.21	2.223	0.533	2.208				
77.76	2.253	0.554	2.238				
19.34	2.279	0.572	2.266				
4.71	2.299	0.586	2.289				

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

## SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	2.30	Unit Weight, kN/m <sup>3</sup>	20.69
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	16.94
Area, cm <sup>2</sup>	31.57	Specific Gravity, measured	2.74
Volume, cm <sup>3</sup>	72.58	Solids Height, cm	1.450
Water Content, %	22.10	Volume of Solids, cm <sup>3</sup>	45.76
Wet Mass, g	153.10	Volume of Voids, cm <sup>3</sup>	26.82
Dry Mass, g	125.39		

Prepared By: LFG

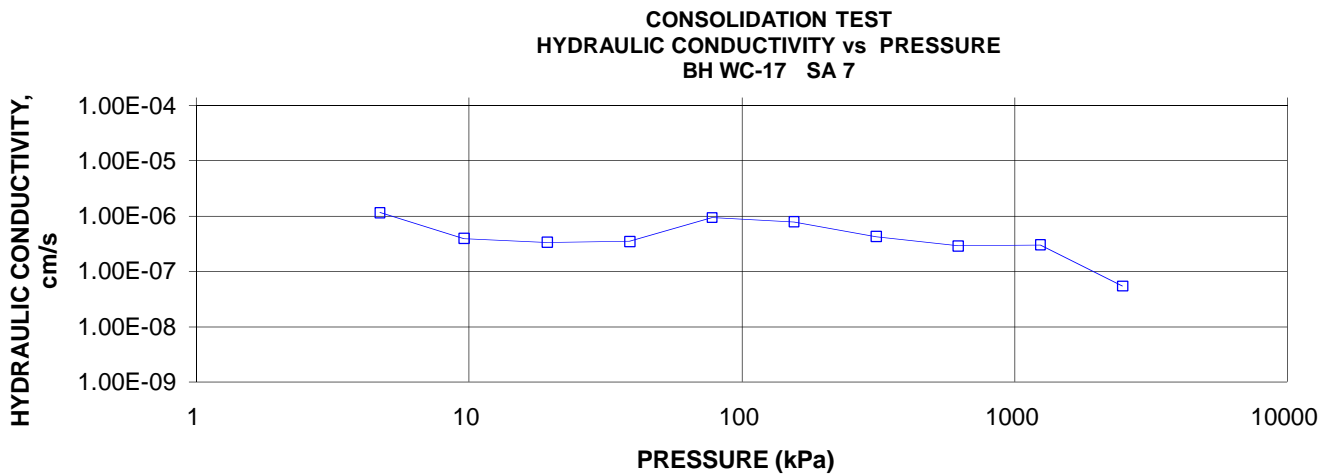
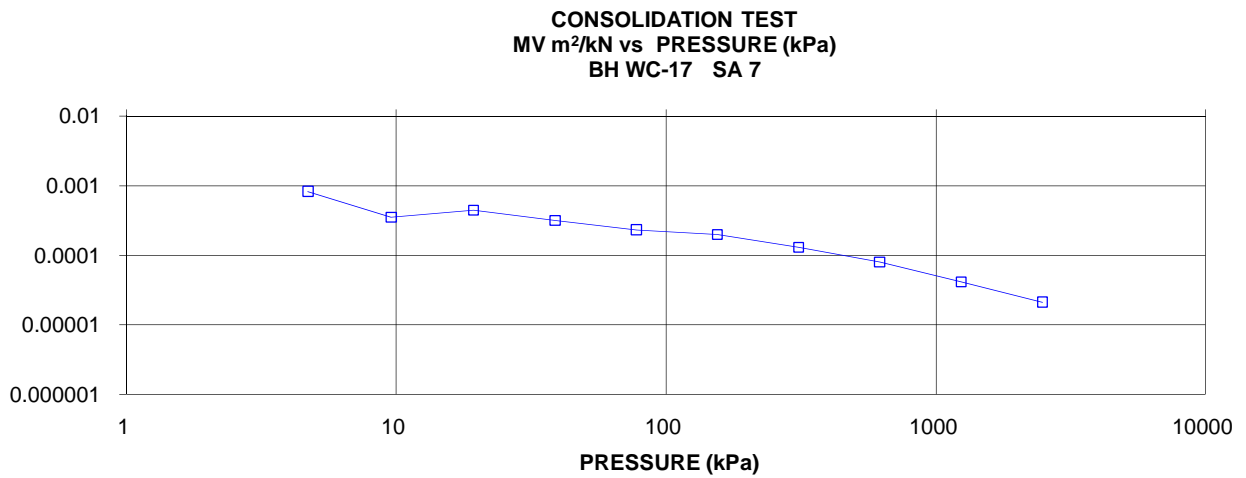
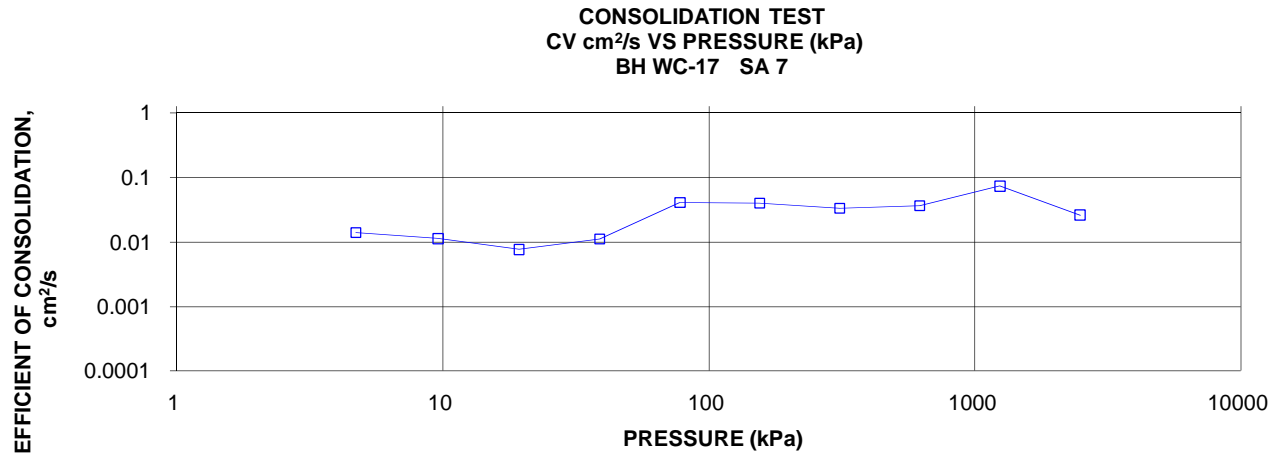
**Golder Associates**

