



November 9, 2018

PRELIMINARY FOUNDATION INVESTIGATION REPORT

**Garden City Skyway
Queen Elizabeth Way from Niagara Street to
Glendale Avenue
St. Catharines, Ontario
W.O. 08-2009**

Submitted to:
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REPORT



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1.0 INTRODUCTION

Golder Associates Ltd. (Golder) has been retained by WSP (formerly MMM Group Ltd.) on behalf of the Ministry of Transportation, Ontario (MTO) to provide foundation engineering services in support of the proposed twinning of the existing Garden City Skyway bridge structure that carries the Queen Elizabeth Way (QEW) over the Welland Canal in St. Catharines, Ontario. Foundation engineering services for this assignment are required under two phases:

- **Phase 1 - Feasibility Study:** This phase of the work is based on a review of existing information (including subsurface data), field reconnaissance, and a limited subsurface investigation. The review includes an assessment of the design and performance of the existing bridge structure foundations and approach embankments, and a feasibility-level assessment of various alignment alternatives with respect to the ground conditions and potential construction concerns for bridge and tunnel options. The final Phase 1 report was completed in April 2012 by Golder.
- **Phase 2 - Preliminary Investigation and Design:** This phase of the work is to include a foundation investigation program developed following Phase 1, as well as analysis and preliminary design for the preferred bridge alignment.

This report addresses Phase 2 of the project for the Preliminary Foundation Investigation and Design Report.

The terms of reference and scope of work for the foundation assignment are outlined in MTO's Request for Proposal (RFP) dated March 2010, and in Section 6.8 of MMM's *Technical Proposal* and the proposed scope of work letter for the preliminary foundation investigation and design services from Golder dated April 9, 2015.

2.0 SITE DESCRIPTION

The existing Garden City Skyway runs in an east-west direction and is a 2.2 km long, 28 m wide, 48-span high level bridge structure that carries the Queen Elizabeth Way (QEW) over the Welland Canal, connecting the City of St. Catharines and the Town of Niagara-on-the-Lake in the Region of Niagara. On the west side, the skyway is surrounded by industrial parks, with a cemetery to the south. On the east side, the skyway is surrounded by private property and a small commercial property to the north, and an older cemetery and public property (MTO and St. Lawrence Seaway) to the south (see Drawing 1).

The overall surface topography of the area is relatively flat, with a gentle slope downward to the north toward Lake Ontario. The natural ground surface in the immediate area of the structure site is at about Elevation 105 m, and the existing QEW grade has a maximum elevation of approximately 145 m as it crosses Welland Canal, with the water surface in the canal at about Elevation 103 m.

Currently, six lanes of traffic are carried on the bridge, with minimal shoulders on either side. It is understood that the projected future traffic conditions across the Garden City Skyway will exceed the existing capacity. As such, we understand based on the results of the feasibility study that the preferred option is twinning of the existing bridge with a similar structure on a new alignment approximately 38 m north of the existing structure and rehabilitation of the existing structure.



3.0 INVESTIGATION PROCEDURES

3.1 Previous Investigations

3.1.1 Golder (2012) – Feasibility Foundation Investigation Report – Garden City Skyway

As part of Golder's Phase 1 scope of work for this project, Golder conducted a feasibility study, which included a review of existing information (including subsurface data), field reconnaissance, and a limited subsurface investigation which included drilling of (8) eight boreholes. The current investigation is supplemented by information contained within this report:

- Report titled "Feasibility Foundation Investigation and Assessment Report – Garden City Skyway, from Niagara Street to Glendale Avenue, St. Catharines, Ontario, WO 08-2009", by Golder Associates Limited dated April 2012 – GEOCRE 30M3-272.

References to the numerous previous historical reports for this site are contained in the above referenced report and relevant Record of Boreholes from Golder's 2012 report as well as the results of laboratory testing have been utilized in the preparation of this report and are included in Appendices C and D following the text of this report.

3.1.2 Geocon (1960) – Soil Conditions and Foundation Analyses, Proposed High Level Bridge, Homer

Due to the proximity of the proposed bridge structure to the existing bridge structure, the current investigation is supplemented by relevant information contained within this report:

- Report titled "Soil Conditions and Foundation Analyses, Proposed High Level Bridge, Homer, Ontario" (W.P. 24-57), by Geocon Ltd., dated January 29, 1960.

The 1960 Geocon report addresses the soil conditions at the site, and includes foundation design and recommendations for the existing bridge structure. Select Record of Boreholes as well as the results of laboratory testing from this investigation have been utilized in the preparation of this report and are included in Appendices C and D following the text of this report.

3.2 Current Investigation

The field work for the subsurface investigation for the Phase 2 Preliminary Foundation Investigation was carried out between March, May, June and July 2015, during which time fourteen boreholes (Boreholes WAPP, WA, W13, W11, W7, W5A/B, 15-2, 15-1, E6, E8, E10, E12, EA, and EAPP) and four Cone Penetration Tests (CPTs) CPT-1, CPT-2, CPT-3 and CPT-4 were advanced using CME 75 truck-mounted drill rigs, supplied and operated by Geo-Environmental Drilling Inc. of Milton, Ontario and Aardvark Drilling Inc. of Guelph, Ontario. The boreholes were advanced using 108 mm inside diameter hollow-stem augers, HW casing and wash boring techniques to depth ranging from 27.9 m to 46.1 m. Samples of the bedrock were obtained using an 'HQ' triple-tube diamond drill core barrel or 'NQ' double-tube diamond drill core barrel.



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Soil samples were obtained at 0.75 m and 1.5 m intervals of depth in the boreholes, using a 50 mm outside diameter split-spoon sampler driven by an automatic hammer in accordance with the Standard Penetration Test (SPT) procedure (ASTM D1586). Samples of the cohesive soils were obtained using 76 mm O.D. thin walled Shelby Tubes (ASTM D1587) for relatively undisturbed samples. Field vane shear tests were conducted in cohesive soils for determination of undrained shear strengths (ASTM D2573) using MTO Standard 'N' size vanes.

Stabilized groundwater conditions were unable to be observed in the open boreholes due to wash boring techniques however, (5) five standpipe piezometers were installed in various boreholes (Boreholes WA, W7, E6, E10 and EA) to permit monitoring of the groundwater level. The piezometers consist of 50 mm diameter PVC pipe, with a slotted screen sealed within a sand filter pack at a selected depth interval within the boreholes. Above the sand filter pack and piezometer screen, the annulus surrounding the piezometer pipes were backfilled to the ground surface with bentonite pellets. The piezometer installation details and water level readings are indicated on the Record of Boreholes are contained in Appendix A. All remaining boreholes were backfilled with bentonite upon completion, in accordance with Ontario Regulation 903 (as amended).

The field work was supervised on a full-time basis by members of Golder's engineering and technical staff who located the boreholes in the field, directed the drilling, sampling, and in situ testing operations, and logged the boreholes. The soil and bedrock samples were identified in the field, placed in labelled containers and transported to Golder's laboratory in Mississauga for further examination and laboratory testing. Index and classification tests consisting of water content determinations, Atterberg limits testing, and grain size distribution analyses were carried out on selected soil samples. In addition, ten (10) one-dimensional consolidation (oedometer) tests were carried out on selected samples of the clay to clayey silt deposit. Three consolidated undrained direct shear tests were performed on Shelby tube samples of the clay to clayey silt deposit from Boreholes 15-1 and 15-2. Point load index and unconfined compression strength tests were carried out on selected bedrock samples. The results of the laboratory testing are contained in Appendix B.

In Boreholes W13 and E8, a 3" PVC casing was installed to depths of 44.2 m and 33.9 m, respectively and grouted into the boreholes upon completion of drilling to allow for Vertical Seismic Profiling (VSP) testing. The fieldwork for the VSP analysis took place on June 17, 2015 by a member of Golder's technical staff. The results of the VSP testing are contained in Appendix E.

Classification of the rock mass quality of the bedrock with respect to the Rock Quality Designation (RQD) is described based on Table 3.10 in the Canadian Foundation Engineering Manual (CFEM, 2006)¹. The degree of weathering of the bedrock samples (i.e., fresh to completely weathered) and the strength classification of the intact rock mass based on field identification (i.e., very poor to very strong) are described in accordance with Table B.3 and Table B.6, respectively, of the International Society for Rock Mechanics (ISRM)² standard classification system. Classification of the bedrock core samples with respect to strength is based on Table 3.5 in CFEM (2006).

The CPTs, an in-situ testing technique used for the nearly continuous characterisation of subsurface soils, were advanced to depths below ground surface ranging from about 24.0 m to 31.2 m, corresponding approximately to the bottom of the cohesive deposit as defined by the adjacent boreholes. The CPT consists of a special probe equipped with electronic sensing elements to continuously measure tip resistance, local side friction on a sleeve

¹Canadian Geotechnical Society, 2006. Canadian Foundation Engineering Manual, 4th Edition.

² International Society for Rock Mechanics Commission on Test Methods, 1985. Int. J. Rock Mech.Min. Sci. & Geomech. Abstr. Vol 22, No. 2, pp. 51-60.



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and porewater pressure. It is pushed into the ground at a constant rate (ASTM D5778-07 Standard Test Method for Piezocone Penetration) and a nearly continuous stratigraphic profile, together with inferred engineering properties such as shear strength and stress history, can be interpreted from the results.

At this site, the CPT equipment was advanced using the hydraulic system on the drill rig. Cone Penetration Test sheets are included with the Record of Borehole sheets in Appendix A. Profiles of tip resistance, friction and porewater pressure are presented together with interpreted profiles of undrained shear strength and classification index that is used to infer the soil type (i.e., soil stratigraphy). During the advancement of the CPTs, a total of nine pore pressure dissipation tests were carried out to provide data to evaluate the in-situ horizontal coefficient of consolidation (c_h) of the clayey strata. The results of the dissipation testing are included on Figures A1 and A2 in Appendix A.

The borehole and CPT locations were established in the field by Golder personnel relative to existing site features and using a hand-held global positioning system (GPS) with a horizontal accuracy of about ± 3 m. The ground surface elevation at each borehole was estimated from the digital terrain model for the site as provided by WSP. The borehole locations (referenced to the MTM NAD83 co-ordinate system) and ground surface elevations (referenced to geodetic datum) are summarized in the following table and are shown on Drawing 1.

Borehole/CPT Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole/CPT Depth (m) * Includes bedrock coring
West Side of Welland Canal				
CPT-1	4 780 973.5	328 298.1	107.8	31.2
WAPP	4 781 005.5	328 344.6	102.4	32.5
WA	4 781 004.6	328 348.0	102.4	46.1*
MW1	4 781 004.0	328 359.7	102.3	7.6
CPT-3	4 781 001.4	328 360.6	102.5	28.5
W13	4 780 950.0	328 558.6	102.5	44.2*
W11	4 780 927.0	328 696.0	103.0	41.4*
W7	4 780 900.1	328 994.1	103.5	38.3*
W5A	4 780 912.4	329 147.3	104.1	12.0
W5B	4 780 912.4	329 147.3	104.1	35.2*
15-2	4 780 910.8	329 482.3	103.5	38.2*
East Side of Welland Canal				
15-1	4 780 909.3	329 662.4	101.8	30.3*
E6	4 780 882.3	330 025.3	106.0	34.1*
E8	4 780 850.9	330 165.4	105.9	33.9*
E10	4 780 789.3	330 283.1	110.7	35.4*
E12	4 780 766.3	330 407.3	110.8	36.9*
EA	4 780 712.7	330 518.0	111.1	35.4*
MW2	4 780 712.5	330 533.3	111.5	7.6
CPT-4	4 780 715.5	330 529.9	111.5	24.0



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Borehole/CPT Number	MTM NAD83 Northing (m)	MTM NAD83 Easting (m)	Ground Surface Elevation (m)	Borehole/CPT Depth (m) * Includes bedrock coring
EAPP	4 780 709.6	330 523.1	111.4	27.9
CPT-2	4 780 595.8	330 453.8	118.7	30.5

4.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

4.1 Regional Geology

The Garden City Skyway and the adjacent portions of the QEW lay within the physiographic region known as the Iroquois Plain, as delineated in *The Physiography of Southern Ontario* (Chapman and Putnam, 1984) and *Urban Geology of Canadian Cities* (Menzies and Taylor, 1998).

The Iroquois Plain extends around the western shores of Lake Ontario; on the south side of the lake, in the St. Catharines area, the Plain is located between the present Lake Ontario shorebluffs and the foot of the Niagara Escarpment. The Plain is comprised of the flat to undulating lakebed and beaches of the former glacial Lake Iroquois, which occupied this area during the last glacial recession.

The surficial soils in the Iroquois Plain are typically comprised of glaciolacustrine clays and silts. However, in the St. Catharines area, surficial deposits of beach sand and gravel are present in some areas. The surficial sands, silts and clays are underlain by an extensive till deposit; portions of the till are considered to be “water-lain” (that is, formed by sediment rain-out either from a floating ice margin or from iceberg dumping), resulting in a predominantly massive, matrix-supported structure, as well as relatively thin sand to silt stringers or interlayers. This extensive till deposit may be underlain by or interlayered with a lower glaciolacustrine clay deposit, although this glaciolacustrine layer is absent in some portions of the Iroquois Plain in the St. Catharines area. Finally, the till and/or glaciolacustrine layer may be underlain by a lower till unit, that typically has increasing gravel content with proximity to the underlying bedrock (Menzies and Taylor, 1998).

The overburden soils are underlain by red shale bedrock of the Queenston Formation. This shale formation contains siltstone interlayers as well as “occasional patches of gypsum” (Menzies and Taylor, 1998).

4.2 Subsurface Conditions

As part of the current subsurface investigation, fourteen (14) boreholes were advanced at various proposed piers along the proposed new Garden City Skyway structure, located north of the existing structure. The borehole locations, ground surface elevations and interpreted stratigraphic conditions at the site are shown on Drawings 1 and 2.

The detailed subsurface soil, bedrock and groundwater conditions encountered in the boreholes and the results of the in situ and laboratory testing are given on the Record of Boreholes and Cone Penetration Test sheets contained in Appendix A. The results of geotechnical laboratory testing are also presented on Figures B1 to B6 contained in Appendix B. The results of the in-situ field tests (i.e., SPT ‘N’-values and undrained shear strengths from field vanes) as presented on the Record of Borehole sheets and in Section 4 are uncorrected. It should be



noted that an Automatic Hammer was used for the SPT testing during the 2011 and 2015 investigations, while it is understood that a Manual Hammer was used for the SPT testing during the 1959 investigations. In Record of Boreholes and select laboratory testing from Boreholes 1 and 3 from Golder's 2012 investigation and Boreholes D185+00, D186+50, D190+00, D195+00, D200+00, D203+70, D209+68, D216+10, D218+45, 222+00, D235+46 and D238+34 from Geocon's 1960 investigation are included in Appendices C and D, respectively. The stratigraphic boundaries shown on the Record of Boreholes and on the interpreted stratigraphy shown on the profile on Drawing 2 is inferred from non-continuous sampling and, therefore, represents transitions between soil types rather than exact planes of geological change. The subsoil conditions will vary between and beyond the borehole locations. The results of the VSP analysis are included in Appendix E.

In summary, the subsoil conditions encountered at the site consist of asphalt, topsoil or fill overlying extensive cohesive deposits. The cohesive deposit consists of a firm to very stiff clay to clayey silt underlain by a clayey silt to silt till deposit which was encountered underlying the cohesive deposit. The till deposit is underlain by clayey silt residual soil and/or shale bedrock in the majority of the boreholes. A more detailed description of the soil and bedrock deposits encountered in these boreholes is provided in Sections 4.2.1 to 4.2.7.

4.2.1 Topsoil

Approximately 200 mm to 800 mm of topsoil was encountered from ground surface in Boreholes W11, W7, E6, E8, E12 and EAPP. Two measured SPT 'N'-values within the topsoil deposit were 6 blows per 0.3 m of penetration, suggesting a loose consistency.

Golder Boreholes (2012)

An approximately 0.3 m thick layer of topsoil was encountered immediately below from ground surface in Borehole 1.

Geocon Boreholes (1960)

Topsoil was encountered from ground surface in all 1960 boreholes ranging from approximately 0.2 m to 0.5 m thick.

4.2.2 Fill

4.2.2.1 Asphalt

An approximately 100 mm thick layer of asphalt was encountered from ground surface in Boreholes CPT-1, CPT-2 and 15-2.

4.2.2.2 Silty Sand and Gravel to Sand and Gravel - Fill

A 0.3 m to 2.0 m thick layer of silty sand and gravel to sand and gravel fill was encountered from ground surface in Boreholes WAPP, W13, W5A, 15-1, E10, E12 and EA and underlying the asphalt in Borehole 15-2.

The measured SPT 'N'-values within the silty sand and gravel range from 4 blows to 20 blows per 0.3 m of penetration indicating a loose to compact relative density. In two instances, SPT 'N'-values did not fully penetrate the full 0.3 m of the split-spoon sample and in one instance a SPT 'N'-value of 116 blows per 0.3 m of penetration, however these are likely indicative of the frozen state of the material and are not representative.



The natural water content measured on samples of the silty sand and gravel fill strata range from 7 per cent to 13 per cent.

Golder Boreholes (2012)

Underlying the topsoil and below the clayey silt with sand layers in Boreholes 1 and 3, respectively, a fill stratum comprised of silty sand, some gravel, trace clay was encountered and ranged from 0.2 m to 0.8 m thick, respectively.

One SPT 'N'-value of 10 blows per 0.3 m of penetration were noted in this stratum indicating a compact relative density.

Geocon Boreholes (1960)

Underlying the topsoil or from the ground surface in Boreholes D222+00, D235+46 and D238+34 between approximately 1.0 m and 2.9 m of silty sand and gravel fill was encountered.

SPT 'N'-values between 18 and 97 blows per 0.3 m of penetration were noted in this stratum indicating a compact to very dense relative density.

4.2.2.3 Sandy Clayey Silt to Silty Clay - Fill

A 0.4 m to 2.0 m thick sandy clayey silt to silty clay, with gravel, trace organics fill strata was encountered in Boreholes WA, W13, W11, E8, E12 and EAPP, from ground surface or underlying the topsoil and/or granular fill. In Boreholes CPT-1 and CPT-2, which were advanced through the existing west and east approach embankments, respectively, to facilitate advancing the CPTs into the underlying native clayey strata, a 7.1 m thick silty clay, trace to some sand, trace to some gravel fill was encountered underlying the asphalt.

The measured SPT 'N'-values within the sandy clayey silt to silty clay fill strata range from 4 blows to 21 blows per 0.3 m of penetration suggesting a firm to very stiff consistency. In one instance the SPT 'N'-value did not fully penetrated the full 0.3 m, likely indicative of the underlying concrete and is not representative. In one instance the SPT 'N'-value of 38 blows per 0.3 m was measured, however this is likely indicative of the frozen nature of the material.

The natural water content measured on samples of the sandy clayey silt to silty clay fill strata range from 8 per cent to 26 per cent.

Golder Boreholes (2012)

A layer of clayey silt with sand to silty clay trace sand fill was encountered, underlying the concrete and from ground surface in Boreholes 1 and 3, respectively and was 1.0 m and 0.7 m thick, respectively.

SPT 'N'-values between 6 and 12 blows per 0.3 m of penetration were noted in this stratum, suggesting a firm to stiff consistency.

4.2.2.4 Concrete

Underlying the silty sand and gravel or sandy clayey silt to silty clay fill strata, a 200 mm to 250 mm thick concrete layer was encountered in Boreholes WA and WAPP at 0.4 m and 0.5 m depth below ground surface, respectively.



Golder Boreholes (2012)

Underlying the silty sand fill strata in Borehole 1, an approximately 200 mm layer of concrete was encountered at a depth of approximately 0.4 m below ground surface.

4.2.3 Clay to Clayey Silt

An approximately 15.6 m to 27.9 m thick brown to grey clay to clayey silt deposit was encountered underlying the topsoil and/or fill in all boreholes. The surface of the deposit was encountered between Elevations 110.7 m and 100.2 m. At Boreholes CPT-1 and CPT-2, the boreholes were advanced to Elevation 92.7 m and 111.5 m within the native silty clay stratum, respectively, prior to advancing the CPT test. The upper portion of the deposit consists generally of silty clay to clay transitioning to clayey silt with depth. Trace organics/rootlets were encountered generally within the upper 4.4 m in Boreholes E12, EA and EAPP. Trace to some sand and trace to some gravel were encountered at depth in Boreholes 15-1 and EA.

The results of grain size distribution tests completed on selected samples of the clay to clayey silt deposit are shown on Figure B1.1, to B1.3 in Appendix B.

Atterberg limits testing was carried out on selected samples of the clay to clayey silt deposit and measured plastic limits ranging from about 15 per cent to 21 per cent, liquid limits from about 26 per cent to 56 per cent, and corresponding plasticity indices from about 10 per cent to 36 per cent. These lab results, which are plotted on the plasticity chart on Figure B2.1 to B2.5 in Appendix B, confirm that the deposit consists of high plasticity clay to low plasticity clayey silt.

The natural water content measured on samples of the clay to clayey silt range from 18 per cent to 73 per cent.

The measured SPT 'N'-values within the clay to clayey silt deposit range from 0 blows (weight of hammer) to 33 blows per 0.3 m of penetration and a value of 39 blows at the bottom of the deposit in Borehole E12. The field vane tests measured undrained shear strengths of approximately 29 kPa to over 96 kPa, with the higher SPT "N" values and shear strengths corresponding to a weathered and desiccated crust and/or the transition with the underlying till deposit. Typically, the crust is less than about 6 m thick except at the easternmost portion of the alignment (i.e. Boreholes E12, EA and EAPP). These results confirm that the deposit has a firm to very stiff (and in one instance hard) consistency.

Laboratory consolidation tests were carried out on ten samples of the clay to clayey silt deposit from Boreholes WAPP, WA, EA and EAPP. The consolidation test results are presented on Figures B3.1 to B3.10 in Appendix B, and summarized below.

Borehole/ Sample No.	Sample Depth/ Elevation	Unit Wt. (kN/m³)	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	C_c	C_r	e_o	OCR
WAPP / Sa. 5	3.4 m / 99.0 m	21.0	70	520	450	0.23	0.043	0.527	7.4
WAPP / Sa. 12	12.5 m / 89.9 m	20.7	240	515	275	0.36	0.037	0.621	2.1



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Borehole/ Sample No.	Sample Depth/ Elevation	Unit Wt. (kN/m ³)	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	C_c	C_r	e_o	OCR
WAPP / Sa. 20	24.7 m / 77.7 m	20.5	370	430	160	0.26	0.031	0.624	1.2
WA / Sa. 9	7.9 m / 94.5 m	19.0	150	450	300	0.39	0.034	0.861	3.0
WA / Sa. 16	18.6 m / 83.8 m	19.1	270	285	15	0.39	0.048	0.889	1.1
EA / Sa. 3	1.8 m / 109.3 m	20.4	37	660	623	0.16	0.023	0.641	17.8
EA / Sa. 8	6.4 m / 104.7 m	20.2	130	700	570	0.28	0.024	0.699	5.4
EA / Sa. 12	12.5 m / 98.6 m	19.4	220	560	340	0.42	0.044	0.847	2.5
EAPP / Sa. 10	9.5 m / 101.9 m	20.0	185	810	655	0.33	0.024	0.724	4.4
EAPP / Sa. 15	17.1 m / 94.3 m	18.3	325	405	80	0.55	0.063	1.108	1.2

where: σ_{vo}' is the in situ vertical effective overburden stress in kPa
 σ_p' is the preconsolidation stress in kPa
OCR is the over consolidation ratio
 C_c is the compression index
 C_r is the recompression index
 e_o is the initial void ratio
 c_v is the coefficient of consolidation in cm²/s

Laboratory consolidated undrained triaxial tests (CIU) with pore pressure measurement were carried out on five (5) samples of the clayey silt to clay deposit from Boreholes 15-1 and 15-2. In total, 2 sets of 4 specimens and 1 set of 3 specimens (total of 11 tests) were tested. All tests were carried out on specimens trimmed from the relatively 'undisturbed' Shelby tube samples. The details of the test results are shown on Figures B4.1 to B4.3 in Appendix B and the results are summarized below.

Borehole / Sample Number	Depth (m)	Peak		Post-Peak	
		Effective Cohesion Intercept, c' (kPa)	Effective Angle of Internal Friction, ϕ' (degrees)	Effective Cohesion Intercept, c' (kPa)	Effective Angle of Internal Friction, ϕ' (degrees)
15-1, Sa# 4 & 5	2.3-2.9/3.0-3.6	5	25	5	20
15-1, Sa# 9 & 10	9.2-9.8/9.9-10.5	10	25	10	21
15-2, Sa# 16	16.3-16.9	10	23	10	22

Note: The assessed shear strength parameters are only valid over the range of stress conditions employed in the test.



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Laboratory consolidated, drained direct shear (DS) tests were carried out on one (1) sample from the clayey silt to clay deposit from Borehole 15-2. In total, 1 set of 3 specimens (total of 3 tests) were tested. All tests were carried out on specimens trimmed from the relatively 'undisturbed' Shelby tube samples. The details of the test results are shown on Figure B4.4 in Appendix B and the results are summarized below.

Borehole / Sample Number	Depth (m)	Peak		Post-Peak	
		Effective Cohesion Intercept, c' (kPa)	Effective Angle of Internal Friction, ϕ' (degrees)	Effective Cohesion Intercept, c' (kPa)	Effective Angle of Internal Friction, ϕ' (degrees)
15-2, Sa# 14	14.2-14.8	10	20	10	20

Note: The assessed shear strength parameters are only valid over the range of stress conditions employed in the test

Golder Boreholes (2012)

An approximately 24 m to 26 m thick cohesive deposit comprised of clayey silt to silty clay was encountered in Boreholes 1 and 3. In general, SPT 'N'-values (between 3 and 24 blows per 0.3 m of penetration) and shear strengths (between 25 kPa to greater than 100 kPa) were noted with the higher values in the upper portion of this deposit corresponding to a weathered and desiccated crust, similar to that encountered in the current investigation. In Borehole 1, at the westernmost portion of the alignment, the crust extends to approximately 13.3 m below ground surface. Generally, the deposit ranged from very stiff to firm with depth.

In general, the index testing (i.e. moisture content, grain size distributions and Atterberg limits) performed on samples of this deposit are similar to that encountered in the current investigation. In addition, one consolidation test was completed on a sample from Borehole 1 of this deposit, summarized below and shown in Appendix D.

Borehole/ Sample No.	Sample Depth/ Elevation	Unit Wt. (kN/m ³)	σ_{vo}' (kPa)	σ_p' (kPa)	$\sigma_p' - \sigma_{vo}'$ (kPa)	C_c	C_r	e_o	OCR
1, Sa#1	10.9 m / 92.1 m	20.6	151	422	271	0.32	0.06	0.65	2.8

where: σ_{vo}' is the in situ vertical effective overburden stress in kPa
 σ_p' is the preconsolidation stress in kPa
OCR is the over consolidation ratio
 C_c is the compression index
 C_r is the recompression index
 e_o is the initial void ratio
 c_v is the coefficient of consolidation in cm²/s

Geocon Boreholes (1960)

An approximately 21.7 m to 26.9 m thick cohesive deposit comprised of clayey silt to clay was encountered in all boreholes underlying the topsoil. In general SPT 'N'-values (between 7 and greater than 100 blows per 0.3 m of penetration) and shear strengths (between approximately 21 kPa and greater than 100 kPa) were noted with higher values in the upper portion of this deposit corresponding to a weathered and desiccated crust, similar to



that encountered in the current investigation. In Borehole D185+00 at the westernmost portion of the alignment, the crust extends to approximately 7.3 m below ground surface. Generally the deposit ranged from hard to stiff in the crust to stiff to firm with depth.

In general the index testing (i.e. moisture content, grain size distributions and Atterberg limits) performed on samples of this deposit are similar to that encountered in the current investigation. In addition, several consolidation tests were completed on samples of this deposit and are shown in Appendix D.

4.2.4 Clayey Silt to Silt to Sand and Silt Till

An approximately 4.5 m to 14.2 m thick reddish brown to grey clayey silt to silt and/or sand and silt till stratum was encountered underlying the cohesive deposits in all boreholes. The surface of the till deposit was encountered between Elevation 90.0 m to 73.9 m. The till deposit predominantly consists of clayey silt to silt, trace to sandy, trace to gravelly. In three boreholes, a lower layer of sandy silt to sand and silt, trace to some gravel and trace to some clay was encountered. However, gravelly and sandy zones were encountered within the till at some locations. Within the till, trace shale rock fragments were encountered, typically closest to the bedrock surface. In Borehole WA, a 100 mm cobble was encountered at 42.4 m depth overlying the bedrock.

The results of grain size distribution tests completed on selected samples till are shown on Figures B5.1 to B5.3 in Appendix B.

Atterberg limits testing was carried out on selected samples of the clayey silt to silt to sand and silty till and measured plastic limits ranging from about 12 per cent to 16 per cent, liquid limits from about 15 per cent to 23 per cent, and corresponding plasticity indices from about 1 per cent to 7 per cent. These lab results, which are plotted on the plasticity chart on Figure B6.1 and B6.2 in Appendix B, confirm that the deposit consists of clayey silt of low plasticity to silt of slight plasticity.

The natural water content measured on samples of the till range from 9 per cent to 25 per cent.

The measured SPT 'N'-values within the silt to sandy silt till deposit range from 20 blows per 0.3 m of penetration to 166 blows per 0.28 m of penetration, however, in general the values are over 50 blows per 0.3 m of penetration and in some boreholes greater than 100 blows per 0.3 m of penetration. These results indicate that the deposit generally has a very dense relative density.

Golder Boreholes (2012)

A silt till stratum with trace to some sand, trace to some gravel, trace to some clay, containing rock fragments was encountered in both Boreholes 1 and 3. The stratum was noted to be approximately 5.5 m thick where it was fully penetrated.

SPT 'N'-values between 63 blows per 0.3 m of penetration and 158 blows per 0.28 m of penetration were noted in this stratum, indicating a very dense relative density.

In general the index testing (i.e. moisture content, grain size distributions and Atterberg limits) performed on samples of this deposit are similar to that encountered in the current investigation and are shown in Appendix D.



Geocon Boreholes (1960)

A deposit of reddish brown “silty and sandy” till was encountered underlying the clayey silt to clay deposit in all boreholes. The deposit was between approximately 7.5 m and 17.8 m thick where the deposit was fully penetrated.

SPT ‘N’-values between 55 and greater than 100 blows per 0.3 m of penetration were noted in this stratum, indicating a very dense relative density.

In general index testing (i.e. moisture content, grain size distributions and Atterberg limits) performed on samples of this deposit are similar to that encountered in the current investigation.

4.2.4.1 Clayey Silt to Silt to Sand and Silt Till – Surface Elevations

The estimated depth to the surface of the till deposit below ground surface, approximate corresponding till surface elevation and nearest foundation element from the boreholes advanced in current investigation, the Golder 2012 investigation and the Geocon 1960 investigation along/near the proposed bridge alignment are summarized below. In general the surface of the till deposit increases in elevation from west to east along the proposed bridge alignment

Borehole No.	Investigation	Nearest Foundation Element	Inferred Depth to Surface of Till Deposit (m)	Inferred Till Deposit Surface Elevation (m)
1	Golder (2012)	West Abutment	27.7	75.3
D185+00	Geocon (1960)	West Abutment	26.5	75.7
WAPP	Current	West Abutment	28.5	73.9
WA	Current	West Abutment	28.5	73.9
D186+50	Geocon (1960)	Pier W15	24.5	77.6
D190+00	Geocon (1960)	Pier W14	27.5	74.7
W13	Current	Pier W13	24.8	77.7
D195+00	Geocon (1960)	Pier W12	25.9	76.2
W11	Current	Pier W11	26.5	76.5
D200+00	Geocon (1960)	Pier W10	23.9	79.0
D202+00	Geocon (1960)	Pier W9	25.6	78.1
D203+70	Geocon (1960)	Pier W8	24.7	78.6
W7	Current	Pier W7	26.2	77.3
D209+68	Geocon (1960)	Pier W6	25.6	78.3
W5B	Current	Pier W5	26.2	77.9
D216+10	Geocon (1960)	Pier W4/W3	25.6	79.1
D218+45	Geocon (1960)	Pier W3	25.8	78.8
D222+00	Geocon (1960)	Pier W2	23.2	80.6
15-2	Current	Pier W1	22.0	81.5
<u>Welland Canal</u>				
15-1	Current	Pier E1	21.1	80.7



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Borehole No.	Investigation	Nearest Foundation Element	Inferred Depth to Surface of Till Deposit (m)	Inferred Till Deposit Surface Elevation (m)
3	Golder (2012)	Pier E2	25.5	82.2
D235+46	Geocon (1960)	Pier E3	24.5	83.3
D238+34	Geocon (1960)	Pier E4/E5	25.1	84.3
E6	Current	Pier E6	20.9	85.1
E8	Current	Pier E8	17.8	88.1
E10	Current	Pier E10	20.7	90.0
E12	Current	Pier E12	23.2	87.6
EA	Current	East Abutment	22.9	88.2
EAPP	Current	East Abutment	24.0	87.4

4.2.5 Cobbles/Boulders

In addition, although cobbles and boulders were not noted during drilling through the till deposits at this site during the 2015 investigation and were only encountered in a few boreholes (Boreholes 4 and 7) advanced during the 2011 investigation, cobbles and boulders are commonly encountered in glacially derived materials and should be expected within the till deposit at this site.

4.2.6 Clayey Silt Residual Soil

A 0.4 m to 3.3 m thick deposit of red residual soil/completely weathered bedrock was encountered underlying the till deposit in Boreholes W11, W7, E6, E8 and EA underlying the silt deposit in Borehole E12. The surface of the deposit was encountered between Elevation 81.9 m and 67.0 m.

The measured SPT 'N'-values within the deposit ranged from 50 blows per 0.02 m of penetration to 127 blows per 0.15 m of penetration, indicating a hard consistency.

4.2.7 Bedrock

Bedrock was encountered in all boreholes, except for Boreholes WAPP and EAPP which terminated in the hard, residual soil and the till deposit, respectively. In general, the bedrock is described as completely weathered to fresh, thinly laminated, reddish brown with occasional grey limestone bedding, fine grained, non-porous, weak to medium strong, shale of the Queenston Formation. The shale bedrock is typically slightly to highly weathered in the upper portion transitioning to slightly weathered to fresh with depth. The grey limestone interbeds within the shale bedrock range in thickness from about 20 mm to 200 mm. Photographs of the retrieved bedrock cores are shown on Figure B7.1 to B7.4 in Appendix B.



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The Rock Quality Designation (RQD) measured on the core samples is between about 18 per cent and 98 per cent (where the full core run was used to calculate RQD), but is generally over 50 per cent, indicating a rock mass of poor to excellent quality. The Total Core Recovery (TCR) of samples recovered is between about 72 per cent and 100 per cent, but generally over 80 per cent, and the Solid Core Recovery (SCR) of samples recovered is between about 32 per cent and 96 per cent, but generally over 70 per cent.

Point Load tests (with axial and diametral orientation) were carried out on samples of the shale bedrock, with the results summarized on Figure B8 in Appendix B.

Laboratory Unconfined Compression Strength (UCS) tests were carried out, in accordance to ASTM D7012 (Standard Test Method for Compressive Strength), on eleven samples of the shale bedrock. The results of the UCS tests are summarized below and shown on Figures B9.1 to B9.11 in Appendix B.

Borehole No.	Sample Depth (m)	Sample Elevation (m)	Unconfined Compressive Strength – UCS (MPa)
WA	45.9	56.5	17.9
W13	42.0	60.5	23.0
W13	43.5	59.0	21.2
W11	38.2	64.8	30.7
W7	36.6	66.9	1.2
15-1	28.0	73.8	25.4
E10	33.3	77.4	12.6
E10	34.1	76.6	19.2
E12	32.5	78.3	9.4
E12	34.3	76.5	31.2
EA	33.9	77.2	37.3

Based on the UCS test results in accordance with Table 3.5 from CFEM (2006), the shale bedrock within the depth of exploration is classified as very weak (R1, MPa 1 < UCS < 5 MPa) to medium strong (R3, 25 MPa < UCS < 50 MPa), but predominantly weak (R2, MPa 5 < UCS < 25 MPa).

Golder Boreholes (2012)

Bedrock was encountered in Borehole 3 and is described as highly weathered to fresh, thinly laminated, reddish brown, fine grained, non to faintly porous, extremely weak to weak, shale of the Queenston Formation. The bedrock encountered within Borehole 3 is generally consistent with that found within the current investigation. UCS tests and point load test results from the previous investigation are shown in Appendix D. Based on the UCS test results from the previous investigation (which range from 12 MPa to 32 MPa), the shale bedrock within the depth of exploration is classified as weak (R2, 5 MPa < UCS < 25 MPa) to medium strong (R3, 25 MPa < UCS < 50 MPa), but is predominantly weak (R2).



Geocon Boreholes (1960)

In general, the bedrock encountered in the boreholes was comprised of sound, reddish brown shale, generally consistent with that found within the current investigation.

4.2.7.1 Bedrock – Surface Elevations

The estimated depth to bedrock below ground surface, corresponding bedrock surface elevation and the nearest foundation element, the from the boreholes advanced in current investigation, the Golder 2012 investigation and the Geocon 1960 investigation along/near the proposed bridge alignment are summarized below. In general the bedrock increases in Elevation from west to east along the proposed bridge alignment.

Borehole No.	Investigation	Nearest Foundation Element	Inferred Depth to Bedrock Surface (m)	Bedrock Surface Elevation (m)
D185+00	Geocon (1960)	West Abutment	44.3	57.6
WA	Current	West Abutment	42.5	59.9
W13	Current	Pier W13	39.9	62.6
W11	Current	Pier W11	38.0	65.0
D200+00	Geocon (1960)	Pier W10	35.1	67.9
D202+00	Geocon (1960)	Pier W9	35.1	68.7
W7	Current	Pier W7	35.1	68.4
D209+68	Geocon (1960)	Pier W6	36.7	67.2
W5B	Current	Pier W5	32.0	72.8
D216+10	Geocon (1960)	Pier W4/W3	33.1	71.6
D222+00	Geocon (1960)	Pier W2	30.9	72.8
15-2	Current	Pier W1	31.1	72.4
<u>Welland Canal</u>				
15-1	Current	Pier E1	25.6	76.2
3	Golder (2012)	Pier E2	31.0	76.6
D235+46	Geocon (1960)	Pier E3	32.0	75.9
E6	Current	Pier E6	29.0	77.0
E8	Current	Pier E8	27.7	78.2
E10	Current	Pier E10	32.0	78.7
E12	Current	Pier E12	32.0	78.8
EA	Current	East Abutment	32.9	78.2

4.3 Groundwater Conditions

Water levels were unable to be obtained upon completion of drilling due to the wash boring techniques used to advance the boreholes. Piezometers were installed in selected boreholes and the groundwater depths and elevations at the site are summarized as follows:



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Borehole Number	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date of Water Level Measurement
WA	102.4	11.0	91.4	August 26, 2015
		11.1	91.3	September 25, 2015
		11.0	91.4	June 24, 2016
MW1	102.3	10.9	91.4	August 26, 2015
		6.0	96.3	September 25, 2015
		1.3	101.0	June 24, 2016
W7	103.5	4.6	98.9	August 26, 2015
		3.4	100.1	September 25, 2015
		2.9	100.6	June 24, 2016
E6	106.0	6.9	99.1	August 26, 2015
		6.9	99.1	September 25, 2015
		7.0	99.0	June 24, 2016
E10	110.7	9.6	101.1	August 26, 2015
		10.6	100.1	September 25, 2015
		10.7	100.0	June 24, 2016
MW2	111.5	9.8	101.7	August 26, 2015
		7.5	104.0	September 25, 2015
		2.9	108.6	June 24, 2016
EA	111.1	9.8	101.3	August 26, 2015
		9.8	101.3	September 25, 2015
		9.9	101.2	June 24, 2016

Golder Boreholes (2012)

Two piezometers (shallow and deep) were installed within Borehole 1 and the groundwater depth and elevations are summarized below.

Borehole Number	Ground Surface Elevation (m)	Depth to Water Level (m)	Groundwater Elevation (m)	Date of Water Level Measurement
1 (shallow)	103.0	3.0	100.0	June 24, 2011
		3.7	99.3	June 24, 2016
1 (deep)	103.0	10.6	92.4	June 24, 2011
		11.0	92.0	June 24, 2016

The groundwater levels are expected to fluctuate seasonally and are expected to rise during wet periods of the year. Additionally, we also understand that the water level of the Welland Canal can fluctuate drastically and is controlled by man-made lock structures, which may also impact groundwater water levels in vicinity of the Garden City Skyway Bridge.



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Based on the results of the groundwater levels measured during the recent and previous investigations, it appears that the groundwater regime at the site consists of the following aspects:

- Shallow perched groundwater table generally present ranging from about 1 m to 3 m below ground surface;
- Deeper groundwater table controlled by pore pressures in the clayey silt to sand and silt till underlying the clay stratum and ranging from about 4 m to 11 m below ground surface;
- Differences between the shallow and deep piezometric conditions appear to result in a downward gradient across most of the site; and,
- Elevation of deeper groundwater table ranges from about Elev. 91 m (west end of site) to 101 m (east end of site), suggesting a deep groundwater flow regime from east to west.



5.0 CLOSURE

This Preliminary Foundation Investigation Report was prepared by Mr. Adam Core, P.Eng., and reviewed by Ms. Sarah E. M. Poot, P.Eng., a senior geotechnical engineer and Associate with Golder. Mr. Fin Heffernan, P.Eng., a Designated MTO Foundations Contact for Golder, conducted an independent review of this report.

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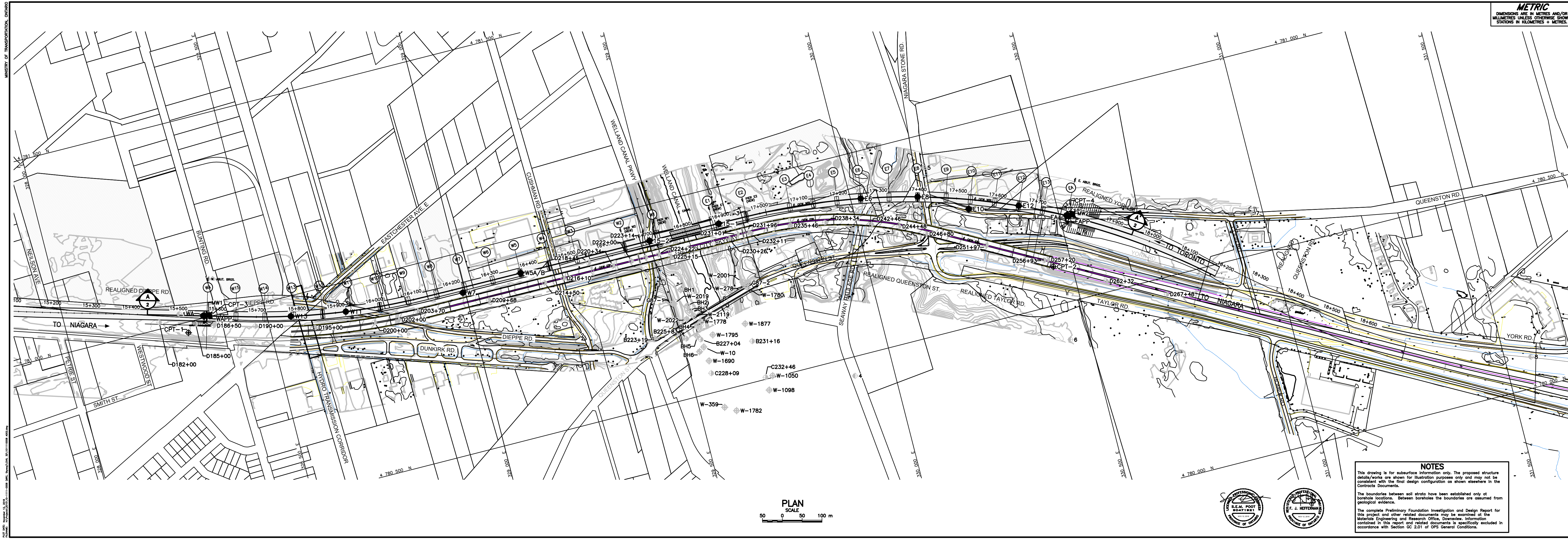
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PREVIOUS INVESTIGATIONS:

Foundation of Canada Engineering Corporation Limited (Fenco). 1959 and 1960. Report titled "Homer Bridge over the Welland Canal to Department of Highways, Ontario", by Foundation of Canada Engineering Corporation Limited (Fenco) and Addendum No. 1, dated October 1959 and February 1960, respectively. Contains report titled "Soil Conditions and Foundations Analyses, Proposed High Level Bridge, Homer, Ontario", by Geocon Ltd., dated January 29, 1960.

Golder Associates Ltd. 2012. "Feasibility Foundation Investigation and Assessment Report, Garden Skyway, from Niagara Street to Glendale Avenue, St. Catharines, Ontario (W.O. 08-2009)," Geocres 30M3-272, dated April 2012.

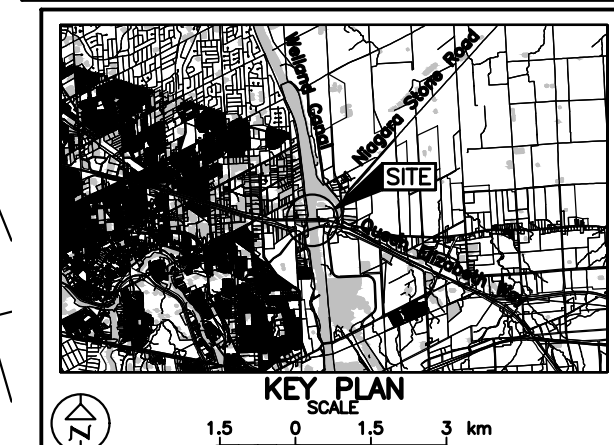


METRIC
DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN. STATIONS IN KILOMETRES + METRES.

CONT No.
GWP No. 08-2009

GARDEN CITY SKYWAY

BOREHOLE LOCATION PLAN



- LEGEND**
- Borehole - Current Investigation
 - Cone Penetration Test - Current Investigation
 - Borehole - Previous Investigation (2011)
 - Borehole - Previous Investigation by Geocon (1960)
 - Borehole - Previous Investigation by Golder (2000)
 - Borehole - Previous Investigation by St. Lawrence Seaway Authority (1958-1998)

BOREHOLE CO-ORDINATES

No.	ELEVATION	NORTHING	EASTING
WAPP	102.4	4781005.5	328344.6
WA	102.4	4781004.6	328348.0
W13	102.5	4780950.0	328558.6
W11	103.0	4780927.0	328696.0
W7	103.5	4780900.1	328994.1
W5A/B	104.1	4780912.4	329147.3
15-2	103.5	4780910.8	329482.3
15-1	101.8	4780909.3	329662.4
E6	106.0	4780882.3	330025.3
E8	105.9	4780850.9	330165.4
E10	110.7	4780789.3	330283.1
E12	110.8	4780766.3	330407.3
EA	111.1	4780712.7	330518.0
EAPP	111.4	4780709.6	330523.1
CPT-1	107.8	4780973.5	328298.1
CPT-3	102.5	4781001.4	328360.6
CPT-2	118.7	4780595.8	330453.8
CPT-4	111.5	4780715.5	330529.9

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.

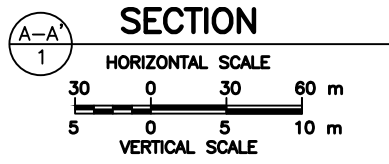
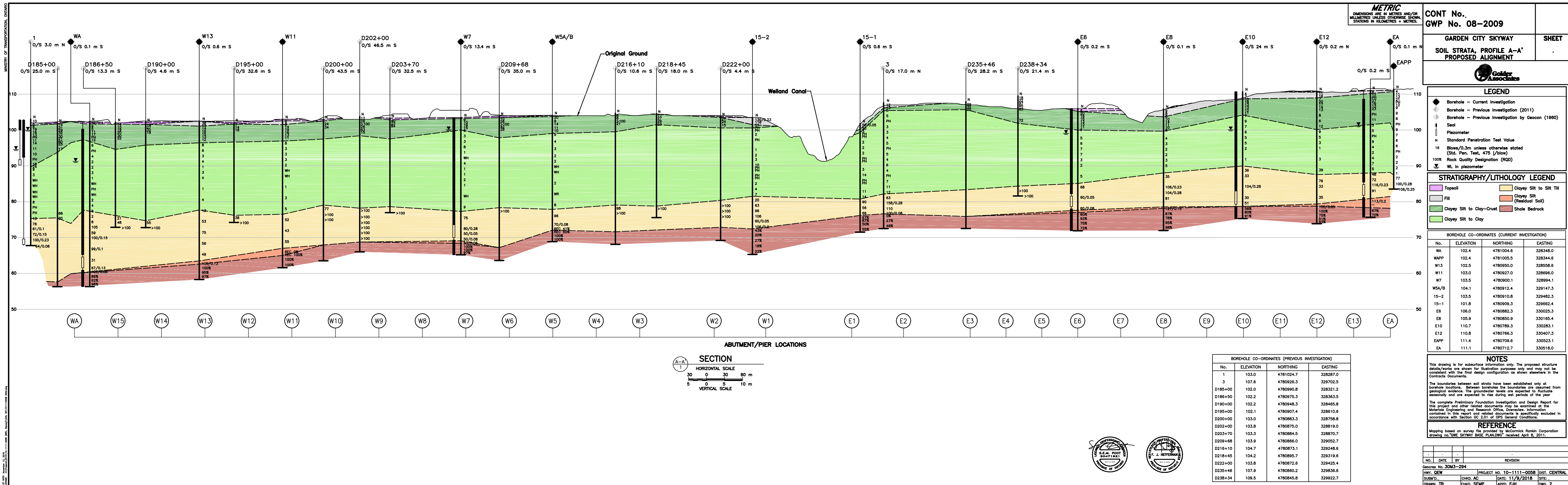
The complete Preliminary Foundation Investigation and Design Report for this project and other related documents may be examined at the Materials Engineering and Research Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with Section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

REFERENCE

Mapping based on survey file provided by McCormick Rankin Corporation drawing no. "GWP SKYWAY BASE PLAN.DWG" received April 8, 2011.

PLAN SCALE
50 0 50 100 m





ABUTMENT/PIER LOCATIONS

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

CONT No.
GWP No. 08-2009

GARDEN CITY SKYWAY

SOIL STRATA, PROFILE A-A'
PROPOSED ALIGNMENT



LEGEND

- Borehole - Current Investigation
- Borehole - Previous Investigation (2011)
- Borehole - Previous Investigation by Geocoin (1960)
- Seal
- Piezometer
- N Standard Penetration Test Value
- 16 Blows/0.3m unless otherwise stated (Std. Pen. Test, 475 l/blow)
- 100% Rock Quality Designation (RQD)
- WL in piezometer

STRATIGRAPHY/LITHOLOGY LEGEND

- Topsoil
- Fill
- Clay Silt to Silt Till
- Clay Silt (Residual Soil)
- Clay Silt to Clay-Crust
- Shale Bedrock
- Clay Silt to Clay

BOREHOLE CO-ORDINATES (CURRENT INVESTIGATION)

No.	ELEVATION	NORTHING	EASTING
WA	102.4	4781004.6	328348.0
WAPP	102.4	4781005.5	328344.6
W13	102.5	4780950.0	328558.6
W11	103.0	4780927.0	328696.0
W7	103.5	4780900.1	328994.1
W5A/B	104.1	4780912.4	329147.3
15-2	103.5	4780910.8	329482.3
15-1	101.8	4780909.3	329662.4
E6	106.0	4780882.3	330025.3
E8	105.9	4780850.9	330165.4
E10	110.7	4780789.3	330283.1
E12	110.8	4780766.3	330407.3
EAPP	111.4	4780709.6	330523.1
EA	111.1	4780712.7	330518.0

NOTES

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The boundaries between soil strata have been established only at borehole locations. Between boreholes the boundaries are assumed from geological evidence. The groundwater levels are expected to fluctuate seasonally and are expected to rise during wet periods of the year.

The complete Preliminary 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

Mapping based on survey file provided by McCormick Rankin Corporation drawing no. "GWE SKYWAY BASE PLAN.DWG" received April 8, 2011.

BOREHOLE CO-ORDINATES (PREVIOUS INVESTIGATION)			
No.	ELEVATION	NORTHING	EASTING
1	103.0	4781024.7	328287.0
3	107.6	4780926.3	329702.5
D185+00	102.0	4780990.8	328321.2
D186+50	102.2	4780975.3	328363.5
D190+00	102.2	4780948.3	328465.8
D195+00	102.1	4780907.4	328610.6
D200+00	103.0	4780883.3	328758.8
D202+00	103.8	4780875.0	328819.0
D203+70	103.3	4780884.5	328870.7
D209+68	103.9	4780866.0	329052.7
D216+10	104.7	4780873.1	329248.6
D218+45	104.2	4780895.7	329319.6
D222+00	103.8	4780872.6	329425.4
D235+46	107.9	4780860.2	329836.6
D238+34	109.5	4780845.8	329922.7



NO.	DATE	BY	REVISION
1	2018-09-10	J. HEFFERNAN	ISSUED FOR CONSTRUCTION

Geosens No. 30M3-294

HWY: QEW	PROJECT: 10-1111-0058	DIST: CENTRAL
SUBM'D: J. HEFFERNAN	CHKD: AC	DATE: 11/9/2018
DRAWN: TB	CHKD: SEMP	APPD: FJH
		DWG: 2



APPENDIX A

Record of Boreholes, Drillholes and CPTs



LIST OF SYMBOLS

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

I. GENERAL

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

II. STRESS AND STRAIN

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

III. SOIL PROPERTIES

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

(a) Index Properties (continued)

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

(b) Hydraulic Properties

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

(c) Consolidation (one-dimensional)

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

(d) Shear Strength

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

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

Notes: 1
2

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



LIST OF ABBREVIATIONS

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

I. SAMPLE TYPE

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

II. PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

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

Dynamic Cone Penetration Resistance; N_d :

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

PH: Sampler advanced by hydraulic pressure

PM: Sampler advanced by manual pressure

WH: Sampler advanced by static weight of hammer

WR: Sampler advanced by weight of sampler and rod

Piezo-Cone Penetration Test (CPT)

A electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm² pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (Q_t), porewater pressure (PWP) and friction along a sleeve are recorded electronically at 25 mm penetration intervals.

III. SOIL DESCRIPTION

(a) Non-Cohesive (Cohesionless) Soils

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

(b) Cohesive Soils Consistency

	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 _p	plastic limit
w _l	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test ¹
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement ¹
D _R	relative density (specific gravity, G_s)
DS	direct shear test
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO ₄	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V	field vane (LV-laboratory vane test)
γ	unit weight

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

V. MINOR SOIL CONSTITUENTS

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



LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of weathering

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

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

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

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

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

BEDDING THICKNESS

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

JOINT OR FOLIATION SPACING

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

GRAIN SIZE

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

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

CORE CONDITION

Total Core Recovery (TCR)

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

Solid Core Recovery (SCR)

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

Rock Quality Designation (RQD)

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

DISCONTINUITY DATA

Fracture Index

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

Dip with Respect to Core Axis

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

Description and Notes

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

Abbreviations

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

PROJECT 10-1111-0058			RECORD OF BOREHOLE No CPT-1			1 OF 2 METRIC										
G.W.P. 08-2009			LOCATION N 4780973.5; E 328298.1 NAD83 MTM ZONE			ORIGINATED BY AJS										
DIST _____ HWY QEW			BOREHOLE TYPE CME 75 Truck-mount; 70 mm I.D. Hollow Stem Augers			COMPILED BY BM/AJS										
DATUM Geodetic			DATE August 23, 2015			CHECKED BY JPD										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa							WATER CONTENT (%)	
107.8	GROUND SURFACE						20	40	60	80	100					
0.0	ASPHALT															
	Silty clay, trace to some sand, trace to some gravel (FILL) Firm to very stiff Brown Moist to wet		1	SS	5											
			2	SS	7											
			3	SS	8											
	- 100 mm seam of grey sand and gravel at a depth of 6.30 m		4	SS	21											
100.6																
7.2	SILTY CLAY, trace sand, trace gravel Firm to very stiff Brown Moist to wet		5	SS	23											
			6	SS	17											
			7	SS	13											
	- Becoming grey at 14.49 m		8	SS	8											

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTY10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

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



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

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

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No WAPP		2 OF 3 METRIC	
G.W.P. <u>08-2009</u>		LOCATION <u>N 4781005.5; E 328344.6 NAD83 MTM ZONE</u>		ORIGINATED BY <u>BC</u>	
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring</u>		COMPILED BY <u>AC</u>	
DATUM <u>Geodetic</u>		DATE <u>May 19, 2015</u>		CHECKED BY <u>SEMP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100	20 40 60 80 100					
	--- CONTINUED FROM PREVIOUS PAGE ---													
	SILTY CLAY to CLAYEY SILT, trace to some sand, trace to some gravel Stiff to very stiff Brown Moist to wet		14	SS	13		87							2 16 59 23
							86							
			15	SS	3		85							
							84							
			16	SS	2		83							
							82							
	Sand lenses at 19.8 m depth.		17	SS	4		81							
							80							
			18	SS	7		79							
							78							
			19	SS	8		77							
							76							
			20	TO	PH		75							
							74							
			21	SS	6		73							
	Some silt seams at 27.7 m depth.		22	SS	12									
73.9 28.5	Gravelly CLAYEY SILT to SILT of slight plasticity, some sand (TILL) Hard Reddish brown Moist		23	SS	85/0.28									

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT		10-1111-0058				RECORD OF BOREHOLE No WAPP				3 OF 3		METRIC					
G.W.P.		08-2009		LOCATION		N 4781005.5; E 328344.6 NAD83 MTM ZONE				ORIGINATED BY		BC					
DIST		HWY		QEW		BOREHOLE TYPE		Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring				COMPILED BY		AC			
DATUM		Geodetic		DATE		May 19, 2015				CHECKED BY		SEMP					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	--- CONTINUED FROM PREVIOUS PAGE ---																
	Gravelly CLAYEY SILT to SILT of slight plasticity, some sand (TILL) Hard Reddish brown Moist		24	SS	84		72										22 20 47 11
							71										
69.9			25	SS	66/0.28		70										
32.5	END OF BOREHOLE SPLIT-SPOON REFUSAL Note: 1. Water level upon completion in open borehole not obtained as borehole was advanced using wash boring techniques.																