Checked By: MM

# OEDOMETER CONSOLIDATION SUMMARY

Figure B-8

Page 2 of 4



Project No. 07-1191-0008

Prepared By: LFG

Golder Associates

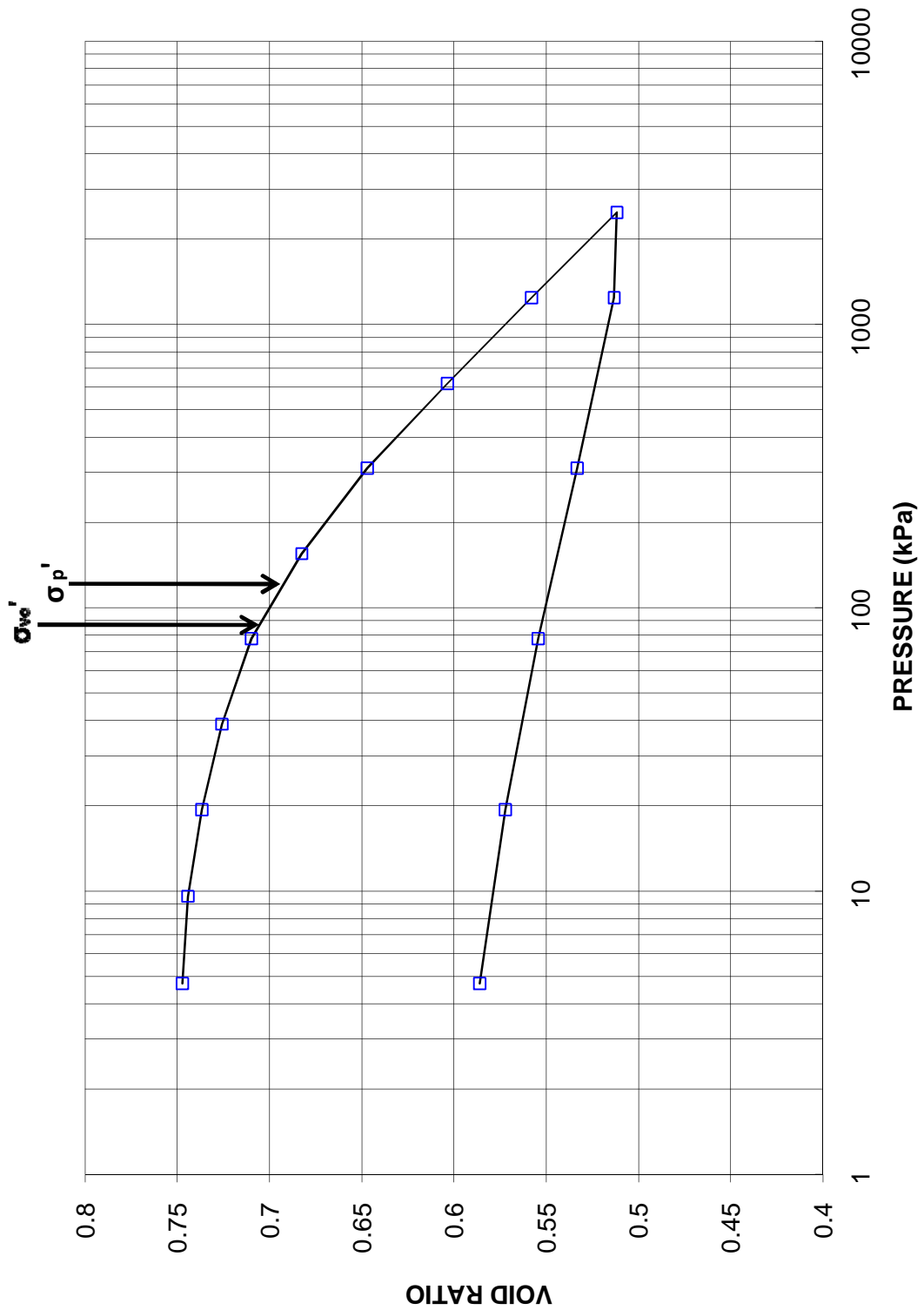
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# CONSOLIDATION TEST VOID RATIO VS. LOG PRESSURE

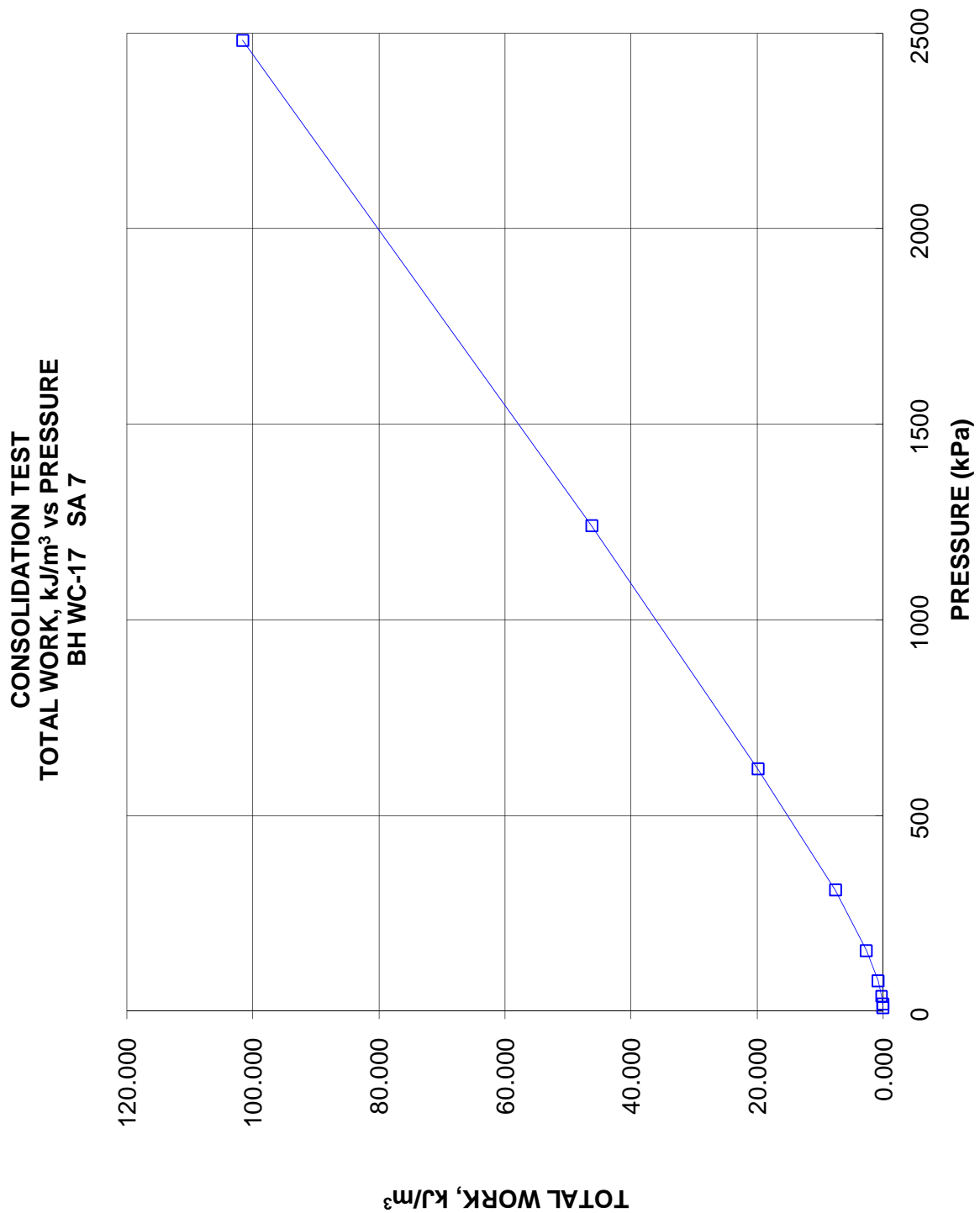
FIGURE B-8  
Page 3 of 4

CONSOLIDATION TEST  
VOID RATIO vs PRESSURE  
BH WC-17 SA 7



**CONSOLIDATION TEST  
TOTAL WORK VS. PRESSURE**

**FIGURE B-8**  
Page 4 of 4



# OEDOMETER CONSOLIDATION SUMMARY

**Figure B-9**

Page 1 of 4

## SAMPLE IDENTIFICATION

Project Number	07-1191-0008	Sample Number	8
Borehole Number	WC-18	Sample Depth, m	8.8-9.8

## TEST CONDITIONS

Test Type	Standard	Load Duration, hr	24
Oedometer Number	7		
Date Started	11/24/2008		
Date Completed	12/13/2008		

## SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.89	Unit Weight, kN/m <sup>3</sup>	17.42
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	12.01
Area, cm <sup>2</sup>	31.55	Specific Gravity, measured	2.75
Volume, cm <sup>3</sup>	59.76	Solids Height, cm	0.843
Water Content, %	45.03	Volume of Solids, cm <sup>3</sup>	26.61
Wet Mass, g	106.12	Volume of Voids, cm <sup>3</sup>	33.15
Dry Mass, g	73.17	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	1.894	1.246	1.894				
4.84	1.881	1.230	1.888	7	1.08E-01	1.42E-03	1.50E-05
9.54	1.877	1.226	1.879	60	1.25E-02	4.27E-04	5.22E-07
19.48	1.862	1.208	1.870	120	6.18E-03	8.07E-04	4.89E-07
38.83	1.841	1.183	1.852	89	8.17E-03	5.65E-04	4.52E-07
77.73	1.804	1.139	1.822	79	8.91E-03	5.13E-04	4.48E-07
155.24	1.703	1.019	1.753	567	1.15E-03	6.87E-04	7.73E-08
310.47	1.617	0.917	1.660	540	1.08E-03	2.93E-04	3.10E-08
621.61	1.540	0.826	1.578	46	1.15E-02	1.31E-04	1.47E-07
1243.21	1.473	0.746	1.506	69	6.97E-03	5.67E-05	3.88E-08
2484.35	1.412	0.675	1.443	30	1.47E-02	2.57E-05	3.70E-08
1243.21	1.413	0.675	1.413				
310.47	1.445	0.713	1.429				
77.73	1.481	0.756	1.463				
19.48	1.513	0.794	1.497				
4.84	1.539	0.825	1.526				

Note:  
k calculated using cv based on  $t_{90}$  values.