PROJECT 10-1111-0058			RECORD OF BOREHOLE No WA			1 OF 4 METRIC		
G.W.P. 08-2009			LOCATION N 4781004.6; E 328348.0 NAD83 MTM ZONE			ORIGINATED BY BC		
DIST _____ HWY QEW			BOREHOLE TYPE Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring			COMPILED BY AC		
DATUM Geodetic			DATE May 21, 2015			CHECKED BY SEMP		
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED 20 40 60 80 100
102.4	GROUND SURFACE							PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT W _p W W _L WATER CONTENT (%)
0.0	Sandy clayey silt with gravel, trace organics (FILL)		1	SS	58/0.2		102	○
0.6	Brown Moist							
	CONCRETE (200 mm)		2	SS	9		101	
	CLAYEY SILT, trace sand, trace gravel, trace organics							
100.8	Stiff		3A	SS	5			
1.6	Dark brown to black Moist		3B					
	SILTY CLAY to CLAYEY SILT, trace to some sand, trace gravel		4	SS	11		100	
	Firm to very stiff							
	Brown Moist		5	SS	17		99	○
	75 mm silty sand seam, noted in Sample 3B.		6	TO	PH		98	
			7	SS	12		97	○ 48
			8	SS	6		96	
			9	TO	PH		95	>96 ○
			10	SS	4		94	>96
			11	SS	2		93	
			12	SS	2		92	○
			13	SS	3		91	
							90	
							89	
							88	

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTY10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD


PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No WA		3 OF 4 METRIC	
G.W.P. <u>08-2009</u>		LOCATION <u>N 4781004.6; E 328348.0 NAD83 MTM ZONE</u>		ORIGINATED BY <u>BC</u>	
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring</u>		COMPILED BY <u>AC</u>	
DATUM <u>Geodetic</u>		DATE <u>May 21, 2015</u>		CHECKED BY <u>SEMP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		WATER CONTENT (%)				
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED	w _p	w	w _L		
	--- CONTINUED FROM PREVIOUS PAGE ---													
	CLAYEY SILT to SILT of slight plasticity, some sand, some gravel to gravelly (TILL) Hard Reddish brown Moist		24	SS	59									
			25	SS	100/0.15									
			26	SS	99/0.1									
			27	SS	31									
			28	SS	67/0.13									
			29	SS	100/0.05									
59.9	A 100 mm cobble encountered at 42.4 m depth.													
42.5	SHALE (BEDROCK) Bedrock cored from 42.5 m to 46.1 m depth. For coring details see Record of Drillhole WA.		1	RC	REC 86%									RQD = 32%
			2	RC	REC 92%									RQD = 69%
			3	RC	REC 98%									RQD = 91%

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No WA				4 OF 4 METRIC						
G.W.P. <u>08-2009</u>		LOCATION <u>N 4781004.6; E 328348.0 NAD83 MTM ZONE</u>				ORIGINATED BY <u>BC</u>						
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring</u>				COMPILED BY <u>AC</u>						
DATUM <u>Geodetic</u>		DATE <u>May 21, 2015</u>				CHECKED BY <u>SEMP</u>						
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)		
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	○ UNCONFINED + FIELD VANE	W _p W W _L		
								20 40 60 80 100	● QUICK TRIAXIAL × REMOULDED	10 20 30		
56.3	SHALE (BEDROCK)		3	RC	REC 98%		57					
46.1	Bedrock cored from 42.5 m to 46.1 m depth. For coring details see Record of Drillhole WA.											
	END OF BOREHOLE											
	Notes: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques. 2. Water level in piezometer 11.0 m (Elev. 91.4 m) below ground surface on August 26, 2015. 2. Water level in piezometer 11.1 m (Elev. 91.3 m) below ground surface on September 25, 2015.											

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Geo Environmental Drilling

SUD-RCK N/E H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11-13-18 CD

CHECKED: SEMP



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

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No W13		1 OF 4 METRIC	
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780950.0; E 328558.6 NAD83 MTM ZONE</u>		ORIGINATED BY <u>BC</u>	
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring</u>		COMPILED BY <u>AC</u>	
DATUM <u>Geodetic</u>		DATE <u>May 26, 2015</u>		CHECKED BY <u>SEMP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
102.5	GROUND SURFACE													
0.0	Sand and gravel, trace silt (FILL)		1A	SS	38									
102.2	Dense Grey Moist		1B											
0.3	Silty clay, some sand, trace gravel (FILL)		2	SS	13									
	Stiff Brown Moist													
101.1	SILTY CLAY to CLAYEY SILT, trace to some sand, trace gravel		3	SS	14									
1.4	Stiff to very stiff Brown to grey Moist		4	SS	16									
			5	SS	15									
			6	SS	13									
			7	SS	12									
			8	SS	8									
			9	SS	6									
			10	SS	3									
			11	SS	4									
			12	SS	1									
			13	SS	3									






Continued Next Page

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No W13		3 OF 4 METRIC										
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780950.0; E 328558.6 NAD83 MTM ZONE</u>		ORIGINATED BY <u>BC</u>										
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring</u>		COMPILED BY <u>AC</u>										
DATUM <u>Geodetic</u>		DATE <u>May 26, 2015</u>		CHECKED BY <u>SEMP</u>										
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES						SHEAR STRENGTH kPa	
													20	40
--- CONTINUED FROM PREVIOUS PAGE ---						20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED		20 40 60 80 100 WATER CONTENT (%)						
63.5	CLAYEY SILT to SILT of slight plasticity, some sand, some gravel, trace shale fragments (TILL) Hard Reddish brown to grey Moist		19	SS	75								1 8 83 8	
39.0	CLAYEY SILT (Residual soil) Hard Red Moist		20	SS	56									
62.6	SHALE (BEDROCK) Bedrock cored from 39.9m to 44.2 m depth. For coring details see Record of Drillhole W13.		21	SS	49									
39.9			22	SS	100/0.1									
58.3			1	RC	REC 100%								RQD = 68%	
														RQD = 86%
														RQD = 93%
44.2														

Continued Next Page

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No W13				4 OF 4 METRIC														
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780950.0; E 328558.6 NAD83 MTM ZONE</u>				ORIGINATED BY <u>BC</u>														
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring</u>				COMPILED BY <u>AC</u>														
DATUM <u>Geodetic</u>		DATE <u>May 26, 2015</u>				CHECKED BY <u>SEMP</u>														
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL				
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa												
--- CONTINUED FROM PREVIOUS PAGE ---							<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE </div> <div style="display: flex; justify-content: space-between;"> ● QUICK TRIAXIAL × REMOULDED </div>					<div style="display: flex; justify-content: space-between;"> 10 20 30 </div>								
	END OF BOREHOLE Note: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques. 2. A 75 mm PVC pipe was installed to carry out seismic analysis (VSP).																			

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT: 10-1111-0058

RECORD OF DRILLHOLE: W13

SHEET 1 OF 1

LOCATION: N 4780950.0 ; E 328558.6

DRILLING DATE: May 26, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75 Truck Mount

DRILLING CONTRACTOR: Geo Environmental Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - 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.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
							RECOVERY				R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA												HYDRAULIC CONDUCTIVITY				Diameter Point Load Index (MPa)	RMC -Q AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
							TOTAL CORE %	SOLID CORE %	FLUSH	% RETURN			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jh	k, cm/s	10 ⁻⁸	10 ⁻⁷	10 ⁻⁶																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
40	HW	BEDROCK SURFACE		62.6																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											

DEPTH SCALE

1 : 50



GOLDER

LOGGED: BC

CHECKED: SEMP

SUD-RCK N/E H:\PROJECTS\2010\10-11-11-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11-13-18 CD

PROJECT		10-1111-0058		RECORD OF BOREHOLE No W11		1 OF 3 METRIC											
G.W.P.		08-2009		LOCATION		N 4780927.0; E 328696.0 NAD83 MTM ZONE											
DIST		HWY QEW		BOREHOLE TYPE		Hollow Stem Augers, HW Casing, HQ Coring and Wash Boring											
DATUM		Geodetic		DATE		June 13, 2015											
ORIGINATED BY		BC		COMPILED BY		AC											
CHECKED BY		SEMP															
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 _p	W	W _L	γ	GR	SA	SI	CL
103.0	GROUND SURFACE																
0.0	TOPSOIL		1	SS	6												
102.6																	
0.4	Silty clay, trace sand, trace gravel, trace organics (FILL) Firm Brown to black Moist		2	SS	8		102										
101.5																	
1.5	SILTY CLAY to CLAY, trace sand, trace gravel Firm to very stiff Brown to grey Moist		3	SS	14		101						51		3	7	34 56
			4	SS	19		100										
			5	SS	16		99										
			6	SS	13		98										
			7	SS	11		97										
			8	SS	8		96										
	Clayey silt seam encountered at 6.1 m depth.		9	SS	3		95										
			10	SS	3		94										
			11	SS	3		93										
			12	SS	2		92										
			13	SS	WH		91										
							90										
							89						48		0	1	36 63

Continued Next Page

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No W11		3 OF 3 METRIC															
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780927.0; E 328696.0 NAD83 MTM ZONE</u>		ORIGINATED BY <u>BC</u>															
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, HQ Coring and Wash Boring</u>		COMPILED BY <u>AC</u>															
DATUM <u>Geodetic</u>		DATE <u>June 13, 2015</u>		CHECKED BY <u>SEMP</u>															
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)						
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					W _p W W _L						
	--- CONTINUED FROM PREVIOUS PAGE ---						20	40	60	80	100								
	Gravelly Sandy CLAYEY SILT to SILT of slight plasticity (TILL) Hard Reddish brown Moist		19	SS	43														
67.0																			
36.0	CLAYEY SILT (Residual soil) Hard Red Moist		1	RC	REC 0%														
			2	RC	REC 100%														
65.0																			
38.0	SHALE (BEDROCK) Bedrock cored from 38 m to 41.4 m depth. For coring details see Record of Drillhole W11.		3	RC	REC 100%														RQD = 89%
			4	RC	REC 100%														RQD = 94%
61.6																			
41.4	END OF BOREHOLE Notes: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques.																		

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Geo Environmental Drilling

LOGGED: BC
CHECKED: SEMP

SUD-RCK N/E H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

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

SUD-MTO 001 H:\PROJECTS\2010\10-11\11-0058 (MRC, SKYWAY)\GINT\10-11\11-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No W7		2 OF 3 METRIC	
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780900.1; E 328994.1 NAD83 MTM ZONE</u>		ORIGINATED BY <u>BC</u>	
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring</u>		COMPILED BY <u>AC</u>	
DATUM <u>Geodetic</u>		DATE <u>June 16, 2015</u>		CHECKED BY <u>SEMP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								20 40 60 80 100	20 40 60 80 100					
	--- CONTINUED FROM PREVIOUS PAGE ---													
	SILTY CLAY, some sand, trace gravel Firm to very stiff Brown to grey Moist		13	SS	1		88							
							87							
			14	SS	2		86							
							85							
			15	SS	1		84							
							83							
			16	SS	WH		82							
			1	RC	REC 100%		81							
							80							
			17	SS	9		79							
							78							
77.3							77							
26.2	Sandy CLAYEY SILT to SILT of slight plasticity, trace to some gravel (TILL) Hard Brown Moist		18	SS	75		76							
							75							
							74							

Continued Next Page

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT 10-1111-0058		RECORD OF BOREHOLE No W7				3 OF 3 METRIC											
G.W.P. 08-2009		LOCATION N 4780900.1; E 328994.1 NAD83 MTM ZONE				ORIGINATED BY BC											
DIST _____ HWY QEW		BOREHOLE TYPE Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring				COMPILED BY AC											
DATUM Geodetic		DATE June 16, 2015				CHECKED BY SEMP											
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT		REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ	GR SA SI CL
							20 40 60 80 100	20 40 60 80 100	W _p	W	W _L	10 20 30	kN/m ³				
	--- CONTINUED FROM PREVIOUS PAGE ---																
	Sandy CLAYEY SILT to SILT of slight plasticity, trace to some gravel (TILL) Hard Brown Moist		19	SS	80/0.28		73										
							72										
			20	SS	50/0.05		71										
			1	RC	REC 100%		70										
			21	SS	50/0.08		69										
69.1																	
34.4	CLAYEY SILT (Residual soil) Hard Red Moist		22	SS	50/0.05		68										
68.4																	
35.1	SHALE (BEDROCK)		2	RC	REC 100%		67										
	Bedrock cored from 35.1m to 38.3 m depth. For coring details see Record of Drillhole W7.						66										
			3	RC	REC 97%												
65.2																	
38.3	END OF BOREHOLE																
	Notes: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques. 2. Water level in piezometer 4.6 m (Elev. 98.9 m) below ground surface on August 26, 2015. 2. Water level in piezometer 3.4 m (Elev. 100.1 m) below ground surface on September 25, 2015.																

PROJECT: 10-1111-0058

RECORD OF DRILLHOLE: W7

SHEET 1 OF 1

LOCATION: N 4780900.1 ; E 328994.1

DRILLING DATE: June 16, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 75 Truck Mount

DRILLING CONTRACTOR: Geo Environmental Drilling

DEPTH SCALE METRES	DRILLING RECORD		DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX METRES	B Angle	DIP w.r.t. CORE AXIS	DISCONTINUITY DATA				HYDRAULIC CONDUCTIVITY				Diametral Point Load Index (MPa)	RMC -Q' AVG.	
								TOTAL CORE %	SOLID CORE %					TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	10 ⁻⁶	10 ⁻⁵	10 ⁻⁴	10 ⁻³			
		BEDROCK SURFACE		68.4																				
	HW	SHALE - QUEENSTON FORMATION Slightly weathered to fresh; thinly laminated Reddish brown with occasional grey banding Fine grained, non-porous Weak		35.1	1	100																		
			2	100																				
36	CME 75 HQ Coring																							
						3	100																	
37																								
38																								
					65.2																			
		END OF DRILLHOLE		38.3																				
39																								
40																								
41																								
42																								
43																								
44																								
45																								

DEPTH SCALE

1 : 50



GOLDER

LOGGED: BC

CHECKED: SEMP

SUD-RCK N/E H:\PROJECTS\2010\10-11-11-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11-13-18 CD

PROJECT		10-1111-0058		RECORD OF BOREHOLE No W5A		1 OF 1 METRIC													
G.W.P.		08-2009		LOCATION		N 4780912.4; E 329147.3 NAD83 MTM ZONE													
DIST		HWY QEW		BOREHOLE TYPE		Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring													
DATUM		Geodetic		DATE		June 19, 2015													
						ORIGINATED BY BC													
						COMPILED BY AC													
						CHECKED BY SEMP													
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)					
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80	100	20	40
104.1	GROUND SURFACE																		
0.0	Sand and gravel, trace silt, trace asphalt fragments (FILL)		1	SS	20														
103.8	Compact Grey Moist																		
0.3	SILTY CLAY, trace sand, trace gravel		2	SS	9														
	Firm to stiff																		
	Brown to grey		3	SS	14														
	Moist																		
			4	SS	11														
			5	SS	10														
			6	SS	5														
			7	SS	4														
			8	SS	3														
			9	SS	3														
			10	SS	1														
92.1	END OF BOREHOLE																		
12.0	Note: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques.																		



SUD-MTO 001 H:\PROJECTS\201010-1111-0058 (MRC, SKYWAY)\GINTY10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

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

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

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No W5B				3 OF 3 METRIC											
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780912.4; E 329147.3 NAD83 MTM ZONE</u>				ORIGINATED BY <u>JIL</u>											
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring</u>				COMPILED BY <u>AC</u>											
DATUM <u>Geodetic</u>		DATE <u>July 7, 2015</u>				CHECKED BY <u>SEMP</u>											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100					
								○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%)				
								20	40	60	80	100	10	20	30		
72.1	CLAYEY SILT to SILT of slight plasticity, some sand, trace gravel (TILL) Hard Brown Moist		9	SS	70/0.08		74										
			1	RC	REC 41%												
			2	RC	REC 50%		73										
32.0	SHALE (BEDROCK) Bedrock cored from 32.0 m to 35.2 m depth. For coring details see Record of Drillhole W5B.						72										
			3	RC	REC 100%		71										RQD = 72%
			4	RC	REC 100%		70										RQD = 57%
68.9							69										
35.2	END OF BOREHOLE Notes: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques.																

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Geo Environmental Drilling

CHECKED: SEMP

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No 15-2		1 OF 3 METRIC	
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780910.8; E 329482.3 NAD83 MTM ZONE</u>		ORIGINATED BY <u>BC</u>	
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring</u>		COMPILED BY <u>AC</u>	
DATUM <u>Geodetic</u>		DATE <u>March 10, 2015</u>		CHECKED BY <u>SEMP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W _p	W	W _L		
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED					
103.5	GROUND SURFACE													
0.0	ASPHALT													
0.1	Silty sand and gravel (FILL) Very dense to compact Grey Moist		1	SS	30/0.23									
			2	SS	116									
			3A	SS	11									
101.5	SILTY CLAY to CLAYEY SILT, trace sand, trace gravel Stiff Brown to grey Moist		3B	SS										
2.0			4	TO	PH									
			5	TO	PH									
			6	SS	2									
			7	TO	PH									
			8	SS										
			9	SS	1									
			10	SS	2									
			11	SS	3									
			12	SS	10									
			13	TO	PH									
			14	TO	PH									

Continued Next Page

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTY10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD



PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No 15-2		2 OF 3 METRIC	
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780910.8; E 329482.3 NAD83 MTM ZONE</u>		ORIGINATED BY <u>BC</u>	
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring</u>		COMPILED BY <u>AC</u>	
DATUM <u>Geodetic</u>		DATE <u>March 10, 2015</u>		CHECKED BY <u>SEMP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED					
	--- CONTINUED FROM PREVIOUS PAGE ---													
	SILTY CLAY to CLAYEY SILT, trace sand, trace gravel Stiff Brown to grey Moist		15	TO	PH		88							
			16	TO	PH		87							
			17	SS	2		86							
			18	SS	4		84							
			19	SS	7		83							
81.5 22.0	CLAYEY SILT to SILT of slight plasticity, trace to some sand, trace to some gravel, trace shale (TILL) Very stiff to hard Grey to reddish brown Moist		20	SS	20		81							
			21	SS	63		80							
			22	SS	96		78							
77.0 26.5	SAND and SILT, trace to some clay, trace gravel (TILL) Very dense Reddish brown Moist		23	SS	106		77							
			24	SS	80/0.05		75							
							74							

Continued Next Page

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No 15-2				3 OF 3 METRIC											
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780910.8; E 329482.3 NAD83 MTM ZONE</u>				ORIGINATED BY <u>BC</u>											
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring</u>				COMPILED BY <u>AC</u>											
DATUM <u>Geodetic</u>		DATE <u>March 10, 2015</u>				CHECKED BY <u>SEMP</u>											
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
	--- CONTINUED FROM PREVIOUS PAGE ---							20	40	60	80	100					
72.4	SAND and SILT, trace to some clay, trace gravel (TILL) Very dense Reddish brown Moist		25	SS	106/0.2		73										
31.1	SHALE (BEDROCK) Bedrock cored from 31.1 m to 38.2 m depth. For coring details see Record of Drillhole 15-2.		1	RC	REC 92%		72									RQD = 43%	
			2	RC	REC 72%		71									RQD = 20%	
			3	RC	REC 72%		70									RQD = 27%	
			4	RC	REC 92%		69									RQD = 18%	
			5	RC	REC 93%		68									RQD = 22%	
65.3	END OF BOREHOLE						67										
38.2	Notes: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques.						66										

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Aardvark Drilling

SUD-RCK N/E H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

CHECKED: SEMP

PROJECT 10-1111-0058			RECORD OF BOREHOLE No 15-1			1 OF 3 METRIC															
G.W.P. 08-2009			LOCATION N 4780909.3; E 329662.4 NAD83 MTM ZONE			ORIGINATED BY BC															
DIST _____ HWY QEW			BOREHOLE TYPE Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring			COMPILED BY AC															
DATUM Geodetic			DATE March 4 to 6, 2015			CHECKED BY SEMP															
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT			REMARKS & GRAIN SIZE DISTRIBUTION (%)						
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa					WATER CONTENT (%)			γ					
101.8	GROUND SURFACE							20 40 60 80 100	20 40 60 80 100	10 20 30	W _p	W	W _L	20 40 60 80 100	20 40 60 80 100	10 20 30	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100	20 40 60 80 100
0.0	Sand and gravel to sand, some gravel, some silt (FILL) Compact Brown		1	SS	50/0.05		101														
	Frozen to 0.8 m depth, moist		2	SS	20		100														
100.2	Augers grinding from ground surface to 0.8 m depth.						99														
1.6	SILTY CLAY to CLAYEY SILT, trace to some sand, trace gravel Stiff Grey Moist		3	SS	3		98														
			4	TO	PH		97														
			5	TO	PH		96														
			6	SS	2		95														
			7	SS	2		94														
			8	SS	2		93														
			9	TO	PH		92														
			10	TO	PH		91														
			11	SS	3		90														
	Some sand, some gravel below 13.3 m depth.		12	SS	14		89														
							88														
							87														


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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No 15-1				3 OF 3 METRIC	
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780909.3; E 329662.4 NAD83 MTM ZONE</u>				ORIGINATED BY <u>BC</u>	
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring</u>				COMPILED BY <u>AC</u>	
DATUM <u>Geodetic</u>		DATE <u>March 4 to 6, 2015</u>				CHECKED BY <u>SEMP</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					W _p	W			W _L
								<div style="display: flex; justify-content: space-between; font-size: small;"> 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between; font-size: x-small;"> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED </div>									
71.5 30.3	<div style="text-align: center;">--- CONTINUED FROM PREVIOUS PAGE ---</div> END OF BOREHOLE Notes: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques.		4	RC													RQD = 55%

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

SHEET 1 OF 1

DATUM: Geodetic

DRILL RIG: Track Mount CME 75 Power Auger

DRILLING CONTRACTOR: Aardvark Drilling

UD-RCK N/E H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

CHECKED: SEMP

PROJECT <u>10-1111-0058</u>			RECORD OF BOREHOLE No E6			1 OF 3 METRIC		
G.W.P. <u>08-2009</u>			LOCATION <u>N 4780882.3; E 330025.3 NAD83 MTM ZONE</u>			ORIGINATED BY <u>BC</u>		
DIST <u> </u> HWY <u>QEW</u>			BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, HQ Coring and Wash Boring</u>			COMPILED BY <u>AC</u>		
DATUM <u>Geodetic</u>			DATE <u>June 12 and 15, 2015</u>			CHECKED BY <u>SEMP</u>		

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			20	40						60	80
106.0	GROUND SURFACE															
0.0	Sandy TOPSOIL Loose Brown Moist		1	SS	6											
105.2	SILTY CLAY to CLAY, trace sand, trace gravel Stiff to very stiff Brown to grey Moist		2	SS	20											
0.8			3	SS	16											
			4	SS	15											
			5	SS	13											
			6	SS	13											
			7	SS	11											
			8	SS	9											
			9	SS	5											
			10	SS	6											
			11	SS	7											
			12	SS	7											
			13	SS	3											

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

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

H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

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

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No E6				3 OF 3 METRIC						
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780882.3; E 330025.3 NAD83 MTM ZONE</u>				ORIGINATED BY <u>BC</u>						
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, HQ Coring and Wash Boring</u>				COMPILED BY <u>AC</u>						
DATUM <u>Geodetic</u>		DATE <u>June 12 and 15, 2015</u>				CHECKED BY <u>SEMP</u>						
SOIL PROFILE			SAMPLES			DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV. DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	SHEAR STRENGTH kPa		WATER CONTENT (%)		
	--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100	20 40 60 80 100	10 20 30		
	SHAILE (BEDROCK)		2	RC	REC 98%							
	Bedrock cored from 29.0 m to 34.1 m depth. For coring details see Record of Drillhole E6.		3	RC	REC 92%		75					
			4	RC	REC 84%		74					
							73					
71.9							72					
34.1	END OF BOREHOLE											
	Notes: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques. 2. Water level in piezometer 6.9 m (Elev. 99.1 m) below ground surface on August 25, 2015. 3. Water level in piezometer 6.9 m (Elev. 99.1 m) below ground surface on September 25, 2015.											

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT: 10-1111-0058

RECORD OF DRILLHOLE: E6

SHEET 1 OF 1

LOCATION: N 4780882.3 ;E 330025.3

DRILLING DATE: June 12 and 15, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 75 Truck Mount

DRILLING CONTRACTOR: Geo Environmental Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY k, cm/s	Diametral Point Load Index (MPa)	RMC -Q AVG.	
							TOTAL CORE %	SOLID CORE %			TYPE AND SURFACE DESCRIPTION						Jr	Ja	Jn					
							20 30 40 50 60 70 80 90 100	20 30 40 50 60 70 80 90 100	0 10 20 30 40 50 60 70 80 90 100	B Angle 0 30 60 90 120 150 180 210 240 270	DIP w.r.t CORE AXIS 0 30 60 90 120 150 180 210 240 270													
							JN - 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													
29	HW CME 75 Truck Mount HQ Coring	BEDROCK SURFACE		77.0																				
		SHALE - QUEENSTON FORMATION Slightly weathered to fresh, thinly laminated Reddish brown with occasional grey banding Fine grained Weak		29.0	1	RED 100																		
30																								
31																								
32																								
33																								
34																								
		END OF DRILLHOLE		71.9 34.1																				
35																								
36																								
37																								
38																								
39																								

DEPTH SCALE

1 : 50



GOLDER

LOGGED: BC

CHECKED: SEMP

SUD-PC/N/E H:\PROJECTS\2010\10-1111-0058 (MRC_SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT 10-1111-0058			RECORD OF BOREHOLE No E8			1 OF 3 METRIC											
G.W.P. 08-2009			LOCATION N 4780850.9; E 330165.4 NAD83 MTM ZONE			ORIGINATED BY BC											
DIST _____ HWY QEW			BOREHOLE TYPE Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring			COMPILED BY AC											
DATUM Geodetic			DATE June 10 and 11, 2015			CHECKED BY SEMP											
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 _p	W	W _L	γ	GR	SA	SI	CL
105.9	GROUND SURFACE																
0.0	TOPSOIL																
0.2	Sandy silty clay, trace gravel, trace organics (FILL) Stiff Brown Moist		1	SS	9		105										
			2	SS	8												
			3	SS	8		104										
103.7	CLAY, trace sand, trace gravel Firm to very stiff Brown to grey Moist		4	SS	10		103										
2.2			5	SS	14												
			6	SS	11		102										
			7	SS	10		101										
			8	SS	8		100										
							99										
			9	SS	4		98										
							97										
			10	SS	3		96										
							95										
			11	SS	2		94										
							93										
			12	SS	2		92										
							91										

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


SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT 10-1111-0058				RECORD OF BOREHOLE No E8				2 OF 3 METRIC					
G.W.P. 08-2009				LOCATION N 4780850.9; E 330165.4 NAD83 MTM ZONE				ORIGINATED BY BC					
DIST _____ HWY QEW				BOREHOLE TYPE Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring				COMPILED BY AC					
DATUM Geodetic				DATE June 10 and 11, 2015				CHECKED BY SEMP					
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES		20 40 60 80 100	20 40 60 80 100	W _p W W _L	10 20 30	GR SA SI CL		
88.1	CLAY, trace sand, trace gravel Firm to very stiff Brown to grey Moist		14	SS	5								
17.8	Sandy CLAYEY SILT to SILT of slight plasticity, trace to some gravel (TILL) Dense to very dense Reddish brown Moist		15	SS	35								
			16	SS	06/0.23								
			17	SS	04/0.23								
			18	SS	81								
78.6	CLAYEY SILT (Residual soil) Hard Red Moist		19	SS	27/0.14								
27.7	SHALE (BEDROCK) Bedrock cored from 27.7 m to 33.9 m depth. For coring details see Record of Drillhole E8.		1	RC	REC 100%								RQD = 87%
			2	RC	REC 93%								RQD = 78%

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

SUD-MTO 001 H:\PROJECTS\201010-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No E8				3 OF 3 METRIC														
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780850.9; E 330165.4 NAD83 MTM ZONE</u>				ORIGINATED BY <u>BC</u>														
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, NQ Coring and Wash Boring</u>				COMPILED BY <u>AC</u>														
DATUM <u>Geodetic</u>		DATE <u>June 10 and 11, 2015</u>				CHECKED BY <u>SEMP</u>														
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								20	40	60	80	100						20	40	60
	--- CONTINUED FROM PREVIOUS PAGE ---																			
	SHALE (BEDROCK)		2	RC	REC 93%															
	Bedrock cored from 27.7 m to 33.9 m depth. For coring details see Record of Drillhole E8.		3	RC	REC 95%															
			4	RC	REC 98%															
72.0																				
33.9	END OF BOREHOLE																			
	Notes: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques. 2. A 75 mm PVC pipe was installed tp carry out seismic analysis (VSP).																			

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT: 10-1111-0058

RECORD OF DRILLHOLE: E8

SHEET 1 OF 1

LOCATION: N 4780850.9 ;E 330165.4

DRILLING DATE: June 10 and 11, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 75 Truck Mount

DRILLING CONTRACTOR: Geo Environmental Drilling

DEPTH SCALE METRES	DRILLING RECORD		DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - 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.										DISCONTINUITY DATA										HYDRAULIC CONDUCTIVITY		Diameter Point Load Index (MPa)	RMC -Q AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
								RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DIP w.r.t. CORE AXIS		TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	k ₁	k ₂	k ₃	k ₄	k ₅	k ₆	k ₇	k ₈	k ₉	k ₁₀																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
								FLUSH	RECOVERED			RECOVERED	RECOVERED															RECOVERED	RECOVERED			RECOVERED	RECOVERED	RECOVERED	RECOVERED	RECOVERED	RECOVERED	RECOVERED	RECOVERED	RECOVERED	RECOVERED	RECOVERED	RECOVERED	RECOVERED	RECOVERED	RECOVERED																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
28	HW	BEDROCK SURFACE		78.2																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No E10		1 OF 3 METRIC	
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780789.3; E 330283.1 NAD83 MTM ZONE</u>		ORIGINATED BY <u>BC</u>	
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, HQ Coring and Wash Boring</u>		COMPILED BY <u>AC</u>	
DATUM <u>Geodetic</u>		DATE <u>June 3 and 4, 2015</u>		CHECKED BY <u>SEMP</u>	

SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					
110.7	GROUND SURFACE						20 40 60 80 100	20 40 60 80 100	10 20 30				
0.0	Silty sand and gravel, trace clay (FILL) Loose to compact Brown Moist		1	SS	4								
			2	SS	7								
			3A	SS	10								
108.7			3B										
2.0	CLAY to CLAYEY SILT, trace sand, trace gravel Stiff to very stiff Brown to grey Moist to wet		4	SS	18								
			5	SS	13								
			6	SS	13								
			7	SS	12								
			8	SS	11								
			9	SS	7								
			10	SS	9								
			11	SS	7								
			12	SS	6								
			13	SS	5								
			14	SS	5								
	Trace reddish brown shale fragments below 13.3 m depth.												

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

Continued Next Page

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

H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

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

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No E10		3 OF 3 METRIC												
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780789.3; E 330283.1 NAD83 MTM ZONE</u>		ORIGINATED BY <u>BC</u>												
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, HQ Coring and Wash Boring</u>		COMPILED BY <u>AC</u>												
DATUM <u>Geodetic</u>		DATE <u>June 3 and 4, 2015</u>		CHECKED BY <u>SEMP</u>												
SOIL PROFILE		SAMPLES		GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER			TYPE	"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
	--- CONTINUED FROM PREVIOUS PAGE ---															
78.7	Gravelly Sandy CLAYEY SILT to SILT of slight plasticity, trace shale fragments (TILL) Hard Grey to reddish brown Moist	[Pattern]	21	SS	51	[Pattern]										27 21 48 4
32.0	SHALE (BEDROCK) Bedrock cored from 32.0 m to 35.4 m depth. For coring details see Record of Drillhole E10.	[Pattern]	1	RC	REC 94%	[Pattern]										RQD = 58%
		[Pattern]	2	RC	REC 100%	[Pattern]										RQD = 80%
		[Pattern]	3	RC	REC 100%	[Pattern]										RQD = 91%
75.3	END OF BOREHOLE															
35.4	Notes: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques. 2. Water level in piezometer 9.6 m (Elev. 101.1 m) below ground surface on August 25, 2015. 3. Water level in piezometer 10.6 m (Elev. 100.1 m) below ground surface on September 25, 2015.															

SUD-MTO 001 H:\PROJECTS\201010-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

SHEET 1 OF 1

DATUM: Geodetic

DRILLING CONTRACTOR: Geo Environmental Drilling

LOGGED: BC
CHECKED: SEMP

SUD-RCK N/E H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD


Continued Next Page

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

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

H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No E12			3 OF 3 METRIC	
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780766.3; E 330407.3 NAD83 MTM ZONE</u>			ORIGINATED BY <u>BC</u>	
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, HQ Coring and Wash Boring</u>			COMPILED BY <u>AC</u>	
DATUM <u>Geodetic</u>		DATE <u>June 5 and 8, 2015</u>			CHECKED BY <u>SEMP</u>	

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20	40	60	80	100	W _p	W	W _L		
	--- CONTINUED FROM PREVIOUS PAGE ---																
79.4	SILT, trace to some sand, to Sandy SILT, trace to some clay (TILL) Dense to very dense Reddish brown to grey Wet																
31.4	CLAYEY SILT (Residual soil) Hard Red Moist		20	SS	100/100												
78.8	SHALE (BEDROCK)		1	RC	REC 100%											RQD = 100%	
32.0	Bedrock cored from 32.0 m to 36.9 m depth. For coring details see Record of Drillhole E12.		2	RC	REC 100%											RQD = 75%	
			3	RC	REC 100%											RQD = 51%	
			4	RC	REC 100%										RQD = 93%		
73.9	END OF BOREHOLE																
36.9	Notes: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques.																

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT: 10-1111-0058

RECORD OF DRILLHOLE: E12

SHEET 1 OF 1

LOCATION: N 4780766.3 ;E 330407.3

DRILLING DATE: June 5 and 8, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 75 Truck Mount

DRILLING CONTRACTOR: Geo Environmental Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - 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.										RECOVERY TOTAL CORE % SOLID CORE % R.Q.D. % FRACT. INDEX METRES B Angle DIP w.r.t. CORE AXIS TYPE AND SURFACE DESCRIPTION Jr Ja Jn HYDRAULIC CONDUCTIVITY k, cm/s Diameter Point Load Index (MPa) RMC -Q' AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
							FLUSH	RECOVERY		R.Q.D. %	FRACT. INDEX METRES	DISCONTINUITY DATA										RECOVERY																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
								TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION	Jr	Ja	Jn	k, cm/s	Diameter Point Load Index (MPa)	RMC -Q' AVG.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
32	CME 75 Truck Mount HW HQ Coring	BEDROCK SURFACE		78.8																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													

DEPTH SCALE

1 : 50



GOLDER

LOGGED: BC

CHECKED: SEMP

SUD-RCK N/E H:\PROJECTS\2010\10-1111-0058 (MRC_SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No EA		1 OF 3 METRIC	
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780712.7; E 330518.0 NAD83 MTM ZONE</u>		ORIGINATED BY <u>BC</u>	
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, HQ Coring and Wash Boring</u>		COMPILED BY <u>AC</u>	
DATUM <u>Geodetic</u>		DATE <u>May 28, 2015</u>		CHECKED BY <u>SEMP</u>	

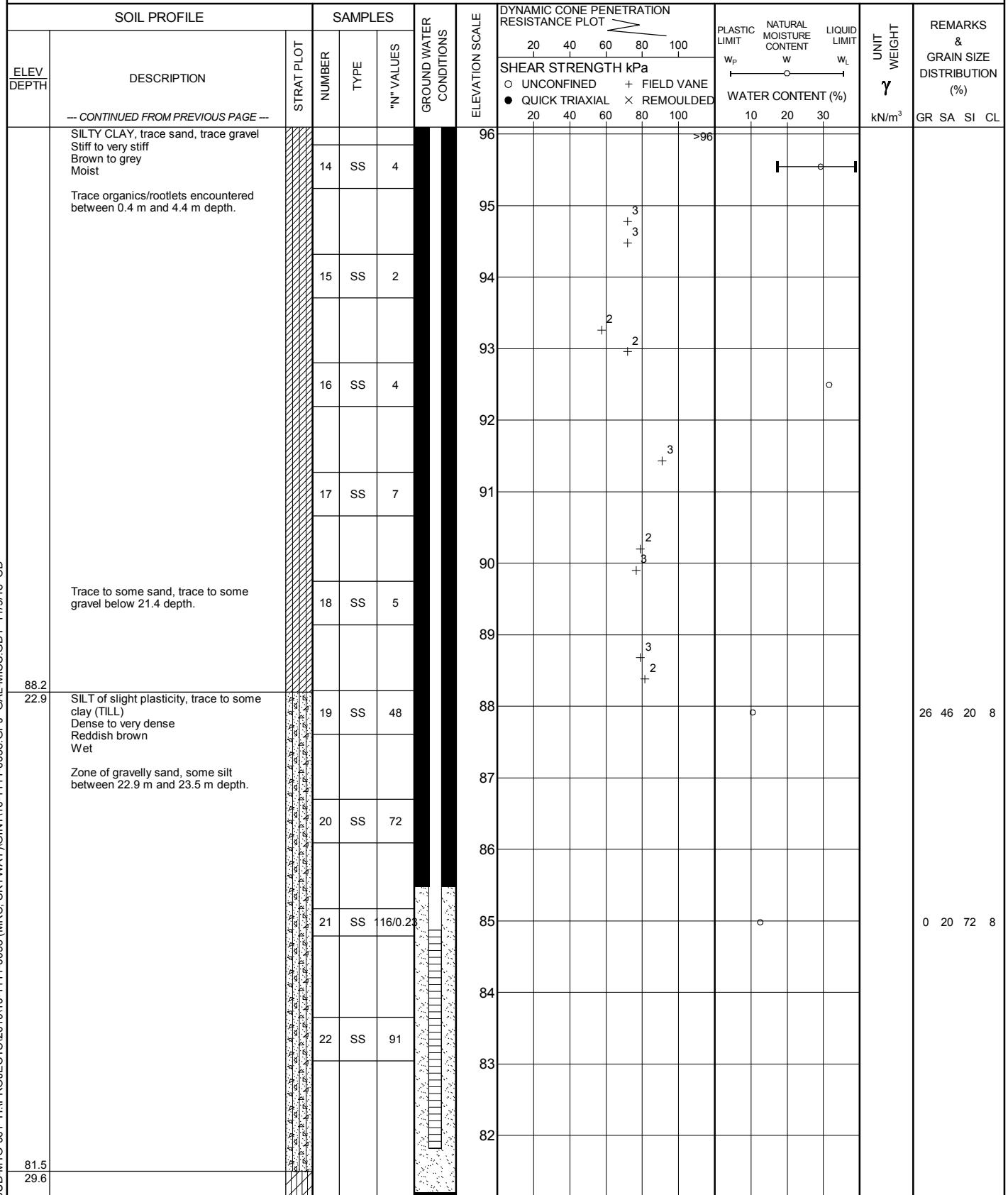
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa			WATER CONTENT (%)				
								○ UNCONFINED ● QUICK TRIAXIAL	+ FIELD VANE × REMOULDED		W _P	W	W _L		
111.1	GROUND SURFACE		1A	SS	6										
0.0	Sand and gravel, some silt, trace organics (FILL)		1B												
110.7	Loose														
0.4	Dark brown														
	Moist														
	SILTY CLAY, trace sand, trace gravel		2	SS	12										
	Stiff to very stiff														
	Brown to grey														
	Moist														
	Trace organics/rootlets encountered between 0.4 m and 4.4 m depth.		3	TO	PH										
			4	SS	27										
			5	SS	16										
			6	SS	13										
			7	SS	23										
			8	TO	PH										
			9	SS	11										
			10	SS	5										
			11	SS	5										
			12	TO	PH										
			13	SS	9										

Continued Next Page

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT <u>10-1111-0058</u>		RECORD OF BOREHOLE No EA		2 OF 3 METRIC	
G.W.P. <u>08-2009</u>		LOCATION <u>N 4780712.7; E 330518.0 NAD83 MTM ZONE</u>		ORIGINATED BY <u>BC</u>	
DIST <u> </u> HWY <u>QEW</u>		BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, HQ Coring and Wash Boring</u>		COMPILED BY <u>AC</u>	
DATUM <u>Geodetic</u>		DATE <u>May 28, 2015</u>		CHECKED BY <u>SEMP</u>	



Continued Next Page

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINTY\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT <u>10-1111-0058</u>				RECORD OF BOREHOLE No EA				3 OF 3 METRIC									
G.W.P. <u>08-2009</u>				LOCATION <u>N 4780712.7; E 330518.0 NAD83 MTM ZONE</u>				ORIGINATED BY <u>BC</u>									
DIST <u> </u> HWY <u>QEW</u>				BOREHOLE TYPE <u>Hollow Stem Augers, HW Casing, HQ Coring and Wash Boring</u>				COMPILED BY <u>AC</u>									
DATUM <u>Geodetic</u>				DATE <u>May 28, 2015</u>				CHECKED BY <u>SEMP</u>									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa					WATER CONTENT (%)				
								20	40	60	80	100	W _p	W	W _L		
	--- CONTINUED FROM PREVIOUS PAGE ---																
	CLAYEY SILT (Residual soil to completely weathered shale) Hard Red Moist		23	SS	113/0.2												
			2	RC	-												
78.2	SHALE (BEDROCK)																
32.9	Bedrock cored from 32.9 m to 35.4 m depth. For coring details see Record of Drillhole EA.		3	RC	REC 100%											RQD = 67%	
			4	RC	REC 89%											RQD = 70%	
75.7	END OF BOREHOLE																
35.4	Notes: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques. 2. Water level in piezometer 9.8 m (Elev. 101.3 m) below ground surface on August 25, 2015. 3. Water level in piezometer 9.8 m (Elev. 101.3 m) below ground surface on September 25, 2015.																

SUD-MTO 001 H:\PROJECTS\201010-1111-0058 (MRC, SKYWAY)\GINTV10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT: 10-1111-0058

RECORD OF DRILLHOLE: EA

SHEET 1 OF 1

LOCATION: N 4780712.7 ;E 330518.0

DRILLING DATE: May 28, 2015

DATUM: Geodetic

INCLINATION: -90° AZIMUTH: —

DRILL RIG: CME 75 Truck Mount

DRILLING CONTRACTOR: Geo Environmental Drilling

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	COLOUR % RETURN	JN - 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.										HYDRAULIC CONDUCTIVITY k, cm/s				Diametral Point Load Index (MPa)	RMC -Q AVG.		
							RECOVERY		R.Q.D. %	FRACT INDEX METRES	DISCONTINUITY DATA													
							TOTAL CORE %	SOLID CORE %			B Angle	DIP w.r.t. CORE AXIS	TYPE AND SURFACE DESCRIPTION		Jr	Ja	Jn							
							FLUSH	24 44 68			24 44 68	0 30 60 90 120 150 180	0 30 60 90 120 150 180	0 30 60 90 120 150 180	0 30 60 90 120 150 180	10 10 10 10	10 10 10 10	10 10 10 10						
33	HQ Coring CME 75 Truck Mount	BEDROCK SURFACE		78.2																				
		SHALE - QUEENSTON FORMATION Thinly laminated with occasional grey bonding Slightly weathered to fresh Reddish brown Fine grained Weak		32.9	3	Red 100								BR										
34														BDUNSM BDPLSM JNPLSM BDUNSM		2 1 1 2	4 4 4 4							
35															JNPLSM		1	3						
					4	Red 100								BDPLRO		1.5	2							
		END OF DRILLHOLE		75.7										BR										
36				35.4																				
37																								
38																								
39																								
40																								
41																								
42																								

DEPTH SCALE

1 : 50



LOGGED: BC



CHECKED: SEMP

SUD-PC/N/E H:\PROJECTS\2010\10-1111-0058 (MRC_SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT		RECORD OF BOREHOLE				No MW2		SHEET 1 OF 1		METRIC						
W.P. 08-2009		LOCATION N 4780712.5; E 330533.3 MTM NAD				ZONE		ORIGINATED BY AJS								
DIST		HWY QEW		BOREHOLE TYPE CME 75 Truck Mount, 108 mm I.D. Hollow Stem Augers				COMPILED BY AJS								
DATUM Geodetic		DATE August 25, 2015						CHECKED BY JPD								
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT NATURAL MOISTURE CONTENT LIQUID LIMIT			UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)			
111.5 0.0	GROUND SURFACE Augered through soil for well installation. No samples collected. For stratigraphy refer to Record of Borehole EA						20	40	60	80	100	W _p	W	W _L	kN/m ³	GR SA SI CL
						111										
						110										
						109										
						108										
						107										
						106										
						105										
103.9 7.6	END OF BOREHOLE NOTE: Water Level measurements in piezometer Date Depth(m) Elev(mbgs) 26/08/15 9.77 101.73 25/09/15 7.51 103.99					104										

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

SUD-MTO 001 H:\PROJECTS\2010\10-1111-0058 (MRC, SKYWAY)\GINT\10-1111-0058.GPJ GAL-MISS.GDT 11/9/18 CD

PROJECT 10-1111-0058			RECORD OF BOREHOLE No EAPP			2 OF 2 METRIC												
G.W.P. 08-2009			LOCATION N 4780709.6; E 330523.1 NAD83 MTM ZONE			ORIGINATED BY BC												
DIST _____ HWY QEW			BOREHOLE TYPE Hollow Stem Augers, HW Casing, Wash Boring			COMPILED BY AC												
DATUM Geodetic			DATE June 1, 2015			CHECKED BY SEMP												
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 (%) W _p W W _L			γ	GR SA SI CL			
--- CONTINUED FROM PREVIOUS PAGE ---																		
87.4	SILTY CLAY to CLAY, trace sand Firm to very stiff Brown to grey Moist		14	SS	6		96											
							95											
							94											
							93											
							92											
							91											
							90											
							89											
							88											
							87											
24.0	Trace reddish brown shale fragments encountered below 21.3 m depth. Fine clay laminations encountered below 21.3 m depth.		15	TO	PH		94											
			16	SS	2		93											
			17	SS	2		92											
			18	SS	2		91											
			19	SS	1		90											
			20	SS	77		87											
			21	SS	100/0.28		86											
			22	SS	106/0.25		84											
83.5	Sandy SILT of slight plasticity, trace gravel, trace clay (TILL) Very dense Grey Moist																	
27.9	Trace reddish brown shale fragments encountered from 23.9 m to 27.9 m depth.																	
END OF BOREHOLE																		
Notes: 1. Water level upon completion of drilling not obtained as borehole was advanced using wash boring techniques.																		

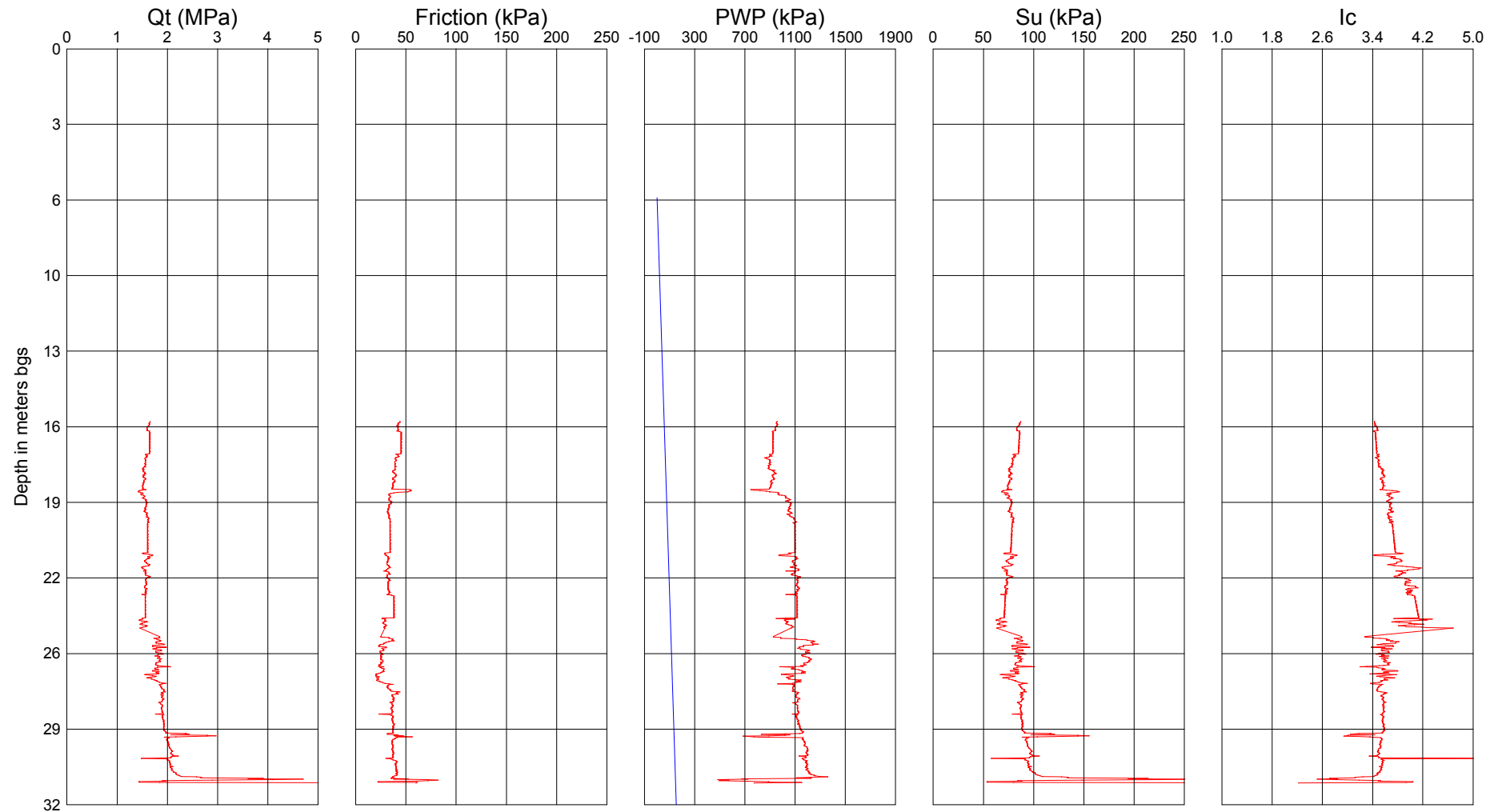
PROJECT		RECORD OF BOREHOLE				No CPT-2		1 OF 1		METRIC							
G.W.P. 08-2009		LOCATION N 4780595.8; E 330453.8 NAD83 MTM ZONE				ORIGINATED BY		AJS									
DIST _____ HWY QEW		BOREHOLE TYPE CME 75 Truck-mount; 70 mm I.D. Hollow Stem Augers				COMPILED BY		BM/AJS									
DATUM Geodetic		DATE August 24, 2015				CHECKED BY		JPD									
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
118.7	GROUND SURFACE																
0.0	ASPHALT																
	Silty clay, trace to some sand, trace gravel, containing rootlets (FILL) Firm to stiff Brown Moist to wet		1	SS	6												
			2	SS	7												
			3	SS	7												
			4	SS	9												
111.5																	
7.2	SILTY CLAY, trace sand, trace gravel, trace organics at 9.76 m Stiff to hard Brown to grey Moist to wet		5	SS	33												
			6	SS	15												
			7	SS	12												
106.5																	
12.2	END OF BOREHOLE																
	CPT conducted from 12.4 m to 30.5 m depth. For CPT details refer to Record of Cone Penetration Test CPT-2.																
	NOTE: 1. Open borehole dry upon completion of drilling.																