## SAMPLE DIMENSIONS AND PROPERTIES - FINAL

Sample Height, cm	1.54	Unit Weight, kN/m <sup>3</sup>	19.26
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m <sup>3</sup>	14.77
Area, cm <sup>2</sup>	31.55	Specific Gravity, measured	2.75
Volume, cm <sup>3</sup>	48.57	Solids Height, cm	0.843
Water Content, %	30.34	Volume of Solids, cm <sup>3</sup>	26.61
Wet Mass, g	95.37	Volume of Voids, cm <sup>3</sup>	21.96
Dry Mass, g	73.17		

Prepared By: LFG

**Golder Associates**

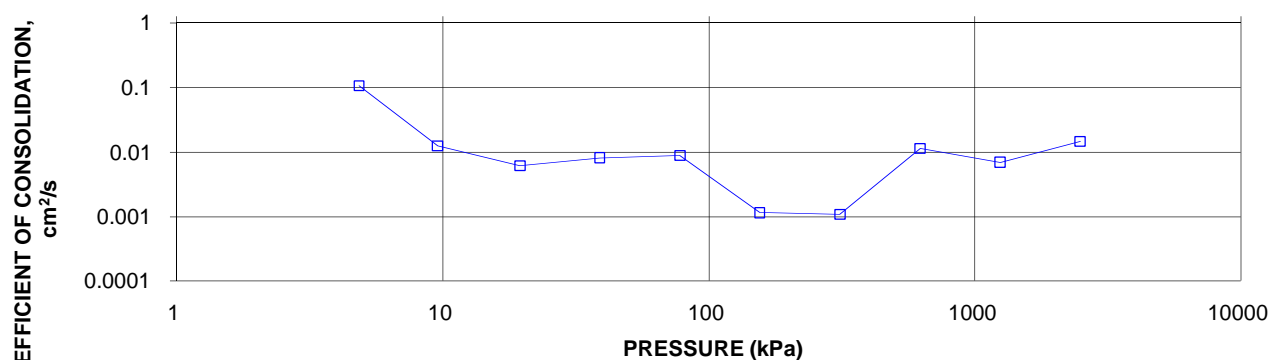
Checked By: MM

# OEDOMETER CONSOLIDATION SUMMARY

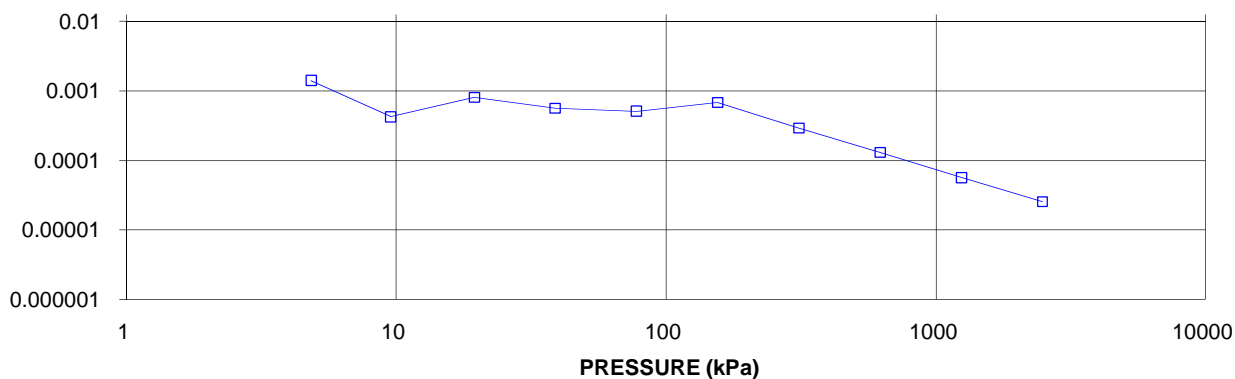
Figure B-9

Page 2 of 4

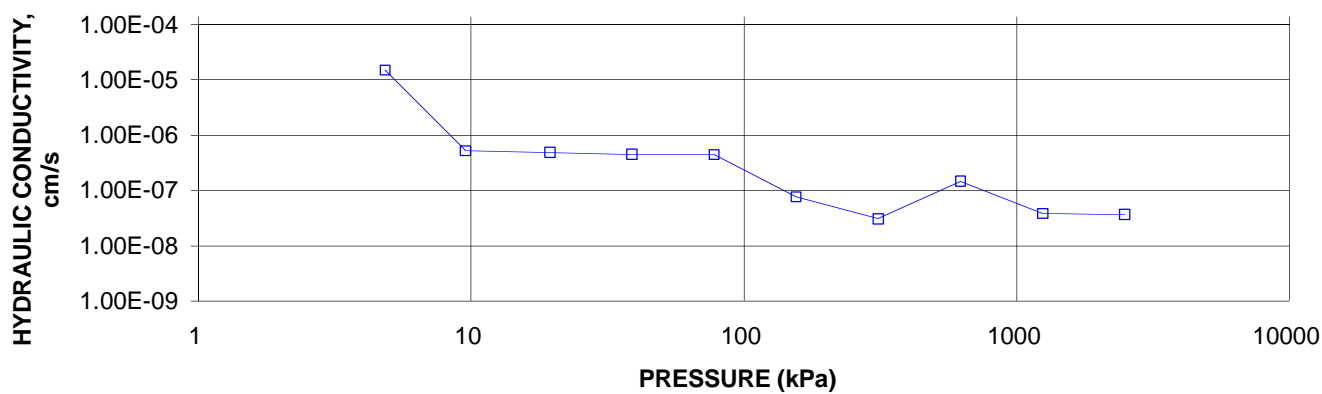
CONSOLIDATION TEST  
CV cm<sup>2</sup>/s VS PRESSURE (kPa)  
BH WC-18 SA 8



CONSOLIDATION TEST  
MV m<sup>2</sup>/kN vs PRESSURE (kPa)  
BH WC-18 SA 8



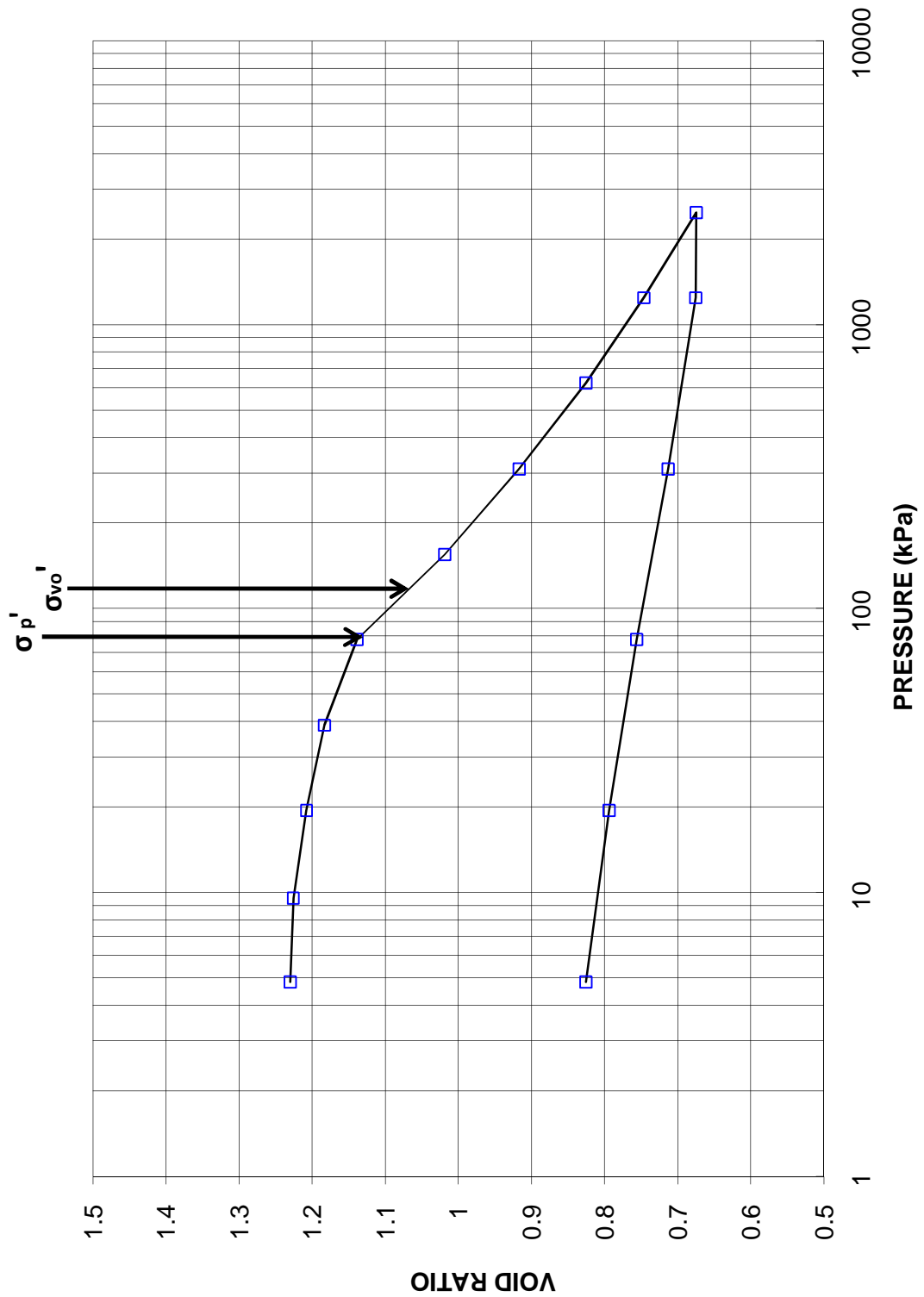
CONSOLIDATION TEST  
HYDRAULIC CONDUCTIVITY vs PRESSURE  
BH WC-18 SA 8