Cone Penetration Test - CPT-1

Test Date : September 2015
Location : N4780973.5 ; E328298.1

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 107.80
Water Table Depth : 6.30



Qt normalized for
unequal end area effects

$S_u = (Q_t - \sigma_{av}) / N_k$
 $N_k = 15.45$
 $\gamma = 19.5 \text{ kN/m}^3$

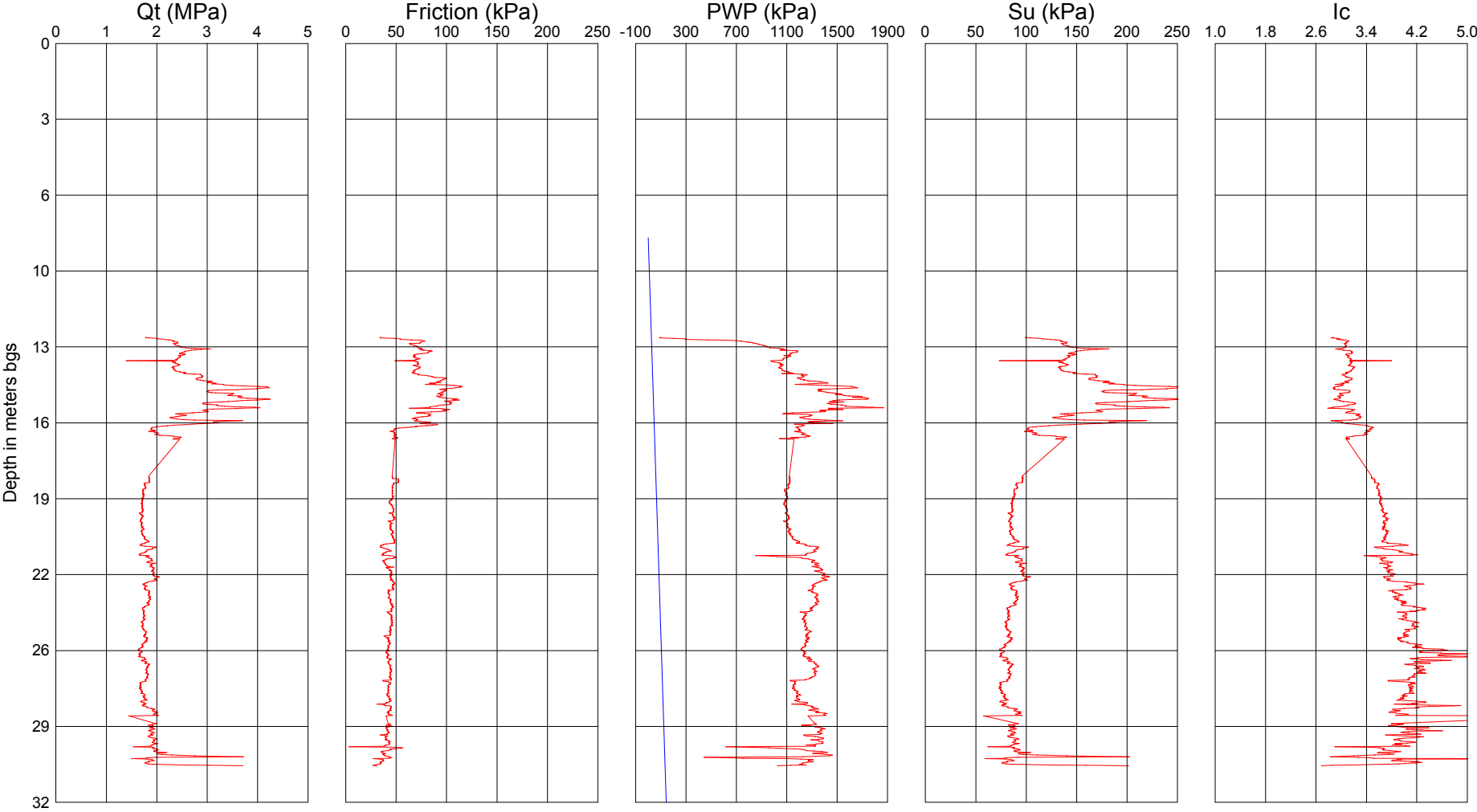
After Jefferies and Davies (1991)
 $I_c < 1.25$ - Gravelly sands
 $1.25 < I_c < 1.90$ - Clean to silty sand
 $1.90 < I_c < 2.54$ - Silty sand to sandy silt
 $2.54 < I_c < 2.82$ - Clayey silt to silty clay
 $2.82 < I_c < 3.22$ - Clays

Cone Penetration Test - CPT-2

Test Date : September 2015
Location : N4780595.8 ; E330453.8

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 118.70
Water Table Depth : 8.20



Qt normalized for
unequal end area effects

$Su = (Qt - \sigma_v) / Nk$
Nk = 15.45
Gamma = 19.5 kN/m³

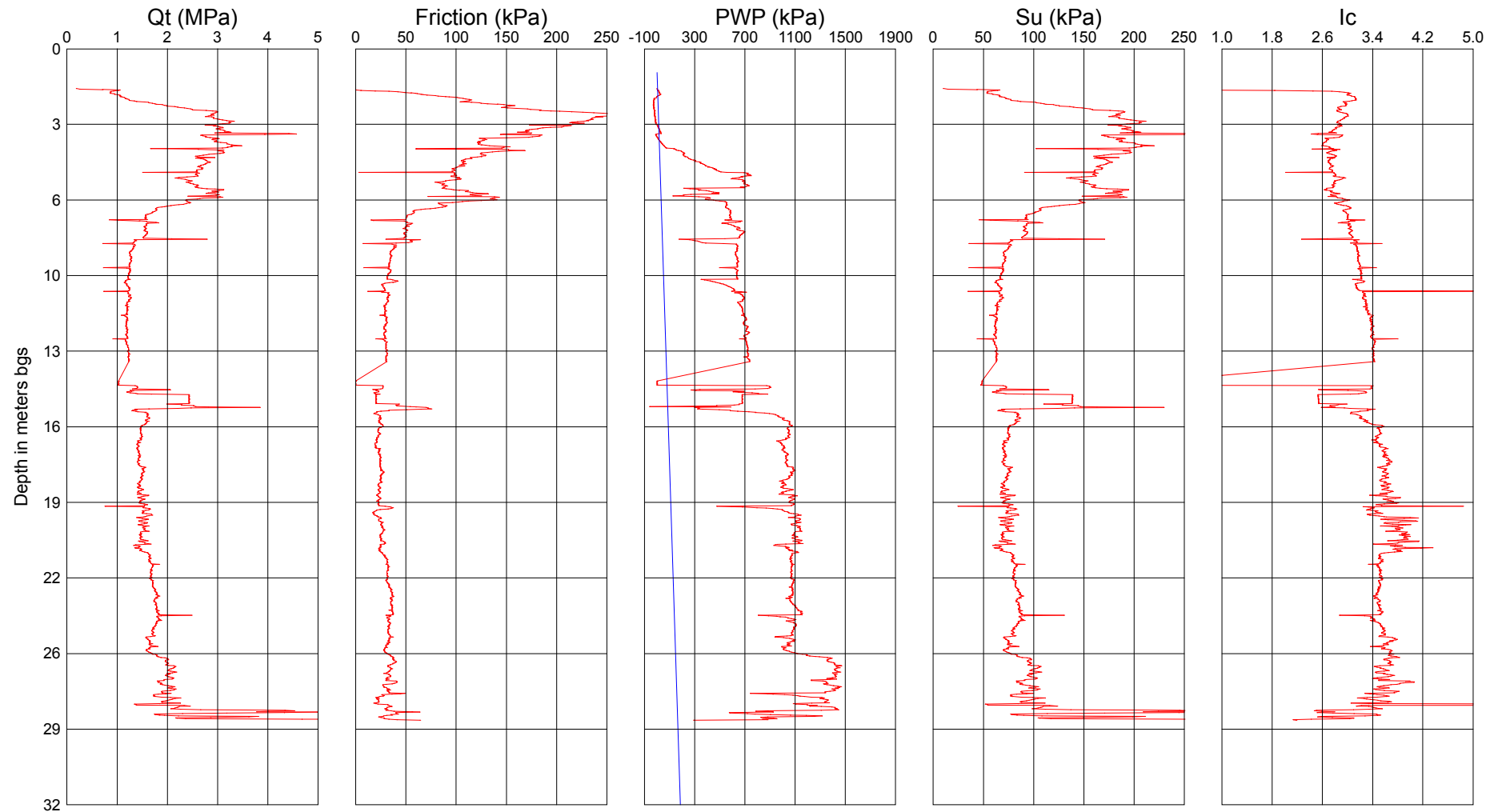
After Jefferies and Davies (1991)
Ic < 1.25 - Gravelly sands
1.25 < Ic < 1.90 - Clean to silty sand
1.90 < Ic < 2.54 - Silty sand to sandy silt
2.54 < Ic < 2.82 - Clayey silt to silty clay
2.82 < Ic < 3.22 - Clays

Cone Penetration Test - CPT-3

Test Date : September 2015
Location : N4781001.4 ; E328360.6

Operator : Golder Associates Ltd.

Ground Surf. Elev. : 102.50
Water Table Depth : 1.00



Qt normalized for
unequal end area effects

$S_u = (Q_t - \sigma_{av}) / N_k$
 $N_k = 15.45$
 $\gamma = 19.5 \text{ kN/m}^3$

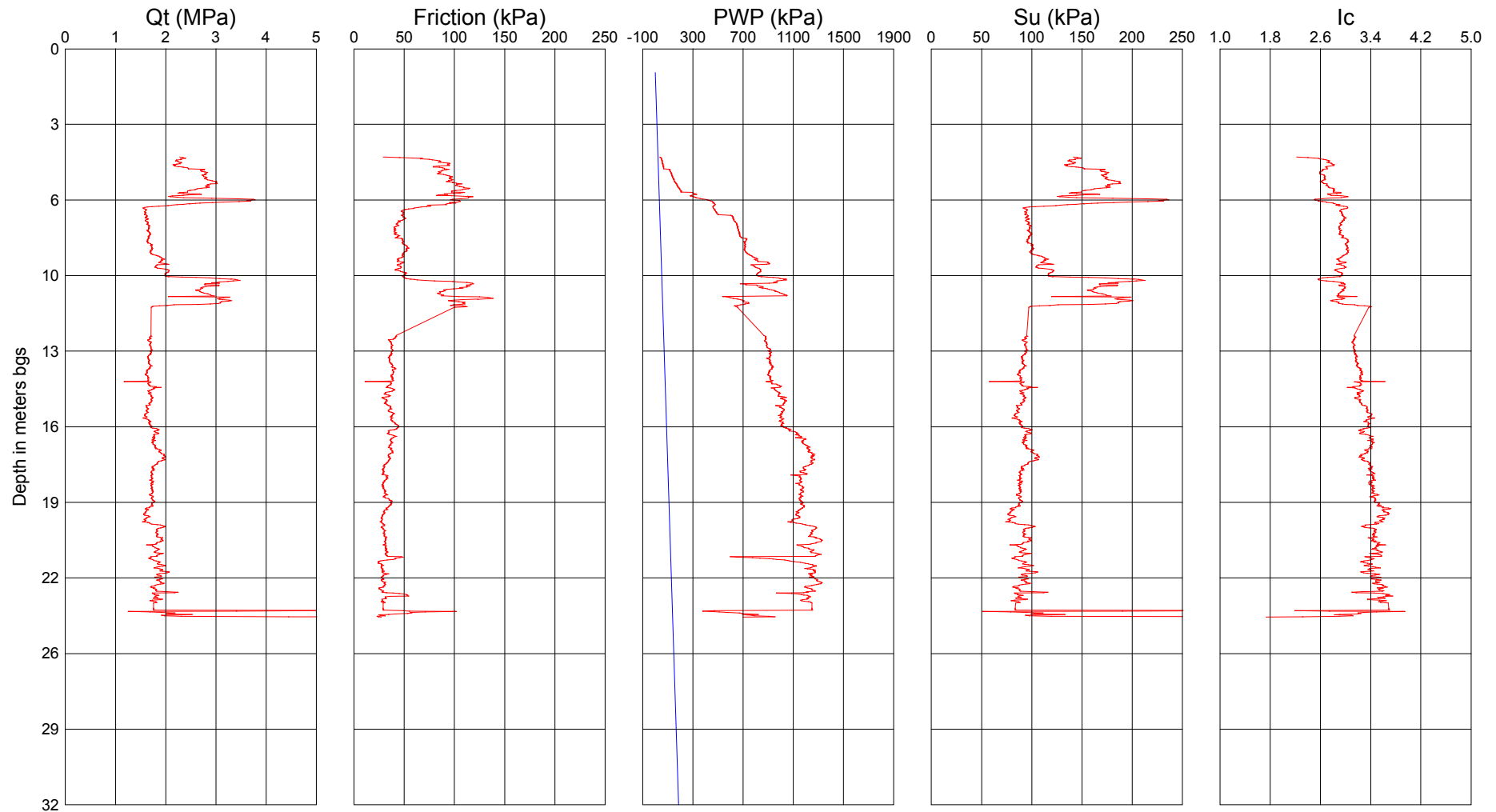
After Jefferies and Davies (1991)
 $I_c < 1.25$ - Gravelly sands
 $1.25 < I_c < 1.90$ - Clean to silty sand
 $1.90 < I_c < 2.54$ - Silty sand to sandy silt
 $2.54 < I_c < 2.82$ - Clayey silt to silty clay
 $2.82 < I_c < 3.22$ - Clays

Cone Penetration Test - CPT-4

Test Date : September 2015
Location : N4780715.5 ; E330529.9

Operator : Golder Associates Ltd.

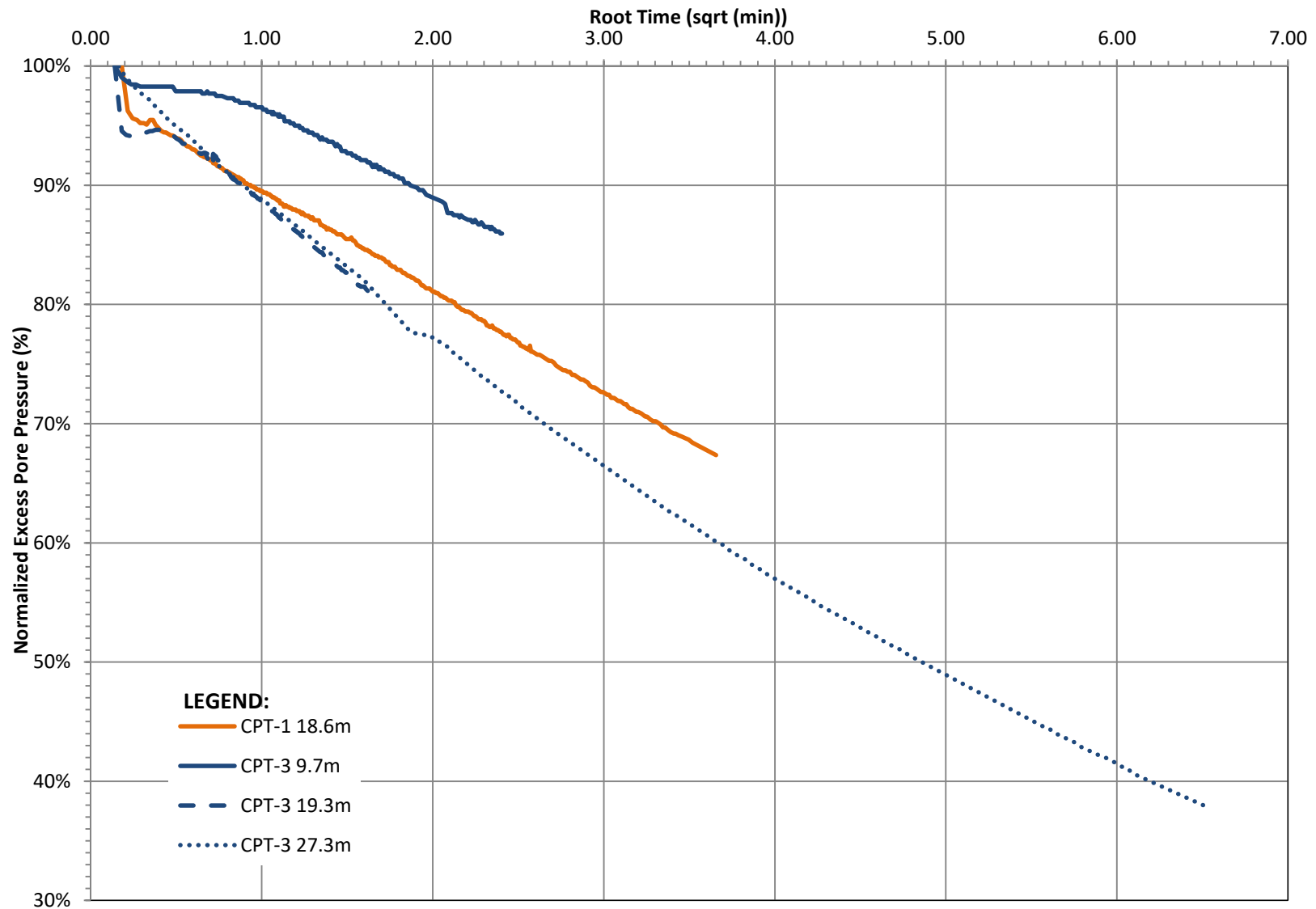
Ground Surf. Elev. : 111.50
Water Table Depth : 1.00



Qt normalized for
unequal end area effects

$S_u = (Q_t - \sigma_{vV}) / N_k$
 $N_k = 15.45$
 $\gamma = 19.5 \text{ kN/m}^3$

After Jefferies and Davies (1991)
 $I_c < 1.25$ - Gravelly sands
 $1.25 < I_c < 1.90$ - Clean to silty sand
 $1.90 < I_c < 2.54$ - Silty sand to sandy silt
 $2.54 < I_c < 2.82$ - Clayey silt to silty clay
 $2.82 < I_c < 3.22$ - Clays



CLIENT
MMM GROUP LTD.

PROJECT
GARDEN CITY SKYWAY

CONSULTANT



YYYY-MM-DD 2018-10-09

PREPARED TZ

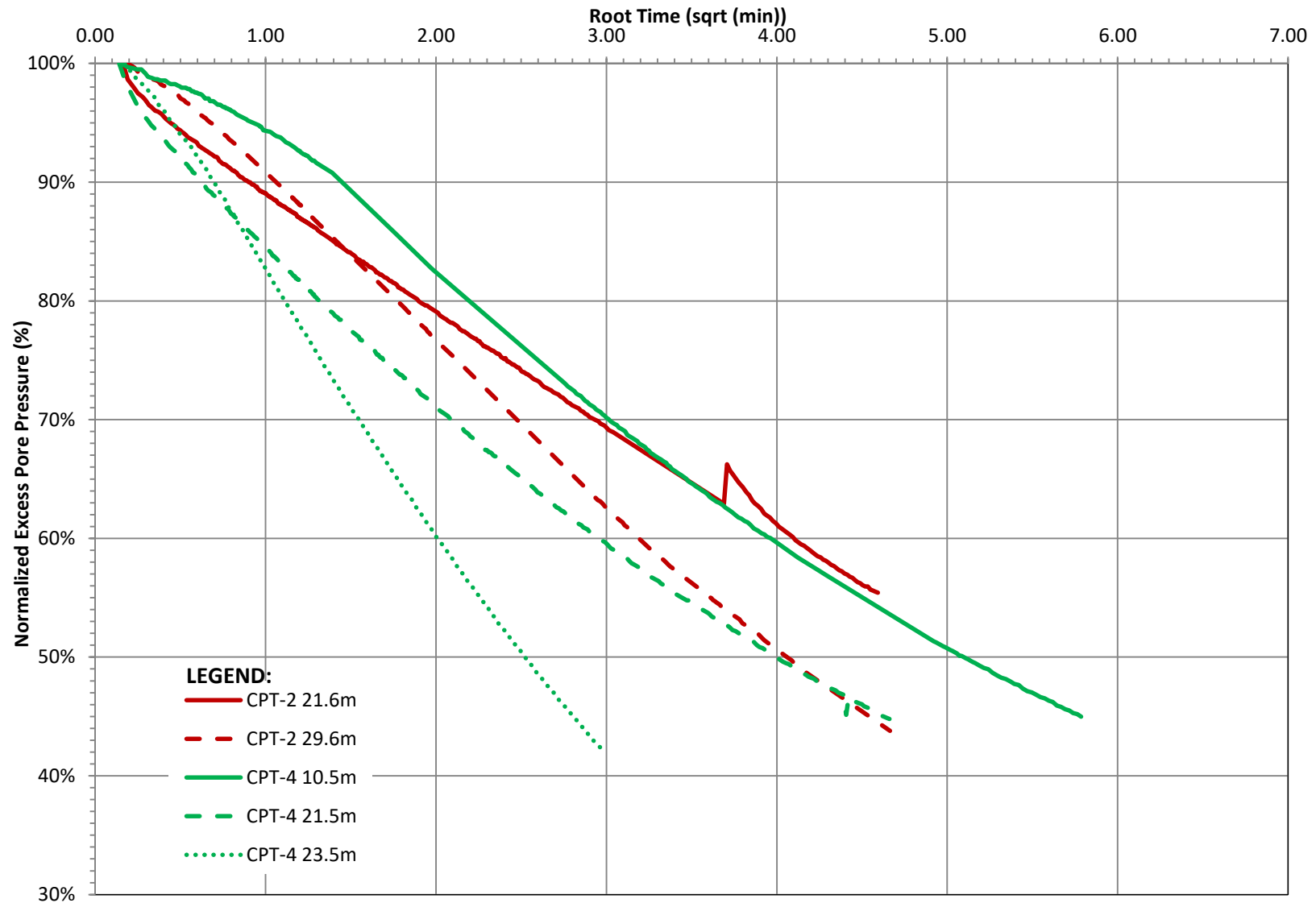
DESIGN TZ

REVIEW JPD

TITLE

**CPT PORE PRESSURE DISSIPATION TESTS – CPT-1 AND CPT-3
(WEST APPROACH)**

PROJECT No.
10-1111-0058



CLIENT
MMM GROUP LTD.

PROJECT
GARDEN CITY SKYWAY

CONSULTANT



YYYY-MM-DD 2018-10-09

PREPARED TZ

DESIGN TZ

REVIEW JPD

TITLE

**CPT PORE PRESSURE DISSIPATION TESTS – CPT-2 AND CPT-4
(EAST APPROACH)**

PROJECT No.
10-1111-0058

A2

1 in IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANSI/A



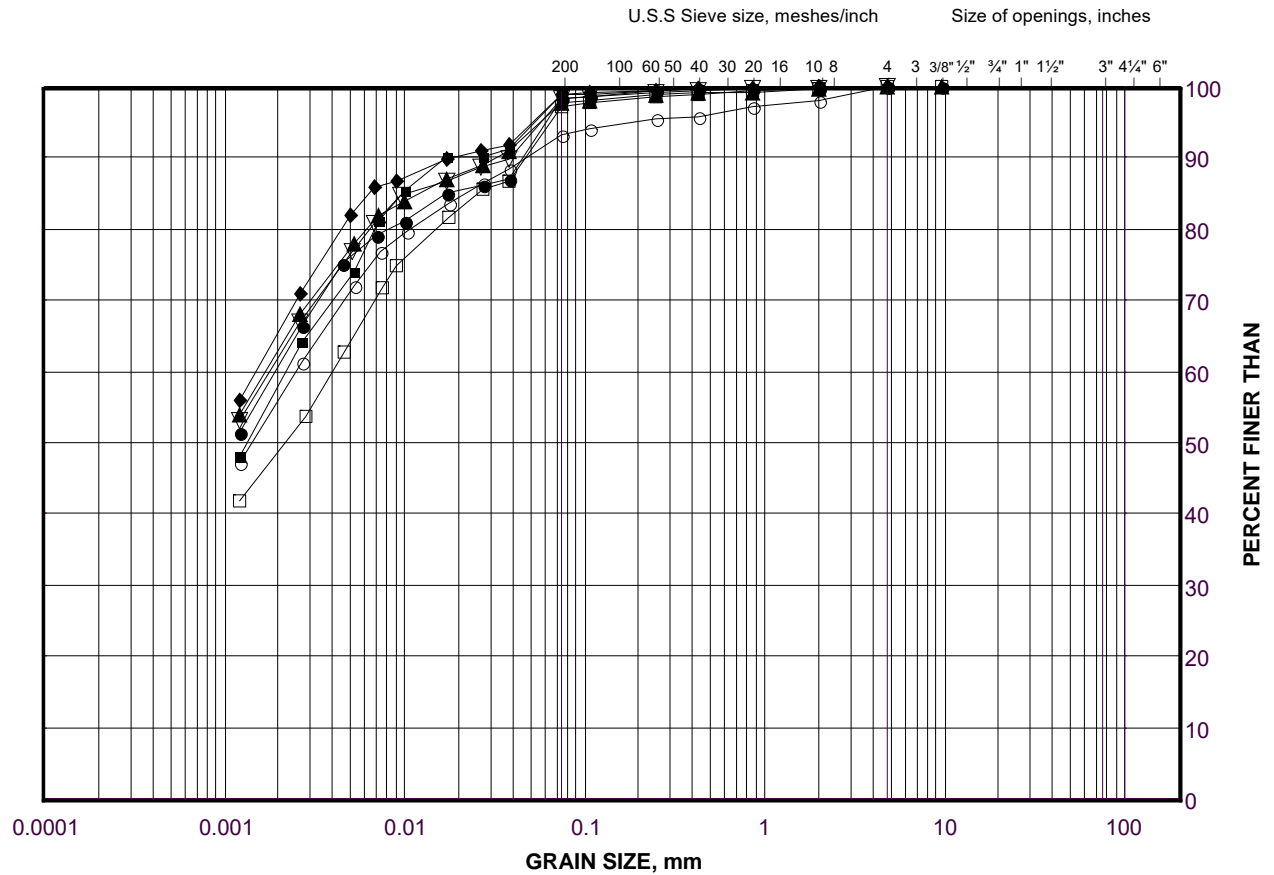
APPENDIX B

Laboratory Test Results

GRAIN SIZE DISTRIBUTION

Clay to Clayey Silt

FIGURE B1.1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	E6	11	95.0
■	E6	13	92.0
◆	EAPP	17	91.3
▲	EAPP	2	110.4
▽	EAPP	7	106.6
○	15-1	7	95.4
□	EA	9	103.2

Project Number: 10-1111-0058

Checked By: SEMP/ AC

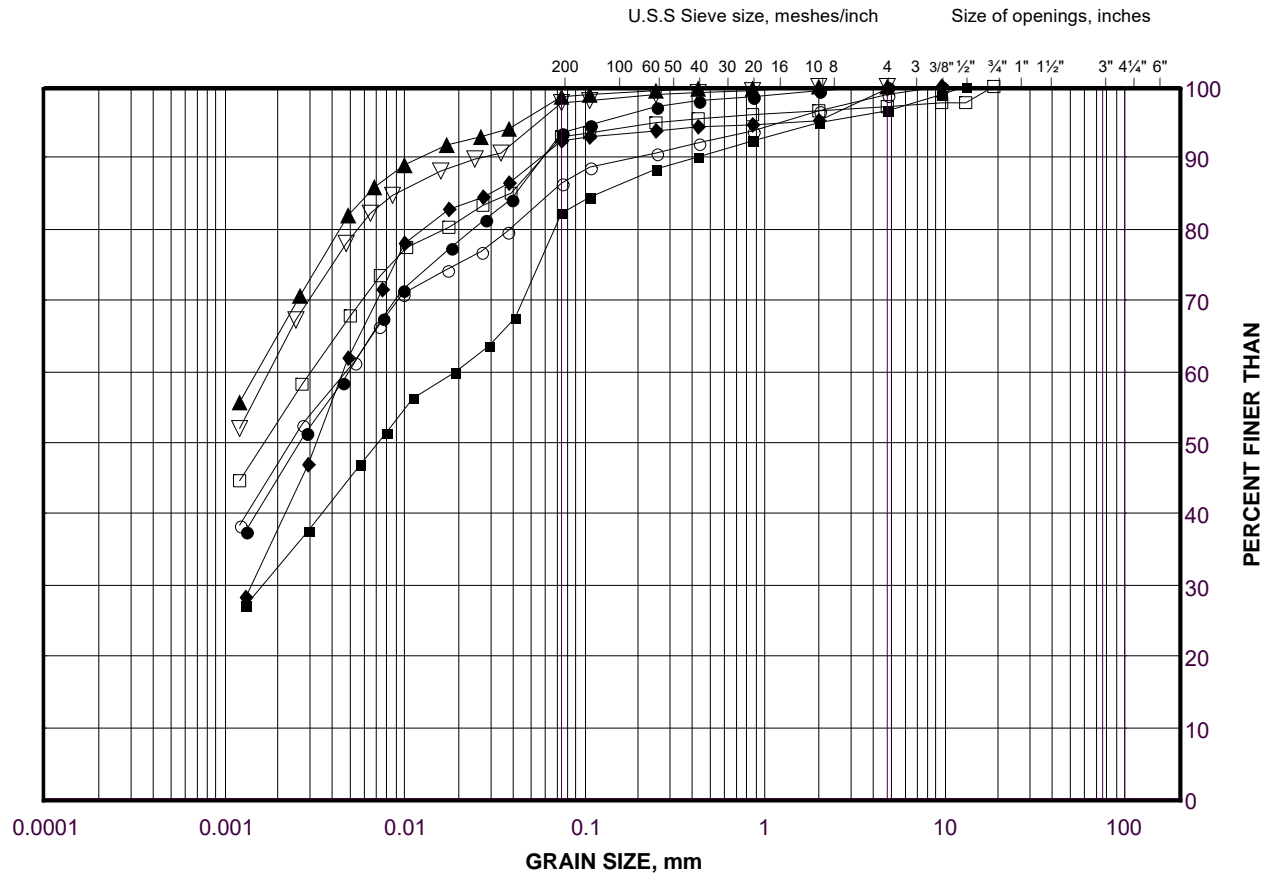
Golder Associates

Date: 18-May-16

GRAIN SIZE DISTRIBUTION

Clay to Clayey Silt

FIGURE B1.2



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	E12	12	98.3
■	E10	14	96.7
◆	15-2	18	83.8
▲	E12	5	107.4
▽	E8	6	101.7
○	W7	6	98.6
□	W5A	7	97.7

Project Number: 10-1111-0058

Checked By: SEMP/ AC

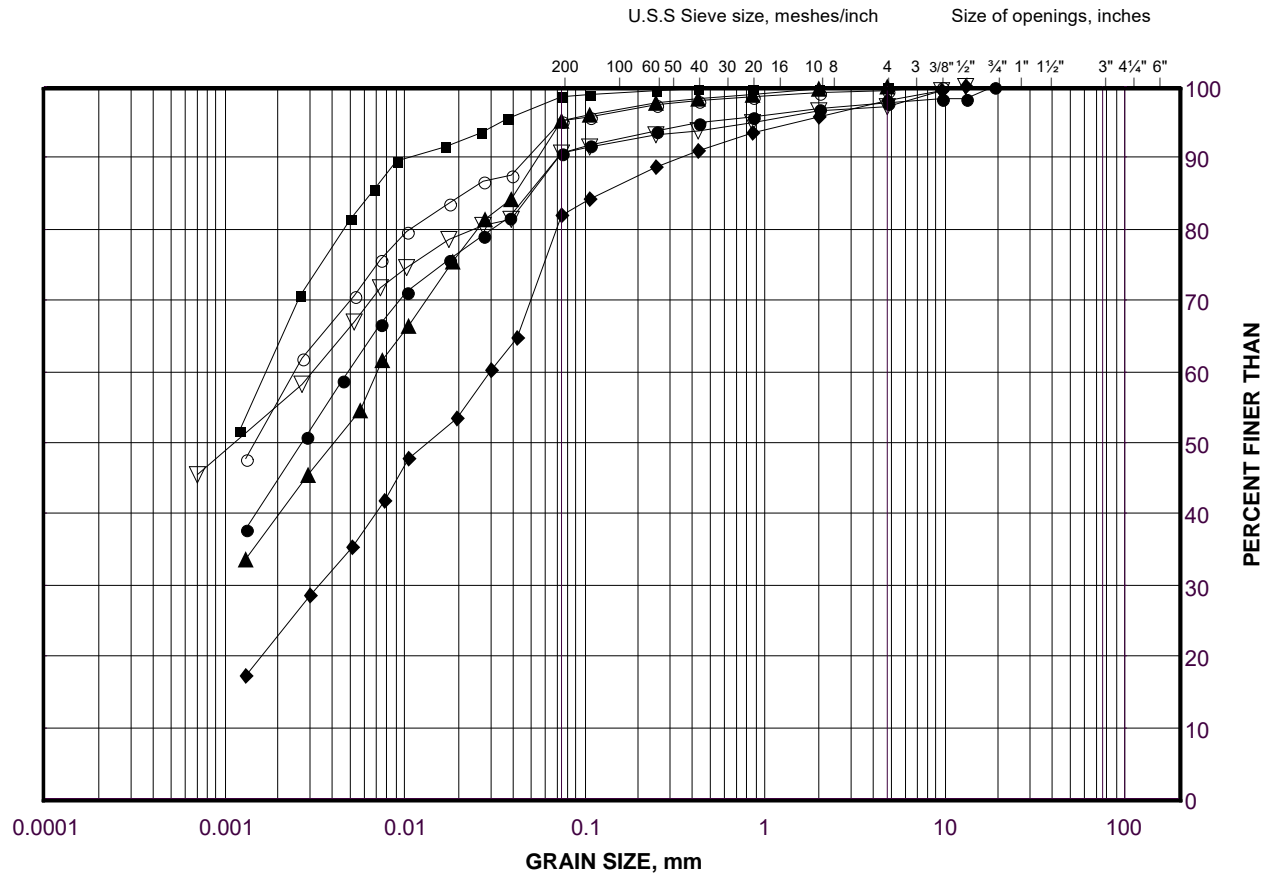
Golder Associates

Date: 18-May-16

GRAIN SIZE DISTRIBUTION

Clay to Clayey Silt

FIGURE B1.3



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

LEGEND

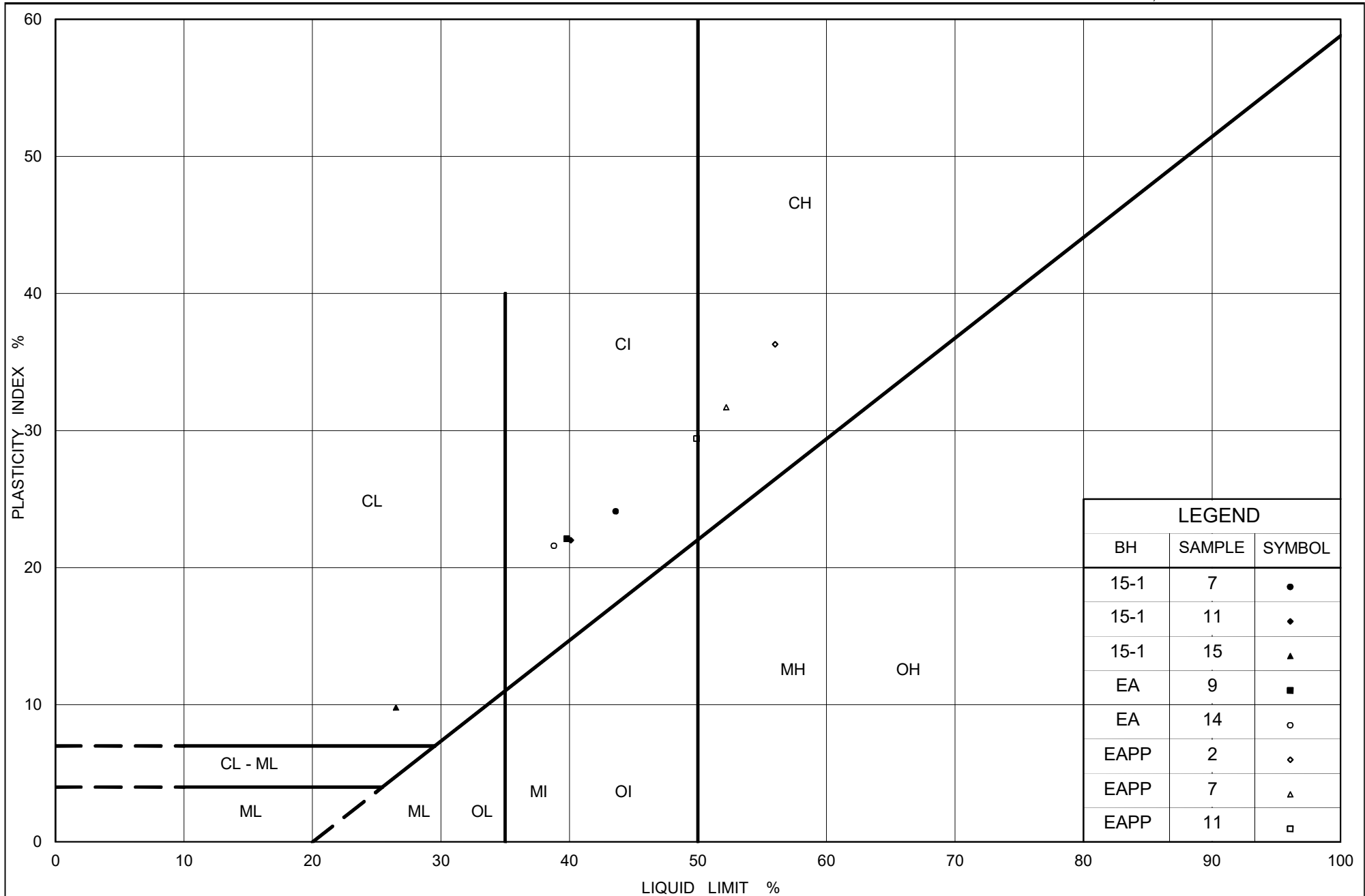
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	W13	11	91.5
■	W11	13	89.0
◆	WAPP	14	86.8
▲	WA	19	79.3
▽	W11	3	101.2
○	WA	7	97.5

Project Number: 10-1111-0058

Checked By: SEMP/ AC

Golder Associates

Date: 18-May-16



Ministry of Transportation

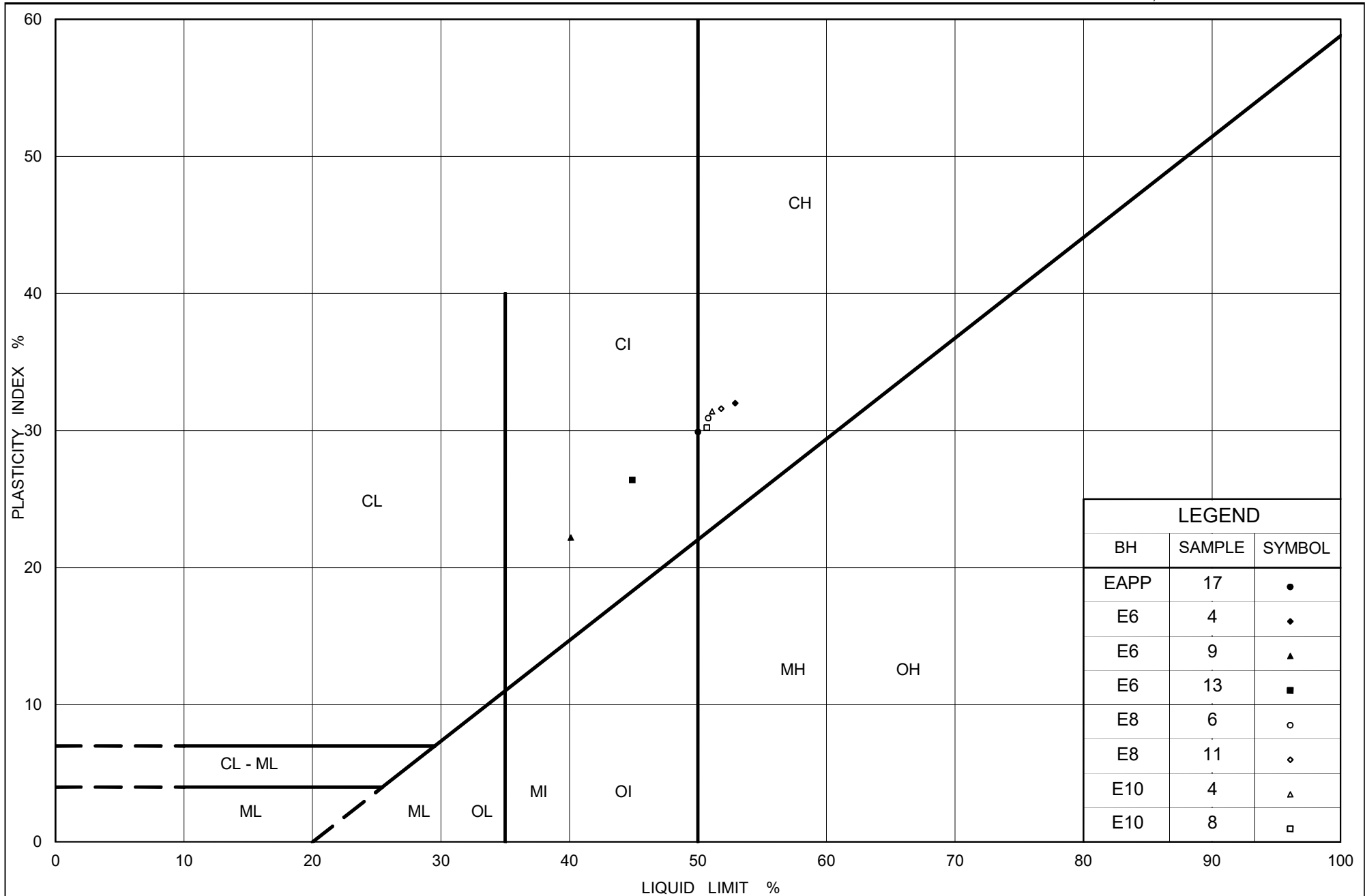
Ontario

PLASTICITY CHART Clay to Clayey Silt

Figure No. B2.1

Project No. 10-1111-0058

Checked By: SEMP/AC



Ministry of Transportation

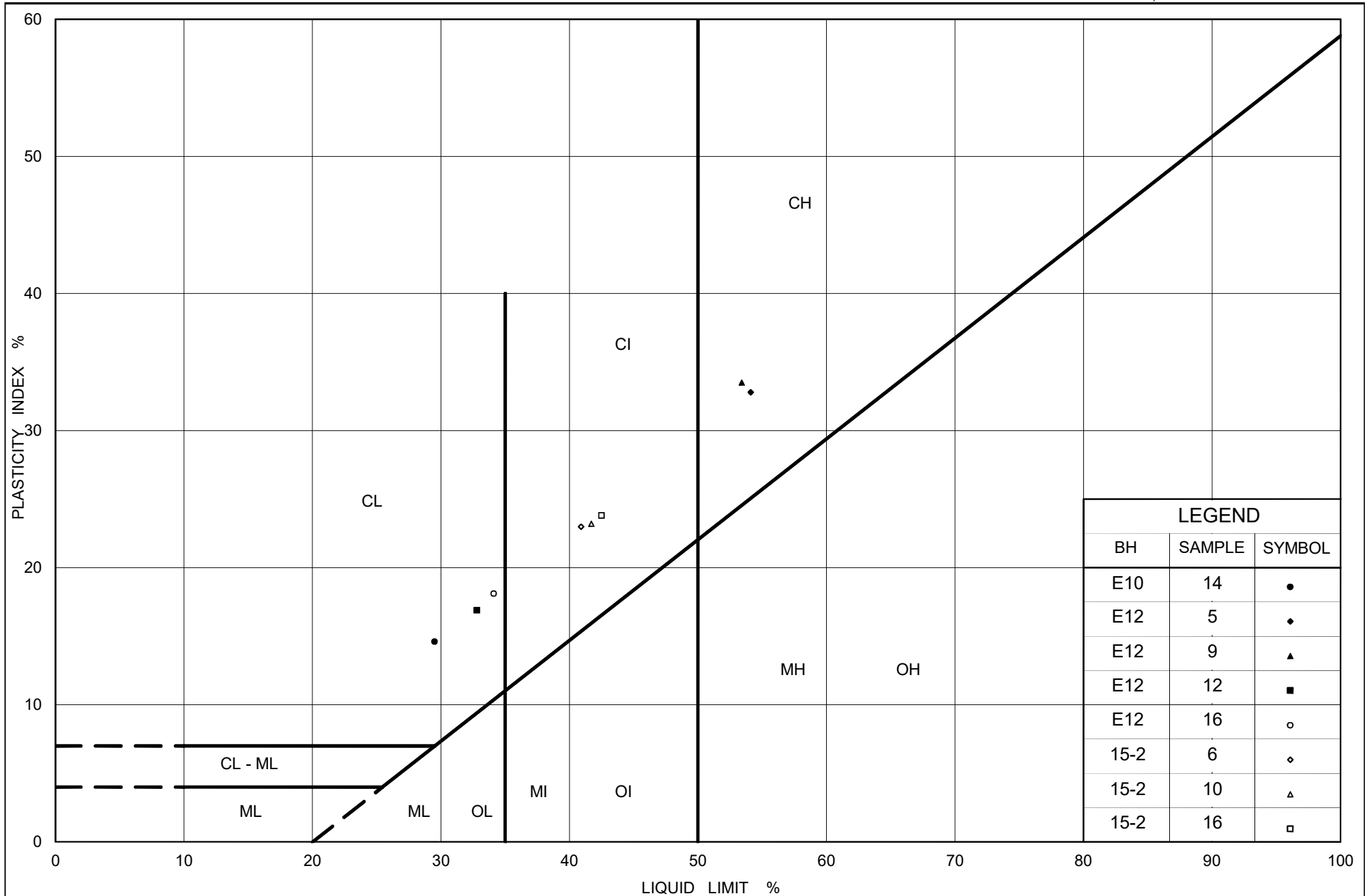
Ontario

PLASTICITY CHART Clay to Clayey Silt

Figure No. B2.2

Project No. 10-1111-0058

Checked By: SEMP/ AC



Ministry of Transportation

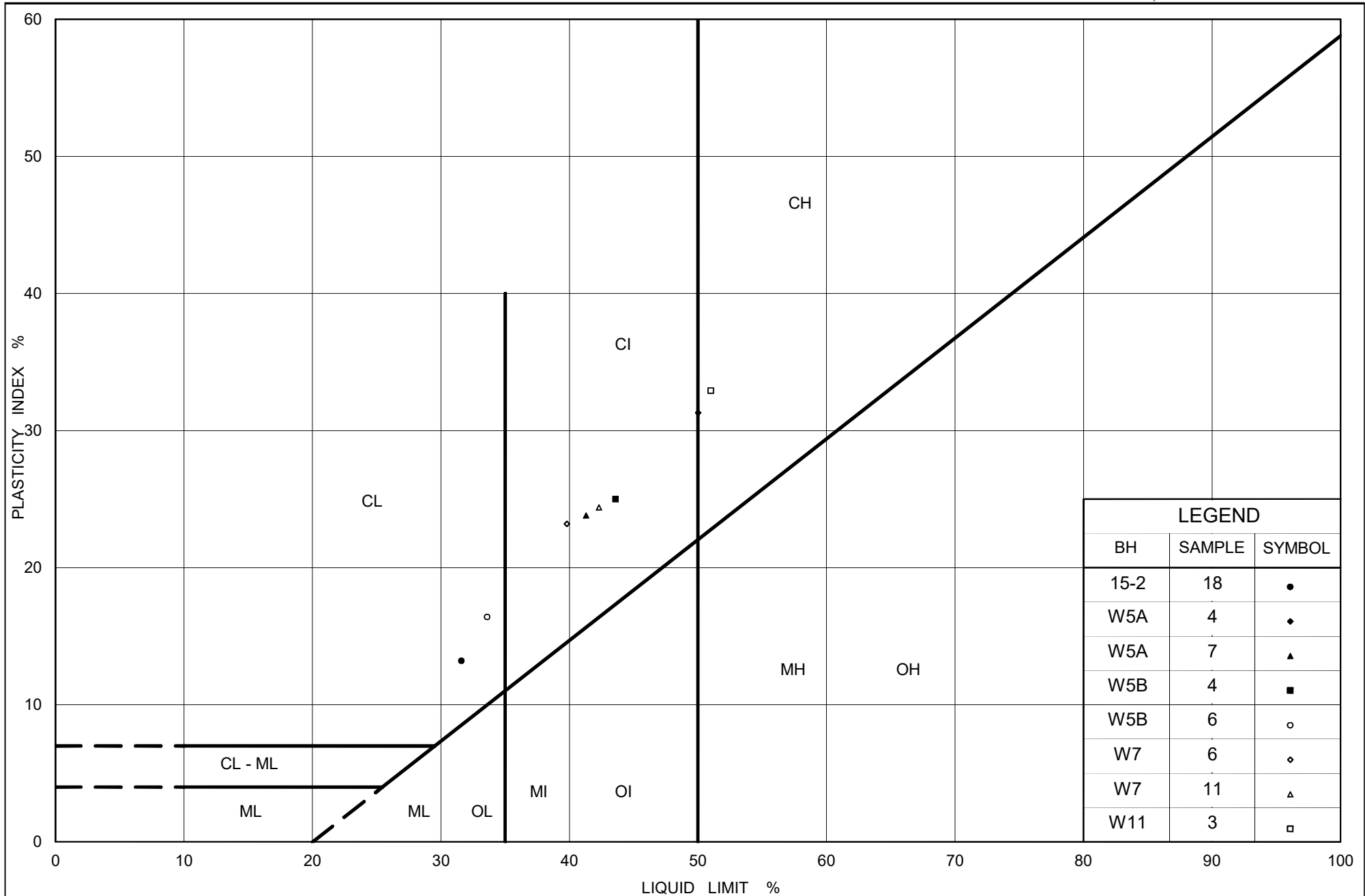
Ontario

PLASTICITY CHART Clay to Clayey Silt

Figure No. B2.3

Project No. 10-1111-0058

Checked By: SEMP/ AC



Ministry of Transportation

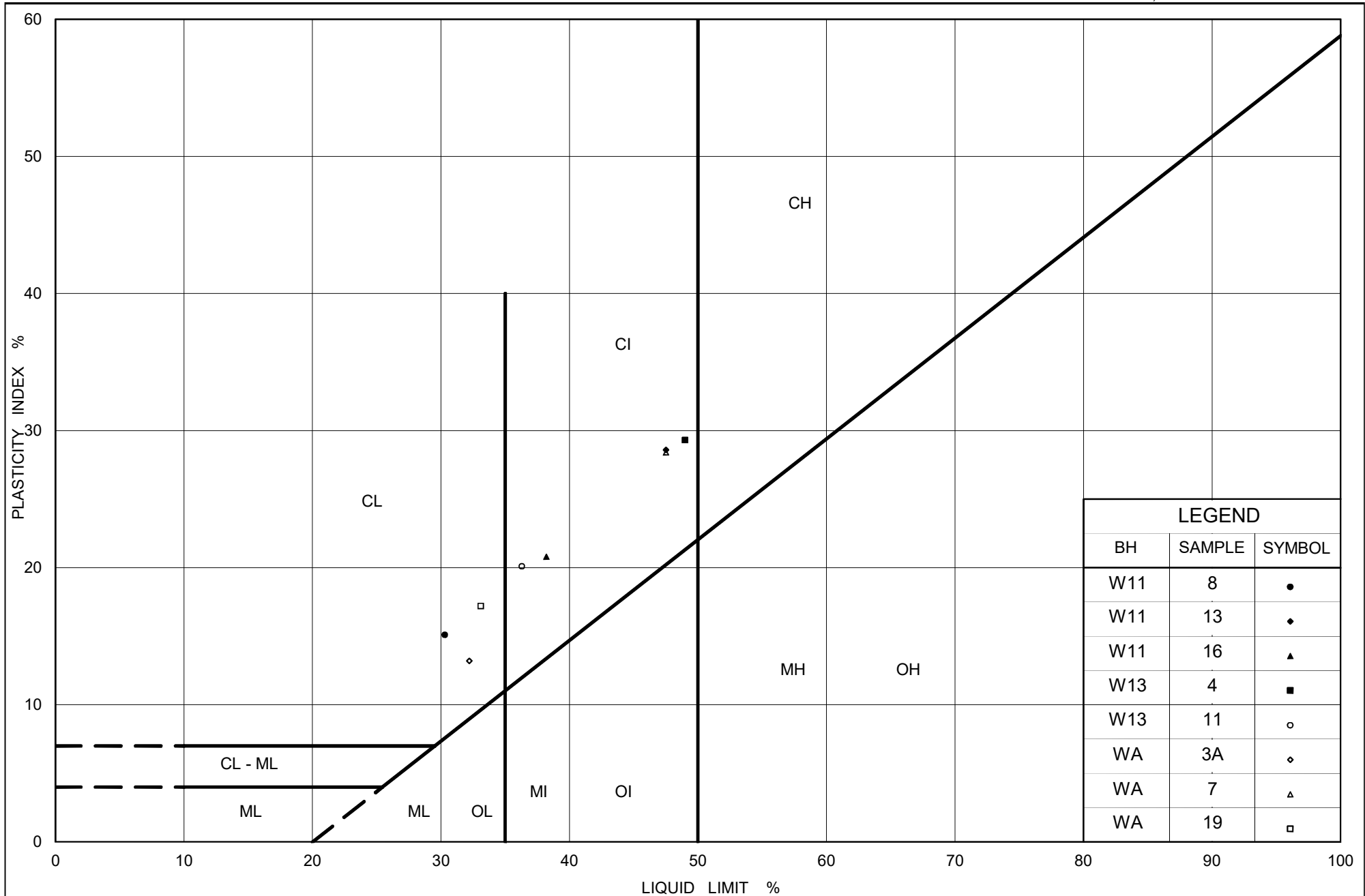
Ontario

PLASTICITY CHART Clay to Clayey Silt

Figure No. B2.4

Project No. 10-1111-0058

Checked By: SEMP/ AC



Ministry of Transportation

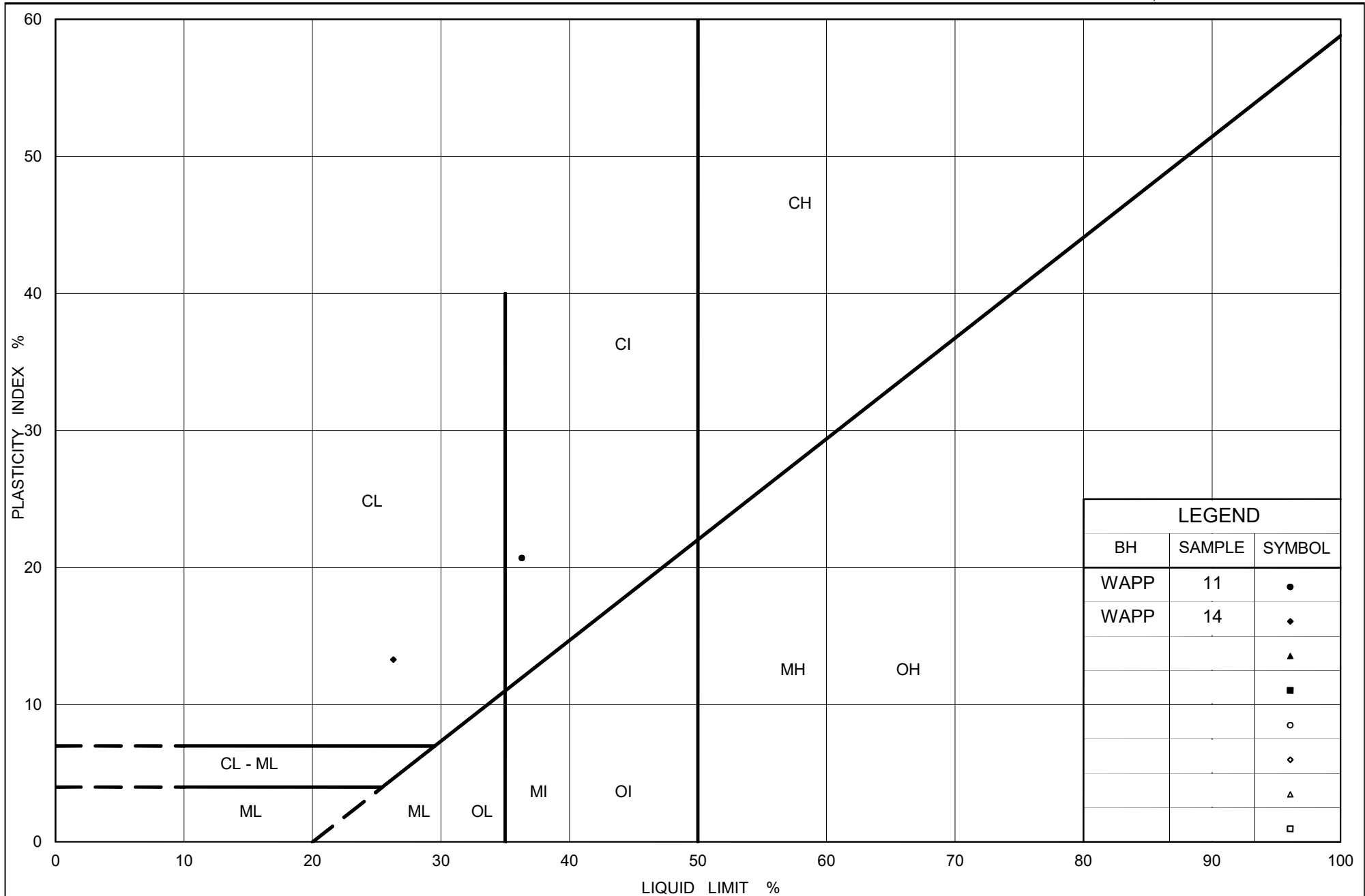
Ontario

PLASTICITY CHART Clay to Clayey Silt

Figure No. B2.5

Project No. 10-1111-0058

Checked By: SEMP/ AC



Ministry of Transportation

Ontario

PLASTICITY CHART Clay to Clayey Silt

Figure No. B2.6

Project No. 10-1111-0058

Checked By: SEMP/ AC

CONSOLIDATION TEST SUMMARY**FIGURE B3.1****ASTM D2435/D2435M****SAMPLE IDENTIFICATION**

Project Number	10-1111-0058	Sample Number	5
Borehole Number	WAPP	Sample Depth, m	3.05-3.66

TEST CONDITIONS

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	5		
Date Started	08/06/2015		
Date Completed	08/21/2015		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.90	Unit Weight, kN/m ³	20.99
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	17.60
Area, cm ²	31.55	Specific Gravity, measured	2.74
Volume, cm ³	60.07	Solids Height, cm	1.247
Water Content, %	19.28	Volume of Solids, cm ³	39.35
Wet Mass, g	128.60	Volume of Voids, cm ³	20.72
Dry Mass, g	107.81	Degree of Saturation, %	100.3

TEST COMPUTATIONS

Stress	Corr.		Average				
kPa	Height	Void	Height	t ₉₀	cv.	mv	k
	cm	Ratio	cm	sec	cm ² /s	m ² /kN	cm/s
0.00	1.904	0.527	1.904				
10.73	1.897	0.521	1.900				
20.71	1.896	0.521	1.897				
39.91	1.889	0.515	1.893	87	8.73E-03	2.02E-04	1.73E-07
78.94	1.868	0.498	1.878	634	1.18E-03	2.84E-04	3.28E-08
156.49	1.837	0.473	1.852	683	1.06E-03	2.13E-04	2.22E-08
78.83	1.847	0.481	1.842				
39.91	1.865	0.495	1.856				
78.94	1.846	0.480	1.855	653	1.12E-03	2.57E-04	2.82E-08
156.49	1.834	0.470	1.840	614	1.17E-03	8.40E-05	9.62E-09
311.61	1.799	0.443	1.816	673	1.04E-03	1.16E-04	1.18E-08
622.15	1.757	0.408	1.778	470	1.43E-03	7.24E-05	1.01E-08
1242.67	1.702	0.364	1.729	487	1.30E-03	4.64E-05	5.92E-09
2484.02	1.630	0.307	1.666	375	1.57E-03	3.02E-05	4.65E-09
622.15	1.670	0.339	1.650				
156.32	1.728	0.385	1.699				
39.91	1.785	0.431	1.756				
20.71	1.836	0.472	1.810				

Note:

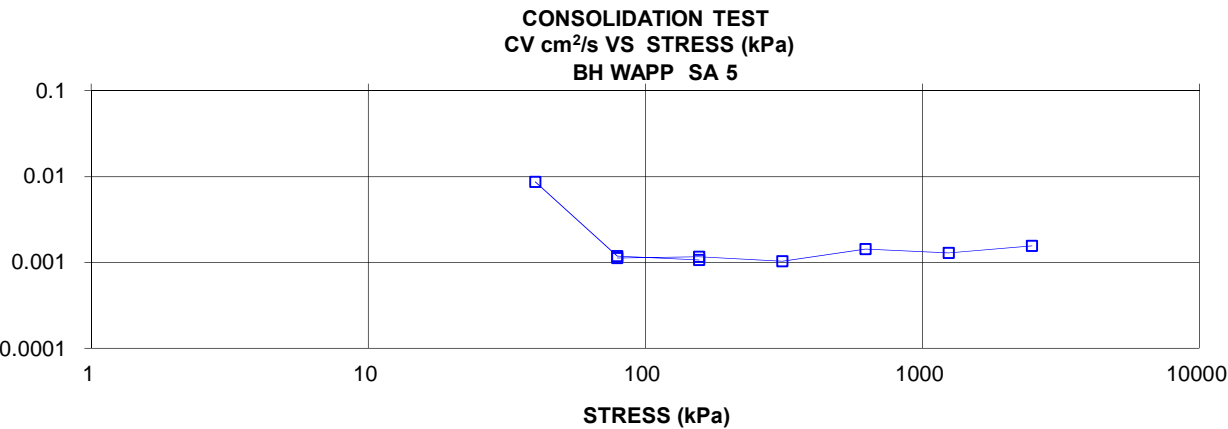
Specimen swelled under 39.91 kPa.

Specimen taken 12-19 cm from bottom of the tube

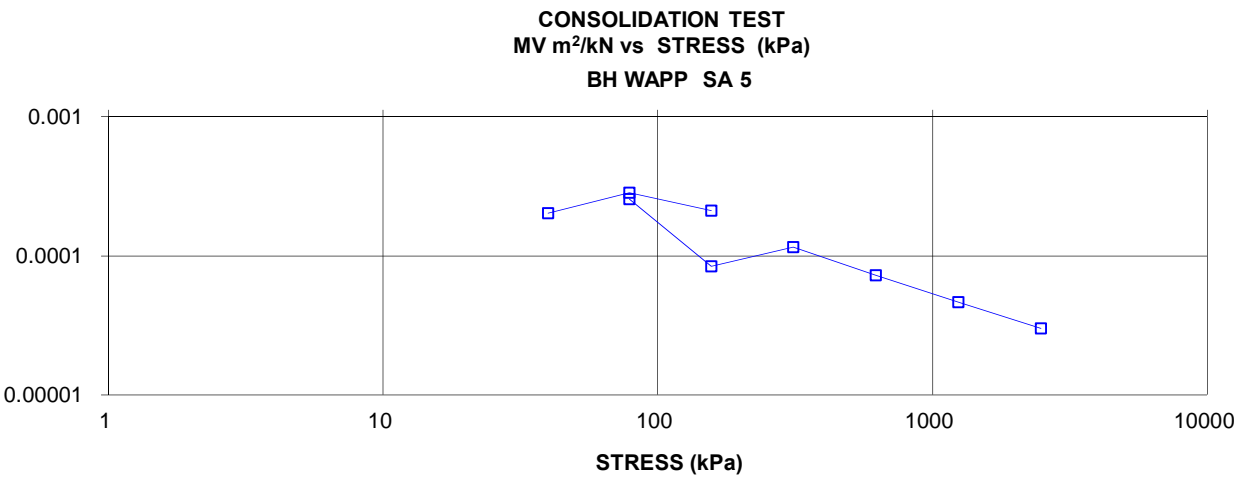
k calculated using cv based on ϕ_0 values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.84	Unit Weight, kN/m ³	22.93
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	18.25
Area, cm ²	31.55	Specific Gravity, measured	2.74
Volume, cm ³	57.92	Solids Height, cm	1.247
Water Content, %	25.64	Volume of Solids, cm ³	39.35
Wet Mass, g	135.45	Volume of Voids, cm ³	18.57
Dry Mass, g	107.81		

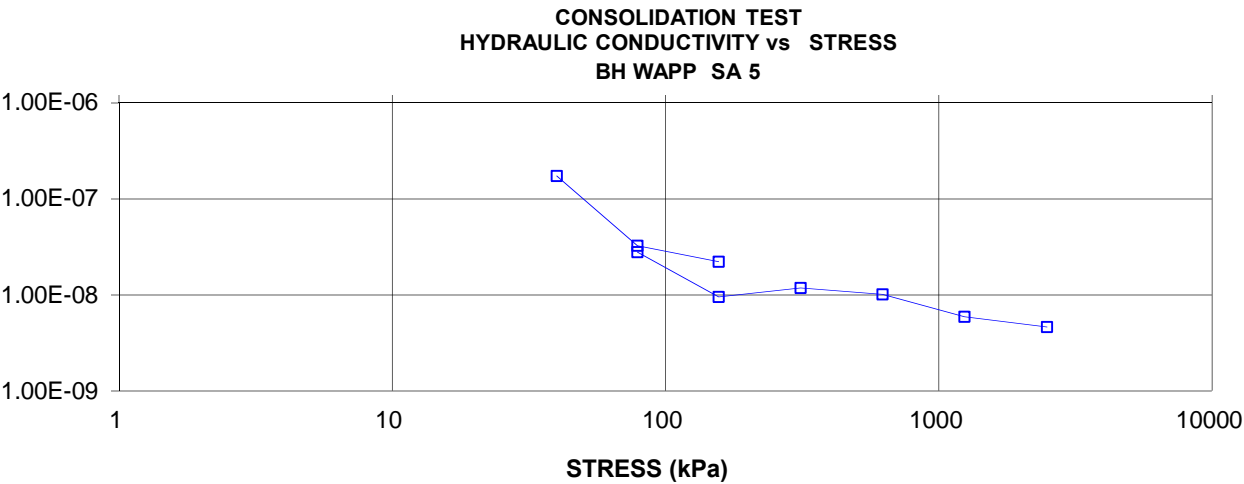
COEFFICIENT OF CONSOLIDATION,
cm²/s

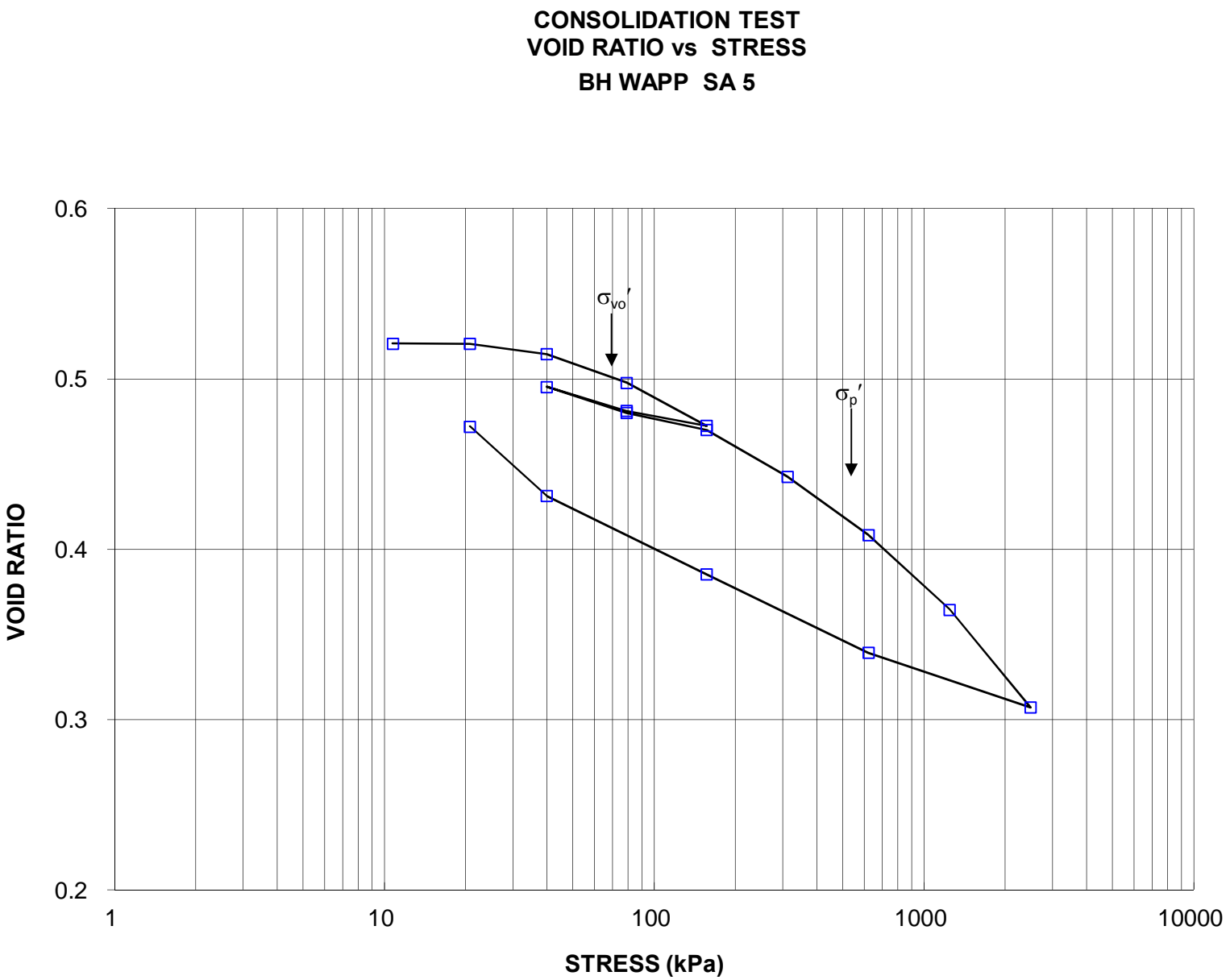


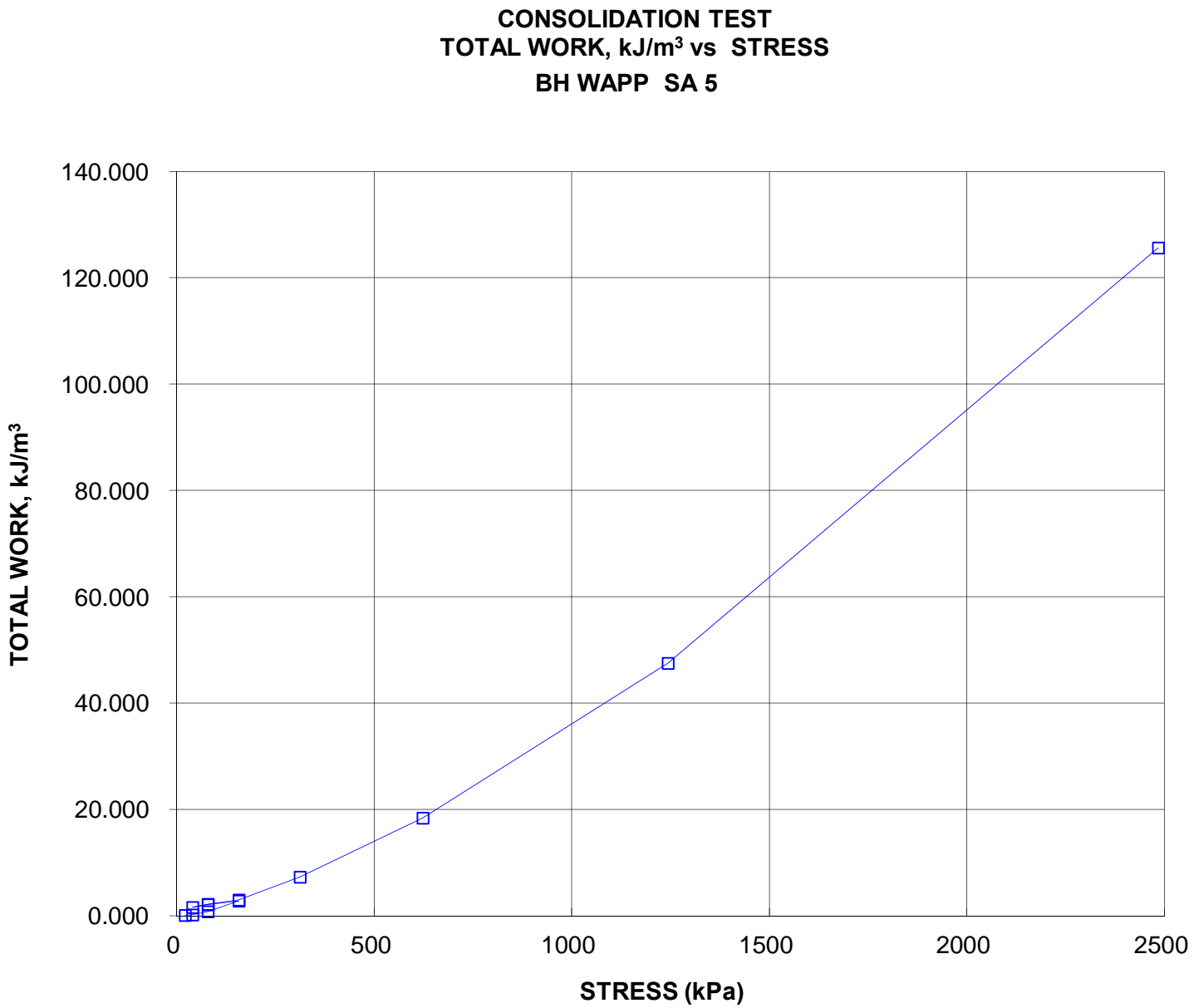
VOLUME COMPRESSIBILITY, m²/kN



HYDRAULIC CONDUCTIVITY,
cm/s







CONSOLIDATION TEST SUMMARY**FIGURE B3.2****ASTM D2435/D2435M****SAMPLE IDENTIFICATION**

Project Number	10-1111-0058	Sample Number	12
Borehole Number	WAPP	Sample Depth, m	12.20-12.80

TEST CONDITIONS

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	6		
Date Started	08/06/2015		
Date Completed	08/21/2015		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.89	Unit Weight, kN/m ³	20.73
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	16.76
Area, cm ²	31.61	Specific Gravity, measured	2.77
Volume, cm ³	59.80	Solids Height, cm	1.167
Water Content, %	23.69	Volume of Solids, cm ³	36.89
Wet Mass, g	126.40	Volume of Voids, cm ³	22.91
Dry Mass, g	102.19	Degree of Saturation, %	105.7

TEST COMPUTATIONS

Stress	Corr.		Average				
kPa	Height	Void	Height	t ₉₀	cv.	mv	k
	cm	Ratio	cm	sec	cm ² /s	m ² /kN	cm/s
0.00	1.892	0.621	1.892				
10.58	1.882	0.612	1.887	4	1.89E-01	5.15E-04	9.51E-06
20.63	1.869	0.601	1.875	43	1.73E-02	6.63E-04	1.13E-06
39.94	1.849	0.584	1.859	73	1.00E-02	5.45E-04	5.36E-07
78.75	1.813	0.553	1.831	113	6.29E-03	4.93E-04	3.04E-07
187.14	1.768	0.515	1.790	118	5.76E-03	2.21E-04	1.25E-07
78.67	1.779	0.524	1.773				
20.54	1.805	0.547	1.792				
79.29	1.788	0.532	1.796	79	8.66E-03	1.57E-04	1.33E-07
186.92	1.764	0.511	1.776	135	4.95E-03	1.18E-04	5.72E-08
311.31	1.741	0.492	1.753	317	2.05E-03	9.48E-05	1.91E-08
621.27	1.691	0.449	1.716	437	1.43E-03	8.53E-05	1.19E-08
1241.10	1.622	0.390	1.657	375	1.55E-03	5.89E-05	8.96E-09
2479.28	1.542	0.322	1.582	240	2.21E-03	3.41E-05	7.39E-09
621.27	1.578	0.352	1.560				
187.07	1.615	0.384	1.596				
39.94	1.669	0.430	1.642				
20.63	1.707	0.463	1.688				

Note:

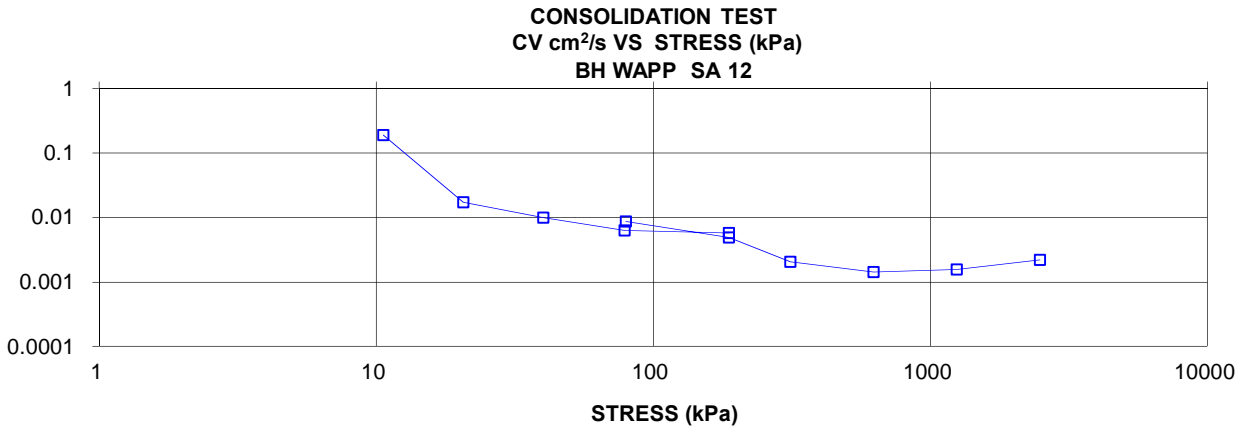
Specimen swelled under 10.58 kPa.

Specimen taken 32-39 cm from bottom of the tube

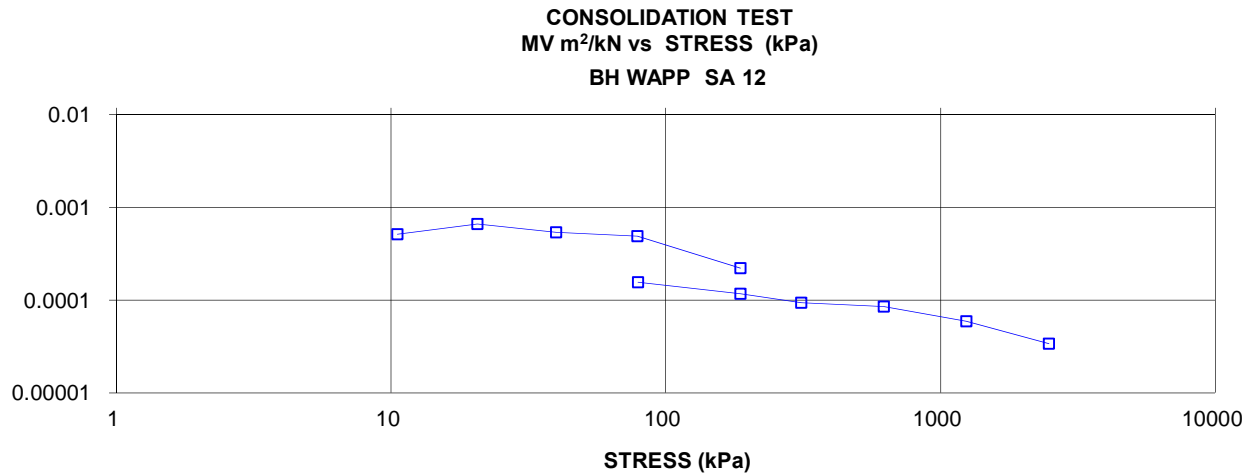
k calculated using cv based on ϕ_0 values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	1.71	Unit Weight, kN/m ³	22.53
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	18.57
Area, cm ²	31.61	Specific Gravity, measured	2.77
Volume, cm ³	53.96	Solids Height, cm	1.167
Water Content, %	21.30	Volume of Solids, cm ³	36.89
Wet Mass, g	123.96	Volume of Voids, cm ³	17.07
Dry Mass, g	102.19		

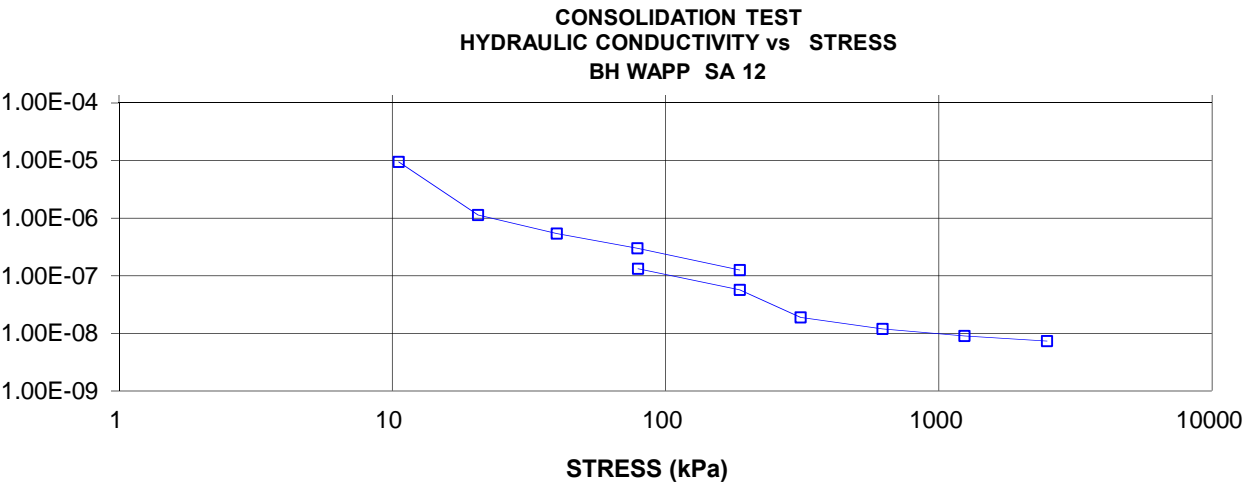
COEFFICIENT OF CONSOLIDATION,
cm²/s

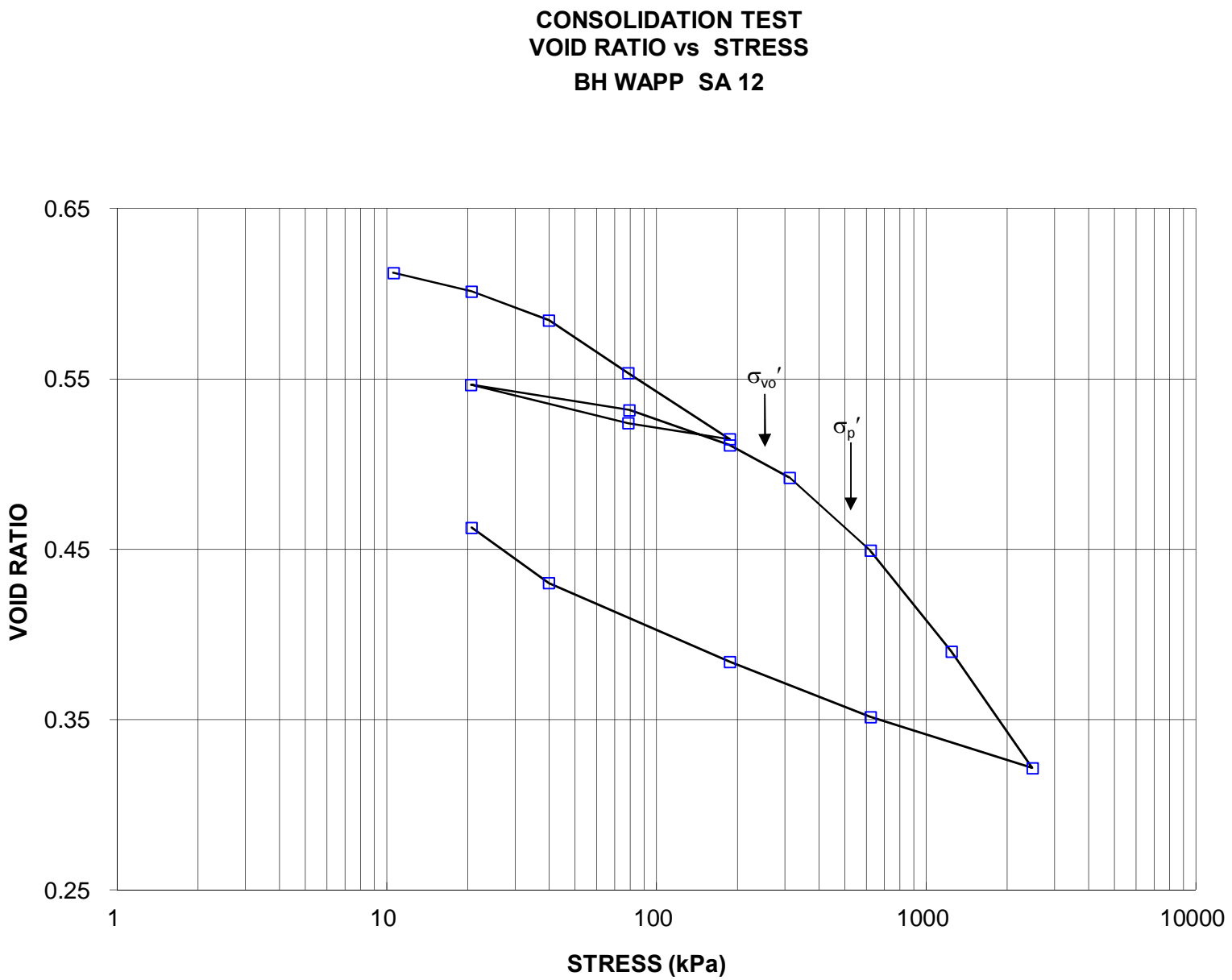


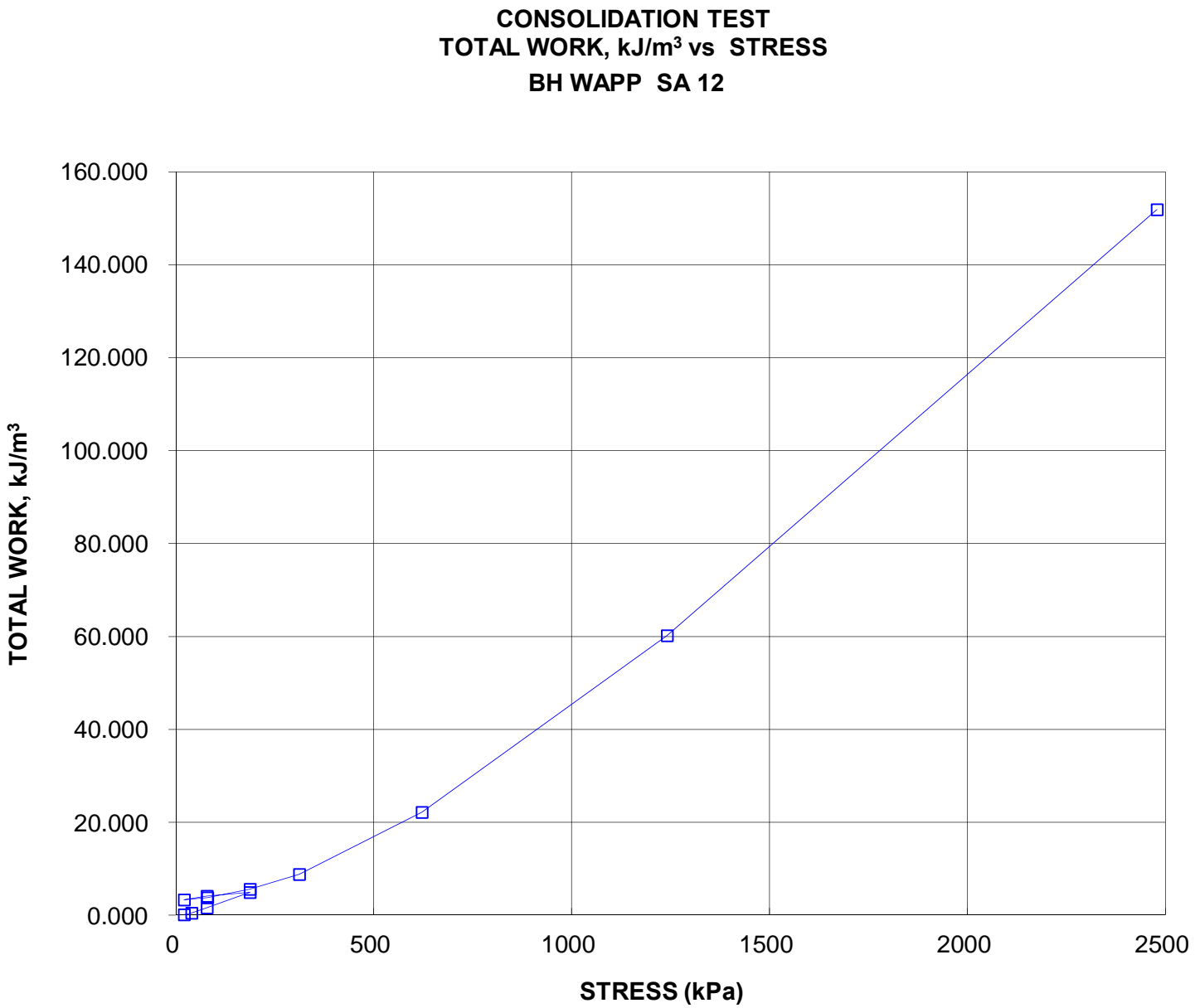
VOLUME COMPRESSIBILITY, m²/kN



HYDRAULIC CONDUCTIVITY,
cm/s







CONSOLIDATION TEST SUMMARY**FIGURE B3.3****ASTM D2435/D2435M****SAMPLE IDENTIFICATION**

Project Number	10-1111-0058	Sample Number	20
Borehole Number	WAPP	Sample Depth, m	24.44-25.00

TEST CONDITIONS

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	4		
Date Started	08/06/2015		
Date Completed	08/18/2015		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m ³	20.45
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	16.55
Area, cm ²	31.60	Specific Gravity, measured	2.74
Volume, cm ³	80.20	Solids Height, cm	1.563
Water Content, %	23.61	Volume of Solids, cm ³	49.39
Wet Mass, g	167.28	Volume of Voids, cm ³	30.81
Dry Mass, g	135.33	Degree of Saturation, %	103.7

TEST COMPUTATIONS

Stress	Corr.		Average				
kPa	Height	Void	Height	t ₉₀	cv.	mv	k
	cm	Ratio	cm	sec	cm ² /s	m ² /kN	cm/s
0.00	2.538	0.624	2.538				
10.89	2.535	0.622	2.536				
20.94	2.532	0.620	2.534	20	6.80E-02	1.06E-04	7.06E-07
40.45	2.523	0.614	2.528	240	5.64E-03	1.84E-04	1.02E-07
79.14	2.507	0.604	2.515	406	3.30E-03	1.67E-04	5.41E-08
156.34	2.485	0.590	2.496	375	3.52E-03	1.13E-04	3.89E-08
350.14	2.447	0.565	2.466	317	4.07E-03	7.73E-05	3.08E-08
79.63	2.466	0.578	2.456				
20.74	2.497	0.598	2.482				
78.97	2.479	0.586	2.488	390	3.36E-03	1.24E-04	4.08E-08
350.15	2.437	0.559	2.458	360	3.56E-03	6.12E-05	2.13E-08
602.08	2.393	0.531	2.415	694	1.78E-03	6.76E-05	1.18E-08
1243.61	2.290	0.465	2.342	577	2.01E-03	6.34E-05	1.25E-08
2482.29	2.190	0.401	2.240	505	2.11E-03	3.20E-05	6.60E-09
1243.61	2.201	0.408	2.195				
350.14	2.231	0.428	2.216				
78.97	2.285	0.462	2.258				
20.94	2.338	0.496	2.311				

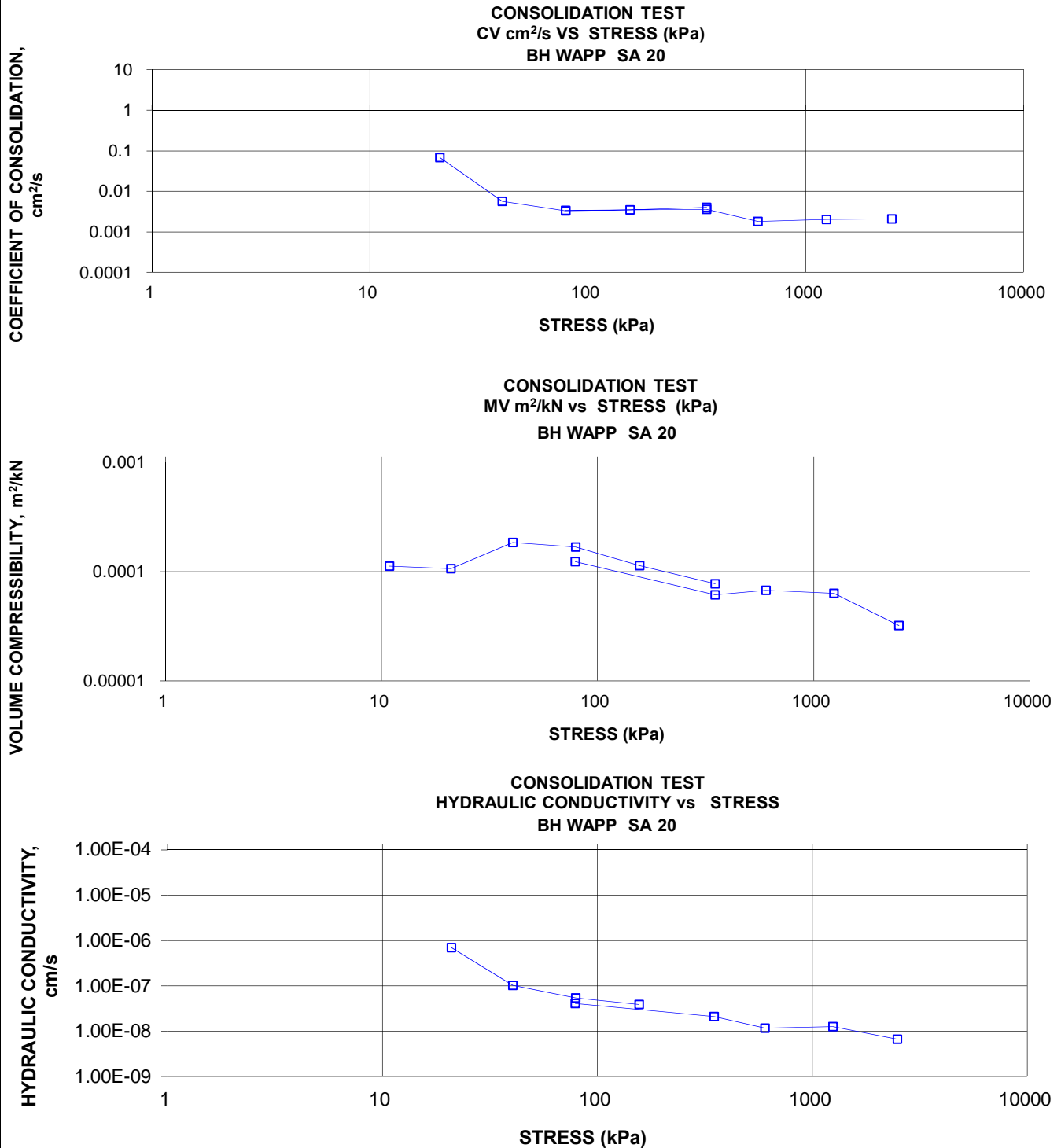
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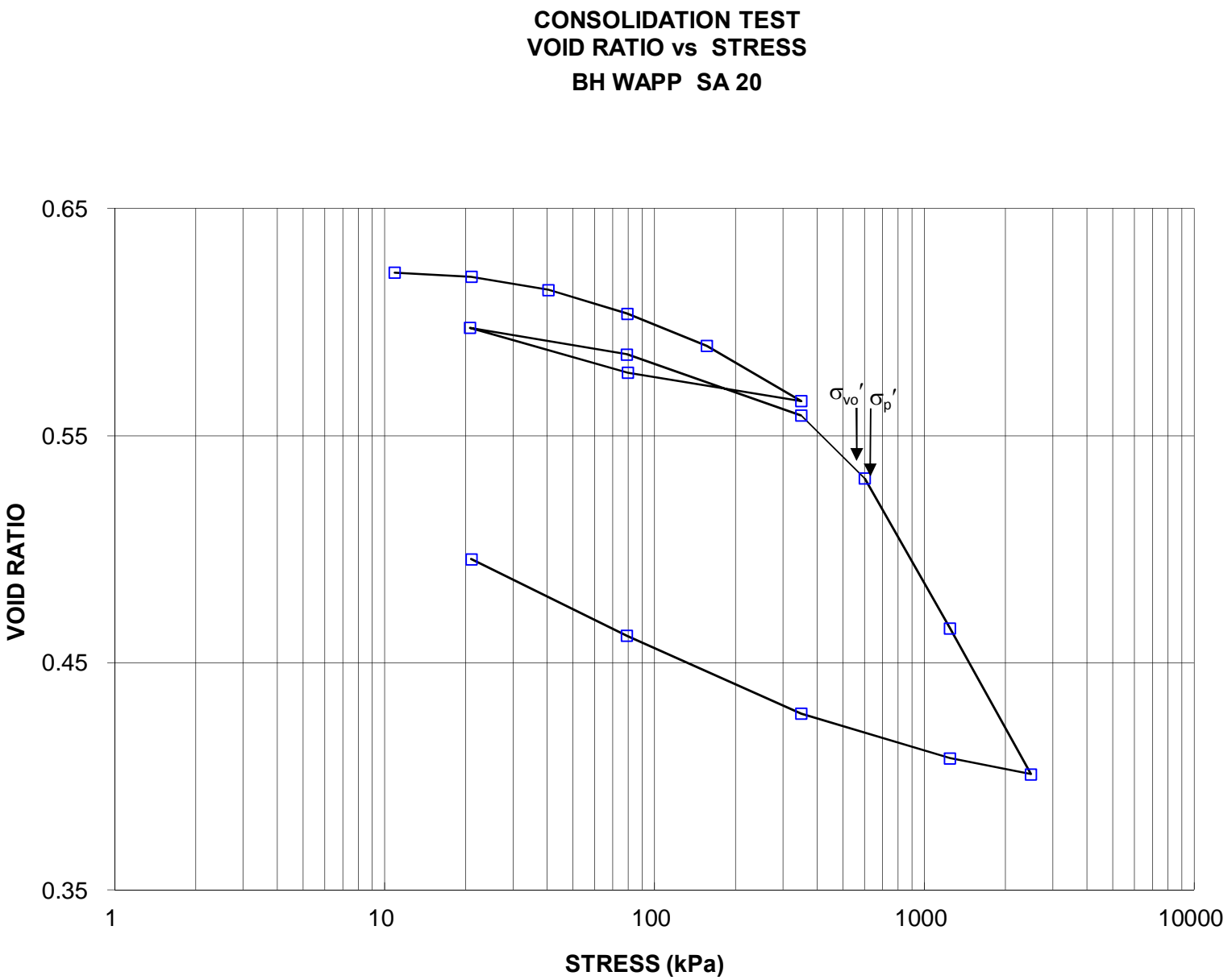
Specimen swelled under 20.94 kPa.

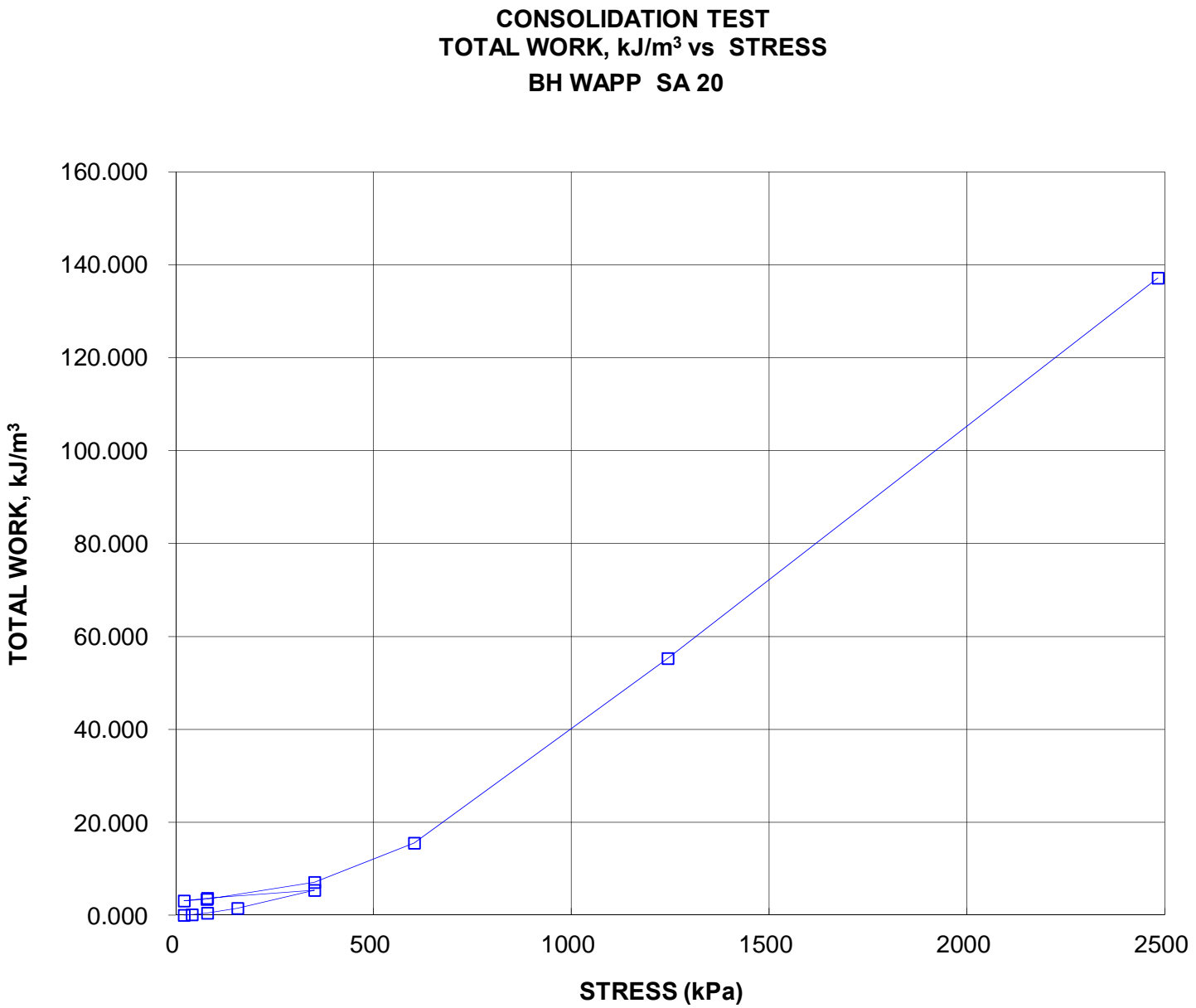
Specimen taken 10-16 cm from bottom of the tube

k calculated using cv based on δ_0 values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	2.34	Unit Weight, kN/m ³	21.54
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	17.97
Area, cm ²	31.60	Specific Gravity, measured	2.74
Volume, cm ³	73.87	Solids Height, cm	1.563
Water Content, %	19.90	Volume of Solids, cm ³	49.39
Wet Mass, g	162.26	Volume of Voids, cm ³	24.48
Dry Mass, g	135.33		







CONSOLIDATION TEST SUMMARY**FIGURE B3.4****ASTM D2435/D2435M****SAMPLE IDENTIFICATION**

Project Number	10-1111-0058	Sample Number	9
Borehole Number	WA	Sample Depth, m	7.62-8.23

TEST CONDITIONS

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	2		
Date Started	08/06/2015		
Date Completed	08/21/2015		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m ³	18.95
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m ³	14.39
Area, cm ²	31.51	Specific Gravity, measured	2.73
Volume, cm ³	80.16	Solids Height, cm	1.367
Water Content, %	31.72	Volume of Solids, cm ³	43.08
Wet Mass, g	154.93	Volume of Voids, cm ³	37.08
Dry Mass, g	117.62	Degree of Saturation, %	100.6

TEST COMPUTATIONS

Stress	Corr. Height	Void	Average Height	t ₉₀	cv.	mv	k
kPa	cm	Ratio	cm	sec	cm ² /s	m ² /kN	cm/s
0.00	2.544	0.861	2.544				
10.70	2.541	0.859	2.543				
20.78	2.542	0.859	2.542				
40.02	2.536	0.854	2.539	144	9.49E-03	1.37E-04	1.27E-07
78.90	2.521	0.843	2.528	304	4.46E-03	1.52E-04	6.62E-08
127.28	2.505	0.832	2.513	454	2.95E-03	1.23E-04	3.55E-08
40.02	2.520	0.843	2.513				
10.70	2.555	0.869	2.538				
40.34	2.540	0.857	2.547	519	2.65E-03	2.04E-04	5.30E-08
127.12	2.504	0.832	2.522	591	2.28E-03	1.59E-04	3.55E-08
166.15	2.495	0.825	2.500	866	1.53E-03	9.47E-05	1.42E-08
583.54	2.379	0.740	2.437	1135	1.11E-03	1.09E-04	1.19E-08
1162.02	2.244	0.641	2.312	614	1.84E-03	9.14E-05	1.65E-08
2310.01	2.103	0.538	2.174	437	2.29E-03	4.83E-05	1.09E-08
609.08	2.139	0.564	2.121				
125.67	2.218	0.622	2.178				
40.34	2.279	0.667	2.249				
10.70	2.354	0.722	2.317				

Note:

Specimen swelled under 20.78 kPa.

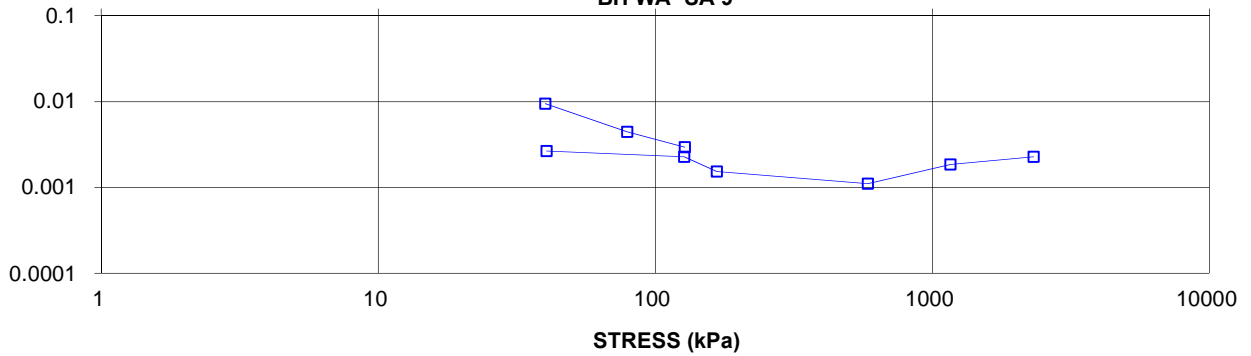
Specimen taken 22-28 cm from bottom of the tube

k calculated using cv based on ϕ_0 values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	2.35	Unit Weight, kN/m ³	20.08
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m ³	15.55
Area, cm ²	31.51	Specific Gravity, measured	2.73
Volume, cm ³	74.17	Solids Height, cm	1.367
Water Content, %	29.10	Volume of Solids, cm ³	43.08
Wet Mass, g	151.85	Volume of Voids, cm ³	31.09
Dry Mass, g	117.62		

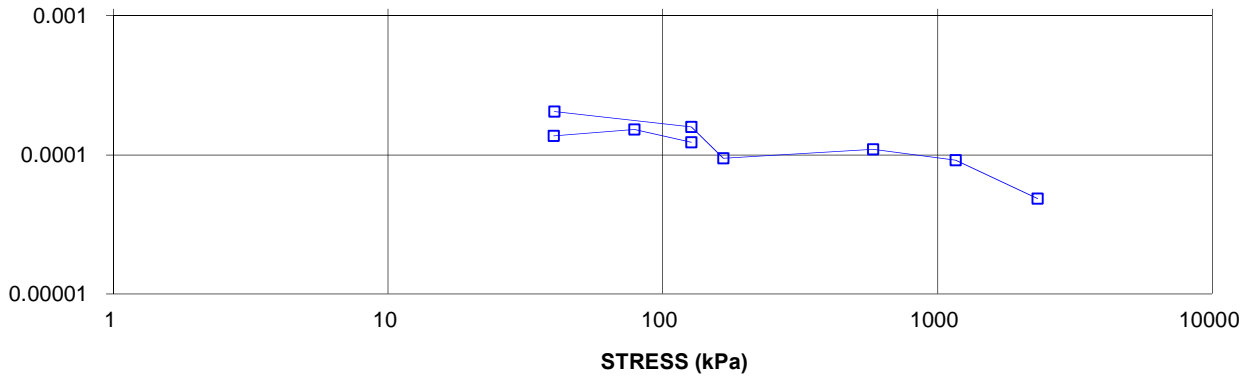
COEFFICIENT OF CONSOLIDATION,
cm²/s

CONSOLIDATION TEST
CV cm²/s VS STRESS (kPa)
BH WA SA 9



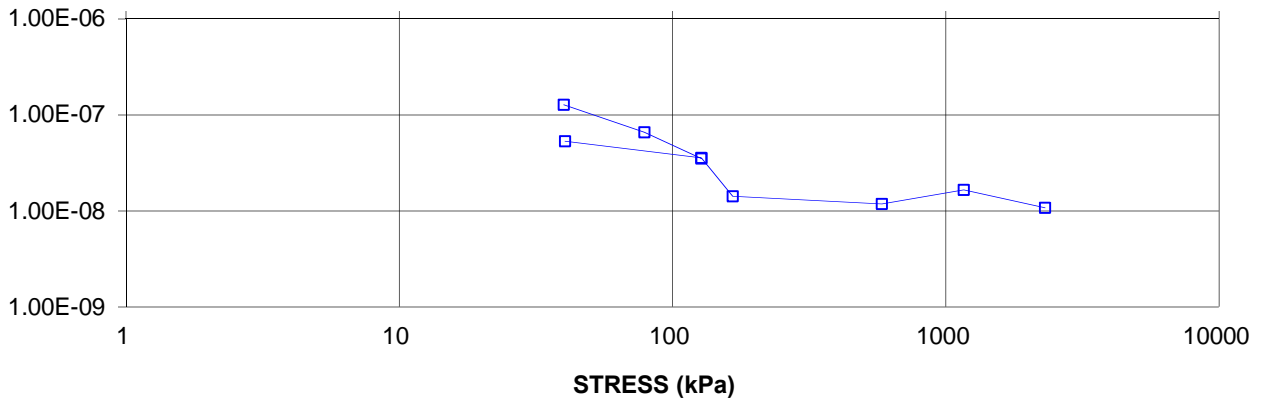
VOLUME COMPRESSIBILITY, m²/kN

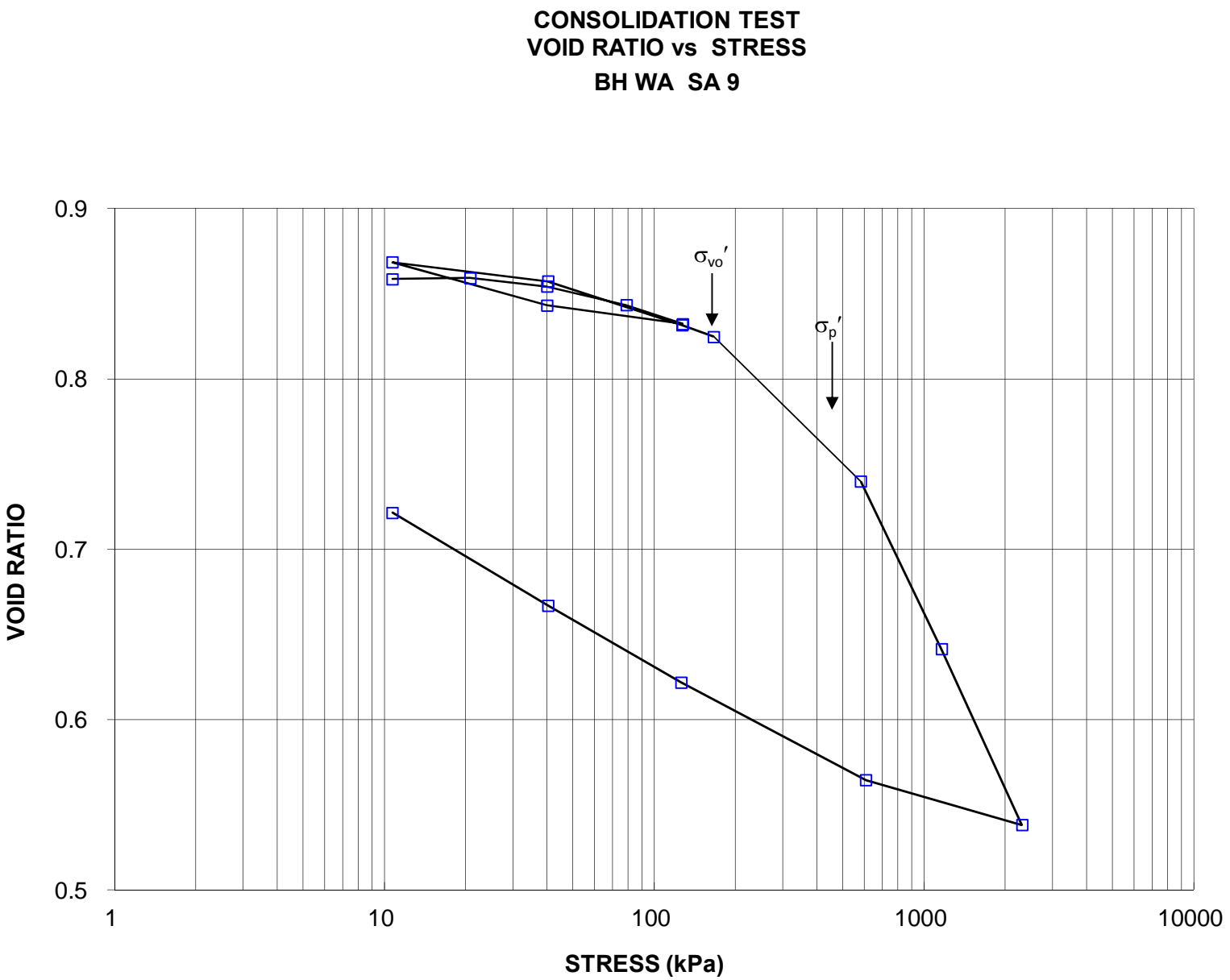
CONSOLIDATION TEST
MV m²/kN vs STRESS (kPa)
BH WA SA 9