# CONSOLIDATION TEST VOID RATIO VS. LOG PRESSURE

FIGURE B-9  
Page 3 of 4

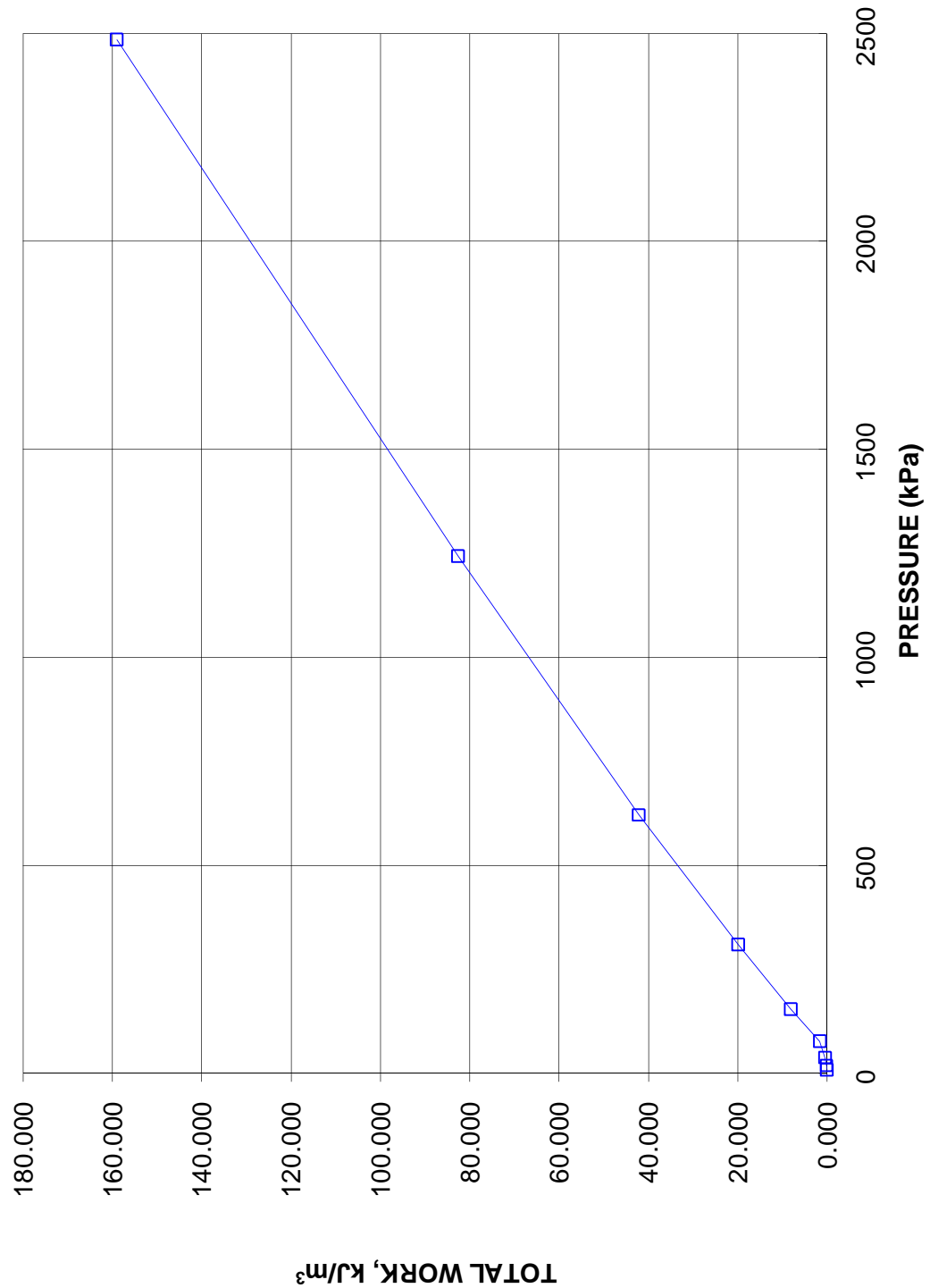
CONSOLIDATION TEST  
VOID RATIO vs PRESSURE  
BH WC-18 SA 8