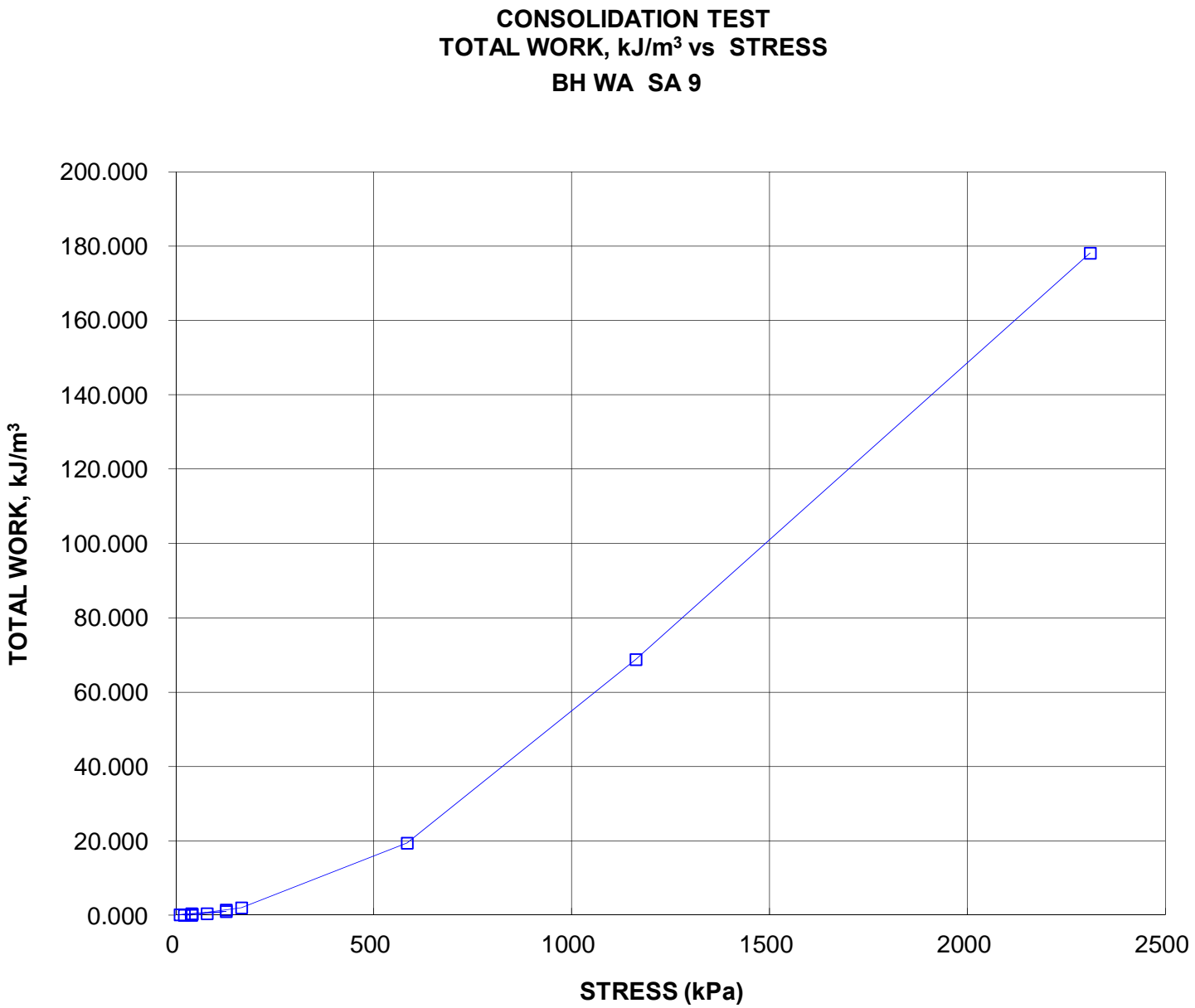


HYDRAULIC CONDUCTIVITY,
cm/s

CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs STRESS
BH WA SA 9







CONSOLIDATION TEST SUMMARY**FIGURE B3.5****ASTM D2435/D2435M****SAMPLE IDENTIFICATION**

Project Number	10-1111-0058	Sample Number	16
Borehole Number	WA	Sample Depth, m	18.29-18.90

TEST CONDITIONS

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	3		
Date Started	08/06/2015		
Date Completed	08/21/2015		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m ³	19.05
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	14.33
Area, cm ²	31.59	Specific Gravity, measured	2.76
Volume, cm ³	80.17	Solids Height, cm	1.344
Water Content, %	32.95	Volume of Solids, cm ³	42.44
Wet Mass, g	155.74	Volume of Voids, cm ³	37.73
Dry Mass, g	117.14	Degree of Saturation, %	102.3

TEST COMPUTATIONS

Stress kPa	Corr. Height cm	Void Ratio	Average Height cm	t ₉₀ sec	cv. cm ² /s	mv m ² /kN	k cm/s
0.00	2.538	0.889	2.538				
10.74	2.512	0.870	2.525	2053	6.58E-04	9.61E-04	6.20E-08
20.49	2.493	0.855	2.502	2458	5.40E-04	7.80E-04	4.13E-08
39.97	2.455	0.827	2.474	2486	5.22E-04	7.58E-04	3.88E-08
78.80	2.406	0.791	2.430	1270	9.86E-04	4.98E-04	4.81E-08
156.15	2.340	0.741	2.373	1162	1.03E-03	3.37E-04	3.39E-08
249.87	2.290	0.704	2.315	1009	1.13E-03	2.11E-04	2.33E-08
78.80	2.309	0.718	2.299				
20.51	2.344	0.745	2.326				
78.80	2.325	0.730	2.335	463	2.50E-03	1.30E-04	3.19E-08
249.87	2.275	0.693	2.300	499	2.25E-03	1.16E-04	2.56E-08
610.51	2.171	0.616	2.223	614	1.71E-03	1.14E-04	1.90E-08
1165.13	2.082	0.549	2.126	454	2.11E-03	6.33E-05	1.31E-08
2330.04	1.983	0.476	2.032	375	2.33E-03	3.35E-05	7.65E-09
606.51	2.017	0.501	2.000				
246.84	2.053	0.528	2.035				
78.80	2.102	0.564	2.077				
10.76	2.199	0.636	2.150				

Note:

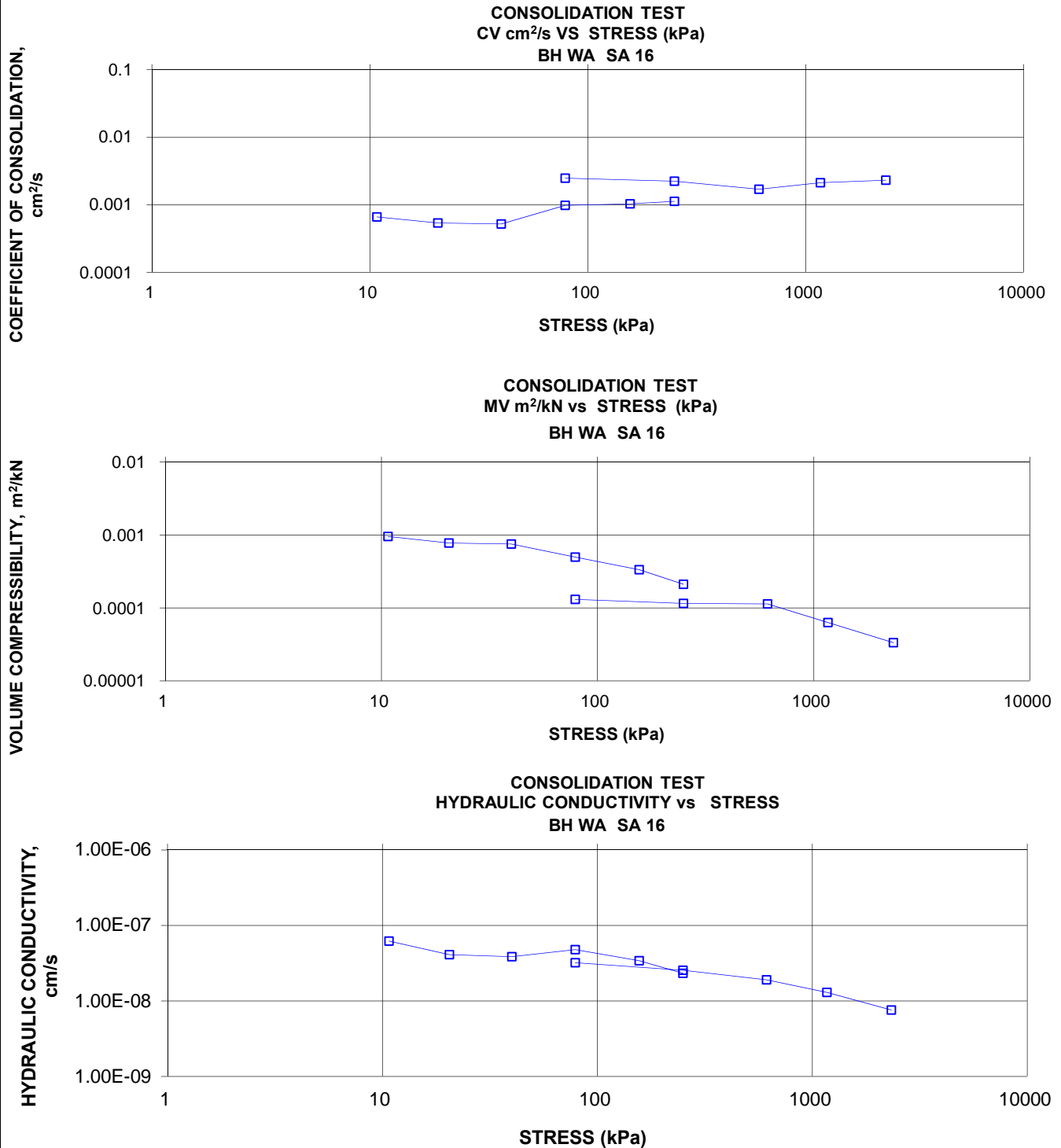
Specimen taken 5-11 cm from bottom of the tube

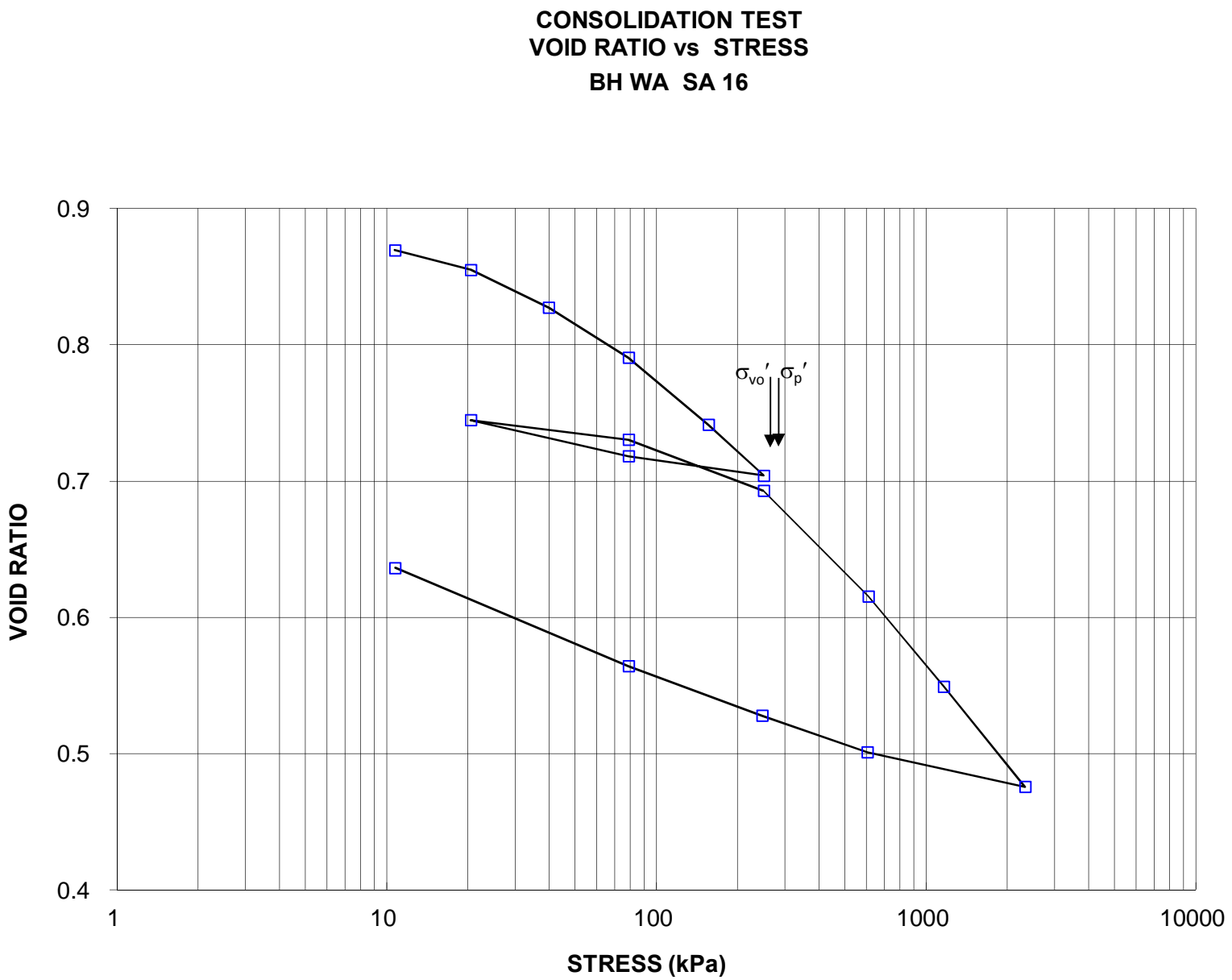
k calculated using cv based on $\dot{\epsilon}_0$ values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

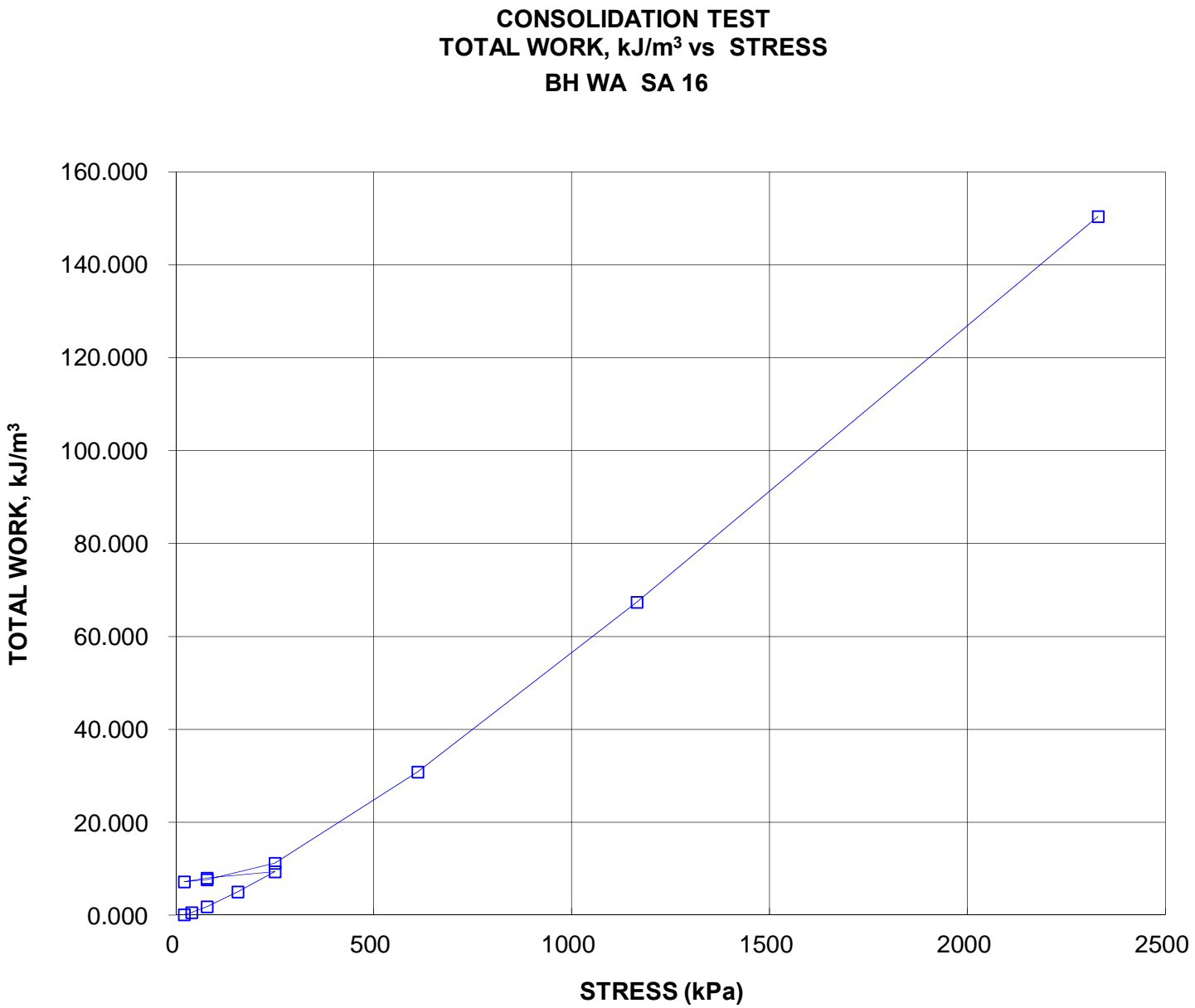
Sample Height, cm	2.20	Unit Weight, kN/m ³	20.66
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	16.54
Area, cm ²	31.59	Specific Gravity, measured	2.76
Volume, cm ³	69.45	Solids Height, cm	1.344
Water Content, %	24.88	Volume of Solids, cm ³	42.44
Wet Mass, g	146.29	Volume of Voids, cm ³	27.01
Dry Mass, g	117.14		

CONSOLIDATION TEST SUMMARY

FIGURE B3.5







CONSOLIDATION TEST SUMMARY**FIGURE B3.6****ASTM D2435/D2435M****SAMPLE IDENTIFICATION**

Project Number	10-1111-0058	Sample Number	3
Borehole Number	EA	Sample Depth, m	1.52-2.13

TEST CONDITIONS

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	2		
Date Started	07/15/2015		
Date Completed	07/24/2015		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m ³	20.40
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m ³	16.55
Area, cm ²	31.51	Specific Gravity, measured	2.77
Volume, cm ³	80.16	Solids Height, cm	1.550
Water Content, %	23.24	Volume of Solids, cm ³	48.84
Wet Mass, g	166.74	Volume of Voids, cm ³	31.32
Dry Mass, g	135.3	Degree of Saturation, %	100.4

TEST COMPUTATIONS

Stress	Corr. Height	Void Ratio	Average Height	t ₉₀	cv.	mv	k
kPa	cm		cm	sec	cm ² /s	m ² /kN	cm/s
0.00	2.544	0.641	2.544				
10.77	2.542	0.640	2.543				
20.57	2.543	0.641	2.543				
40.07	2.545	0.641	2.544				
78.97	2.542	0.640	2.543				
156.56	2.531	0.633	2.536	135	1.01E-02	5.32E-05	5.27E-08
312.48	2.506	0.617	2.519	756	1.78E-03	6.25E-05	1.09E-08
627.56	2.468	0.592	2.487	595	2.20E-03	4.79E-05	1.03E-08
1248.91	2.414	0.557	2.441	577	2.19E-03	3.38E-05	7.26E-09
2492.44	2.333	0.505	2.374	406	2.94E-03	2.57E-05	7.40E-09
627.56	2.377	0.533	2.355				
156.56	2.441	0.575	2.409				
40.07	2.512	0.621	2.477				
10.77	2.578	0.663	2.545				

Note:

Consolidation loading and unloading schedule assigned by the client.

Specimen swelled under 78.97kPa.

Specimen taken 4-11 cm from bottom of the tube

k calculated using cv based on \dot{d}_0 values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

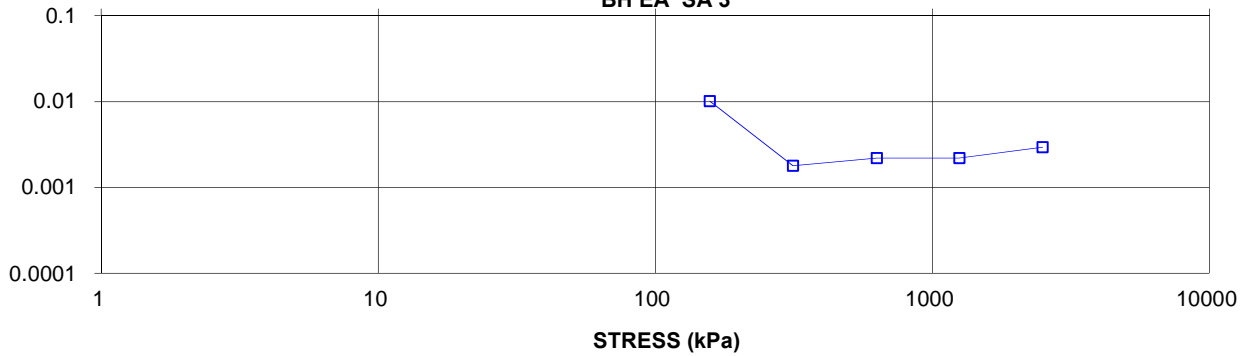
Sample Height, cm	2.58	Unit Weight, kN/m ³	20.65
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m ³	16.33
Area, cm ²	31.51	Specific Gravity, measured	2.77
Volume, cm ³	81.23	Solids Height, cm	1.550
Water Content, %	26.39	Volume of Solids, cm ³	48.84
Wet Mass, g	171.01	Volume of Voids, cm ³	32.38
Dry Mass, g	135.3		

CONSOLIDATION TEST SUMMARY

FIGURE B3.6

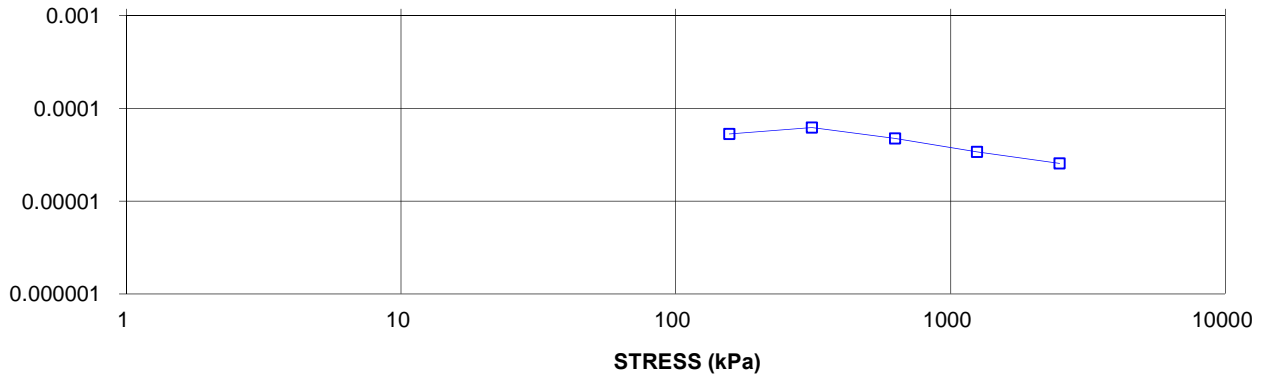
COEFFICIENT OF CONSOLIDATION,
cm²/s

CONSOLIDATION TEST
CV cm²/s VS STRESS (kPa)
BH EA SA 3



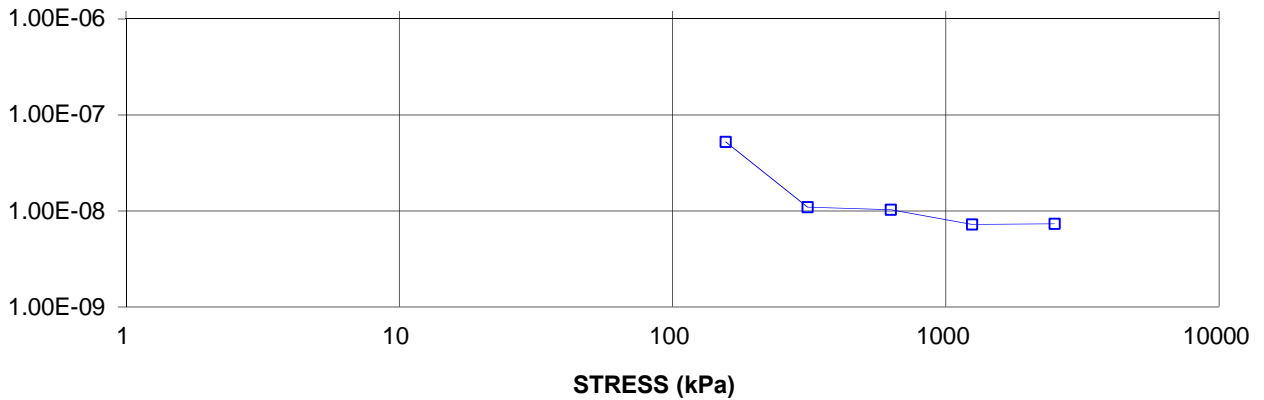
VOLUME COMPRESSIBILITY, m²/kN

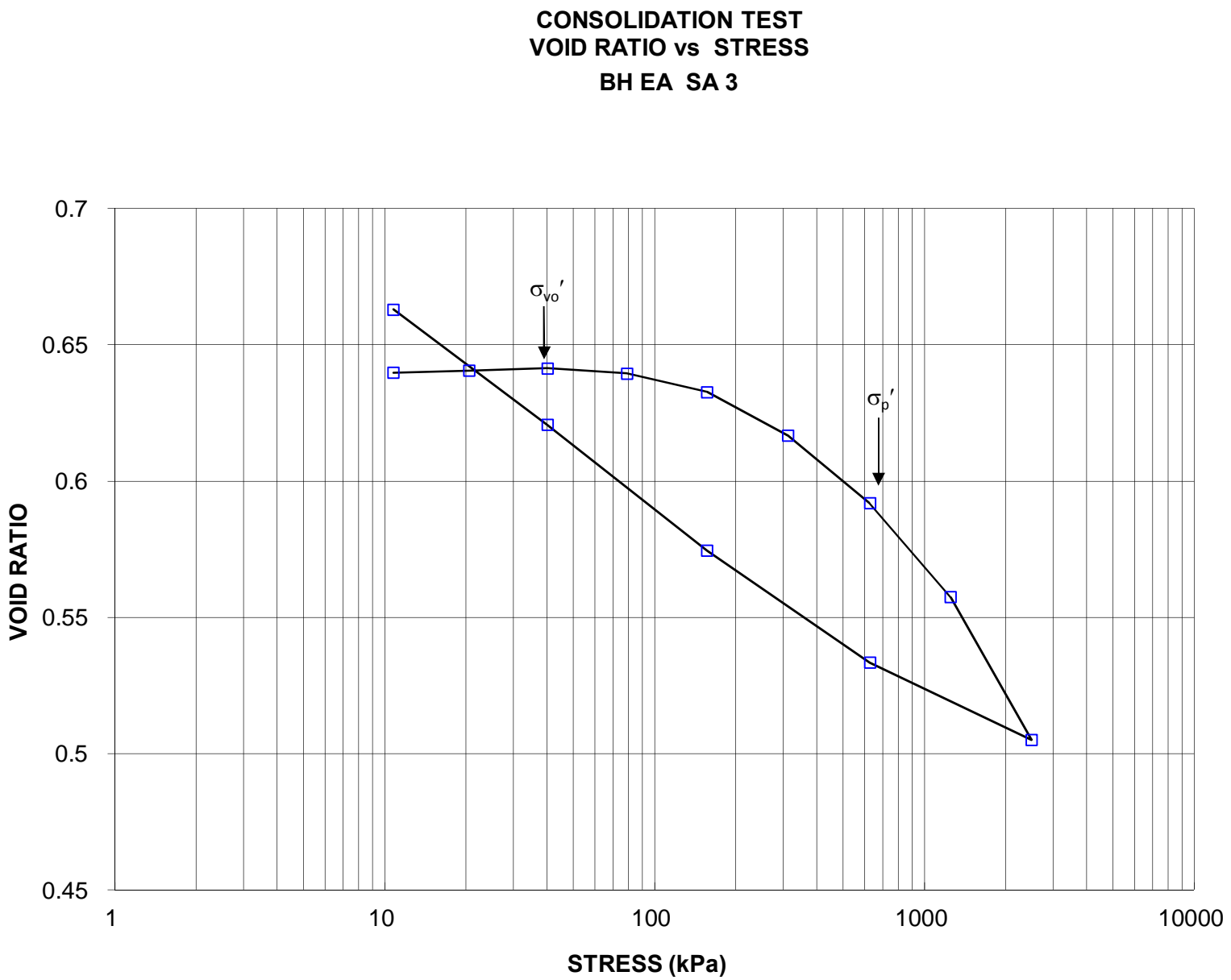
CONSOLIDATION TEST
MV m²/kN vs STRESS (kPa)
BH EA SA 3

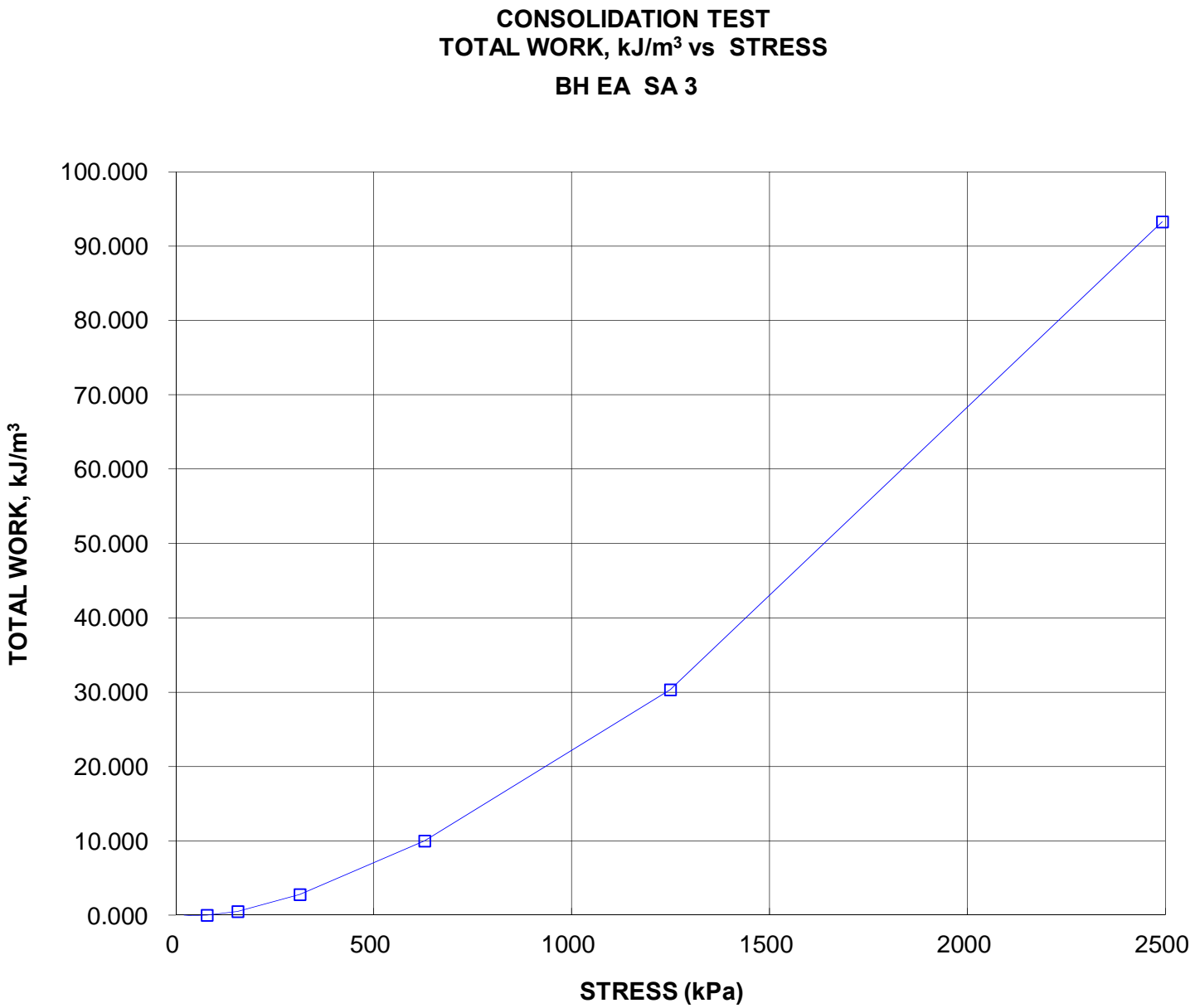


HYDRAULIC CONDUCTIVITY,
cm/s

CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs STRESS
BH EA SA 3







CONSOLIDATION TEST SUMMARY**FIGURE B3.7****ASTM D2435/D2435M****SAMPLE IDENTIFICATION**

Project Number	10-1111-0058	Sample Number	8
Borehole Number	EA	Sample Depth, m	6.10-6.71

TEST CONDITIONS

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	3		
Date Started	07/15/2015		
Date Completed	08/01/2015		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m ³	20.24
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	16.04
Area, cm ²	31.59	Specific Gravity, measured	2.78
Volume, cm ³	80.17	Solids Height, cm	1.494
Water Content, %	26.13	Volume of Solids, cm ³	47.18
Wet Mass, g	165.44	Volume of Voids, cm ³	32.99
Dry Mass, g	131.17	Degree of Saturation, %	103.9

TEST COMPUTATIONS

Stress	Corr. Height	Void	Average Height	t ₉₀	cv.	mv	k
kPa	cm	Ratio	cm	sec	cm ² /s	m ² /kN	cm/s
0.00	2.538	0.699	2.538				
10.74	2.534	0.696	2.536	1	1.36E+00	1.54E-04	2.06E-05
20.51	2.531	0.694	2.532	1	1.36E+00	1.33E-04	1.77E-05
39.96	2.519	0.686	2.525	420	3.22E-03	2.33E-04	7.35E-08
78.76	2.501	0.674	2.510	452	2.95E-03	1.84E-04	5.32E-08
106.67	2.491	0.668	2.496	505	2.62E-03	1.36E-04	3.47E-08
78.76	2.494	0.669	2.492				
39.97	2.507	0.678	2.500				
78.76	2.498	0.672	2.502	581	2.28E-03	8.94E-05	2.00E-08
106.55	2.491	0.668	2.495	756	1.75E-03	9.36E-05	1.60E-08
156.51	2.477	0.658	2.484	591	2.21E-03	1.15E-04	2.50E-08
311.55	2.437	0.632	2.457	452	2.83E-03	9.99E-05	2.77E-08
622.05	2.399	0.606	2.418	406	3.05E-03	4.92E-05	1.47E-08
1242.11	2.331	0.560	2.365	586	2.02E-03	4.33E-05	8.58E-09
2482.35	2.219	0.485	2.275	759	1.45E-03	3.55E-05	5.03E-09
1242.11	2.240	0.500	2.229				
311.55	2.304	0.543	2.272				
106.55	2.371	0.588	2.338				
39.97	2.423	0.622	2.397				

Note:

Consolidation loading and unloading schedule assigned by the client.

Specimen swelled under 20.51kPa

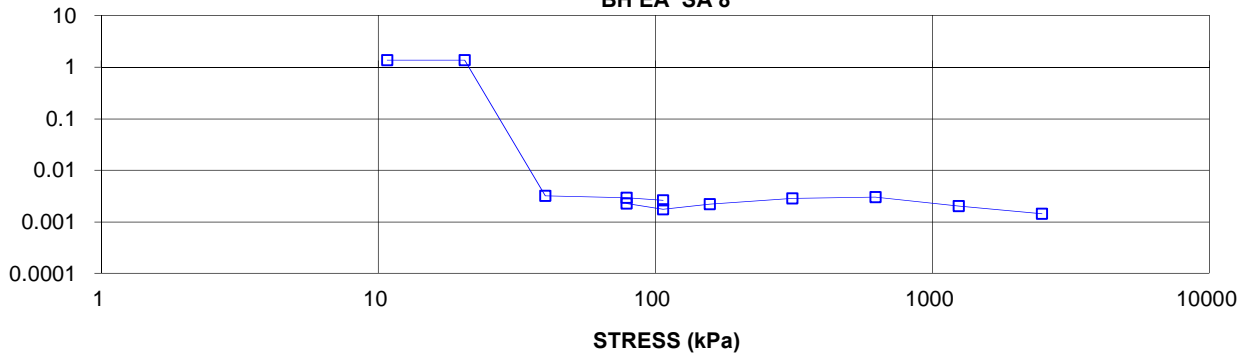
Specimen taken 30-37 cm from bottom of the tube

k calculated using cv based on t₉₀ values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

Sample Height, cm	2.42	Unit Weight, kN/m ³	21.65
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	16.81
Area, cm ²	31.59	Specific Gravity, measured	2.78
Volume, cm ³	76.53	Solids Height, cm	1.494
Water Content, %	28.82	Volume of Solids, cm ³	47.18
Wet Mass, g	168.97	Volume of Voids, cm ³	29.35
Dry Mass, g	131.17		

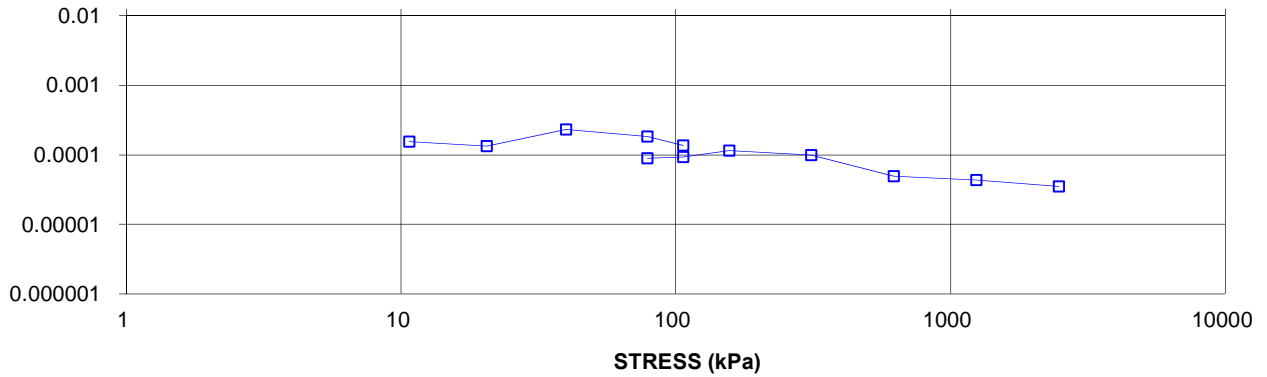
COEFFICIENT OF CONSOLIDATION,
cm²/s

CONSOLIDATION TEST
CV cm²/s VS STRESS (kPa)
BH EA SA 8



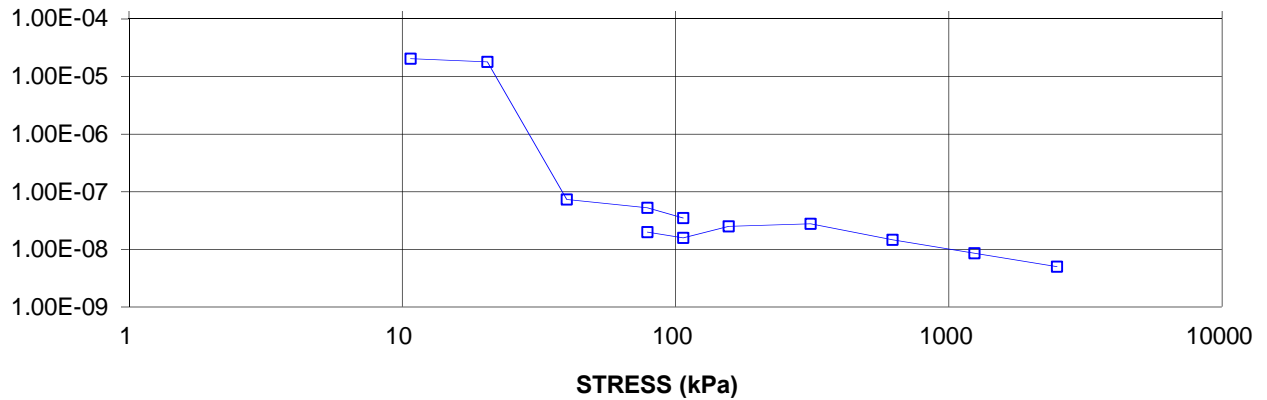
VOLUME COMPRESSIBILITY, m²/kN

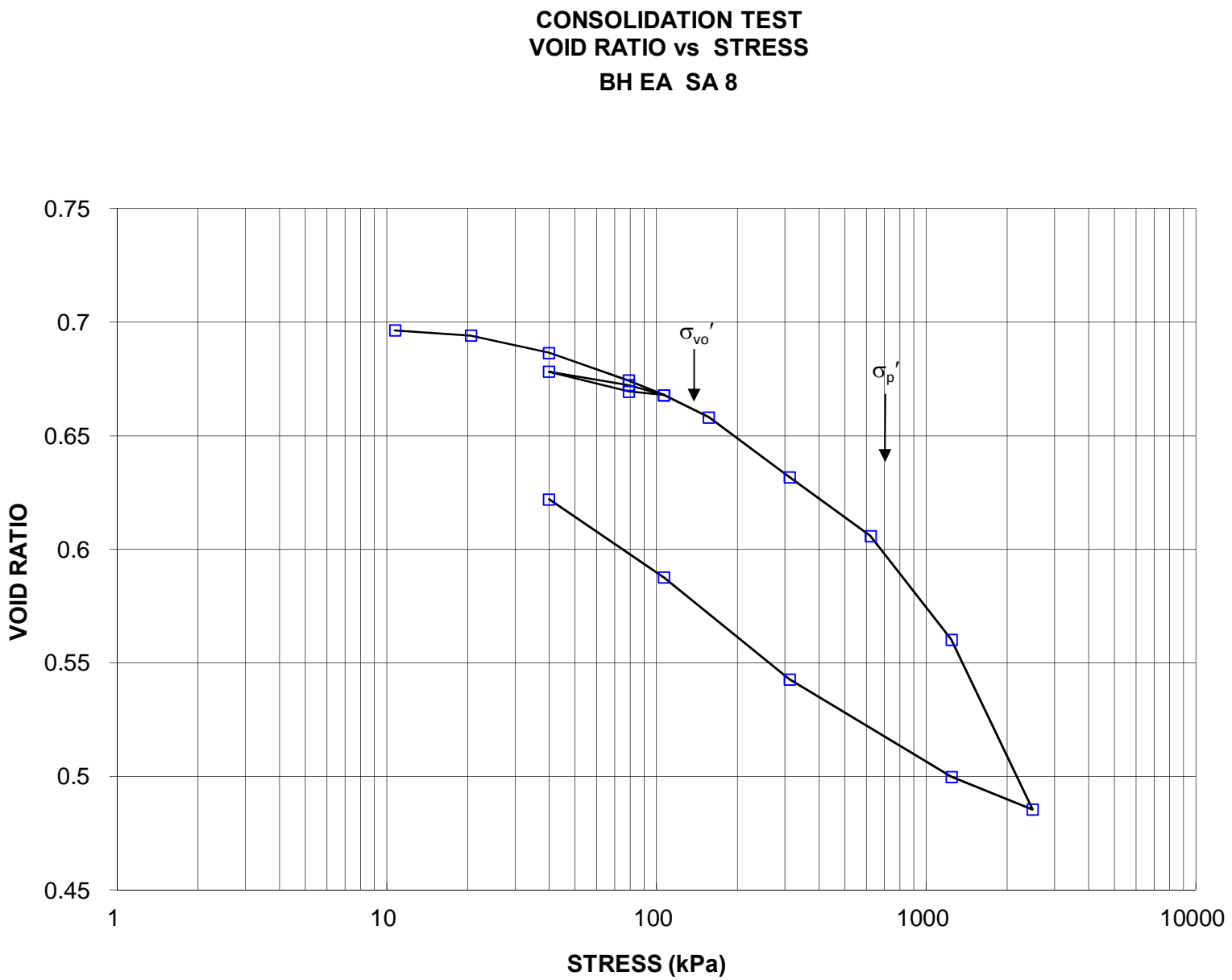
CONSOLIDATION TEST
MV m²/kN vs STRESS (kPa)
BH EA SA 8

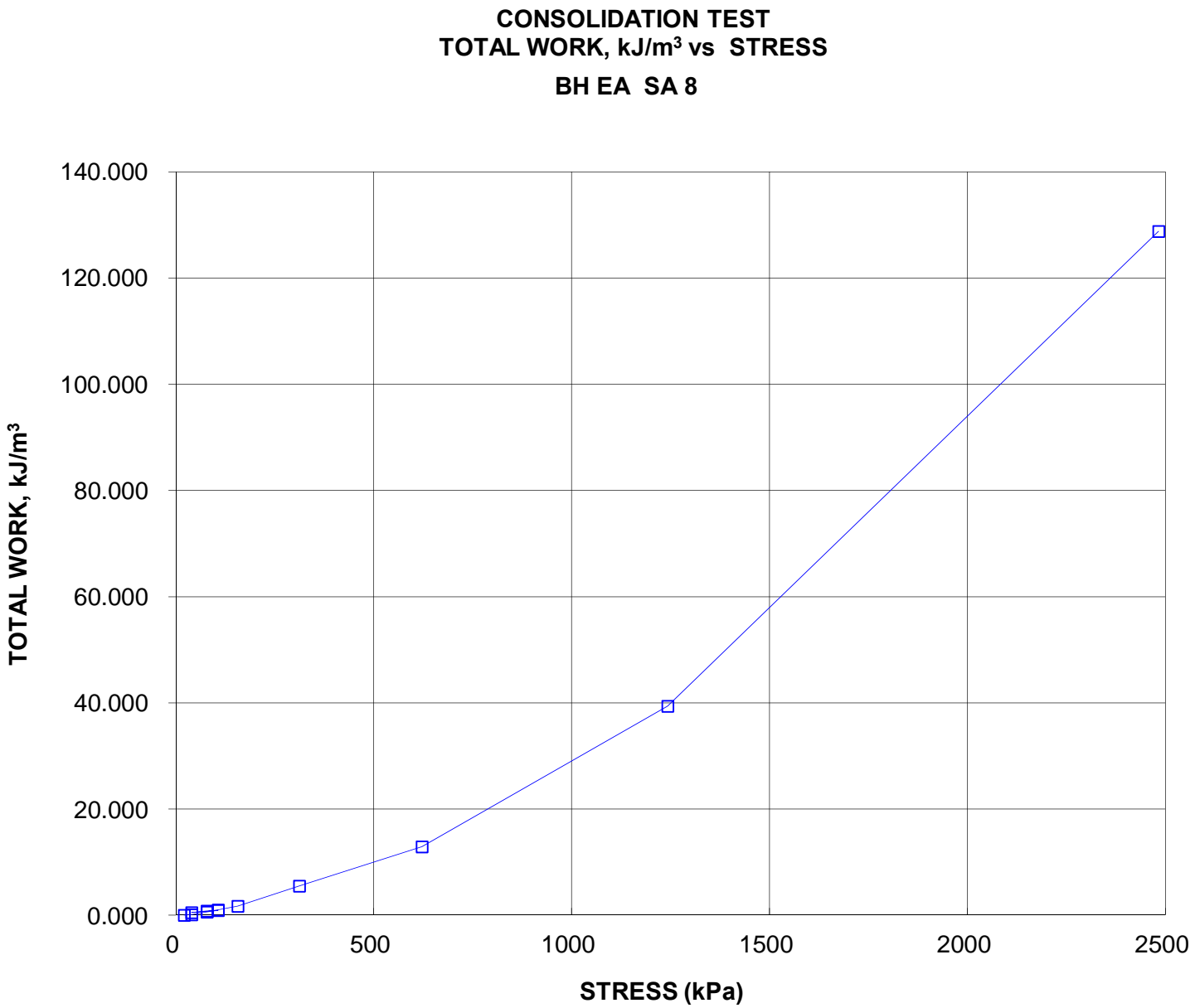


HYDRAULIC CONDUCTIVITY,
cm/s

CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs STRESS
BH EA SA 8







CONSOLIDATION TEST SUMMARY**FIGURE B3.8****ASTM D2435/D2435M****SAMPLE IDENTIFICATION**

Project Number	10-1111-0058	Sample Number	12
Borehole Number	EA	Sample Depth, m	12.20-12.80

TEST CONDITIONS

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	9		
Date Started	07/16/2015		
Date Completed	07/28/2015		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.90	Unit Weight, kN/m ³	19.37
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	14.76
Area, cm ²	31.55	Specific Gravity, measured	2.78
Volume, cm ³	60.04	Solids Height, cm	1.031
Water Content, %	31.18	Volume of Solids, cm ³	32.51
Wet Mass, g	118.57	Volume of Voids, cm ³	27.52
Dry Mass, g	90.39	Degree of Saturation, %	102.4

TEST COMPUTATIONS

Stress	Corr.		Average				
kPa	Height	Void	Height	t ₉₀	cv.	mv	k
	cm	Ratio	cm	sec	cm ² /s	m ² /kN	cm/s
0.00	1.903	0.847	1.903				
11.21	1.899	0.843	1.901				
21.15	1.898	0.841	1.899				
40.45	1.891	0.835	1.894	94	8.09E-03	1.88E-04	1.49E-07
79.46	1.874	0.818	1.882	346	2.17E-03	2.33E-04	4.96E-08
185.52	1.847	0.792	1.860	406	1.81E-03	1.33E-04	2.35E-08
79.46	1.863	0.807	1.855				
40.45	1.876	0.820	1.869				
79.39	1.867	0.811	1.871	427	1.74E-03	1.26E-04	2.14E-08
185.52	1.846	0.791	1.856	375	1.95E-03	1.03E-04	1.97E-08
310.95	1.827	0.773	1.836	228	3.14E-03	7.88E-05	2.42E-08
621.10	1.783	0.730	1.805	390	1.77E-03	7.42E-05	1.29E-08
1241.17	1.677	0.627	1.730	889	7.14E-04	8.98E-05	6.28E-09
2483.84	1.564	0.518	1.621	634	8.78E-04	4.77E-05	4.11E-09
621.10	1.602	0.555	1.583				
186.92	1.656	0.607	1.629				
40.45	1.736	0.684	1.696				
21.15	1.763	0.711	1.749				

Note:

Consolidation loading and unloading schedule assigned by the client.

Specimen swelled under 40.45kPa.

Specimen taken 5-13 cm from bottom of the tube

k calculated using cv based on $\dot{\epsilon}_0$ values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

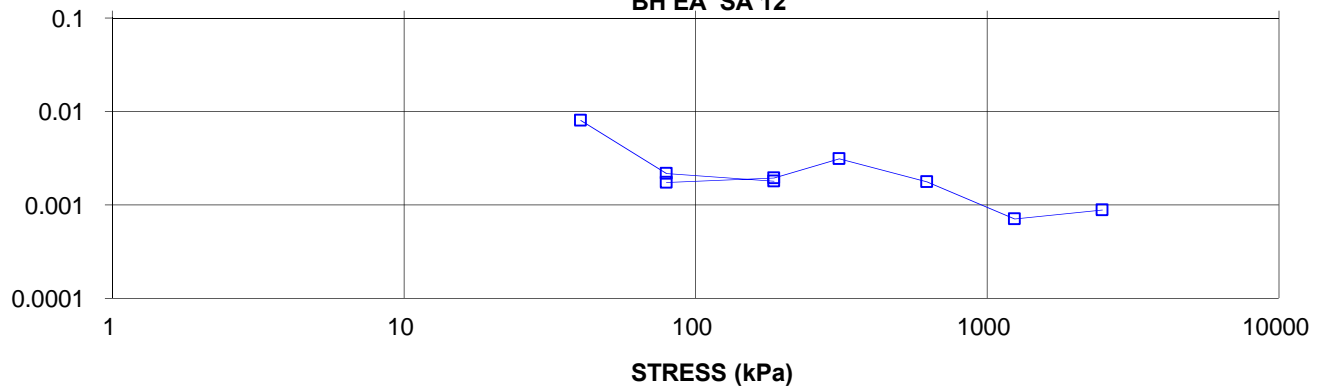
Sample Height, cm	1.76	Unit Weight, kN/m ³	20.39
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	15.94
Area, cm ²	31.55	Specific Gravity, measured	2.78
Volume, cm ³	55.62	Solids Height, cm	1.031
Water Content, %	27.95	Volume of Solids, cm ³	32.51
Wet Mass, g	115.65	Volume of Voids, cm ³	23.10
Dry Mass, g	90.39		

CONSOLIDATION TEST SUMMARY

FIGURE B3.8

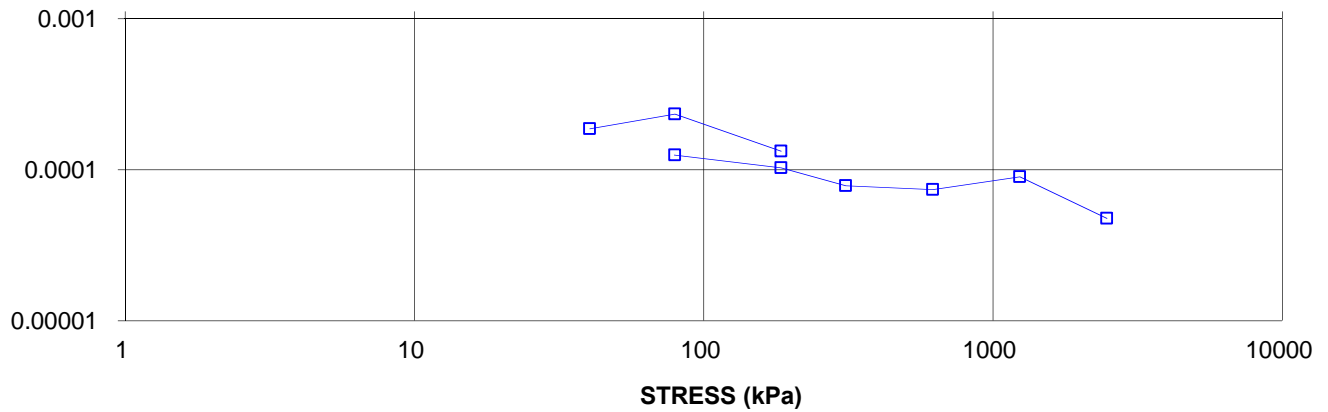
COEFFICIENT OF CONSOLIDATION,
cm²/s

CONSOLIDATION TEST
CV cm²/s VS STRESS (kPa)
BH EA SA 12



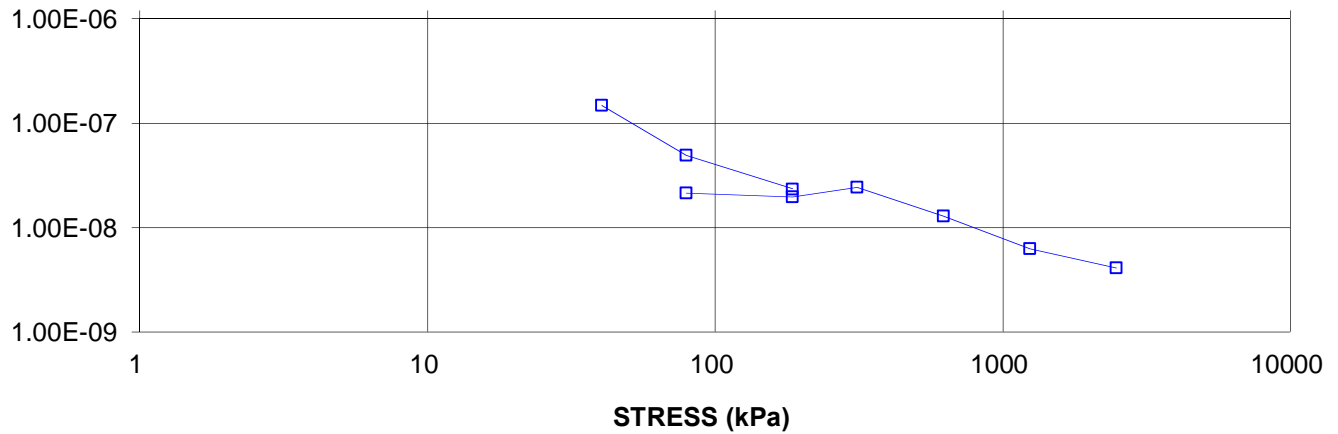
VOLUME COMPRESSIBILITY, m²/kN

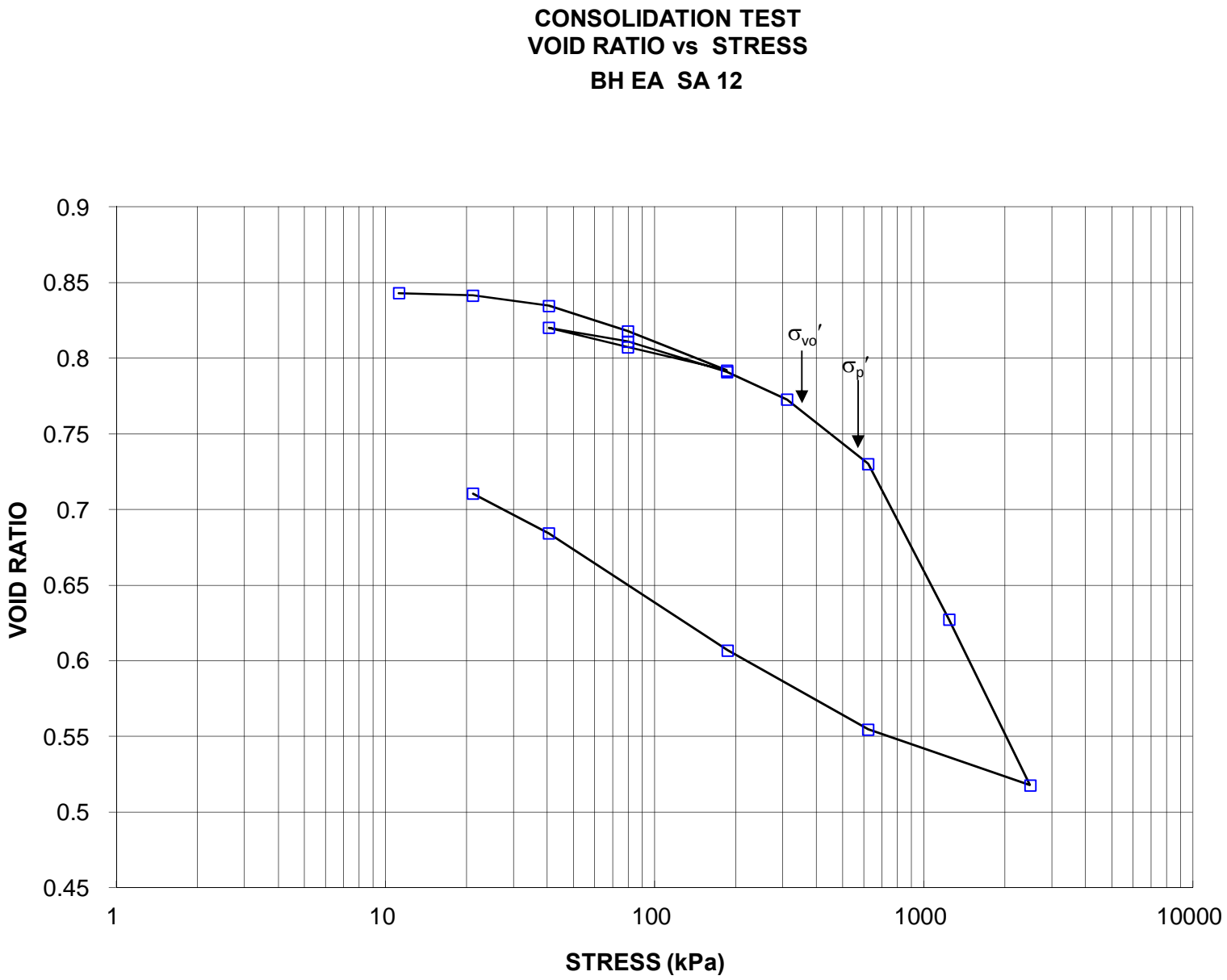
CONSOLIDATION TEST
MV m²/kN vs STRESS (kPa)
BH EA SA 12

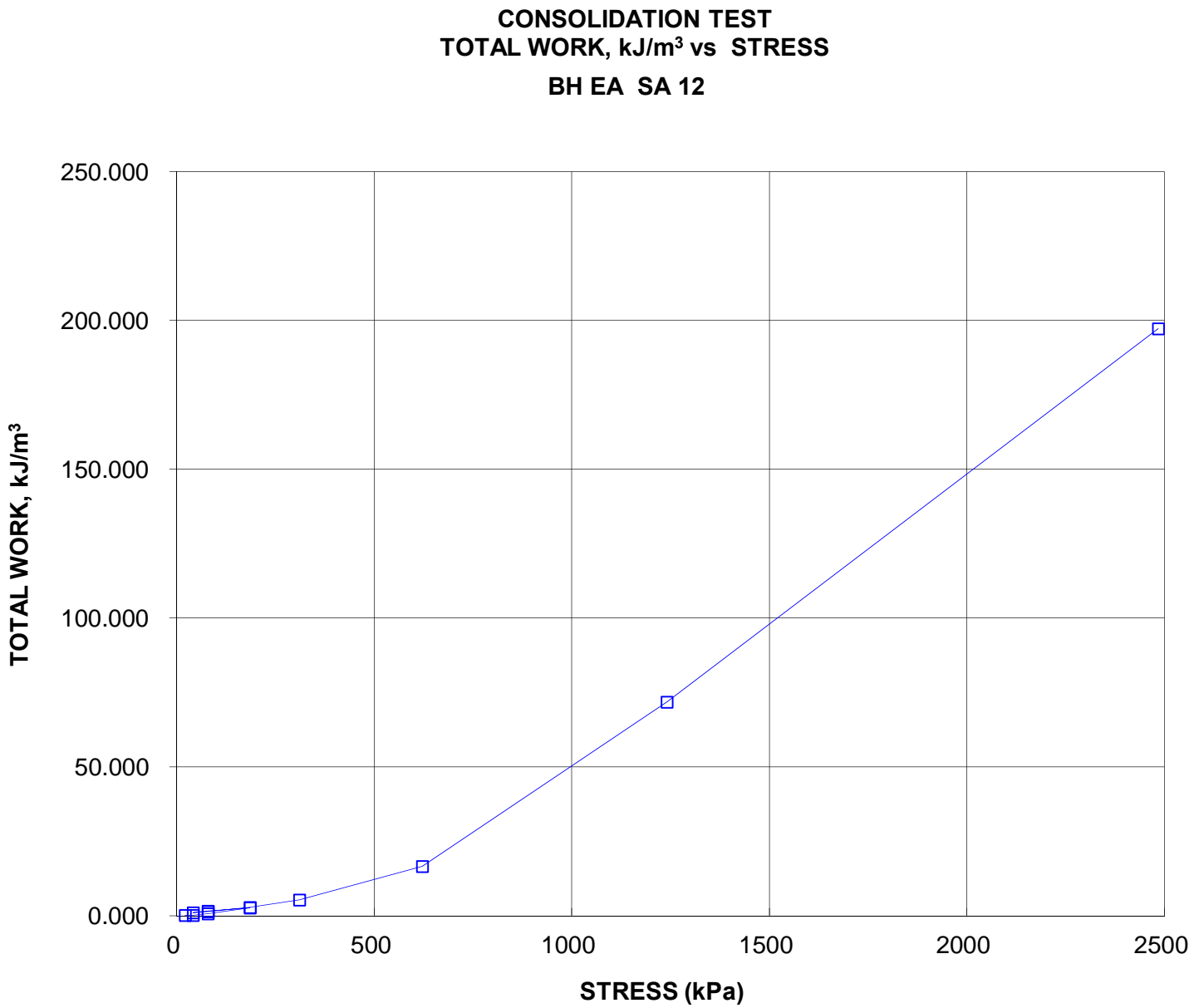


HYDRAULIC CONDUCTIVITY,
cm/s

CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs STRESS
BH EA SA 12







CONSOLIDATION TEST SUMMARY**FIGURE B3.9****ASTM D2435/D2435M****SAMPLE IDENTIFICATION**

Project Number	10-1111-0058	Sample Number	10
Borehole Number	EAPP	Sample Depth, m	9.15-9.76

TEST CONDITIONS

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	4		
Date Started	07/16/2015		
Date Completed	07/29/2015		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	2.54	Unit Weight, kN/m ³	20.02
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	15.81
Area, cm ²	31.60	Specific Gravity, measured	2.78
Volume, cm ³	80.20	Solids Height, cm	1.472
Water Content, %	26.61	Volume of Solids, cm ³	46.51
Wet Mass, g	163.72	Volume of Voids, cm ³	33.68
Dry Mass, g	129.31	Degree of Saturation, %	102.2

TEST COMPUTATIONS

Stress	Corr. Height	Void	Average Height	t ₉₀	cv.	mv	k
kPa	cm	Ratio	cm	sec	cm ² /s	m ² /kN	cm/s
0.00	2.538	0.724	2.538				
10.97	2.538	0.724	2.538				
20.74	2.537	0.724	2.538				
40.18	2.532	0.720	2.535	46	2.96E-02	1.03E-04	3.00E-07
78.97	2.514	0.708	2.523	211	6.40E-03	1.87E-04	1.17E-07
144.79	2.497	0.696	2.505	317	4.20E-03	1.02E-04	4.21E-08
78.97	2.504	0.701	2.500				
40.18	2.517	0.710	2.510				
79.08	2.509	0.704	2.513	329	4.07E-03	7.90E-05	3.15E-08
144.92	2.497	0.696	2.503	375	3.54E-03	7.24E-05	2.51E-08
291.58	2.471	0.678	2.484	290	4.51E-03	6.99E-05	3.09E-08
601.28	2.432	0.652	2.452	240	5.31E-03	4.86E-05	2.53E-08
1220.82	2.365	0.607	2.399	437	2.79E-03	4.27E-05	1.17E-08
2460.67	2.231	0.515	2.298	540	2.07E-03	4.27E-05	8.68E-09
601.28	2.274	0.545	2.252				
144.86	2.349	0.596	2.311				
40.18	2.417	0.642	2.383				
20.74	2.475	0.681	2.446				

Note:

Consolidation loading and unloading schedule assigned by the client.

Specimen swelled under 40.18kPa.

Specimen taken 37-47 cm from bottom of the tube

k calculated using cv based on $\bar{\sigma}_0$ values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

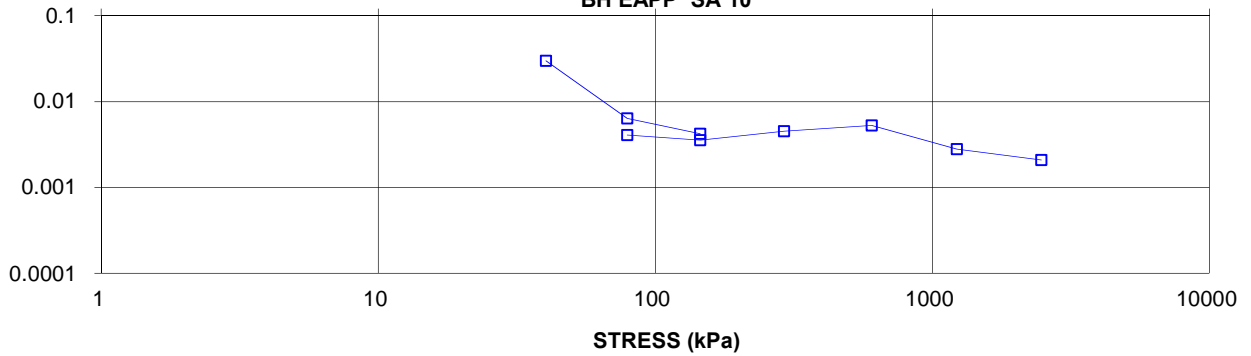
Sample Height, cm	2.47	Unit Weight, kN/m ³	20.89
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	16.22
Area, cm ²	31.60	Specific Gravity, measured	2.78
Volume, cm ³	78.20	Solids Height, cm	1.472
Water Content, %	28.85	Volume of Solids, cm ³	46.51
Wet Mass, g	166.61	Volume of Voids, cm ³	31.68
Dry Mass, g	129.31		

CONSOLIDATION TEST SUMMARY

FIGURE B3.9

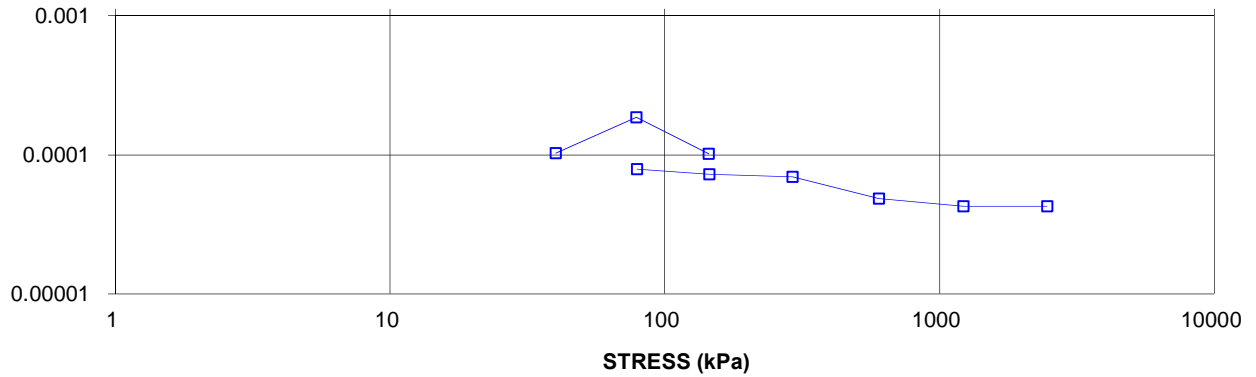
COEFFICIENT OF CONSOLIDATION,
cm²/s

CONSOLIDATION TEST
CV cm²/s VS STRESS (kPa)
BH EAPP SA 10



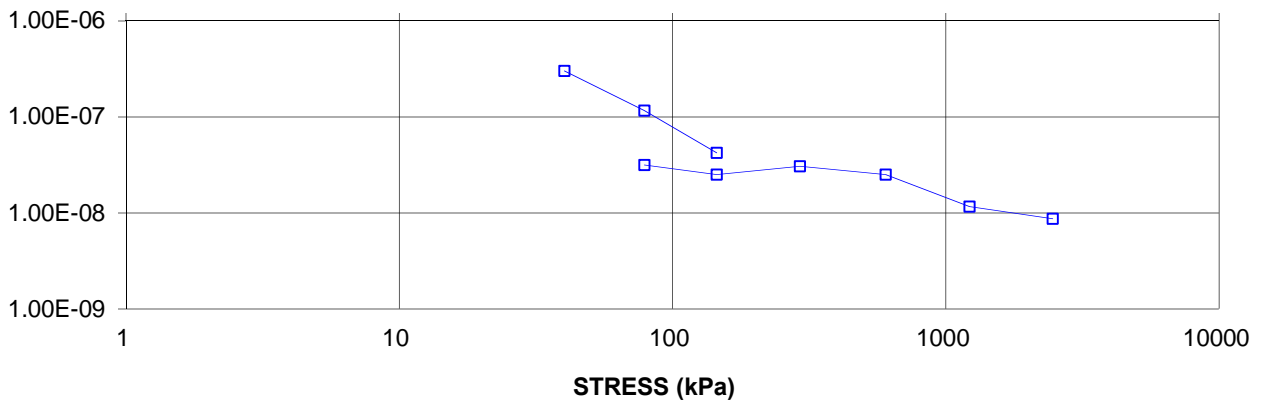
VOLUME COMPRESSIBILITY, m²/kN

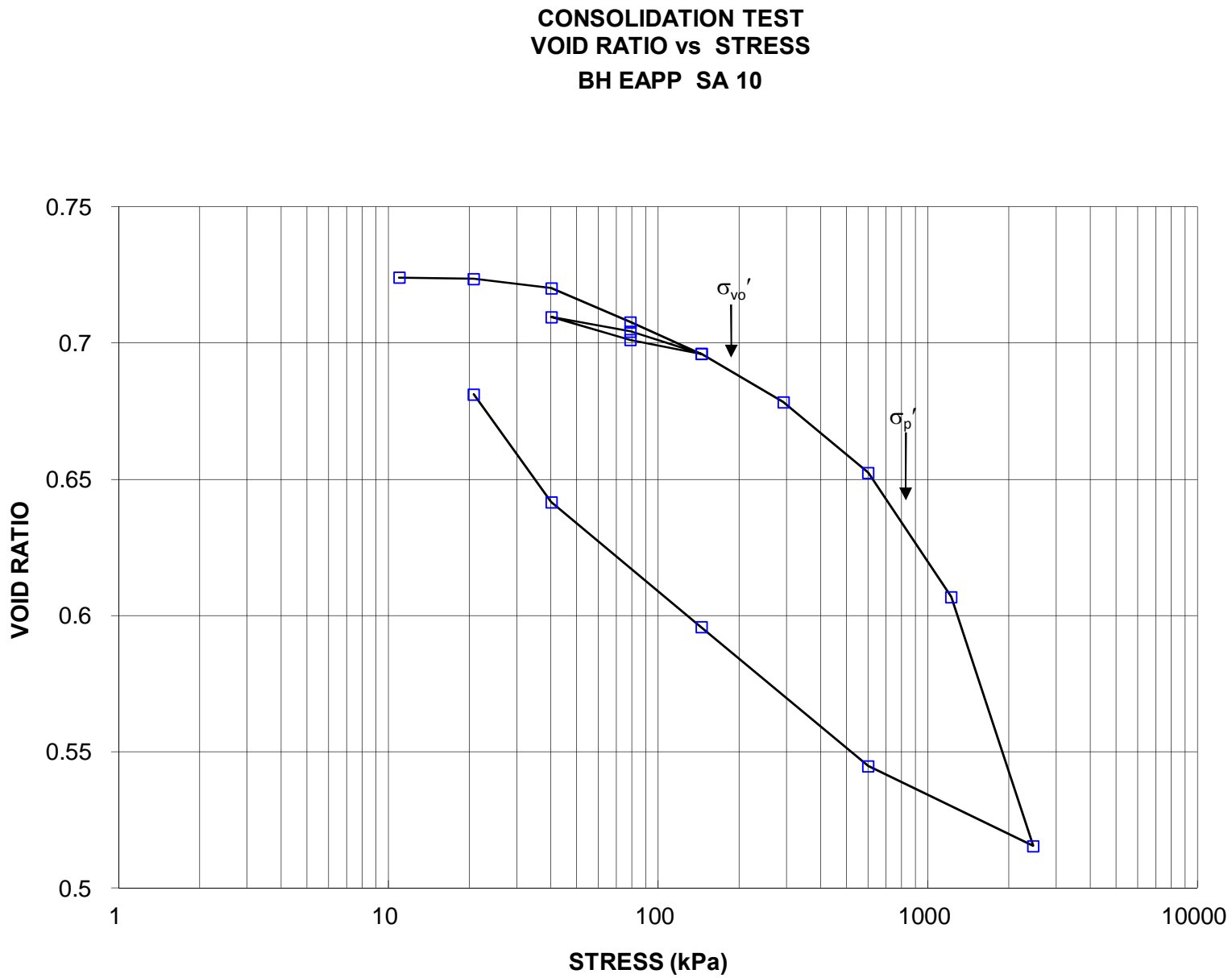
CONSOLIDATION TEST
MV m²/kN vs STRESS (kPa)
BH EAPP SA 10

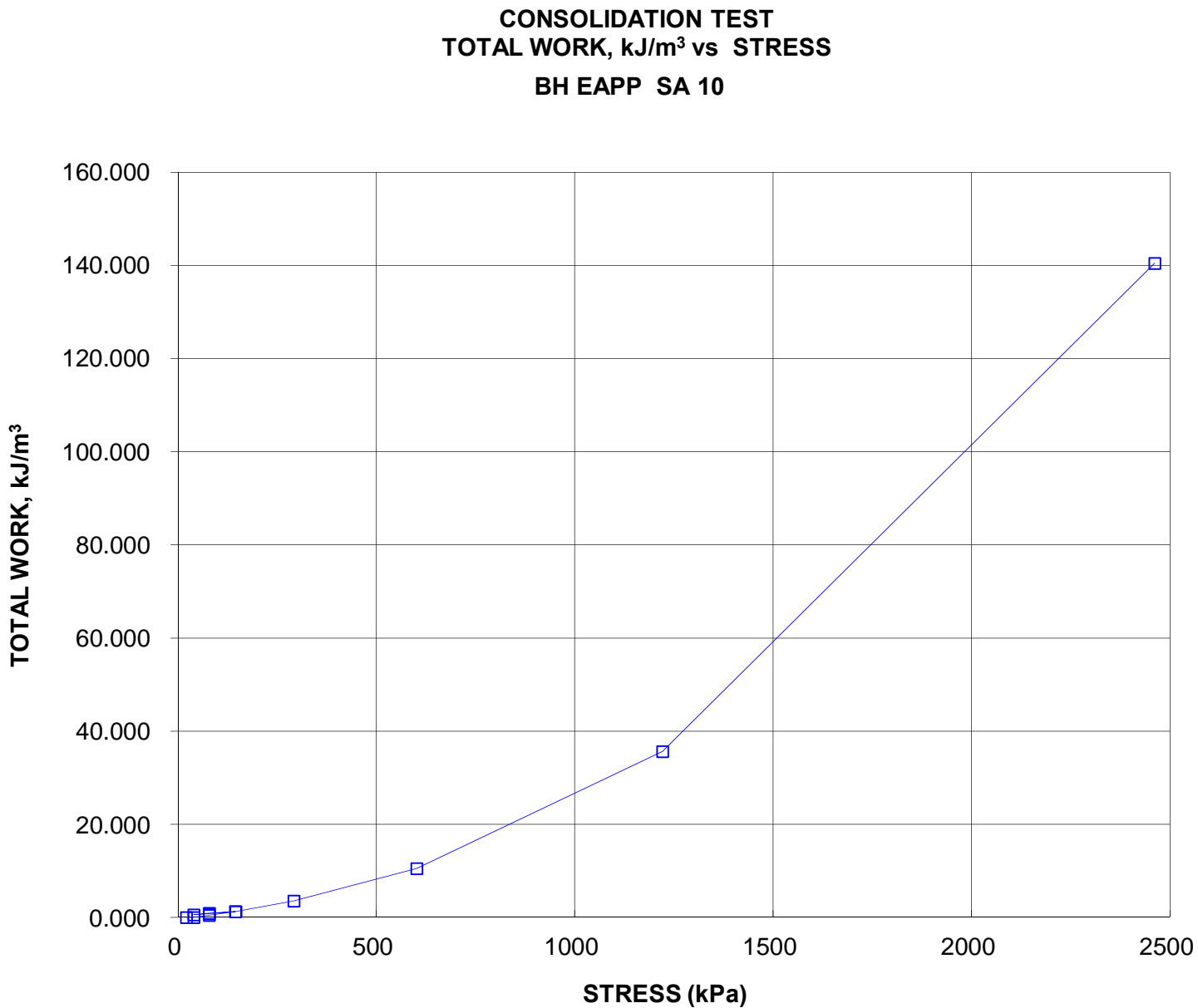


HYDRAULIC CONDUCTIVITY,
cm/s

CONSOLIDATION TEST
HYDRAULIC CONDUCTIVITY vs STRESS
BH EAPP SA 10







Golder Associates

CONSOLIDATION TEST SUMMARY**FIGURE B3.10****ASTM D2435/D2435M****SAMPLE IDENTIFICATION**

Project Number	10-1111-0058	Sample Number	15
Borehole Number	EAPP	Sample Depth, m	16.77-17.38

TEST CONDITIONS

Test Type	Laboratory Standard	Load Duration, hr	24
Oedometer Number	6		
Date Started	07/16/2015		
Date Completed	07/30/2015		

SAMPLE DIMENSIONS AND PROPERTIES - INITIAL

Sample Height, cm	1.89	Unit Weight, kN/m ³	18.26
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	12.98
Area, cm ²	31.61	Specific Gravity, measured	2.79
Volume, cm ³	59.80	Solids Height, cm	0.898
Water Content, %	40.66	Volume of Solids, cm ³	28.38
Wet Mass, g	111.36	Volume of Voids, cm ³	31.43
Dry Mass, g	79.17	Degree of Saturation, %	102.4

TEST COMPUTATIONS

Stress	Corr. Height	Void	Average Height	t ₉₀	cv.	mv	k
kPa	cm	Ratio	cm	sec	cm ² /s	m ² /kN	cm/s
0.00	1.892	1.108	1.892				
10.65	1.888	1.103	1.890				
20.42	1.886	1.101	1.887				
39.86	1.879	1.093	1.883	167	4.50E-03	1.88E-04	8.27E-08
78.64	1.859	1.070	1.869	487	1.52E-03	2.79E-04	4.16E-08
156.08	1.831	1.039	1.845	406	1.78E-03	1.91E-04	3.33E-08
244.00	1.808	1.013	1.819	505	1.39E-03	1.39E-04	1.90E-08
78.13	1.833	1.042	1.820				
39.86	1.850	1.060	1.841				
156.08	1.820	1.027	1.835	360	1.98E-03	1.36E-04	2.65E-08
242.63	1.806	1.011	1.813	437	1.59E-03	8.67E-05	1.35E-08
313.11	1.791	0.996	1.798	421	1.63E-03	1.06E-04	1.69E-08
622.70	1.721	0.918	1.756	454	1.44E-03	1.20E-04	1.69E-08
1242.79	1.590	0.771	1.656	844	6.89E-04	1.12E-04	7.54E-09
2508.60	1.467	0.635	1.529	807	6.14E-04	5.13E-05	3.09E-09
622.70	1.522	0.695	1.494				
242.63	1.571	0.750	1.546				
78.13	1.639	0.826	1.605				
20.42	1.715	0.911	1.677				

Note:

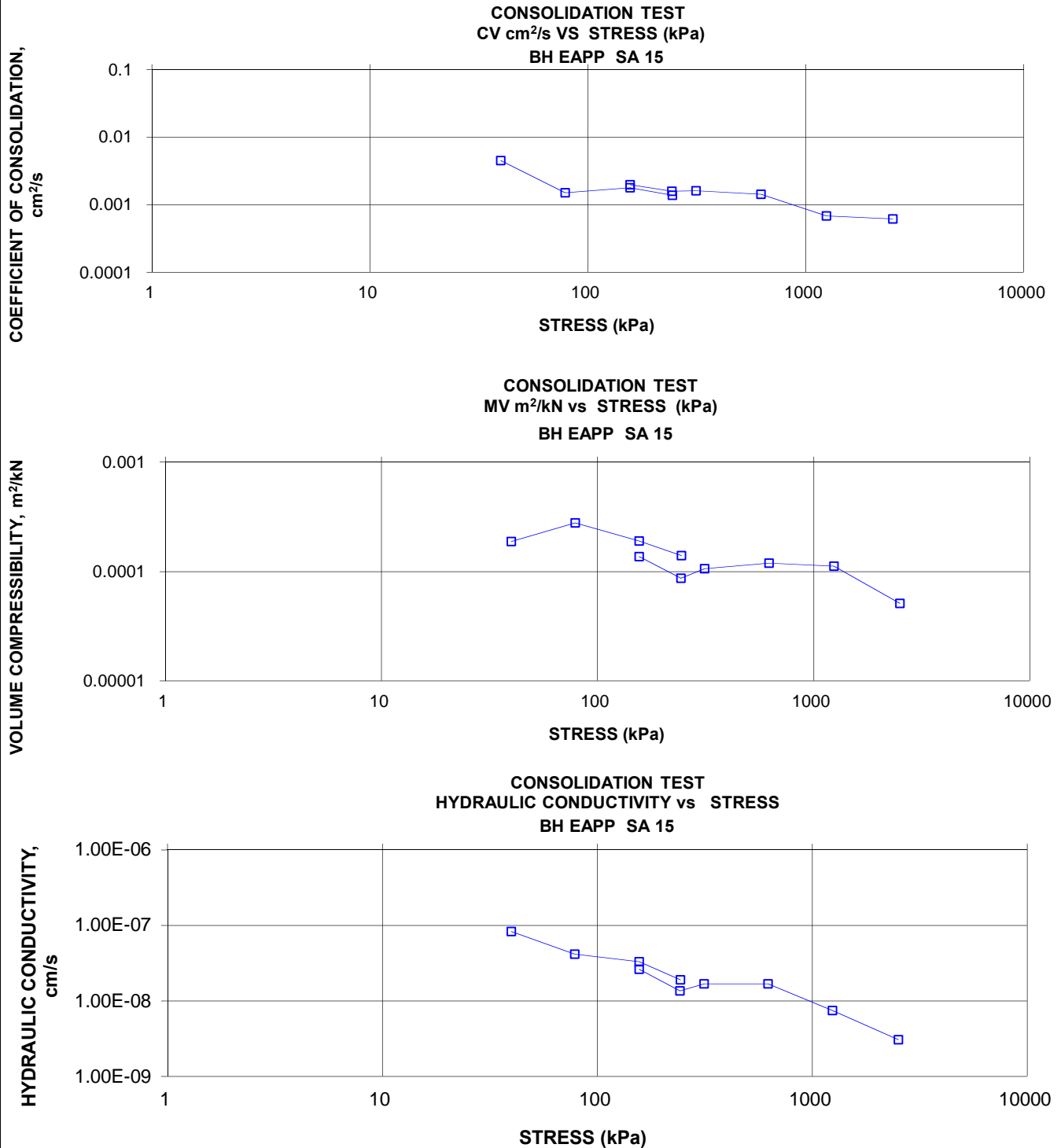
Consolidation loading and unloading schedule assigned by the client.

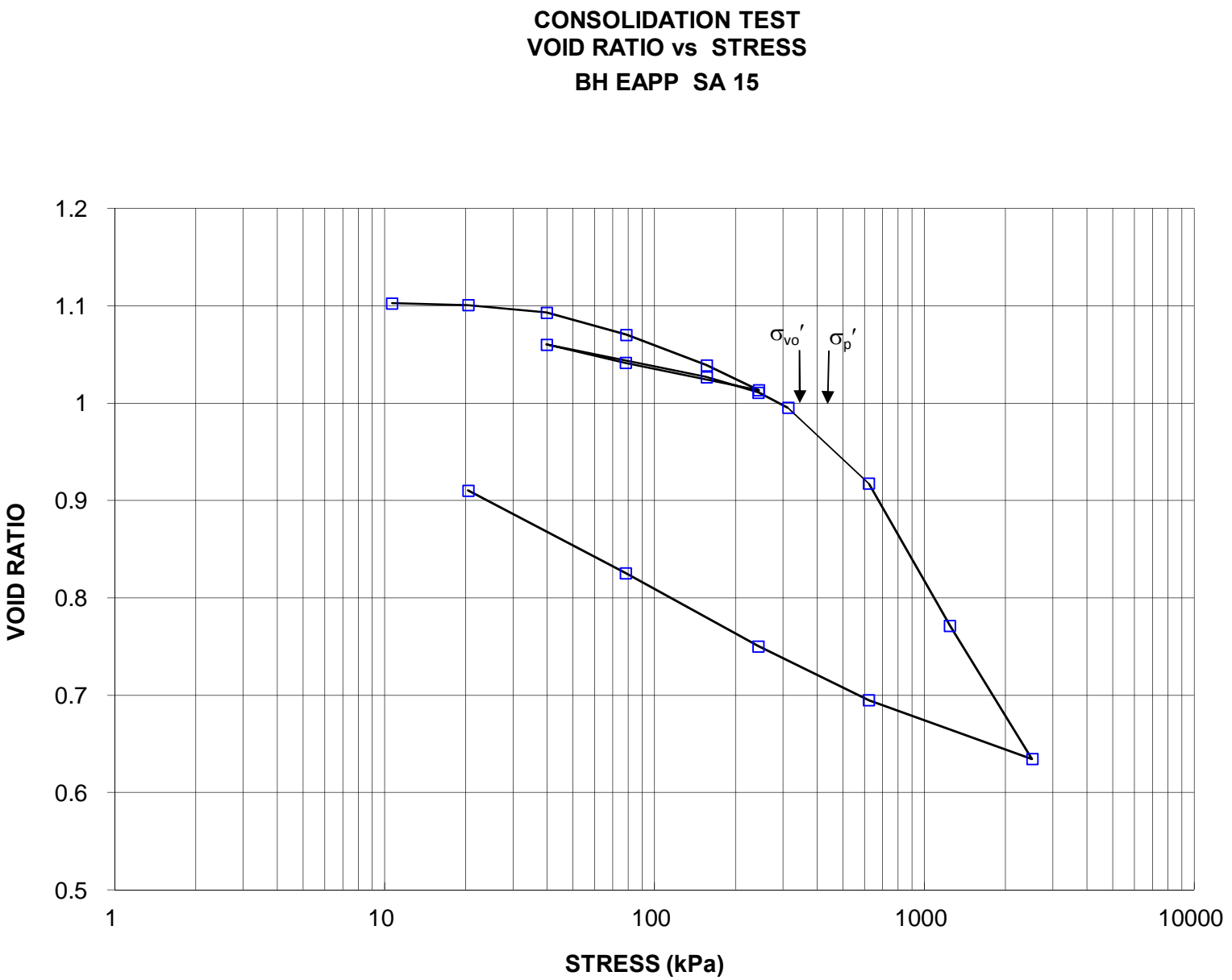
Specimen swelled under 20.42kPa.

Specimen taken 5-12 cm from bottom of the tube

k calculated using cv based on t₉₀ values.**SAMPLE DIMENSIONS AND PROPERTIES - FINAL**

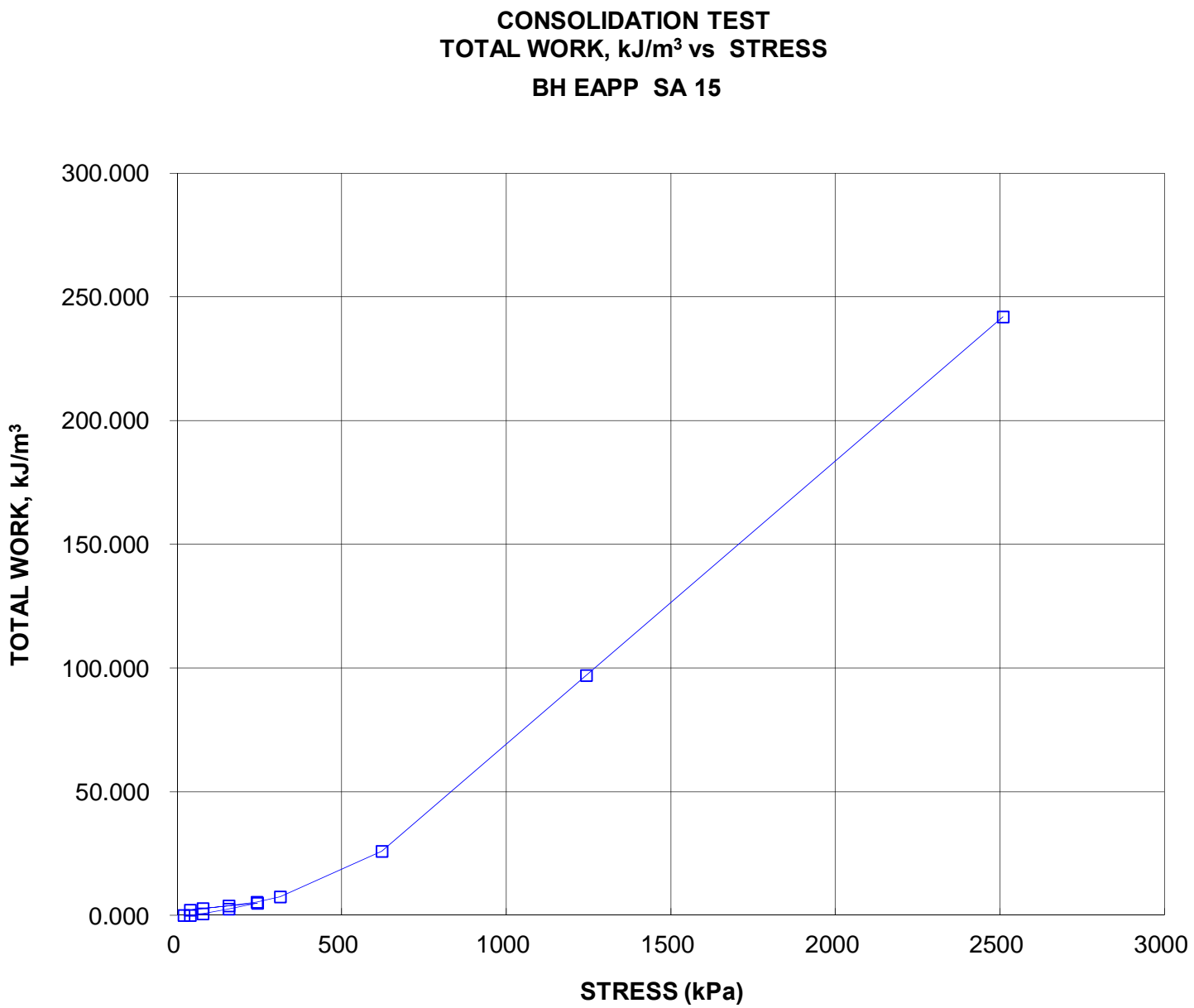
Sample Height, cm	1.72	Unit Weight, kN/m ³	19.35
Sample Diameter, cm	6.34	Dry Unit Weight, kN/m ³	14.32
Area, cm ²	31.61	Specific Gravity, measured	2.79
Volume, cm ³	54.21	Solids Height, cm	0.898
Water Content, %	35.13	Volume of Solids, cm ³	28.38
Wet Mass, g	106.98	Volume of Voids, cm ³	25.84
Dry Mass, g	79.17		





**CONSOLIDATION TEST
TOTAL WORK VS STRESS**

FIGURE B3.10



Project No. 10-1111-0058

Prepared By: LH

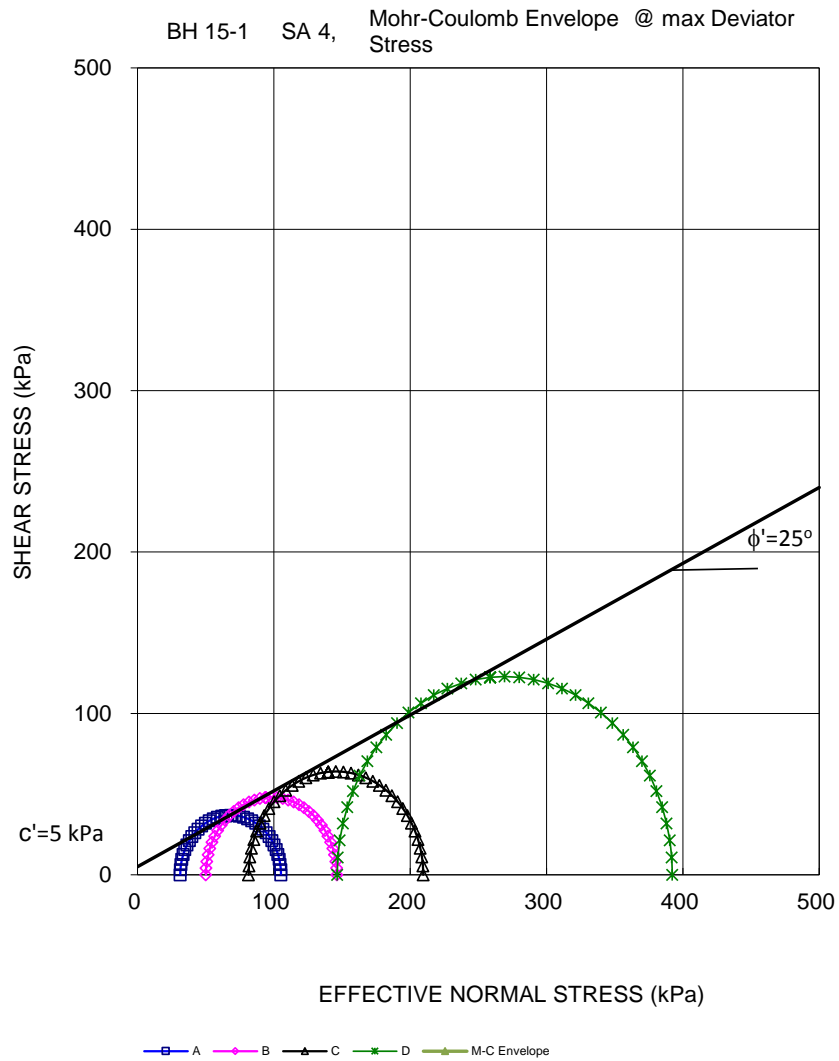
Golder Associates

Checked By: DAM

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS SHEET 1 OF 4			FIGURE B4.1	
TEST STAGE	A	B	C	D
BOREHOLE NUMBER	15-1			
SAMPLE	4		5	
DEPTH, m	2.29-2.89		3.05-3.65	
SPECIMEN DIAMETER, cm	4.99	5.01	4.99	5.0
SPECIMEN HEIGHT, cm	10.13	10.15	10.11	10.1
NATURAL WATER CONTENT, %	33.5	34.1	33.4	31.2
DRY DENSITY, Mg/m ³	1.45	1.43	1.46	1.50
WATER CONTENT AFTER SATURATION, %	33.4	33.2	35.0	31.9
CELL PRESSURE, σ_3 , kPa	375.0	475.0	325.0	515.0
BACK PRESSURE, kPa	345.0	415.0	205.0	275.0
PORE PRESSURE PARAMETER "B"	0.97	0.99	0.97	1.0
EFFECTIVE CONSOLIDATION STRESS, σ_c , kPa	30.0	60.0	120.0	240.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	1.5	3.9	5.6	7.2
WATER CONTENT AFTER CONSOLIDATION, %	32.5	31.3	31.1	27.1
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5	0.5
TIME TO FAILURE, HOURS	12.4	11.7	11.5	20.1
WATER CONTENT AFTER TEST, %	32.4	31.2	29.9	26.8
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$, kPa	73.9	96.1	128.1	245.8
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ maximum, %	6.2	5.8	5.8	10.1
MAX EFFECTIVE PRINCIPAL STRESS RATIO, (σ'_1 / σ'_3) maximum	3.6	3.0	2.6	2.7
DEVIATOR STRESS AT (σ'_1 / σ'_3) maximum, kPa	60.6	94.4	128.1	244.1
AXIAL STRAIN AT (σ'_1 / σ'_3) maximum, %	3.6	5.0	5.8	8.7
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ maximum	-0.02	0.10	0.30	0.38
PORE PRESSURE PARAMETER, Af, AT (σ'_1 / σ'_3) maximum	0.11	0.13	0.30	0.39
FILTER DRAINS USED, y/n	y	y	y	y
TEST NOTES: Effective consolidation stresses are assigned by the client. Specimen A taken 19-32 cm from bottom of tube. Specimen B taken 6-19 cm from bottom of tube. Specimen C taken 19-32 cm from bottom of tube. Specimen D taken 7-19 cm from bottom of tube.				
FAILURE PLANE NUMBER	1.0	1.0	1.0	1.0
ANGLE OF FAILURE PLANE, DEGREES	50.0	60.0	55.0	60.0
Date: 4/9/2015 Project No. 10-1111-0058 Golder Associates Prepared By: RD Checked By: MM/ JPD				

**CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 2a OF 4**

FIGURE B4.1



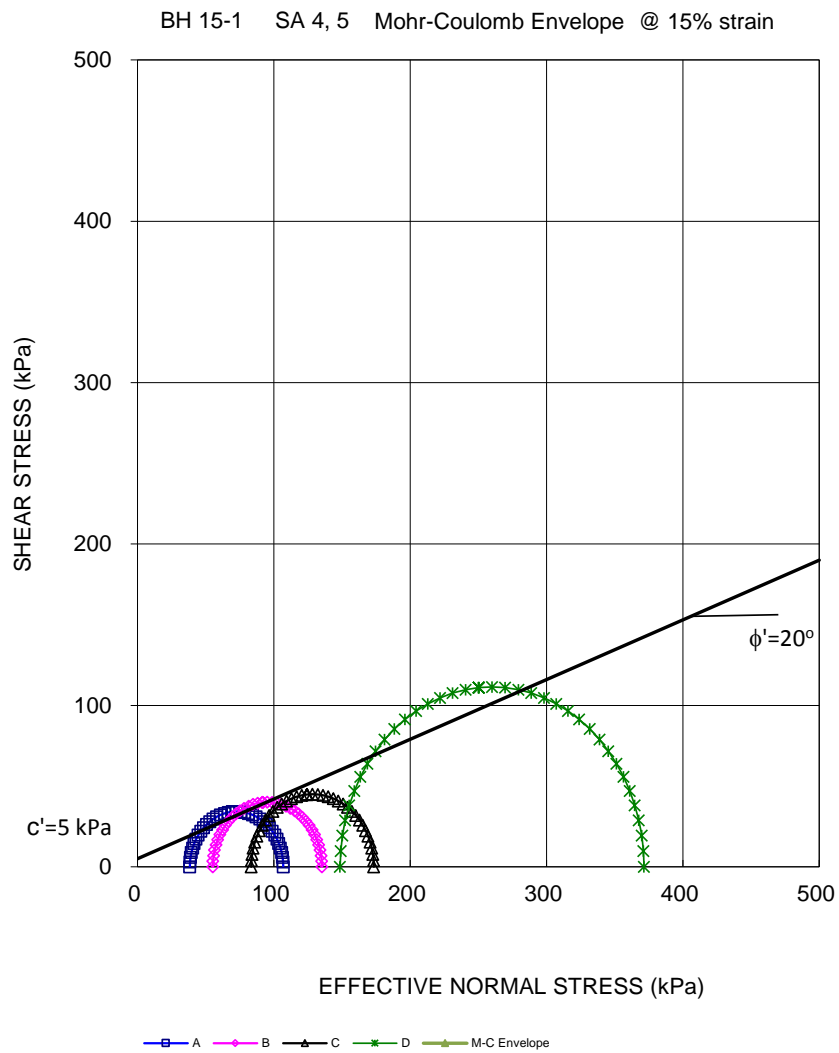
Date: 4/9/2015
Project No. 10-1111-0058

Golder Associates

Prepared By: RD
Checked By: MM / JPD

**CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 2b OF 4**

FIGURE B4.1



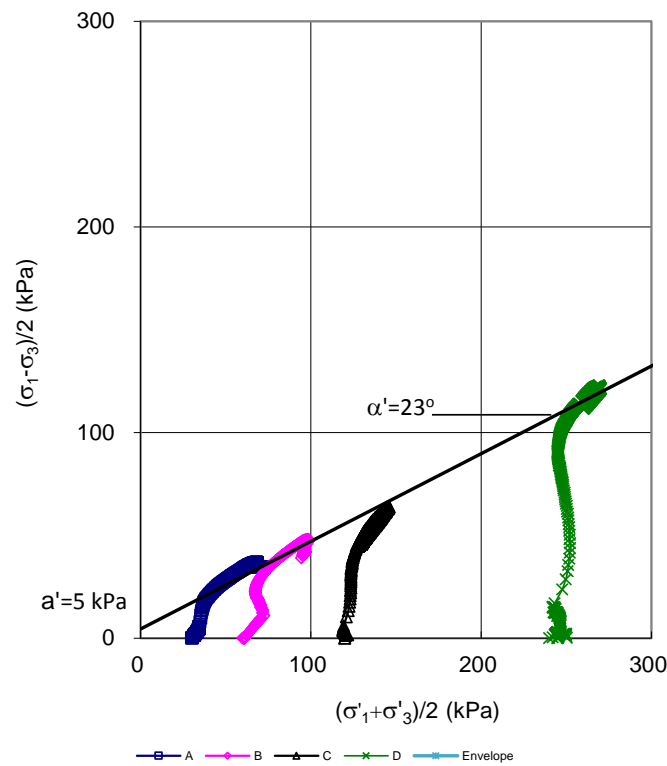
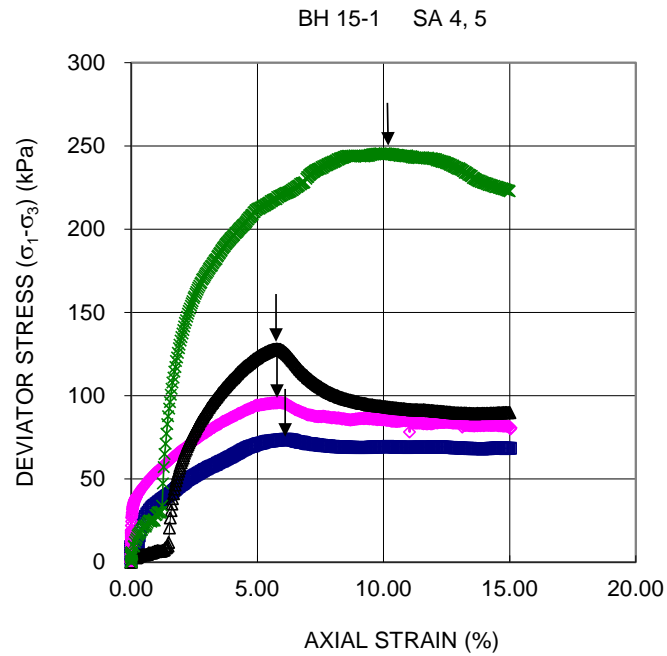
Date: 4/9/2015
Project No. 10-1111-0058

Golder Associates

Prepared By: RD
Checked By: MM / JPD

**CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 3 OF 4**

FIGURE B4.1



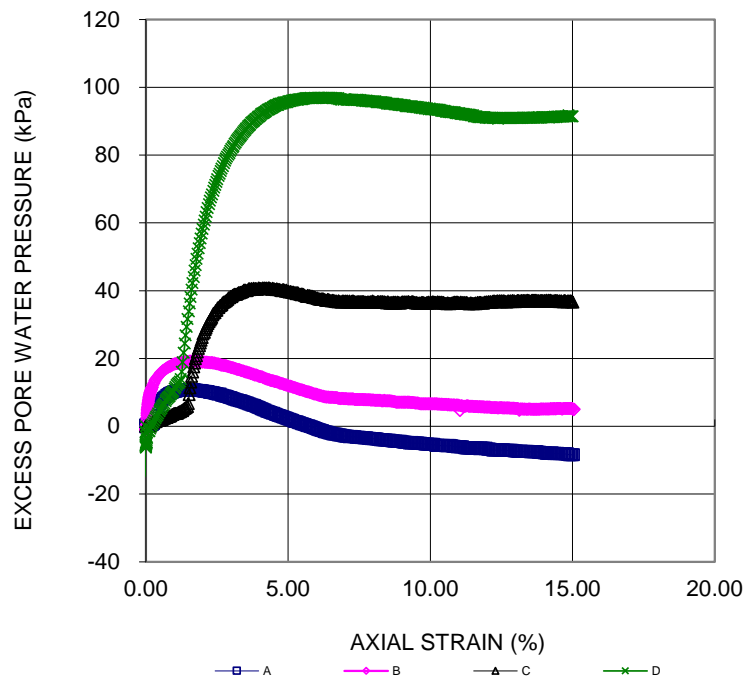
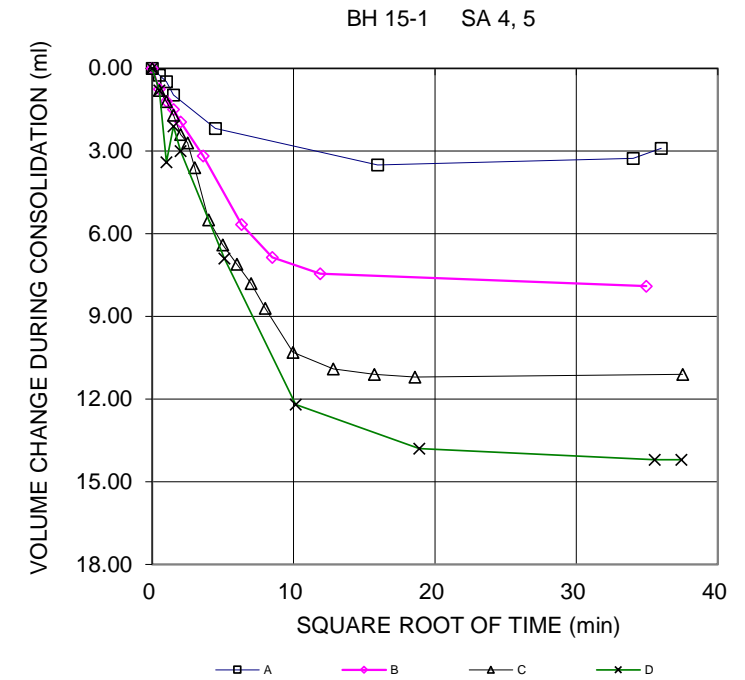
Date: 4/9/2015
Project No. 10-1111-0058

Golder Associates

Prepared By: RD
Checked By: MM / JPD

**CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 4 OF 4**

FIGURE B4.1



Date: 4/9/2015
Project No. 10-1111-0058

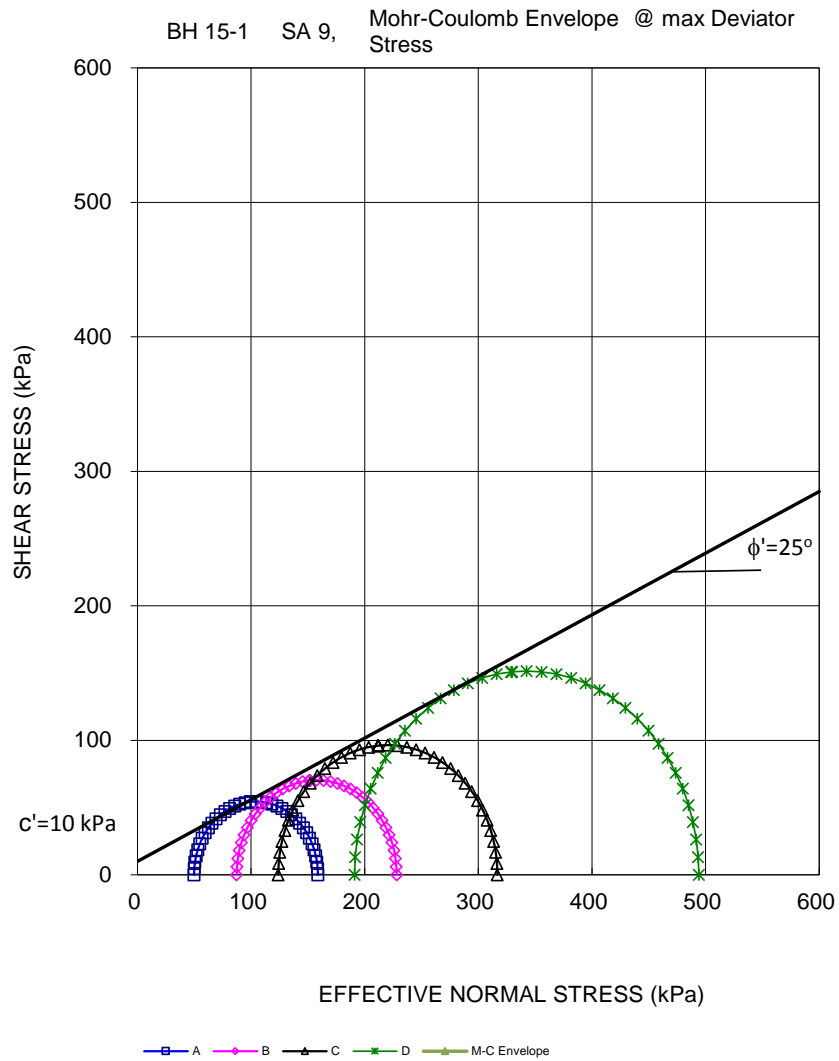
Golder Associates

Prepared By: RD
Checked By: MM / JPD

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS SHEET 1 OF 4			FIGURE B4.2	
TEST STAGE	A	B	C	D
BOREHOLE NUMBER	15-1			
SAMPLE	9		10	
DEPTH, m	9.15-9.75		9.91-10.51	
SPECIMEN DIAMETER, cm	5.05	5.07	5.03	5.0
SPECIMEN HEIGHT, cm	10.45	10.19	10.41	10.4
NATURAL WATER CONTENT, %	23.6	23.3	32.2	29.5
DRY DENSITY, Mg/m ³	1.68	1.71	1.47	1.52
WATER CONTENT AFTER SATURATION, %	24.5	23.8	32.8	29.8
CELL PRESSURE, σ_3 , kPa	250.0	225.0	315.0	425.0
BACK PRESSURE, kPa	205.0	135.0	135.0	65.0
PORE PRESSURE PARAMETER "B"	0.96	0.97	0.96	1.0
EFFECTIVE CONSOLIDATION STRESS, σ_c , kPa	45.0	90.0	180.0	360.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	1.9	3.3	5.4	8.0
WATER CONTENT AFTER CONSOLIDATION, %	23.3	21.9	29.2	24.6
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5	0.5
TIME TO FAILURE, HOURS	16.9	19.8	11.2	10.2
WATER CONTENT AFTER TEST, %	23.2	21.7	29.7	25.0
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$, kPa	109.0	140.9	192.8	303.0
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ maximum, %	8.5	9.9	5.6	5.1
MAX EFFECTIVE PRINCIPAL STRESS RATIO, (σ'_1 / σ'_3) maximum	3.2	2.6	2.6	2.8
DEVIATOR STRESS AT (σ'_1 / σ'_3) maximum, kPa	108.5	133.9	186.6	283.2
AXIAL STRAIN AT (σ'_1 / σ'_3) maximum, %	6.2	4.6	9.1	10.3
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ maximum	-0.04	0.02	0.29	0.56
PORE PRESSURE PARAMETER, Af, AT (σ'_1 / σ'_3) maximum	-0.04	0.06	0.33	0.70
FILTER DRAINS USED, y/n	y	y	y	y
TEST NOTES: Effective consolidation stresses are assigned by the client. Specimen A taken 19-33 cm from bottom of tube. Specimen B taken 7-19 cm from bottom of tube. Specimen C taken 18-31 cm from bottom of tube. Specimen D taken 6-18 cm from bottom of tube.				
FAILURE PLANE NUMBER	1.0	1.0	1.0	1.0
ANGLE OF FAILURE PLANE, DEGREES	55.0	50.0	50.0	50.0
Date: 5/29/2015 Project No. 10-1111-0058 Golder Associates Prepared By: RD Checked By: MM / JPD				

**CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 2a OF 4**

FIGURE B4.2



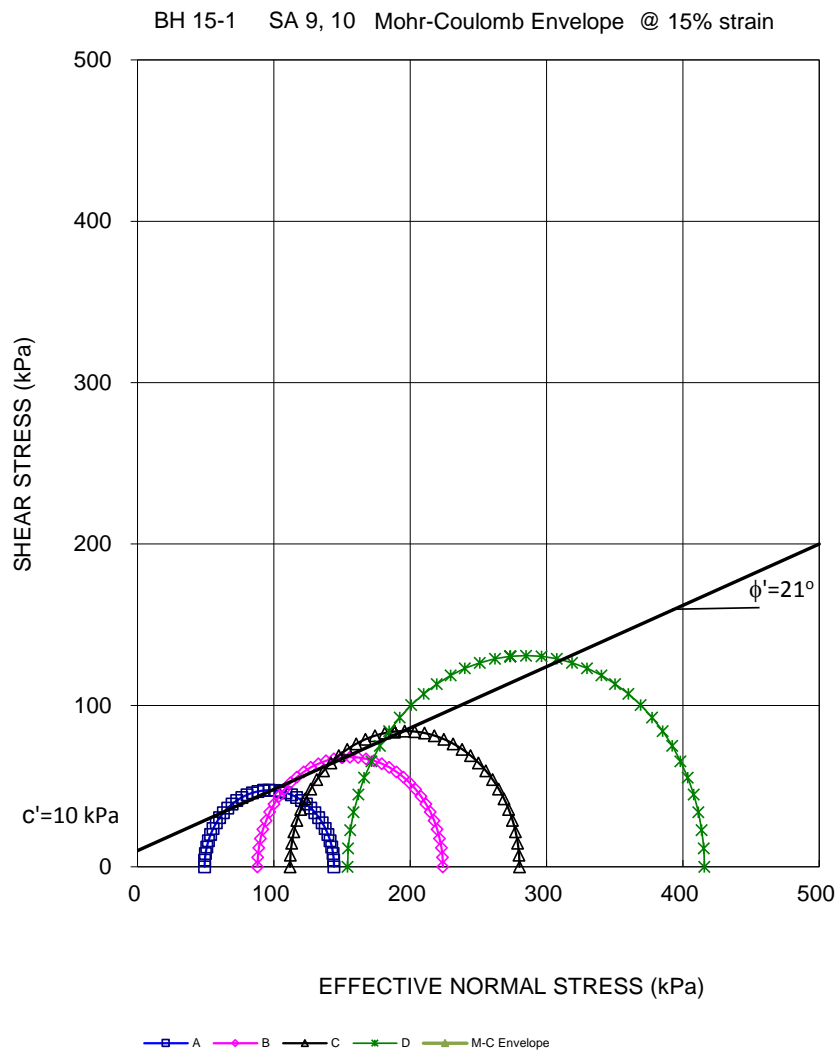
Date: 5/29/2015
Project No. 10-1111-0058

Golder Associates

Prepared By: RD
Checked By: MM / JPD

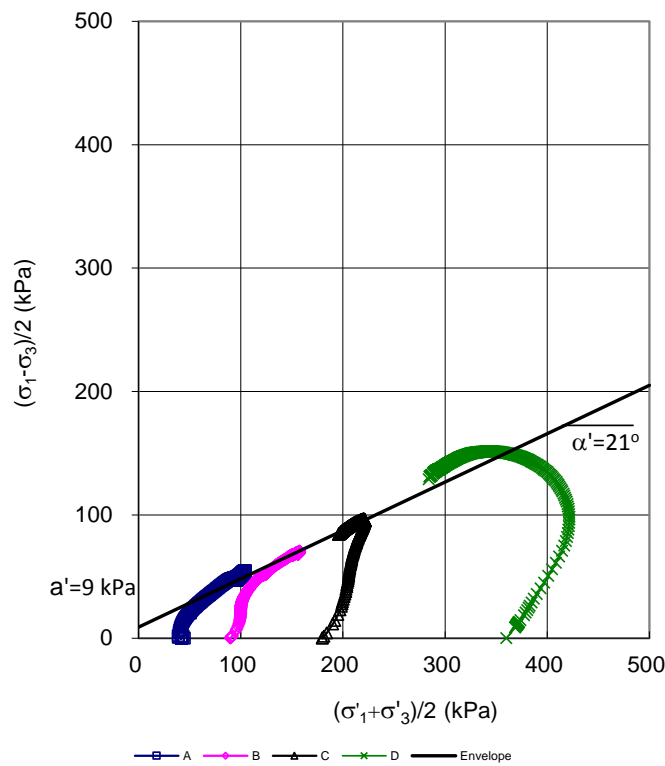
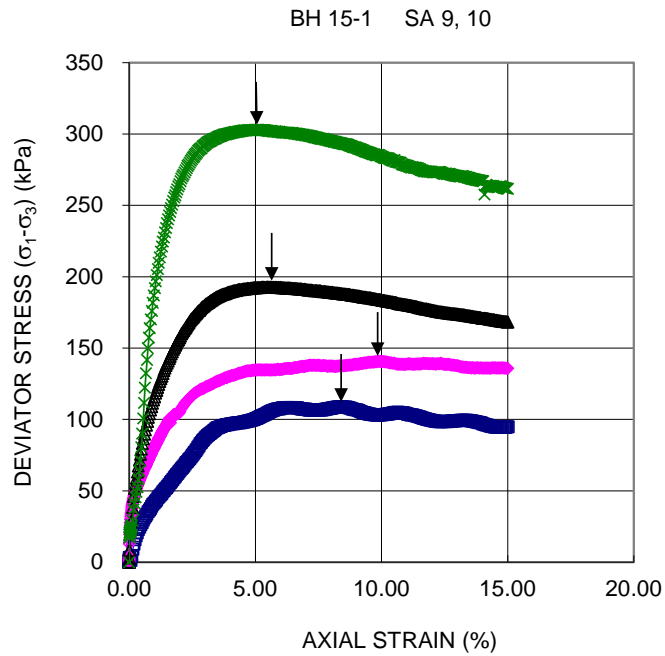
CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 2b OF 4

FIGURE B4.2



**CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 3 OF 4**

FIGURE B4.2



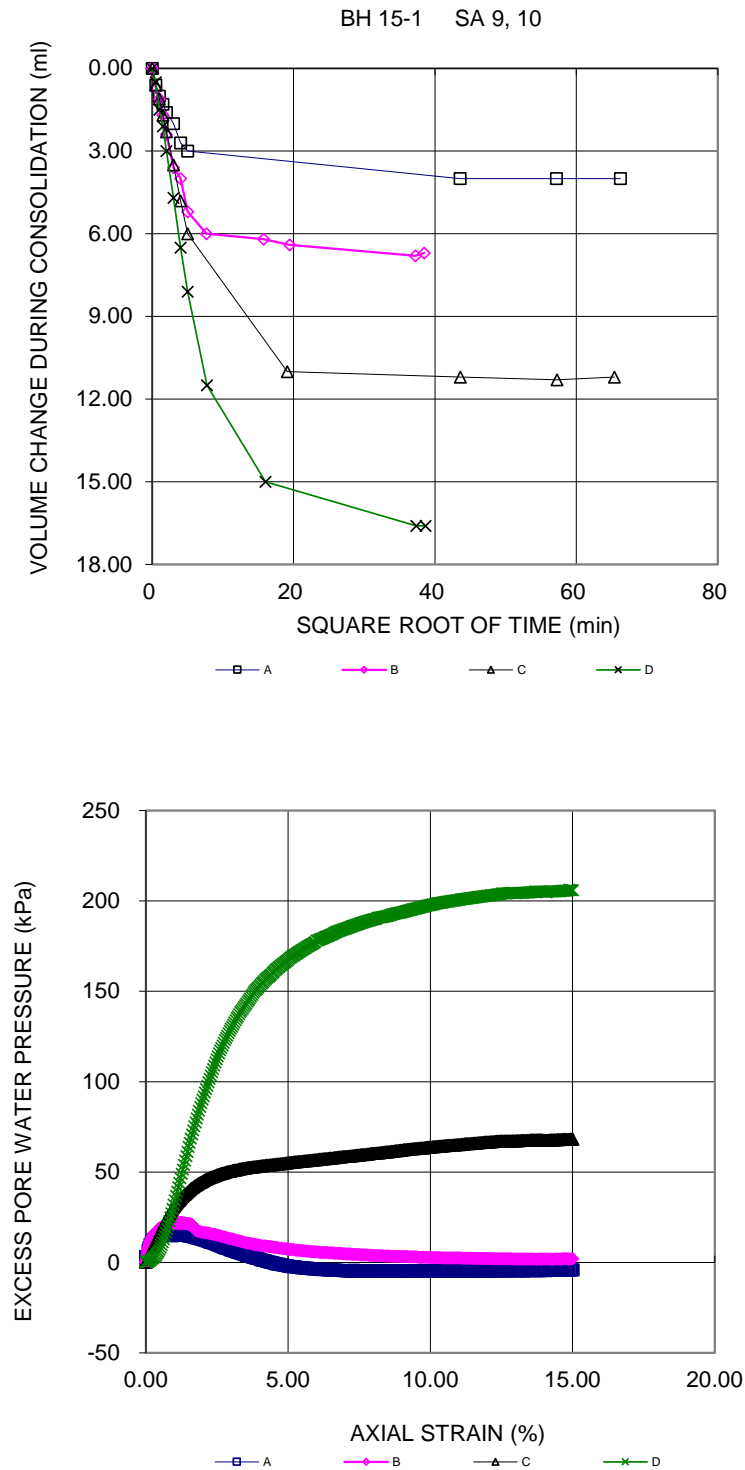
Date: 5/29/2015
Project No. 10-1111-0058

Golder Associates

Prepared By: RD
Checked By: MM / JPD

**CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 4 OF 4**

FIGURE B4.2



Date: 5/29/2015
Project No. 10-1111-0058

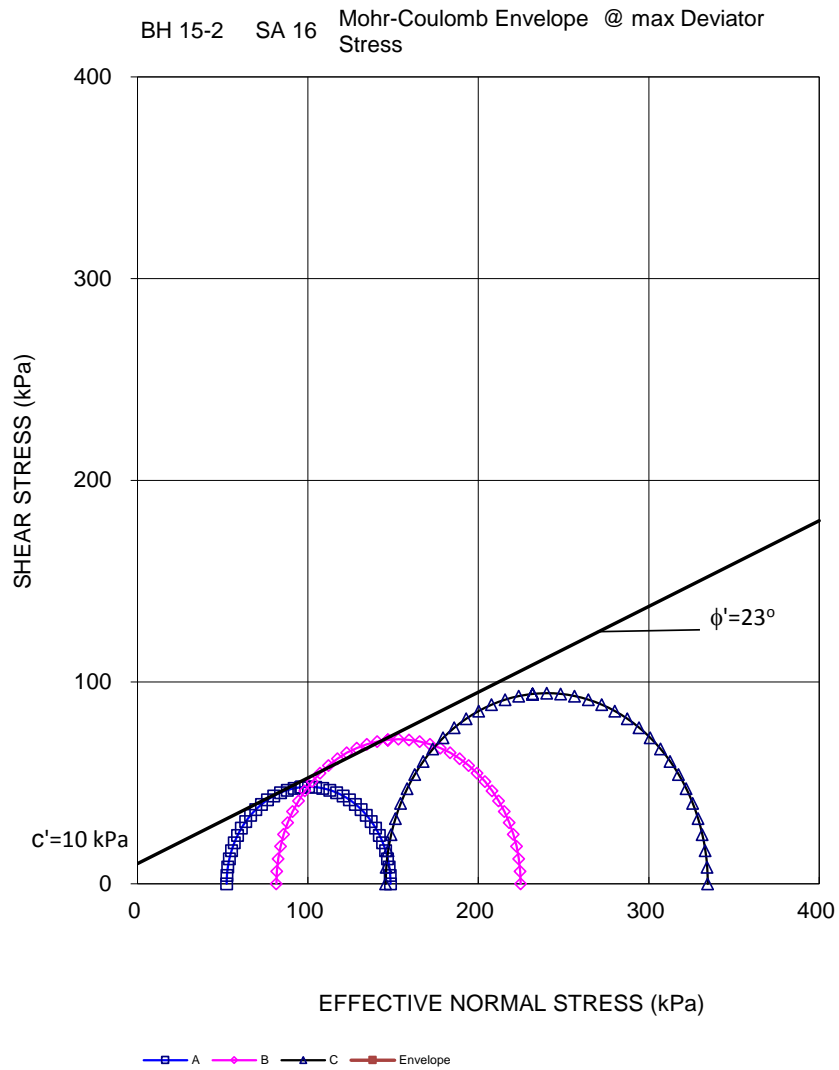
Golder Associates

Prepared By: RD
Checked By: MM / JPD

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS SHEET 1 OF 4			FIGURE B4.3
TEST STAGE	A	B	C
BOREHOLE NUMBER	15-2	15-2	15-2
SAMPLE	16	16	16
DEPTH, m	16.31-16.92	16.31-16.92	16.31-16.92
SPECIMEN DIAMETER, cm	4.99	4.92	5.00
SPECIMEN HEIGHT, cm	10.74	10.51	10.78
NATURAL WATER CONTENT, %	35.6	35.6	37.0
DRY DENSITY, Mg/m ³	1.40	1.44	1.37
WATER CONTENT AFTER SATURATION, %	36.8	38.7	41.0
CELL PRESSURE, σ_3 , kPa	210.0	355.0	505.0
BACK PRESSURE, kPa	135.0	205.0	205.0
PORE PRESSURE PARAMETER "B"	0.96	0.96	0.95
EFFECTIVE CONSOLIDATION STRESS, σ_c , kPa	75.0	150.0	300.0
VOLUMETRIC STRAIN DURING CONSOLIDATION, %	4.0	5.7	8.9
WATER CONTENT AFTER CONSOLIDATION, %	34.0	34.8	34.5
AVERAGE RATE OF STRAIN, %/hr	0.5	0.5	0.5
TIME TO FAILURE, HOURS	26.0	13.2	11.2
WATER CONTENT AFTER TEST, %	34.0	34.1	34.9
MAX. DEVIATOR STRESS, $(\sigma_1 - \sigma_3)$, kPa	96.2	143.3	189.0
AXIAL STRAIN AT $(\sigma_1 - \sigma_3)$ maximum, %	13.0	6.6	5.6
MAX EFFECTIVE PRINCIPAL STRESS RATIO, (σ'_1 / σ'_3) maximum	2.9	2.8	2.6
DEVIATOR STRESS AT (σ'_1 / σ'_3) maximum, kPa	93.7	138.8	160.8
AXIAL STRAIN AT (σ'_1 / σ'_3) maximum, %	9.1	9.5	14.6
PORE PRESSURE PARAMETER, Af, AT $(\sigma_1 - \sigma_3)$ maximum	0.24	0.48	0.82
PORE PRESSURE PARAMETER, Af, AT (σ'_1 / σ'_3) maximum	0.27	0.54	1.23
FILTER DRAINS USED, y/n	y	y	y
TEST NOTES: Effective consolidation stresses are assigned by the client.			
FAILURE PLANE NUMBER	-	1.0	-
ANGLE OF FAILURE PLANE, DEGREES	Bulged	60.0	Bulged
Date: 5/4/2015 Project No. 10-1111-0058			
Golder Associates			
Prepared By: LH Checked By: MM / JPD			

**CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 2a OF 4**

FIGURE B4.3



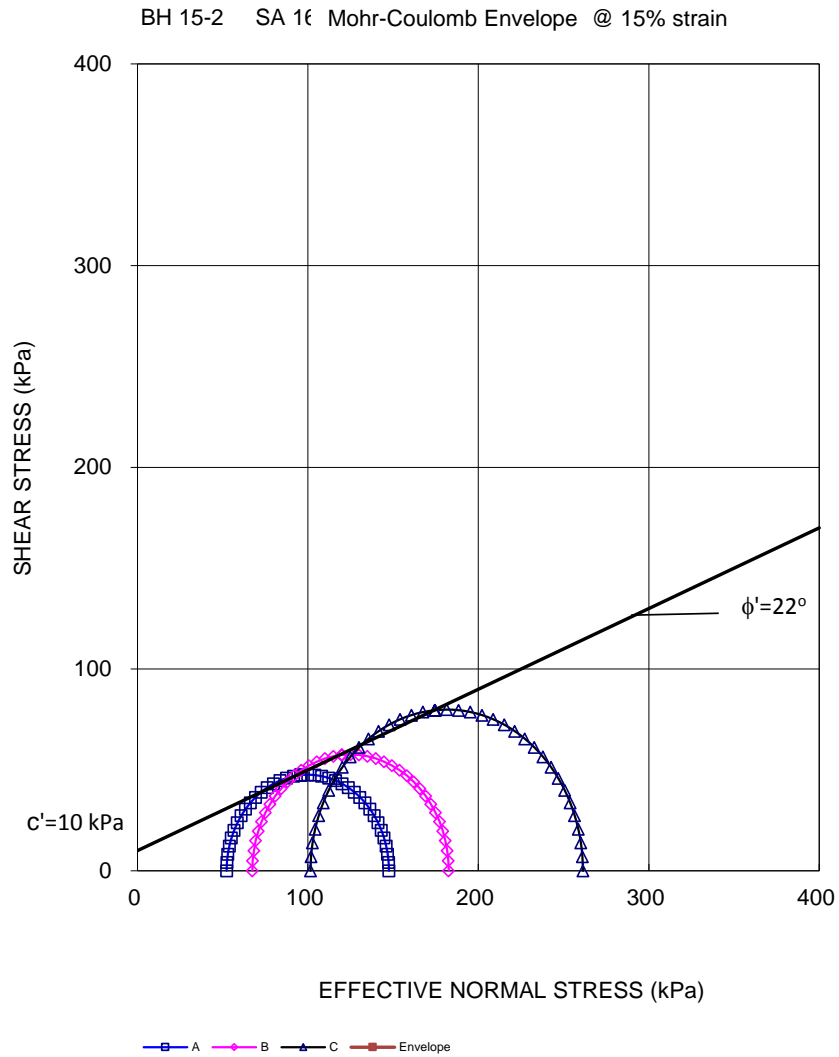
Date: 5/4/2015
Project No. 10-1111-0058

Golder Associates

Prepared By: LH
Checked By: MM / JPD

**CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 2b OF 4**

FIGURE B4.3



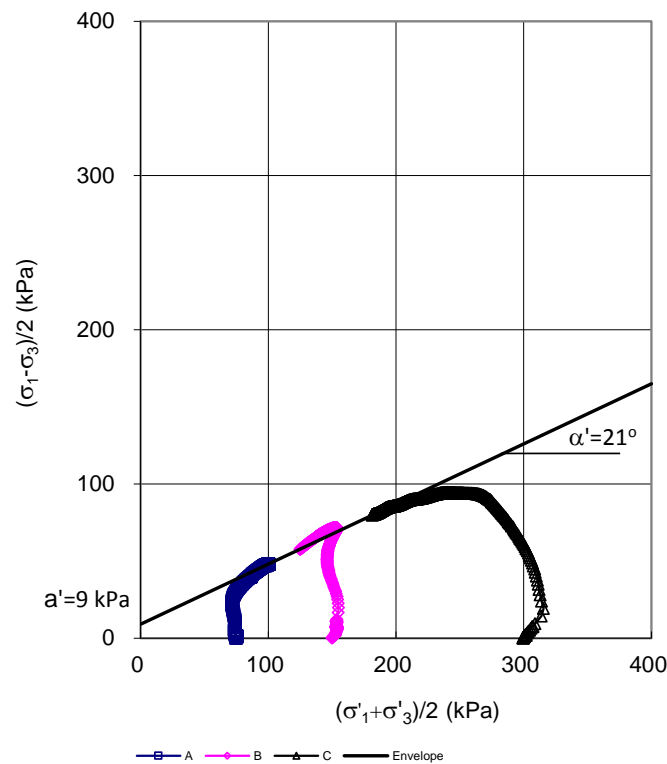
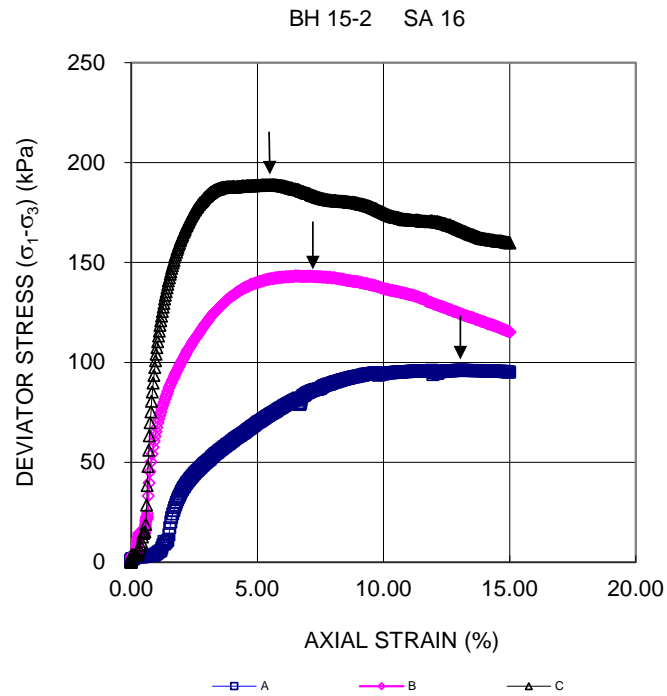
Date: 5/4/2015
Project No. 10-1111-0058

Golder Associates

Prepared By: LH
Checked By: MM / JPD

**CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 3 OF 4**

FIGURE B4.3



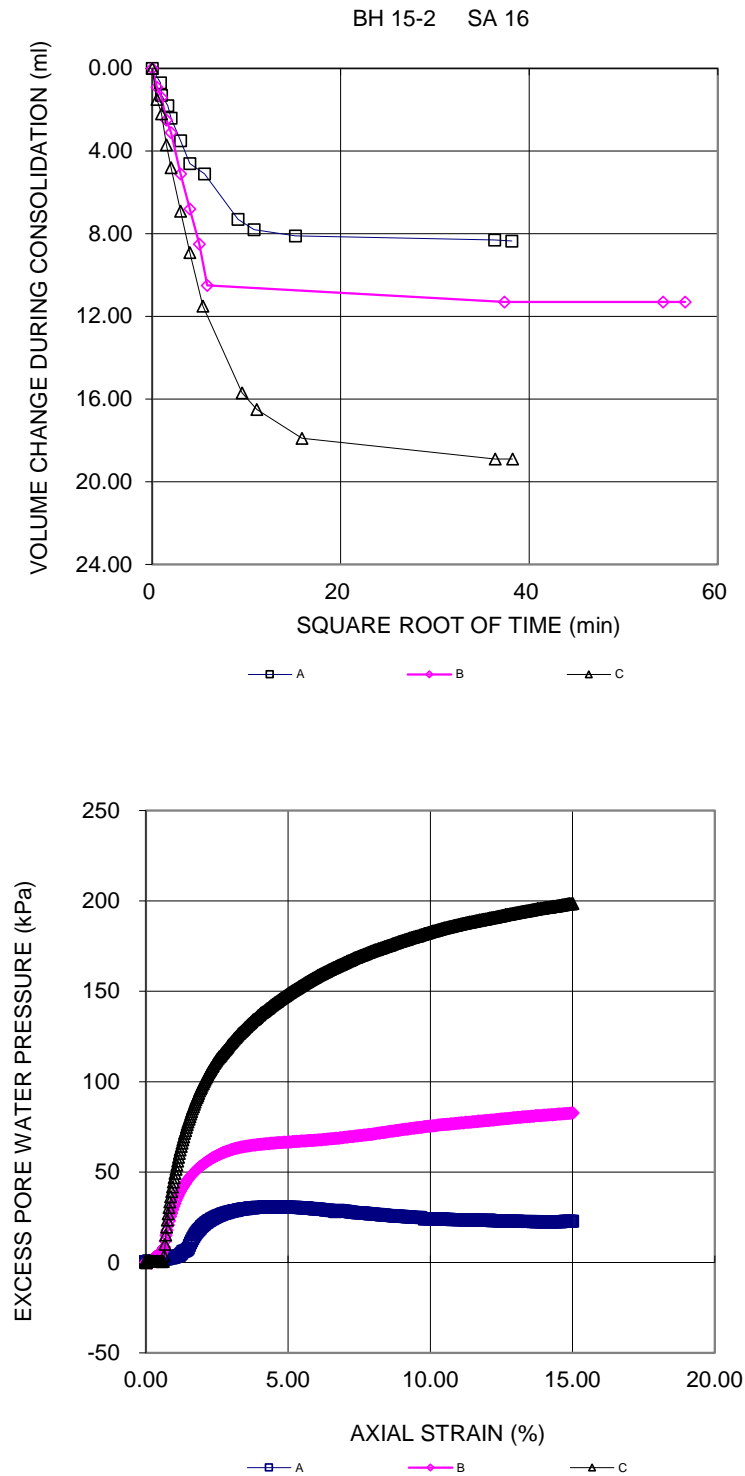
Date: 5/4/2015
Project No. 10-1111-0058

Golder Associates

Prepared By: LH
Checked By: MM / JPD

**CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 4 OF 4**

FIGURE B4.3



Date: 5/4/2015
Project No. 10-1111-0058

Golder Associates

Prepared By: LH
Checked By: MM / JPD

**CONSOLIDATED DRAINED DIRECT SHEAR TEST
SHEET 1 OF 3**

FIGURE B4.4

TEST STAGE	A	B	C
BOREHOLE NUMBER	15-2		
SAMPLE	14		
SAMPLE DEPTH, (m)	14.18-14.79		
SAMPLE HEIGHT, (mm)	6.00	6.00	6.00
SAMPLE LENGTH, (mm)	2.47	2.47	2.47
WATER CONTENT, BEFORE TEST, (%)	32.5	32.5	34.6
NORMAL (CONSOLIDATION) STRESS, (kPa)	35	70	140
WATER CONTENT, AFTER TEST, (%)	31.5	30.2	25.6
DISPLACEMENT RATE, mm/min	0.0024	0.0024	0.0024
TIME TO FAILURE, hours	24	21	22
PEAK SHEAR STRESS ¹ , (kPa)	19.8	32.3	65.8
HORIZONTAL DISPLACEMENT AT PEAK, (mm)	3.4	3.0	3.1
RESIDUAL SHEAR STRESS, (kPa)	19.4	29.7	66.1
HORIZONTAL DISPLACEMENT AT RESIDUAL, (mm)	11.6	8.8	11.6
DRY DENSITY, initial, Mg/m ³	1.502	1.497	1.508
WET DENSITY, initial, Mg/m ³	1.99	1.984	2.03

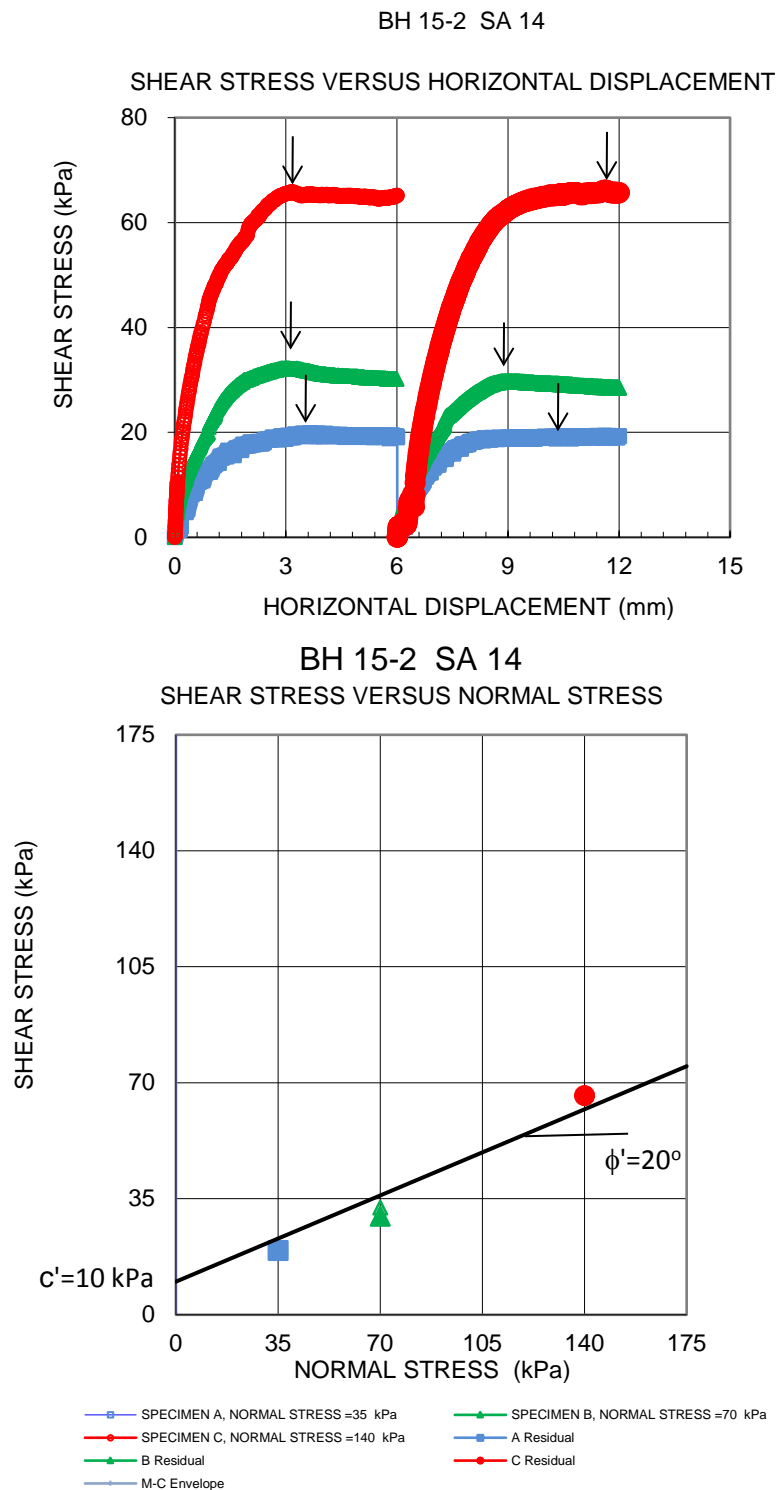
TEST NOTES:

1 In the absence of a peak, the shear stress reported is at 10 percent relative horizontal displacement (ASTM D3080).

Date: 10/14/2015
Project No. 10-1111-0058

Golder Associates

Prepared By: LH
Checked By: MM / JPD



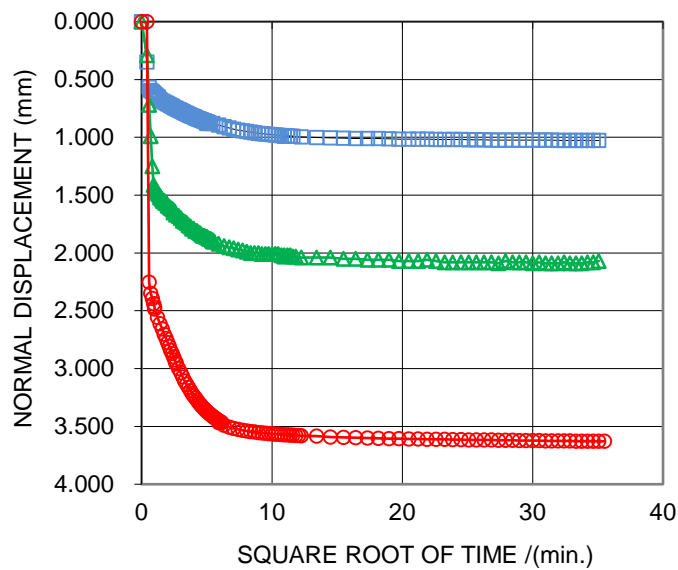
Date: 10/14/2015
 Project No. 10-1111-0058

Golder Associates

Prepared By LH
 Checked By: MM / JPD

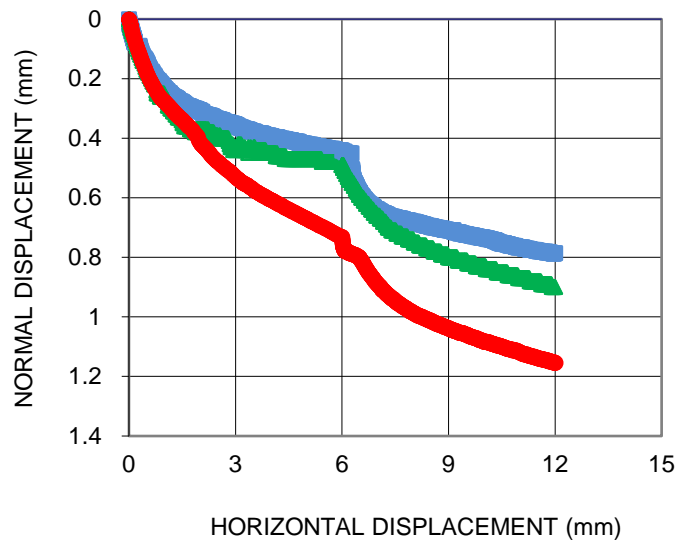
BH 15-2 SA 14

NORMAL DISPLACEMENT VERSUS SQUARE ROOT OF TIME



BH 15-2 SA 14

NORMAL DISPLACEMENT VERSUS HORIZONTAL DISPLACEMENT



HORIZONTAL DISPLACEMENT (mm)

- SPECIMEN A, NORMAL STRESS =35 kPa
- ▲— SPECIMEN B, NORMAL STRESS =70 kPa
- SPECIMEN C, NORMAL STRESS =140 kPa
- A Residual
- ▲— B Residual
- C Residual

Date: 10/14/2015
Project No. 10-1111-0058

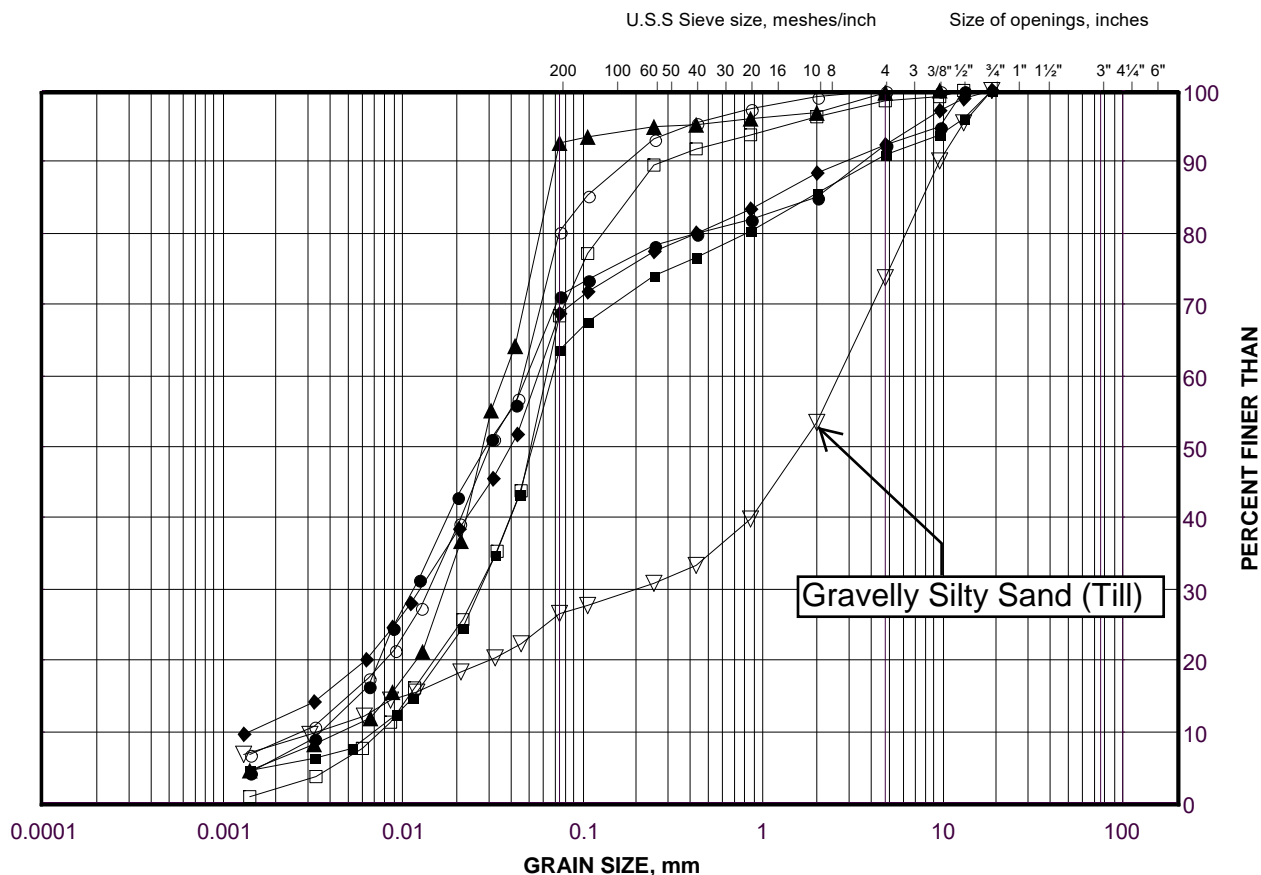
Golder Associates

Prepared By LH
Checked By: MM / JPD

GRAIN SIZE DISTRIBUTION

Gravelly Clayey Silt to Silt (TILL)

FIGURE B5.1



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	15-1	17	72.0
■	E6	17	80.3
◆	E8	17	82.8
▲	15-1	19	77.1
▽	EA	19	87.8
○	EA	21	84.9
□	EAPP	22	83.8

Project Number: 10-1111-0058

Checked By: SEMP/ AC

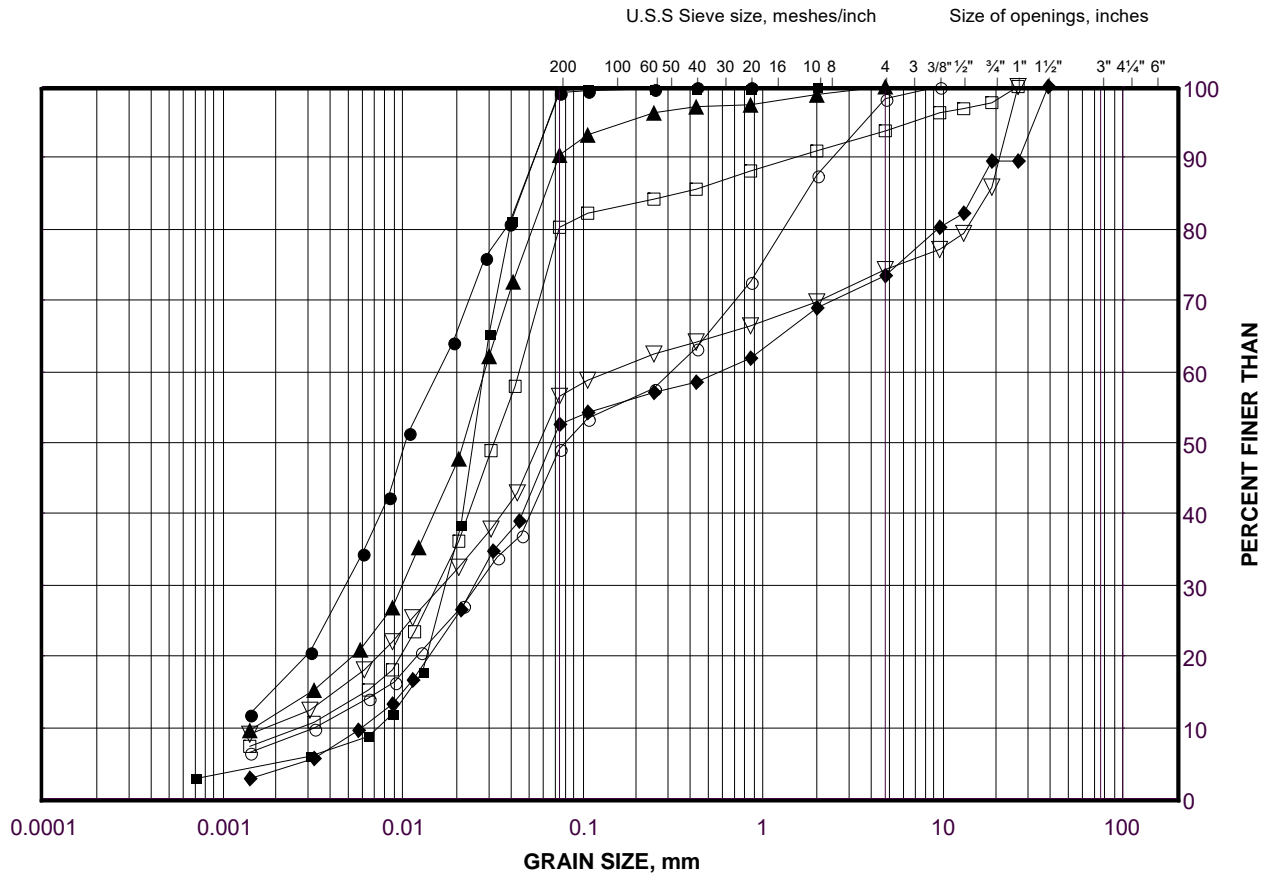
Golder Associates

Date: 18-May-16

GRAIN SIZE DISTRIBUTION

Sandy Clayey Silt to Silt (TILL)

FIGURE B5.2



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	E10	18	87.5
■	E12	18	84.5
◆	E10	21	79.8
▲	15-2	22	77.7
▽	WA	23	73.2
○	15-2	24	74.9
□	WA	26	67.1

Project Number: 10-1111-0058

Checked By: SEMP/ AC

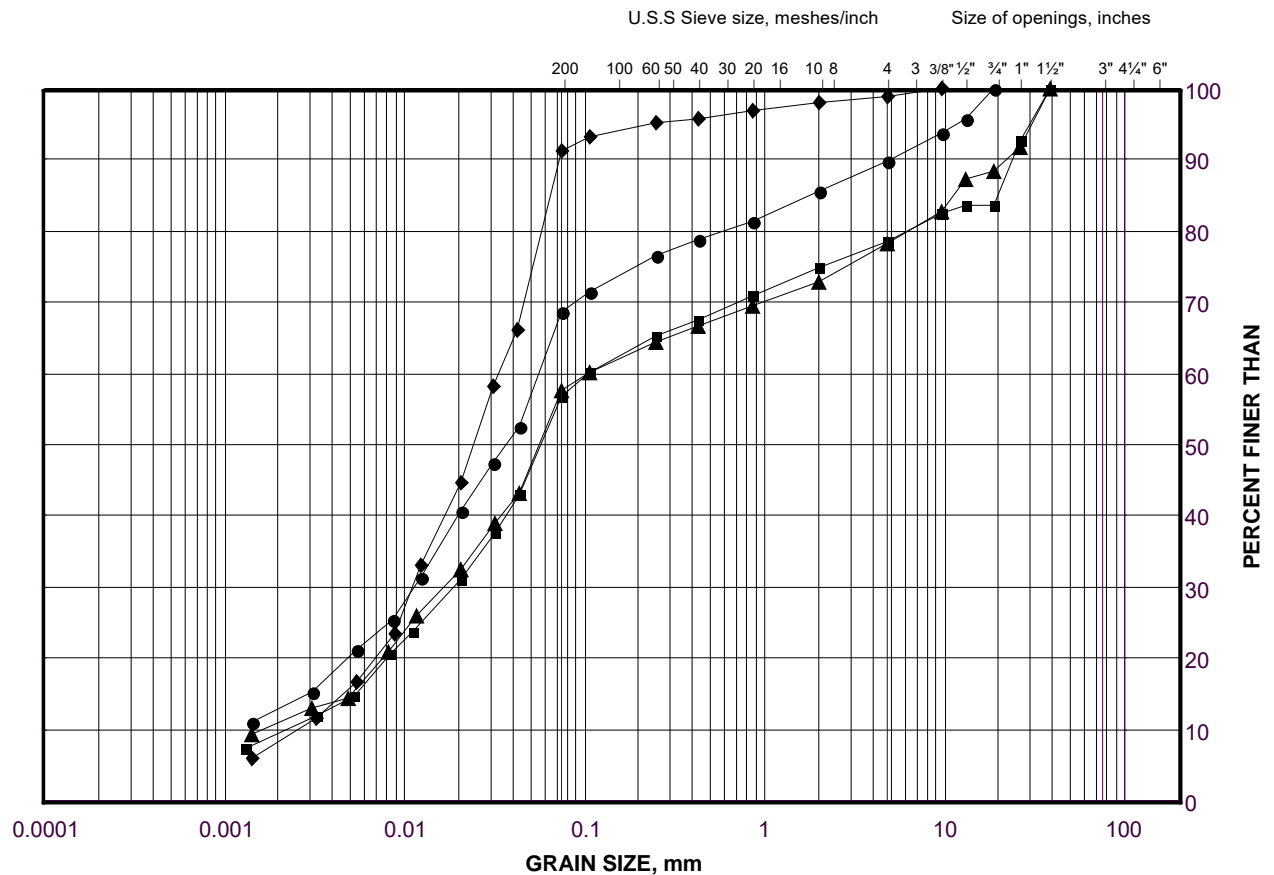
Golder Associates

Date: 18-May-16

GRAIN SIZE DISTRIBUTION

Gravelly Clayey Silt to Silt (TILL)

FIGURE B5.3



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

LEGEND

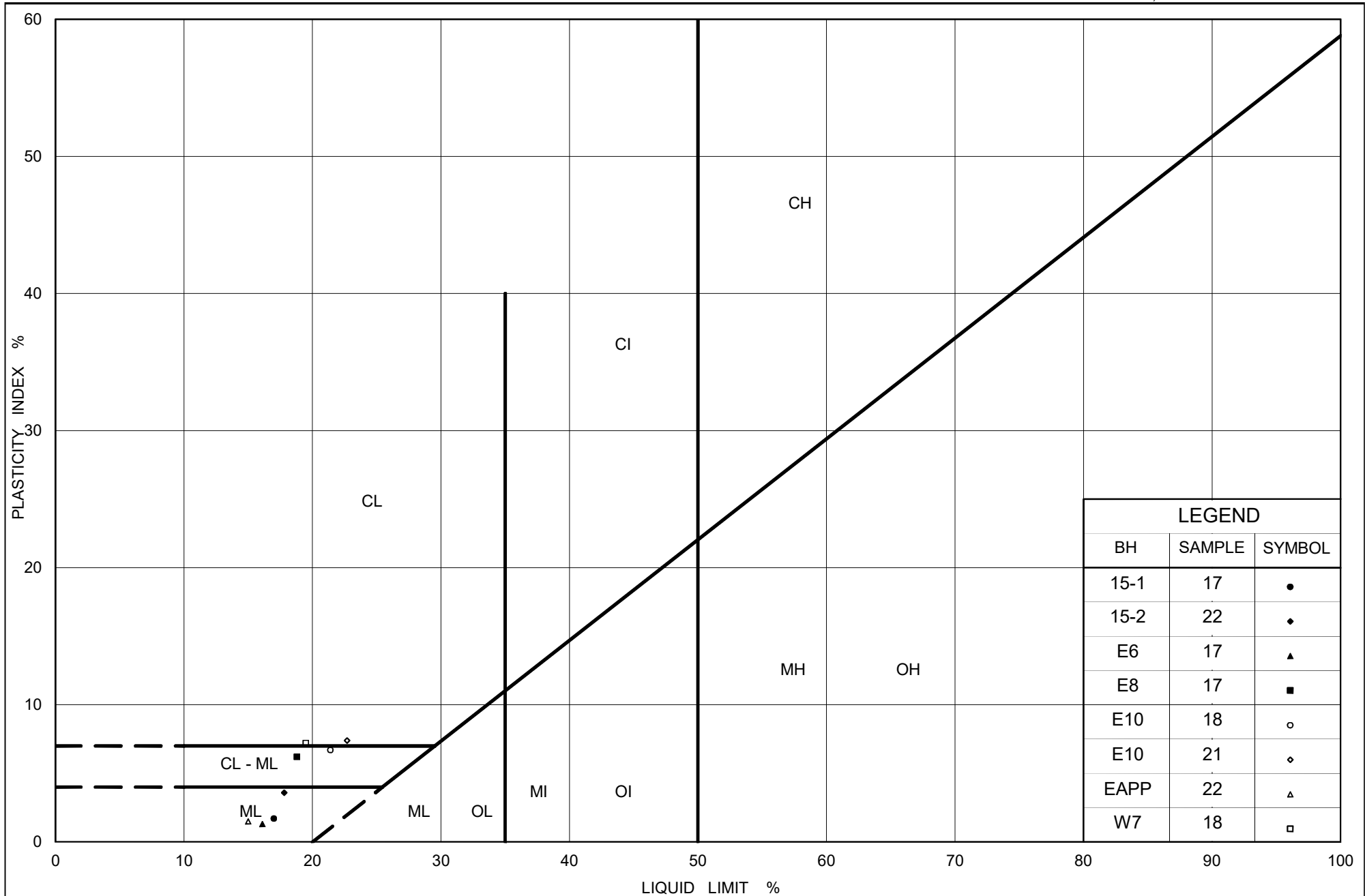
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	W7	18	75.8
■	W11	18	75.3
◆	W13	20	68.7
▲	WAPP	24	71.6

Project Number: 10-1111-0058

Checked By: SEMP/ AC

Golder Associates

Date: 18-May-16



Ministry of Transportation

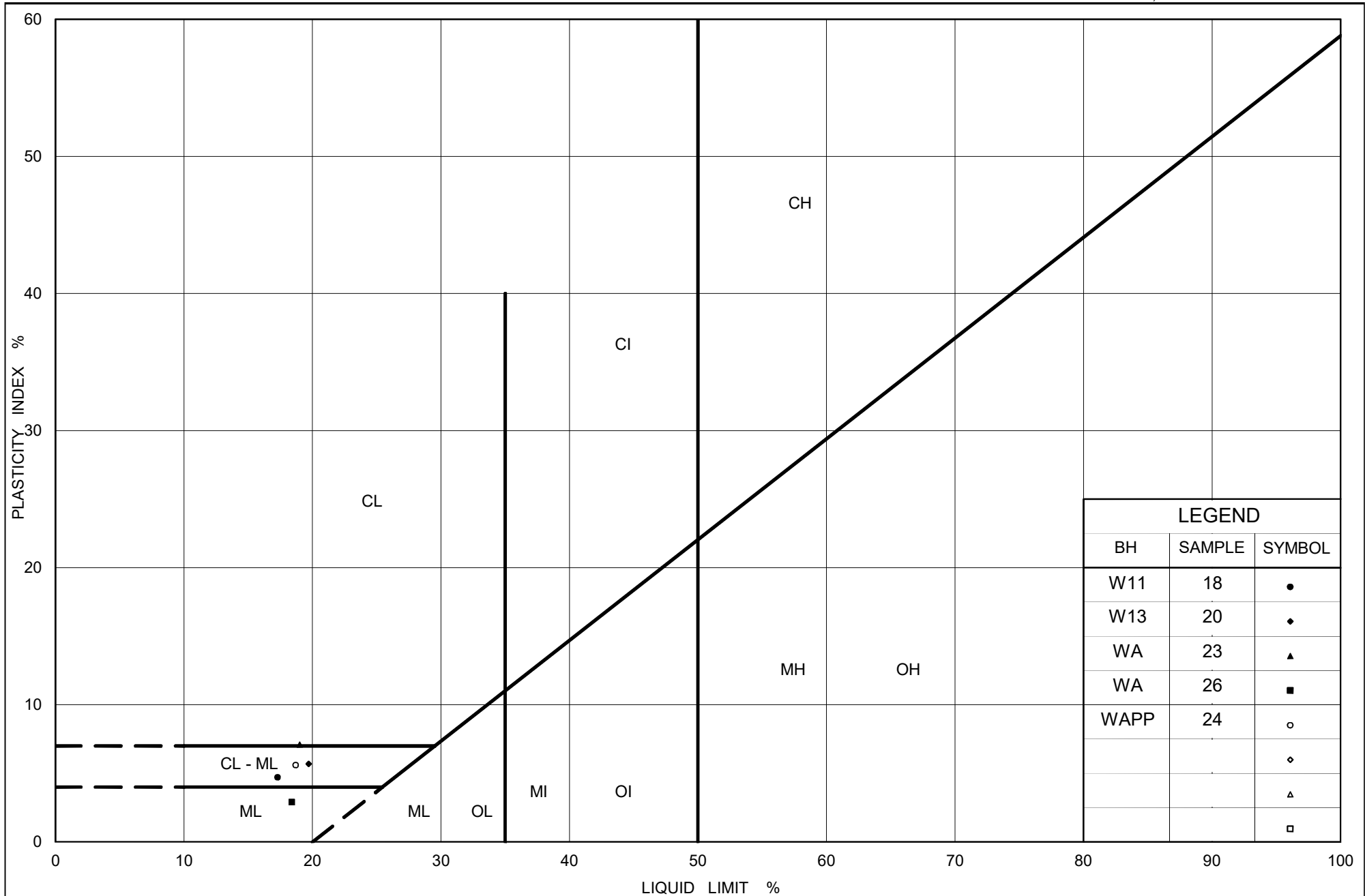
Ontario

PLASTICITY CHART Clayey Silt to Silt to Sandy Silt (TILL) (Fines Portion)

Figure No. B6.1

Project No. 10-1111-0058

Checked By: SEMP/ AC



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt to Silt (TILL) (Fines Portion)

Figure No. B6.2

Project No. 10-1111-0058

Checked By: SEMP/ AC



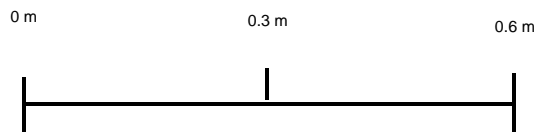
Borehole WA
Elevation 59.9 m to 56.3 m




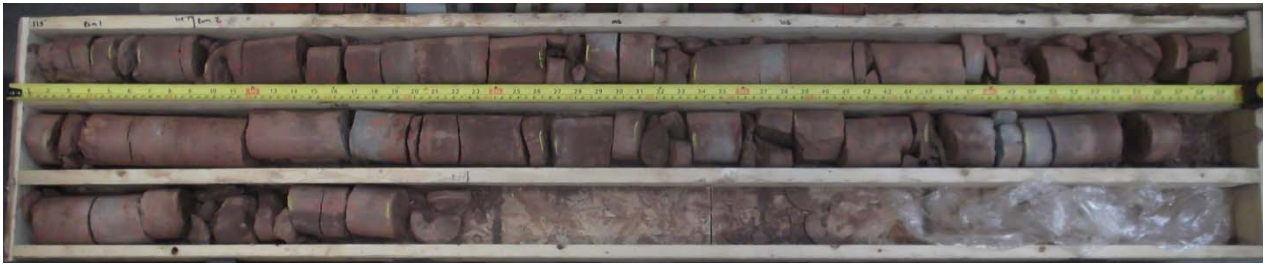
Borehole W13
Elevation 62.6 m to 58.3 m



Borehole W11
Elevation 65.0 m to 61.6 m



PROJECT		GARDEN CITY SKYWAY	
TITLE		BEDROCK CORE PHOTOGRAPHS	
	PROJECT No10-1111-0058		FILE No. ----
	DESIGN	AC	APR 2016
	CADD	--	
	CHECK	SEMP	APR 2016
	REVIEW	FJH	APR 2016
SCALE AS SHOWN			REV.
FIGURE B7.1			



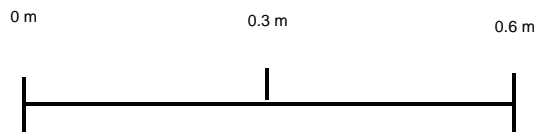
Borehole W7
Elevation 68.4 m to 65.2 m




Borehole W5B
Elevation 32.0 m to 35.2 m



Borehole 15-2
Elevation 72.4 m to 65.3 m



PROJECT		GARDEN CITY SKYWAY	
TITLE		BEDROCK CORE PHOTOGRAPHS	
	PROJECT No10-1111-0058		FILE No.----
	DESIGN	AC	APR 2016
	CADD	--	
	CHECK	SEMP	APR 2016
REVIEW		FJH	APR 2016
		SCALE AS SHOWN	REV.
FIGURE B7.2			