**CONSOLIDATION TEST  
TOTAL WORK VS. PRESSURE**

**FIGURE B-9**  
Page 4 of 4

**CONSOLIDATION TEST  
TOTAL WORK, kJ/m<sup>3</sup> vs PRESSURE  
BH WC-18 SA 8**

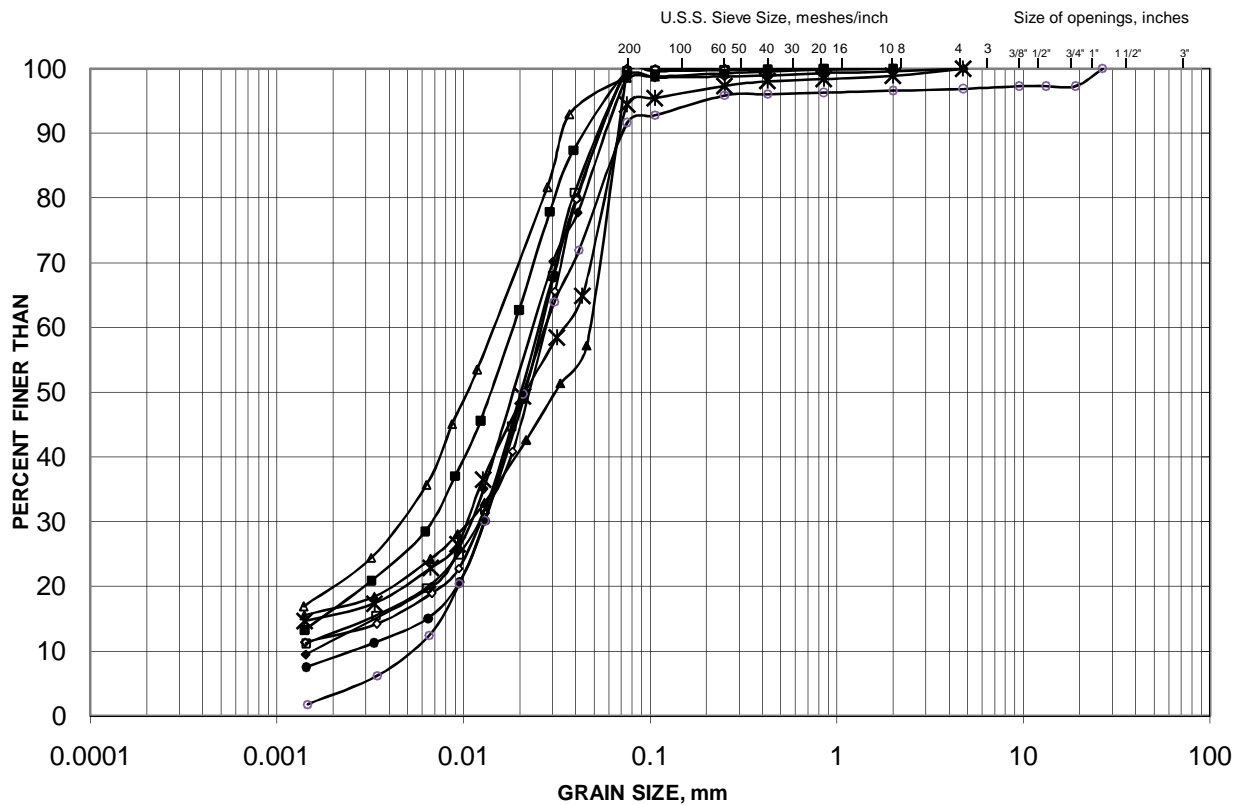


# GRAIN SIZE DISTRIBUTION

Silt

FIGURE

B-10



SILT AND CLAY SIZES				FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE
FINE GRAINED				SAND SIZE			GRAVEL SIZE		
LENGEND	SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)					
	—◆—	WC-4	8b	301.2					
	—●—	WC-6	10	298.3					
	—■—	WC-7	7	298.1					
	—▲—	WC-8	9	298.3					
	—✱—	WC-8	12	293.8					
	—◊—	WC-9	10	296.7					
	—⊖—	WC-11b	4	299.4					
	—◻—	WC-15	7	306.1					
	—△—	WC-19	10	299.8					

Project Number: 07-1191-0008

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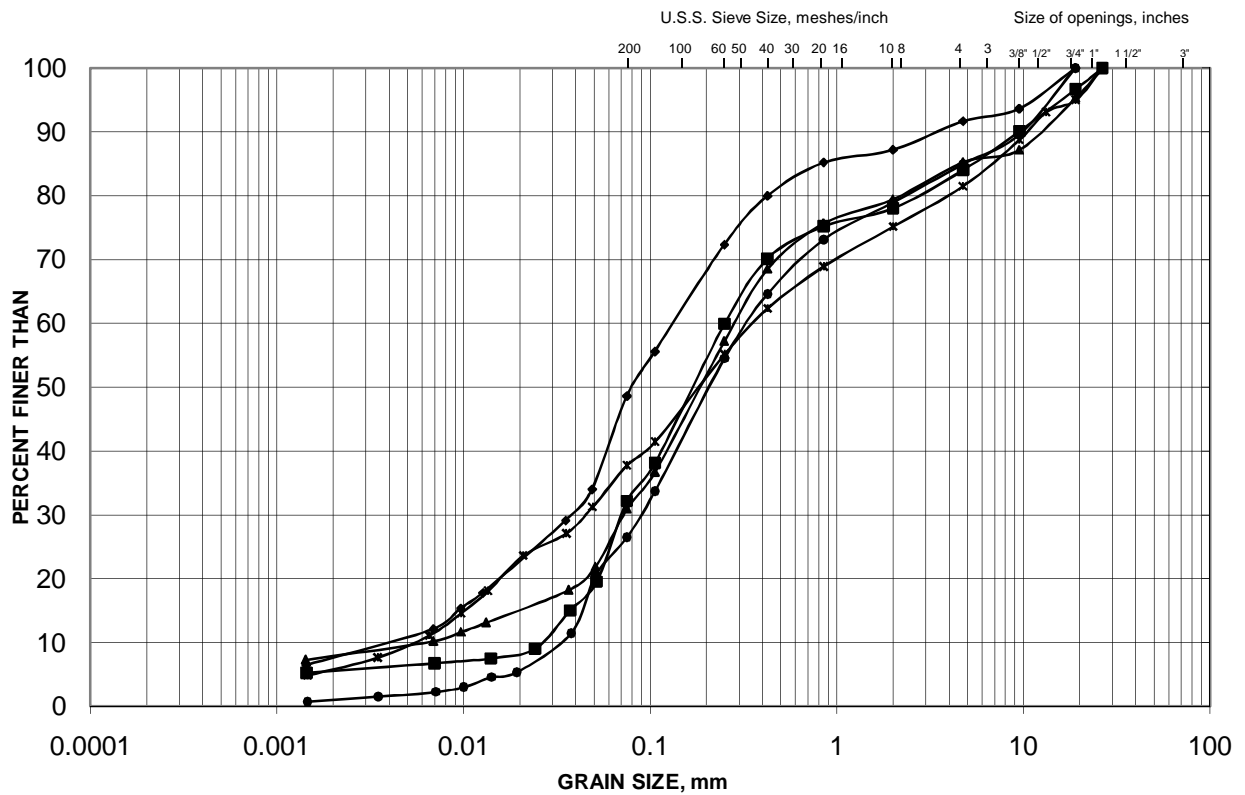
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# GRAIN SIZE DISTRIBUTION

## Silt and Sand to Silty Sand

**FIGURE**  
**B-11a**



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

### LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)
—●—	WC-1	8	306.5
—●—	WC-2	3	306.7
—■—	WC-2	5	305.1
—▲—	WC-3	8	303.0
—*—	WC-14	10	302.8

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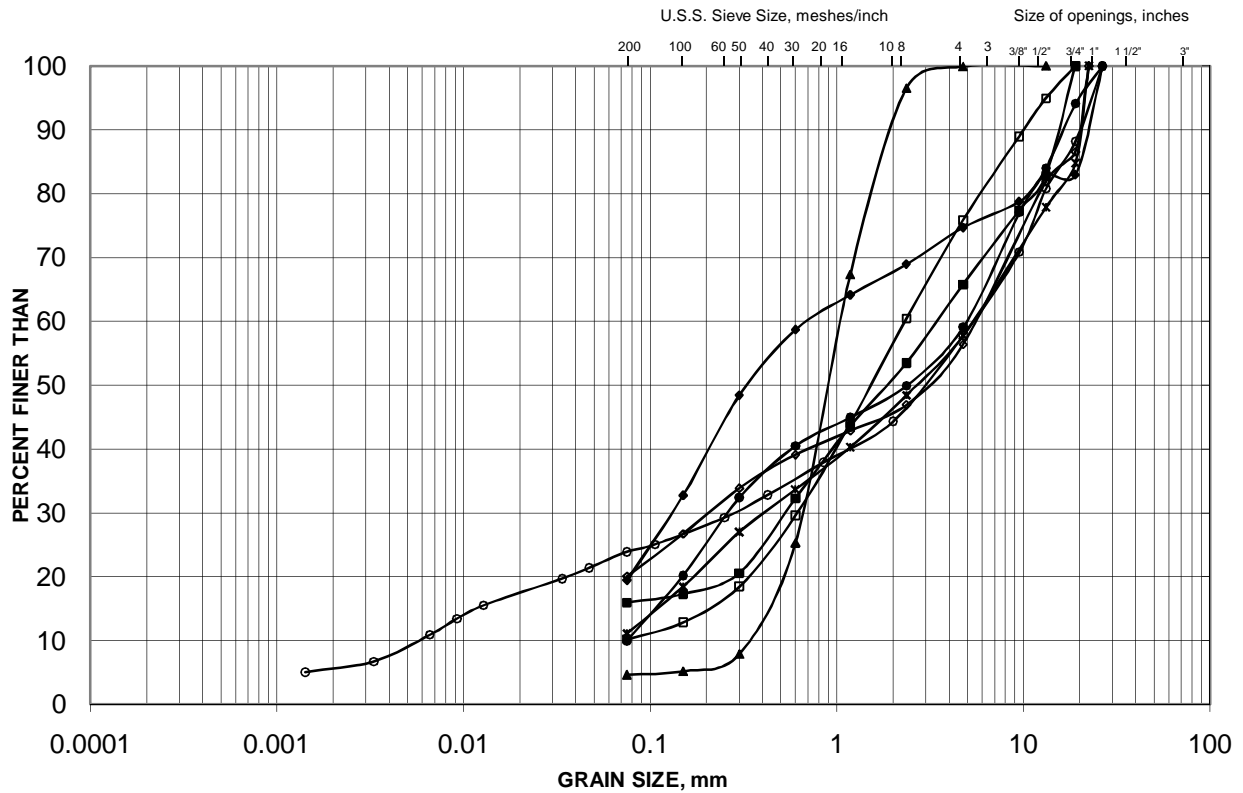
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# GRAIN SIZE DISTRIBUTION

## Sand, Gravelly Sand, Sand and Gravel

**FIGURE**  
**B-11b**



SILT AND CLAY SIZES				FINE	MEDIUM	COARSE	FINE	COARSE	COBBLE SIZE	
FINE GRAINED				SAND SIZE			GRAVEL SIZE			
LEGEND	SYMBOL	BOREHOLE	SAMPLE	ELEVATION (m)						
	—◆—	WC-1	4	309.5						
	—●—	WC-3	6	305.1						
	—■—	WC-6	11b	296.5						
	—▲—	WC-9	12	293.9						
	—✱—	WC-13	11	299.3						
	—◊—	WC-16	8b	303.0						
	—○—	WC-17	11	299.8						
	—◻—	WC-18	12	296.9						

Project Number: 07-1191-0008

Checked By: SEMC

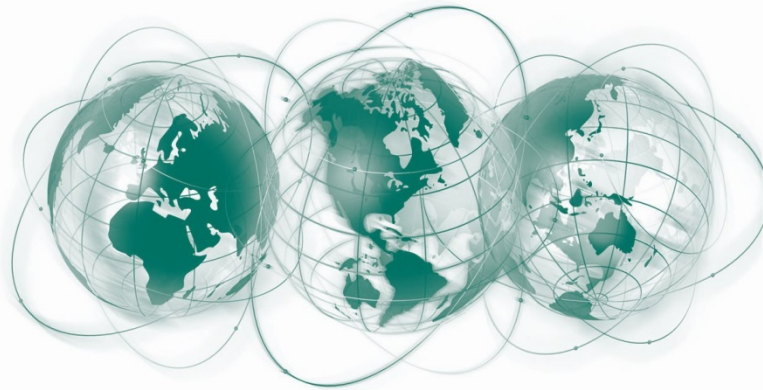
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