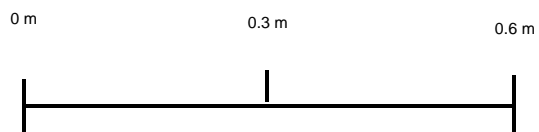
Borehole 15-1
Elevation 68.0 m to 63.3 m




Borehole E6
Elevation 77.0 m to 71.9 m



Borehole E8
Elevation 78.2 m to 72.0 m



PROJECT		GARDEN CITY SKYWAY	
TITLE		BEDROCK CORE PHOTOGRAPHS	
	PROJECT No 10-1111-0058		FILE No. ----
	DESIGN	AC	APR 2016
	CADD	--	
	CHECK	SEMP	APR 2016
	REVIEW	FJH	APR 2016
		SCALE AS SHOWN	REV.
FIGURE B7.3			



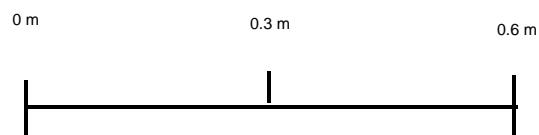
Borehole E10
Elevation 78.7 m to 75.3 m




Borehole E12
Elevation 78.8 m to 73.9 m




Borehole EA
Elevation 78.2 m to 75.7 m



PROJECT		GARDEN CITY SKYWAY	
TITLE		BEDROCK CORE PHOTOGRAPHS	
		PROJECT No10-1111-0058	
		DESIGN	AC
		CADD	--
		CHECK	SEMP
		REVIEW	FJH
		FILE No.----	SCALEAS SHOWN REV.
		FIGURE B7.4	

Borehole No.	Sample Depth (m)	Is (50 mm) (MPa)	Type
WA	44.25	0.96	Diametral
WA	45.05	0.78	Diametral
WA	45.29	2.20	Diametral
WA	45.33	0.13	Diametral
WA	45.49	0.79	Diametral
W13	40.56	0.48	Axial
W13	42.76	1.63	Diametral
W13	42.24	0.18	Diametral
W13	42.95	1.24	Diametral
W13	42.97	2.40	Axial
W11	40.14	0.60	Axial
W11	40.18	2.07	Diametral
W11	40.91	2.86	Diametral
W11	40.89	1.26	Axial
W7	35.38	0.42	Axial
W7	36.73	0.16	Diametral
W7	36.07	0.19	Diametral
W7	35.52	0.14	Diametral
W5B	33.49	0.99	Diametral
W5B	33.93	0.38	Axial
W5B	34.39	0.43	Diametral
W5B	34.49	0.54	Diametral
W5B	35.01	0.88	Axial
W5B	34.56	3.65	Axial
15-2	31.40	4.54	Axial
15-2	32.30	1.24	Axial
15-2	34.40	0.64	Axial

Borehole No.	Sample Depth (m)	Is (50 mm) (MPa)	Type
15-1	27.60	2.87	Axial
15-1	29.10	0.84	Axial
15-1	29.60	2.55	Axial
E6	30.01	0.04	Diametral
E6	30.20	0.60	Axial
E6	31.10	0.09	Diametral
E6	33.45	0.24	Diametral
E6	33.38	0.16	Diametral
E6	33.42	2.64	Axial
E8	29.31	0.48	Axial
E8	29.40	0.10	Diametral
E8	29.63	0.14	Diametral
E8	30.00	1.90	Diametral
E8	31.95	2.07	Diametral
E8	32.04	2.40	Axial
E8	32.61	0.84	Diametral
E8	32.80	0.72	Axial
E8	32.87	0.16	Diametral
E10	34.23	0.10	Diametral
E10	34.56	1.81	Axial
E10	34.97	0.49	Diametral
E10	35.07	1.77	Diametral
E10	35.20	0.94	Axial
E12	34.40	0.12	Diametral
E12	35.19	2.02	Axial
E12	36.03	0.68	Axial
E12	36.06	1.46	Diametral
E12	36.35	1.27	Diametral
EA	33.81	0.72	Diametral
EA	34.01	1.20	Axial
EA	34.05	0.18	Diametral
EA	34.15	2.73	Axial
EA	34.19	0.24	Diametral
EA	34.28	0.49	Diametral

PROJECT		GARDEN CITY SKYWAY			
TITLE		POINT LOAD TEST RESULTS			
	PROJECT No. 10-1111-0058		FILE No. ----		
	DESIGN	AC	NOV 2018	SCALE	AS SHOWN
	CADD	--			REV.
	CHECK	SEMP	NOV 2018	FIGURE B8	
	REVIEW	FJH	NOV 2018		

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B9.1****SAMPLE IDENTIFICATION**

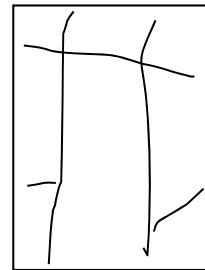
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	-
PROJECT NAME	MRC/GARDEN CITY SKYWAY/ST. CATHERIN	SAMPLE DEPTH, m	45.92
BOREHOLE NUMBER	WA	DATE:	11/08/15

TEST CONDITIONS

MACHINE SPEED, mm/min	N/A	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.06

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	12.97	WATER CONTENT, (specimen) %	1.33
SAMPLE DIAMETER, cm	6.29	UNIT WEIGHT, kN/m ³	25.80
SAMPLE AREA, cm ²	31.02	DRY UNIT WT., kN/m ³	25.46
SAMPLE VOLUME, cm ³	402.35	SPECIFIC GRAVITY	-
WET WEIGHT, g	1058.80	VOID RATIO	-
DRY WEIGHT, g	1044.90		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	N/A	COMPRESSIVE STRENGTH, MPa	17.9
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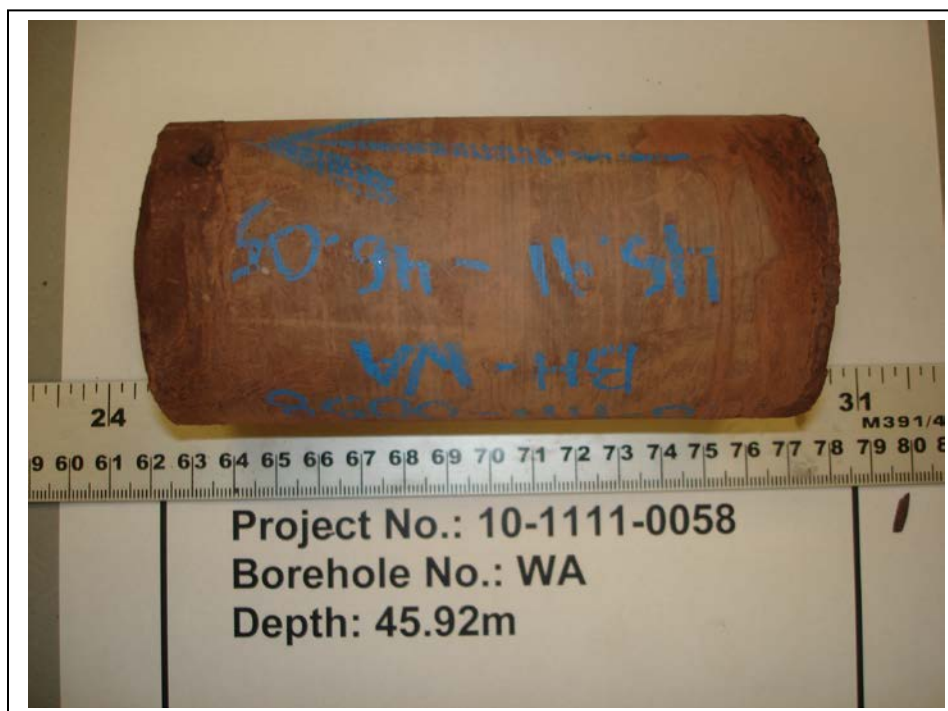
REMARKS:

Checked By: SEMP/ AC

Golder Associates

UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS
ASTM D7012

FIGURE B9.1



BEFORE COMPRESSION



AFTER COMPRESSION

Date Nov. 8, 2015
Project 10-1111-0058

Golder Associates

Drawn Frank
Chkd. SEMP/AC

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B9.2****SAMPLE IDENTIFICATION**

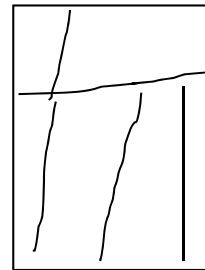
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	-
PROJECT NAME	MRC/GARDEN CITY SKYWAY/ST. CATHERIN	SAMPLE DEPTH, m	42.03
BOREHOLE NUMBER	W13	DATE:	11/08/15

TEST CONDITIONS

MACHINE SPEED, mm/min	N/A	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.23

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	14.06	WATER CONTENT, (specimen) %	1.80
SAMPLE DIAMETER, cm	6.29	UNIT WEIGHT, kN/m ³	25.79
SAMPLE AREA, cm ²	31.08	DRY UNIT WT., kN/m ³	25.33
SAMPLE VOLUME, cm ³	436.94	SPECIFIC GRAVITY	-
WET WEIGHT, g	1149.50	VOID RATIO	-
DRY WEIGHT, g	1129.17		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	N/A	COMPRESSIVE STRENGTH, MPa	23.0
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REMARKS:

Checked By: SEMP/ AC

Golder Associates

UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS
ASTM D7012

FIGURE B9.2



BEFORE COMPRESSION



AFTER COMPRESSION

Date Nov. 8, 2015
Project 10-1111-0058

Golder Associates

Drawn Frank
Chkd. SEMP/ AC

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B9.3****SAMPLE IDENTIFICATION**

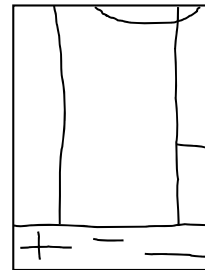
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	01
PROJECT NAME	MRC/GARDEN CITY SKYWAY/ST. CATHERIN	SAMPLE DEPTH, m	43.33-43.74
BOREHOLE NUMBER	W13	DATE:	

TEST CONDITIONS

MACHINE SPEED, mm/min	N/A	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.22

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	13.99	WATER CONTENT, (specimen) %	1.95
SAMPLE DIAMETER, cm	6.29	UNIT WEIGHT, kN/m ³	25.75
SAMPLE AREA, cm ²	31.06	DRY UNIT WT., kN/m ³	25.26
SAMPLE VOLUME, cm ³	434.68	SPECIFIC GRAVITY	-
WET WEIGHT, g	1141.90	VOID RATIO	-
DRY WEIGHT, g	1120.06		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	N/A	COMPRESSIVE STRENGTH, MPa	21.2
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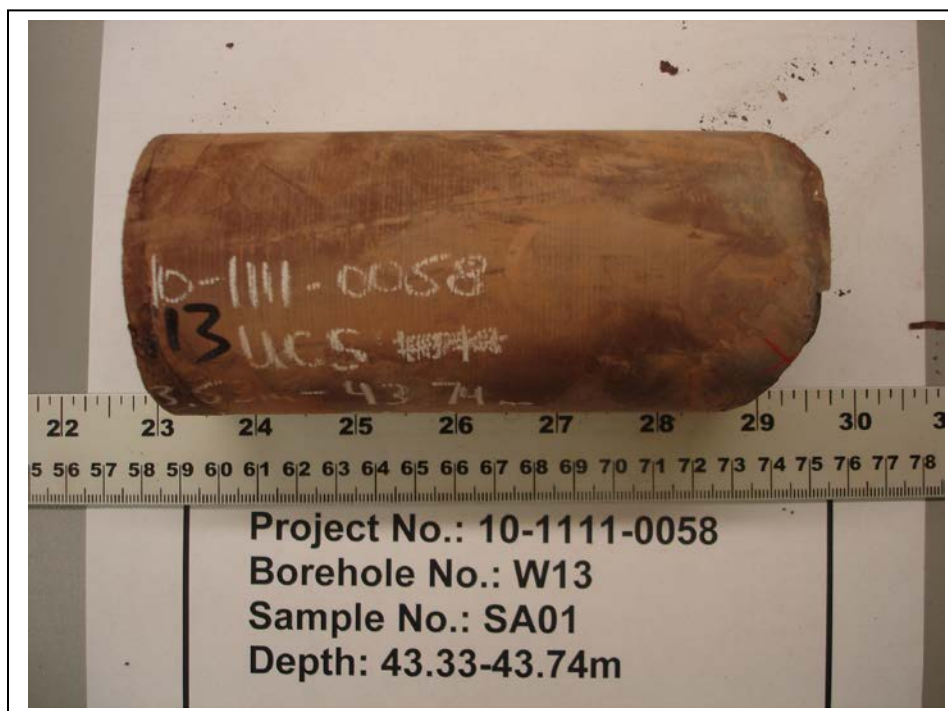
REMARKS:

Checked By: SEMP/ AC

Golder Associates

UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS
ASTM D7012

FIGURE B9.3



BEFORE COMPRESSION



AFTER COMPRESSION

Date Sept. 8, 2015
Project 10-1111-0058

Golder Associates

Drawn Frank
Chkd. SEMP/ AC

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B9.4****SAMPLE IDENTIFICATION**

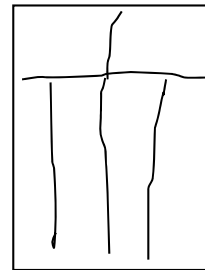
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	-
PROJECT NAME	MRC/GARDEN CITY SKYWAY/ST. CATHERIN	SAMPLE DEPTH, m	38.20
BOREHOLE NUMBER	W11	DATE:	11/08/15

TEST CONDITIONS

MACHINE SPEED, mm/min	N/A	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	1.91

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	11.87	WATER CONTENT, (specimen) %	1.56
SAMPLE DIAMETER, cm	6.23	UNIT WEIGHT, kN/m ³	25.51
SAMPLE AREA, cm ²	30.46	DRY UNIT WT., kN/m ³	25.12
SAMPLE VOLUME, cm ³	361.70	SPECIFIC GRAVITY	-
WET WEIGHT, g	941.20	VOID RATIO	-
DRY WEIGHT, g	926.74		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	N/A	COMPRESSIVE STRENGTH, MPa	30.7
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REMARKS: L/D Ratio not in accordance with ASTM Standard

UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS
ASTM D7012

FIGURE B9.4



BEFORE COMPRESSION



AFTER COMPRESSION

Date Nov. 8, 2015
Project 10-1111-0058

Golder Associates

Drawn Frank
Chkd SEMP/AC

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B9.5****SAMPLE IDENTIFICATION**

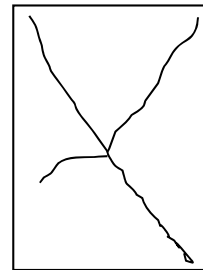
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	-
PROJECT NAME	MRC/GARDEN CITY SKYWAY/ST. CATHERIN	SAMPLE DEPTH, m	36.58
BOREHOLE NUMBER	W7	DATE:	11/08/15

TEST CONDITIONS

MACHINE SPEED, mm/min	N/A	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.10

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	13.29	WATER CONTENT, (specimen) %	1.82
SAMPLE DIAMETER, cm	6.34	UNIT WEIGHT, kN/m ³	23.46
SAMPLE AREA, cm ²	31.57	DRY UNIT WT., kN/m ³	23.04
SAMPLE VOLUME, cm ³	419.62	SPECIFIC GRAVITY	-
WET WEIGHT, g	1004.20	VOID RATIO	-
DRY WEIGHT, g	986.25		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	N/A	COMPRESSIVE STRENGTH, MPa	1.3
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REMARKS:

Checked By: SEMP/ AC

Golder Associates

UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS
ASTM D7012

FIGURE B9.5



BEFORE COMPRESSION



AFTER COMPRESSION

Date Nov. 8, 2015
Project 10-1111-0058

Golder Associates

Drawn Frank
Chkd. SEMP/AC

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B9.6****SAMPLE IDENTIFICATION**

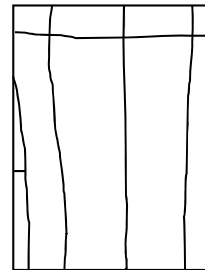
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	-
PROJECT NAME	MRC/GARDEN CITY SKYWAY/ST. CATHERIN	SAMPLE DEPTH, m	27.80
BOREHOLE NUMBER	15-1	DATE:	06/11/15

TEST CONDITIONS

MACHINE SPEED, mm/min	N/A	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.41

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	10.67	WATER CONTENT, (specimen) %	1.64
SAMPLE DIAMETER, cm	4.43	UNIT WEIGHT, kN/m ³	25.75
SAMPLE AREA, cm ²	15.42	DRY UNIT WT., kN/m ³	25.33
SAMPLE VOLUME, cm ³	164.47	SPECIFIC GRAVITY	-
WET WEIGHT, g	432.00	VOID RATIO	-
DRY WEIGHT, g	425.03		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	N/A	COMPRESSIVE STRENGTH, MPa	25.4
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REMARKS:

Checked By: SEMP/ AC

Golder Associates

UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS
ASTM D7012

FIGURE B9.6



BEFORE COMPRESSION



AFTER COMPRESSION

Date June 11, 2015
Project 10-1111-0058

Golder Associates

Drawn Frank
Chkd. SEMP/ AC

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B9.7****SAMPLE IDENTIFICATION**

PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	01
PROJECT NAME	MRC/GARDEN CITY SKYWAY/ST. CATHERIN	SAMPLE DEPTH, m	33.10-33.43
BOREHOLE NUMBER	E10	DATE:	02/09/15

TEST CONDITIONS

MACHINE SPEED, mm/min	N/A	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	1.57

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	9.85	WATER CONTENT, (specimen) %	2.13
SAMPLE DIAMETER, cm	6.29	UNIT WEIGHT, kN/m ³	25.11
SAMPLE AREA, cm ²	31.03	DRY UNIT WT., kN/m ³	24.59
SAMPLE VOLUME, cm ³	305.69	SPECIFIC GRAVITY	-
WET WEIGHT, g	783.01	VOID RATIO	-
DRY WEIGHT, g	766.68		

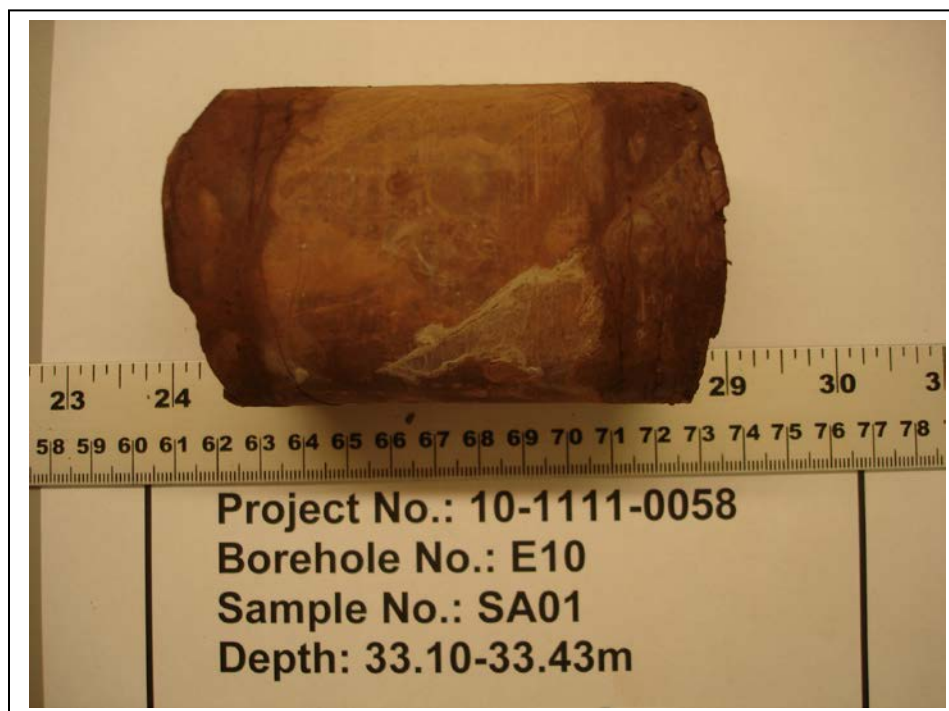
VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	N/A	COMPRESSIVE STRENGTH, MPa	12.6
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REMARKS: L/D Ratio not in accordance with ASTM Standard

UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS
ASTM D7012

FIGURE B9.7



BEFORE COMPRESSION



AFTER COMPRESSION

Date Sept. 8, 2015
Project 10-1111-0058

Golder Associates

Drawn Frank
Chkd. SEMP/ AC

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B9.8****SAMPLE IDENTIFICATION**

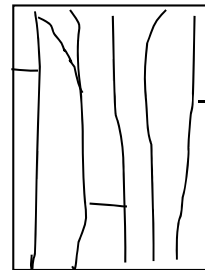
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	-
PROJECT NAME	MRC/GARDEN CITY SKYWAY/ST. CATHERIN	SAMPLE DEPTH, m	34.08
BOREHOLE NUMBER	E10	DATE:	11/08/15

TEST CONDITIONS

MACHINE SPEED, mm/min	N/A	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.05

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	12.92	WATER CONTENT, (specimen) %	2.17
SAMPLE DIAMETER, cm	6.29	UNIT WEIGHT, kN/m ³	25.78
SAMPLE AREA, cm ²	31.07	DRY UNIT WT., kN/m ³	25.23
SAMPLE VOLUME, cm ³	401.35	SPECIFIC GRAVITY	-
WET WEIGHT, g	1055.30	VOID RATIO	-
DRY WEIGHT, g	1032.89		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	N/A	COMPRESSIVE STRENGTH, MPa	19.2
----------------------	-----	---------------------------	------

REMARKS:

Checked By: SEMP/ AC

Golder Associates

UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS
ASTM D7012

FIGURE B9.8



BEFORE COMPRESSION



AFTER COMPRESSION

Date Nov. 8, 2015
Project 10-1111-0058

Golder Associates

Drawn Frank
Chkd. SEMP/AC

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B9.9****SAMPLE IDENTIFICATION**

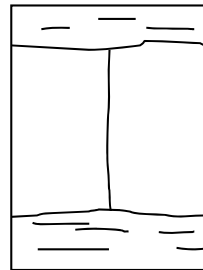
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	01
PROJECT NAME	MRC/GARDEN CITY SKYWAY/ST. CATHERIN	SAMPLE DEPTH, m	32.39-32.61
BOREHOLE NUMBER	E12	DATE:	02/09/15

TEST CONDITIONS

MACHINE SPEED, mm/min	N/A	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	1.38

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	8.63	WATER CONTENT, (specimen) %	2.29
SAMPLE DIAMETER, cm	6.27	UNIT WEIGHT, kN/m ³	25.32
SAMPLE AREA, cm ²	30.85	DRY UNIT WT., kN/m ³	24.75
SAMPLE VOLUME, cm ³	266.27	SPECIFIC GRAVITY	-
WET WEIGHT, g	687.70	VOID RATIO	-
DRY WEIGHT, g	672.30		

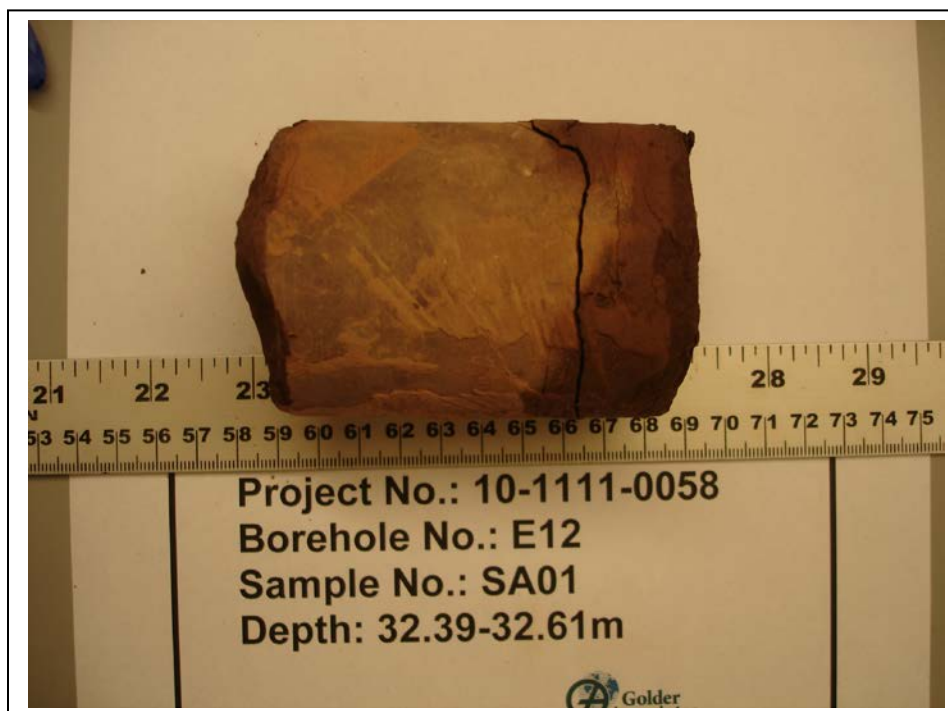
VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	N/A	COMPRESSIVE STRENGTH, MPa	9.4
----------------------	-----	---------------------------	-----

REMARKS: L/D Ratio not in accordance with ASTM Standard

UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS
ASTM D7012

FIGURE B9.9



BEFORE COMPRESSION



AFTER COMPRESSION

Date Sept. 8, 2015
Project 10-1111-0058

Golder Associates

Drawn Frank
Chkd. SEMP/AC

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B9.10****SAMPLE IDENTIFICATION**

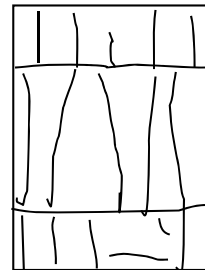
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	-
PROJECT NAME	MRC/GARDEN CITY SKYWAY/ST. CATHERIN	SAMPLE DEPTH, m	34.30
BOREHOLE NUMBER	E12	DATE:	11/08/15

TEST CONDITIONS

MACHINE SPEED, mm/min	N/A	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	1.95

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	12.33	WATER CONTENT, (specimen) %	1.99
SAMPLE DIAMETER, cm	6.31	UNIT WEIGHT, kN/m ³	25.82
SAMPLE AREA, cm ²	31.24	DRY UNIT WT., kN/m ³	25.32
SAMPLE VOLUME, cm ³	385.09	SPECIFIC GRAVITY	-
WET WEIGHT, g	1014.30	VOID RATIO	-
DRY WEIGHT, g	994.51		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	N/A	COMPRESSIVE STRENGTH, MPa	31.2
----------------------	-----	---------------------------	------

REMARKS: L/D Ratio not in accordance with ASTM Standard

Checked By: SEMP/ AC

Golder Associates

UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS
ASTM D7012

FIGURE B9.10



BEFORE COMPRESSION



AFTER COMPRESSION

Date Nov. 8, 2015
Project 10-1111-0058

Golder Associates

Drawn Frank
Chkd. SEMP/AC

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B9.11****SAMPLE IDENTIFICATION**

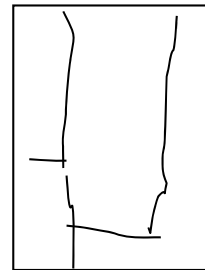
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	-
PROJECT NAME	MRC/GARDEN CITY SKYWAY/ST. CATHERIN	SAMPLE DEPTH, m	33.91
BOREHOLE NUMBER	EA	DATE:	11/08/15

TEST CONDITIONS

MACHINE SPEED, mm/min	N/A	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.33

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	14.67	WATER CONTENT, (specimen) %	1.33
SAMPLE DIAMETER, cm	6.29	UNIT WEIGHT, kN/m ³	25.84
SAMPLE AREA, cm ²	31.03	DRY UNIT WT., kN/m ³	25.50
SAMPLE VOLUME, cm ³	455.39	SPECIFIC GRAVITY	-
WET WEIGHT, g	1200.40	VOID RATIO	-
DRY WEIGHT, g	1184.64		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	N/A	COMPRESSIVE STRENGTH, MPa	37.3
----------------------	-----	---------------------------	------

REMARKS:

Checked By: SEMP/ AC

Golder Associates

UNCONFINED COMPRESSION TEST (UC) OF INTACT ROCK CORE SPECIMENS
ASTM D7012

FIGURE B9.11



BEFORE COMPRESSION



AFTER COMPRESSION

Date Nov. 8, 2015
Project 10-1111-0058

Golder Associates

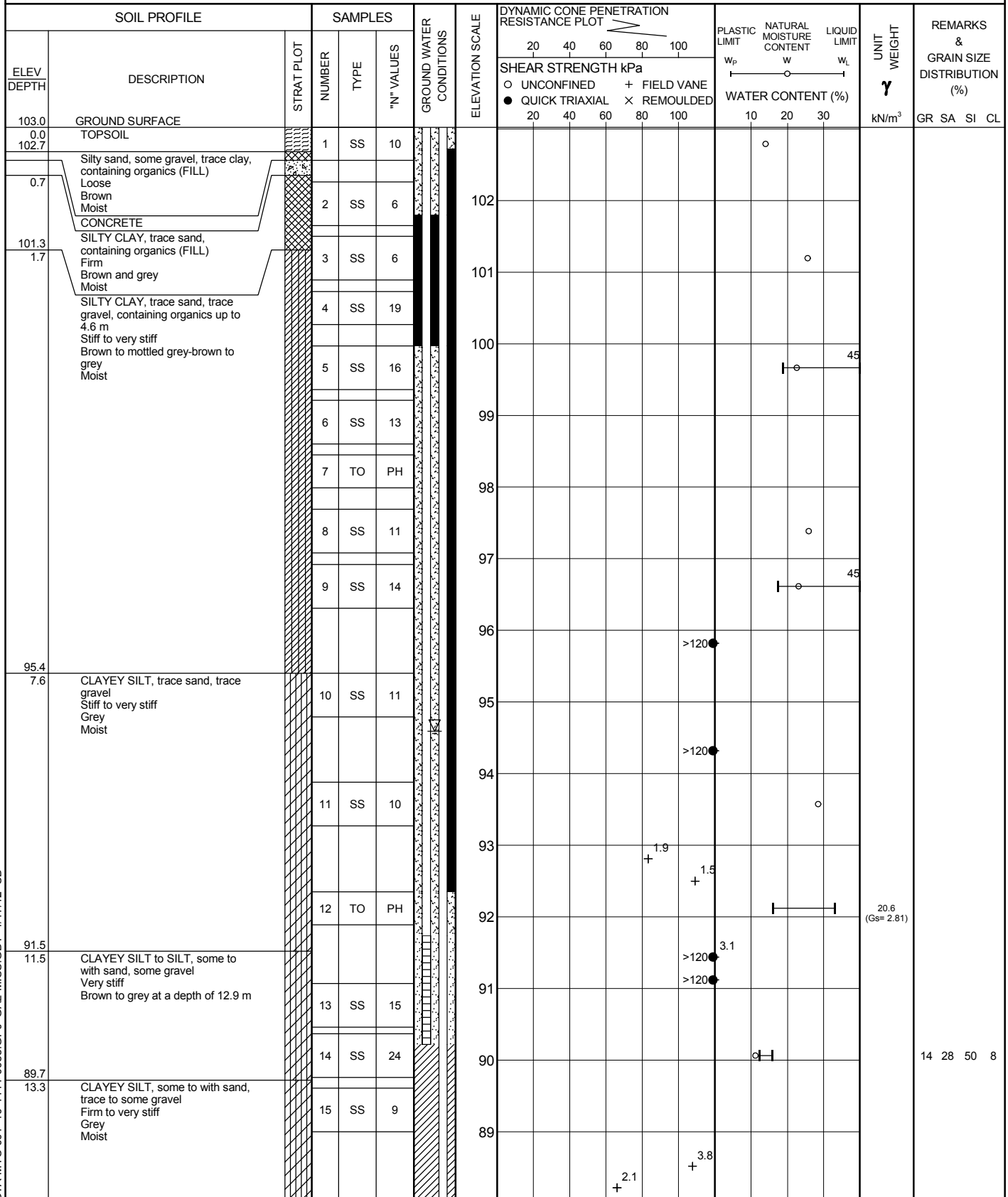
Drawn Frank
Chkd. SEMP/AC



APPENDIX C

Borehole Records from Previous Investigations

PROJECT 10-1111-0058		RECORD OF BOREHOLE No 1		1 OF 3 METRIC	
W.O. 08-2009		LOCATION N 4781024.7 ; E 328287.0		ORIGINATED BY MA	
DIST _____ HWY QEW		BOREHOLE TYPE CME 50 Track-mount; 108 mm Inner Diameter Hollow Stem Augers		COMPILED BY MS/NK	
DATUM Geodetic		DATE January 31 to February 4, 2011		CHECKED BY JPD	




Continued Next Page

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

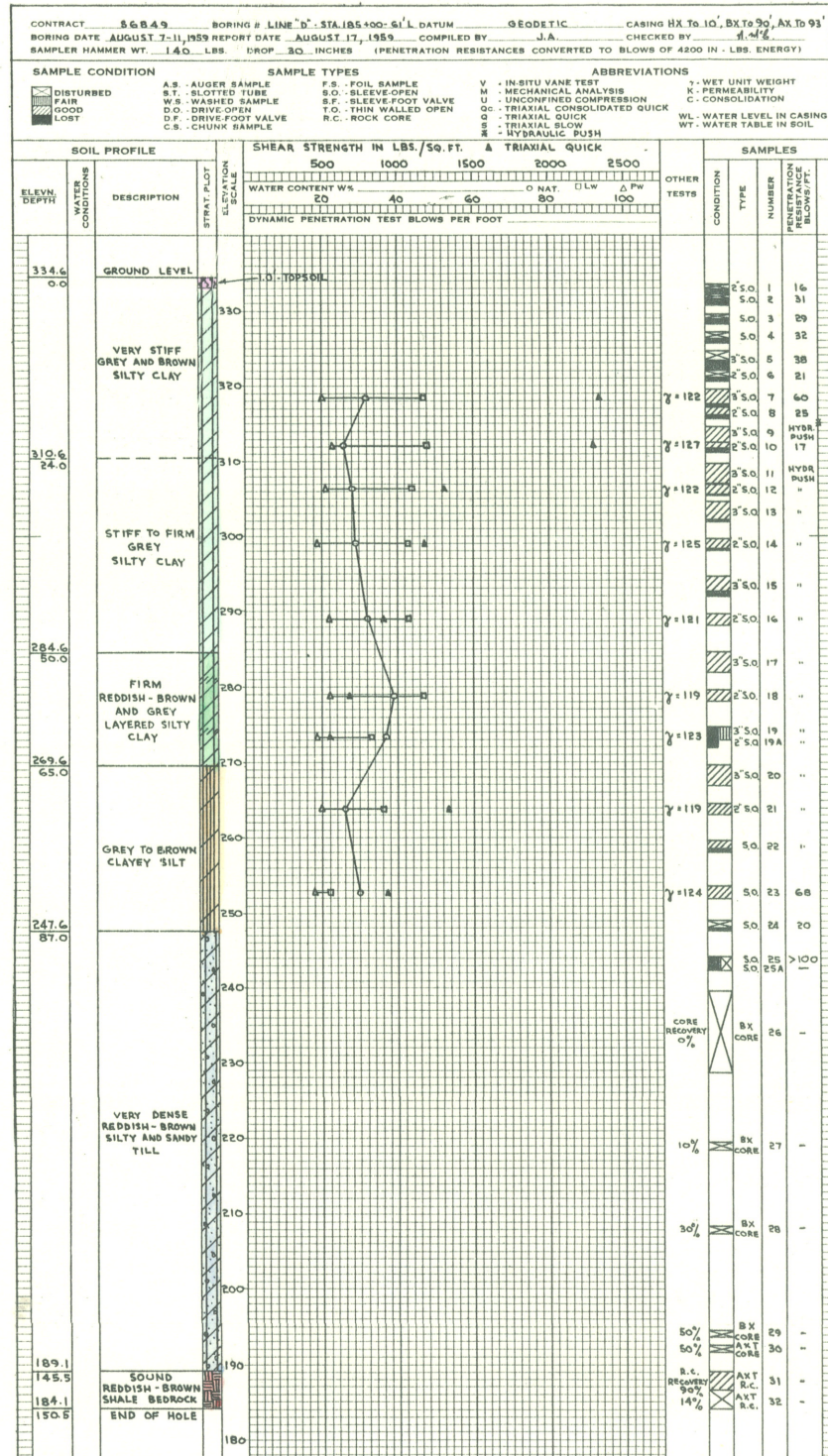
GTA-MTO 001 10-1111-0058.GPJ GAL-MISS.GDT 4/17/12 CD

PROJECT 10-1111-0058				RECORD OF BOREHOLE No 1				3 OF 3		METRIC								
W.O. 08-2009				LOCATION N 4781024.7 ; E 328287.0				ORIGINATED BY MA										
DIST _____ HWY QEW				BOREHOLE TYPE CME 50 Track-mount; 108 mm Inner Diameter Hollow Stem Augers				COMPILED BY MS/NK										
DATUM Geodetic				DATE January 31 to February 4, 2011				CHECKED BY JPD										
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT W _p	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa										
--- CONTINUED FROM PREVIOUS PAGE ---							20 40 60 80 100 ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED					WATER CONTENT (%)						
							20 40 60 80 100					10 20 30						
	SILT, trace to some gravel, trace to some sand, trace to some clay, containing rock fragments (TILL) Very dense Brown to grey Moist to wet		26	SS	61/0.1													0 8 82 10
			27	SS	72/0.15													
			28	SS	100/0.23													
67.7			29	SS	64/0.08													
35.3	END OF BOREHOLE																	
NOTES: 1. Water level in deep piezometer at a depth of 8.4 m (Elev. 94.6 m) upon completion of drilling. 2. Water level in shallow piezometer at a depth of 12.5 m (Elev. 90.5 m) upon completion of drilling. 3. Water level in deep piezometer at a depth of 10.6 m (Elev. 92.4 m) on June 24, 2011. 4. Water level in shallow piezometer at a depth of 3.0 m (Elev. 100.0 m) on June 24, 2011.																		

PROJECT 10-1111-0058		RECORD OF BOREHOLE No 3				3 OF 3		METRIC																		
W.O. 08-2009		LOCATION N 4780926.3 ; E 329702.5				ORIGINATED BY MS																				
DIST _____ HWY QEW		BOREHOLE TYPE CME 50 Track-mount; 70 mm Inner Diameter Hollow Stem Augers				COMPILED BY NK																				
DATUM Geodetic		DATE March 10 to 12, 2011				CHECKED BY JPD																				
SOIL PROFILE		SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC NATURAL LIQUID LIMIT MOISTURE LIMIT CONTENT CONTENT			UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%)										
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE			"N" VALUES	SHEAR STRENGTH kPa					WATER CONTENT (%)													
	--- CONTINUED FROM PREVIOUS PAGE ---						<div style="display: flex; justify-content: space-between;"> 20 40 60 80 100 20 40 60 80 100 </div> <div style="display: flex; justify-content: space-between;"> ○ UNCONFINED + FIELD VANE ● QUICK TRIAXIAL × REMOULDED </div>					<div style="display: flex; justify-content: space-between;"> W_p W W_L </div>														
76.6	Refer to Record of Drillhole 3 for details		22	SS	100/0.00																					
31.0			R1	RC	REC 8%																RQD = 0%					
			R2	RC	REC 96%																	RQD = 27%				
			R3	RC	REC 100%																	RQD = 46%				
72.5	END OF BOREHOLE																									
35.1	NOTE: 1. Water level in open borehole at a depth of 28.3 m (Elev. 79.3 m) upon completion of drilling.																									

OFFICE REPORT ON SOIL EXPLORATION

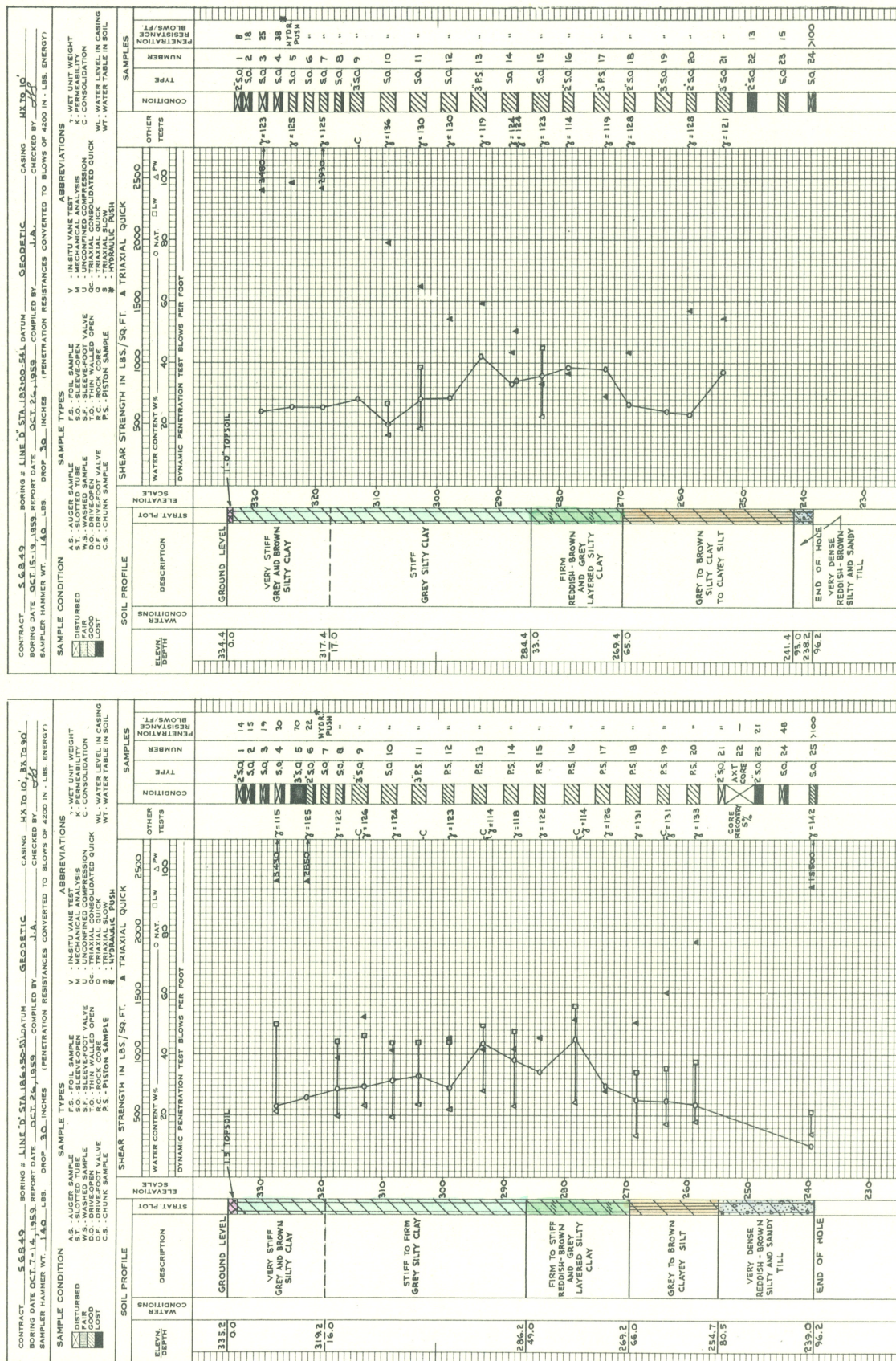
APPENDIX 1
FIGURE 13
PROJECT-S6849



GEOCON

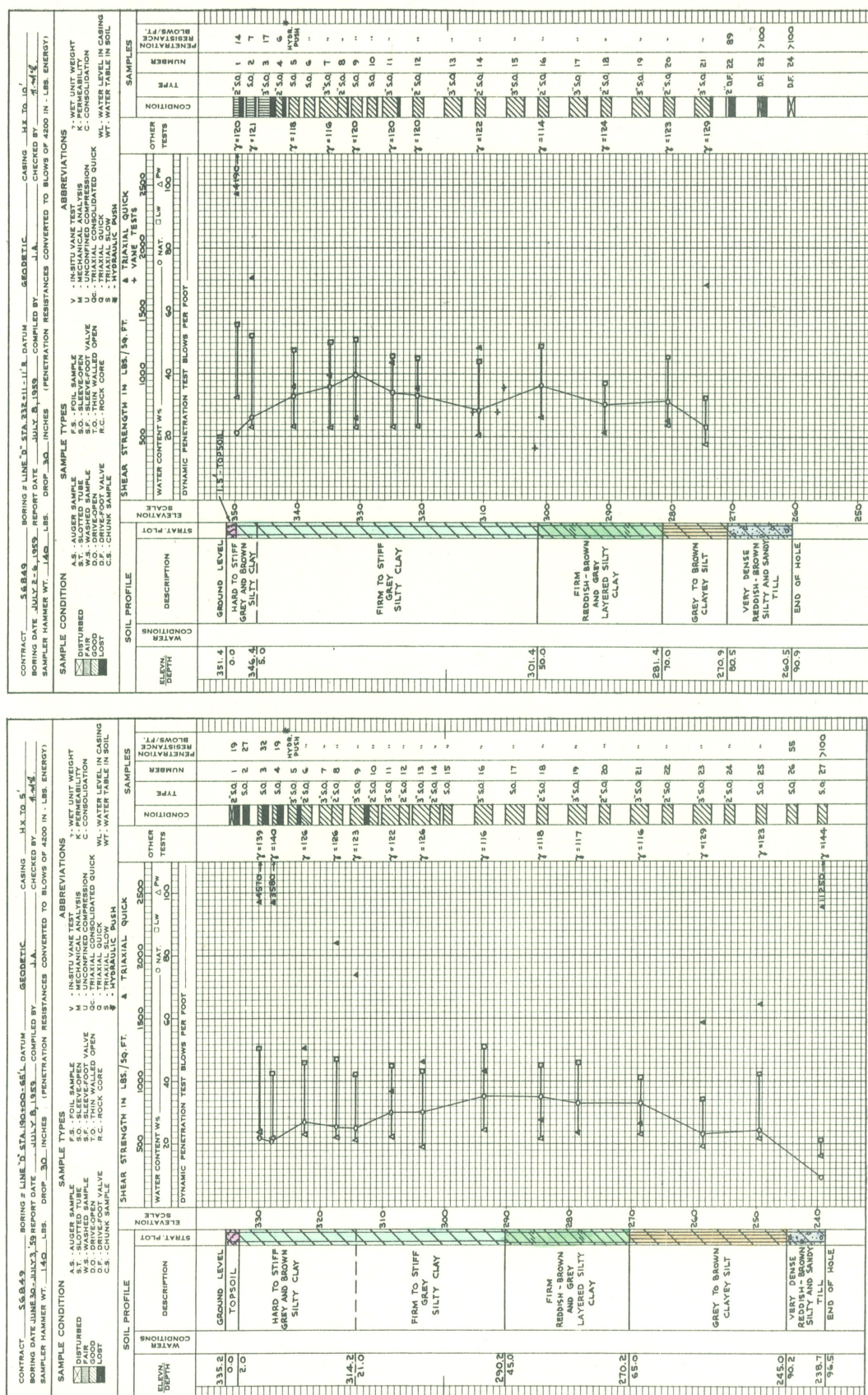
OFFICE REPORT ON SOIL EXPLORATION

APPENDIX 1
FIGURE 16
PROJECT S6849



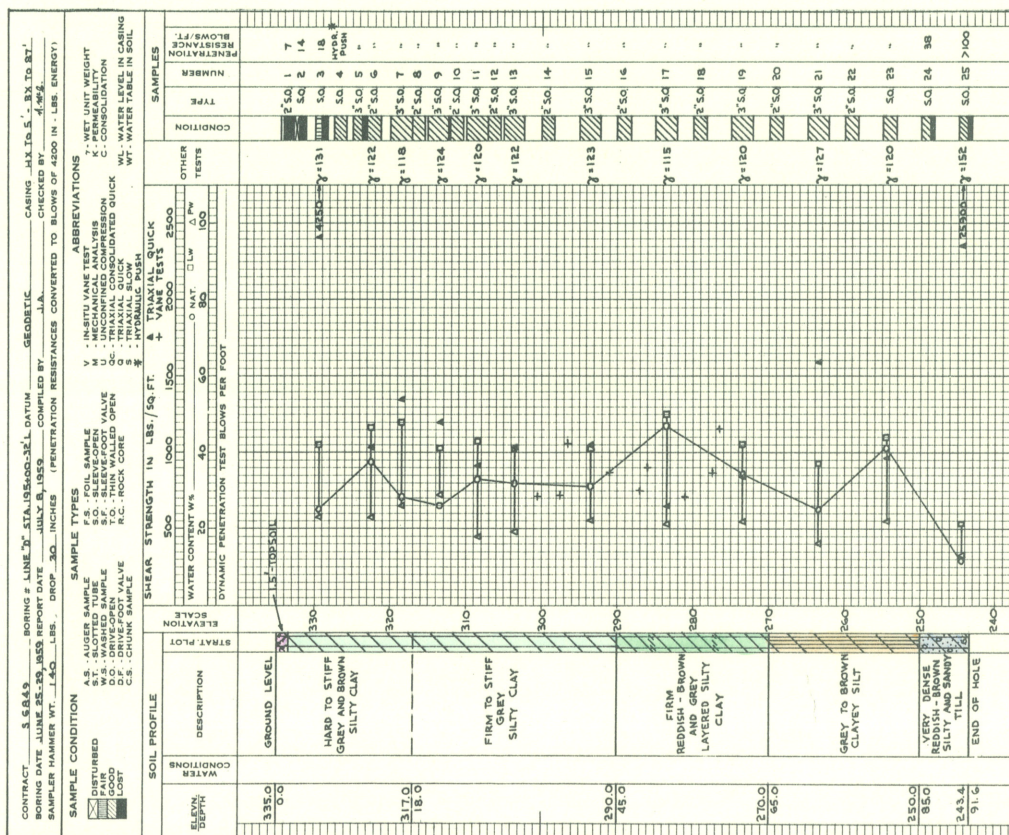
GEOCON

APPENDIX 1
FIGURE 8
PROJECT-S6849



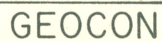
GEOCON

APPENDIX 1
FIGURE 7
PROJECT-S6849



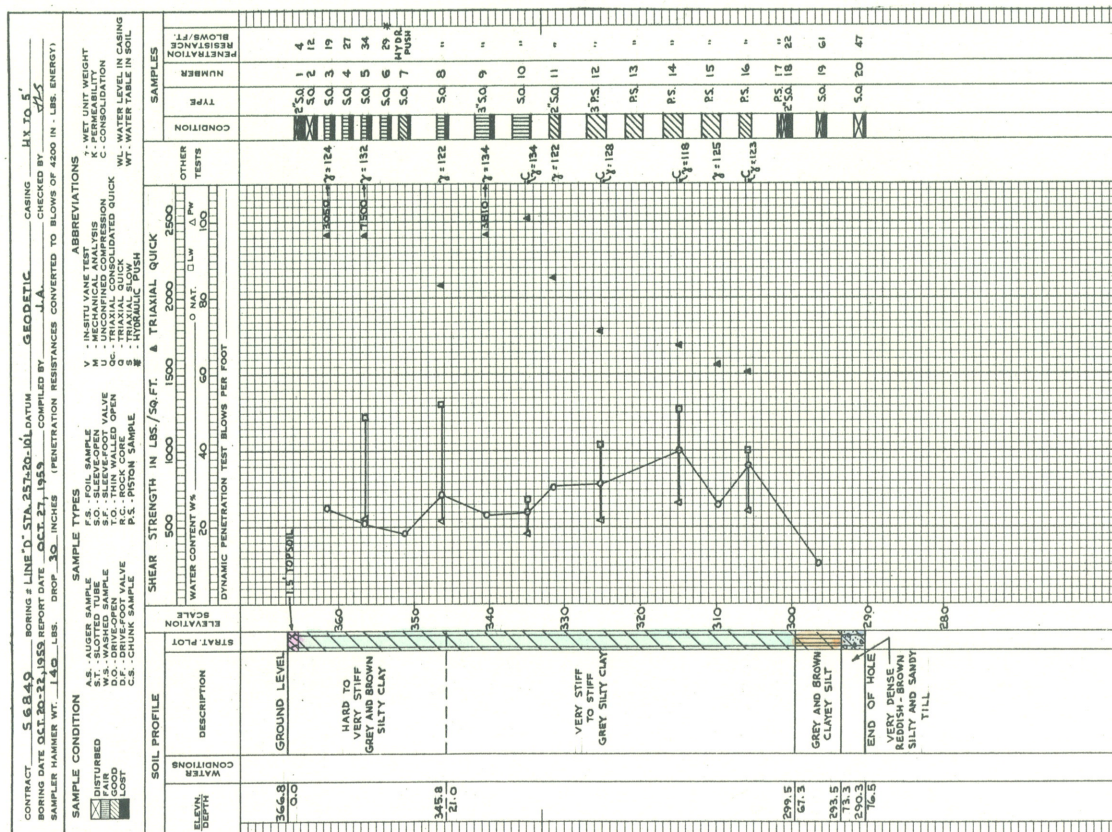
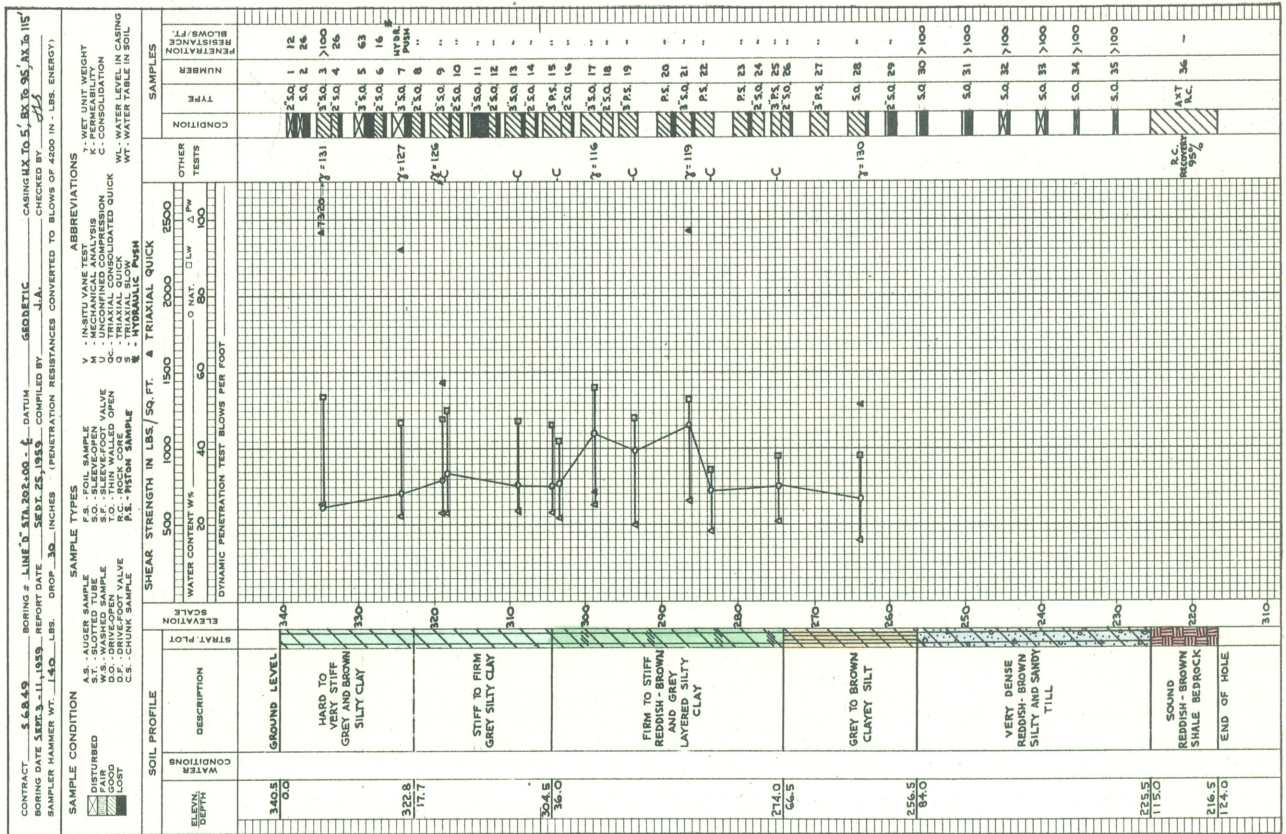
GEOCON

APPENDIX 1
FIGURE 6
PROJECT-S6849



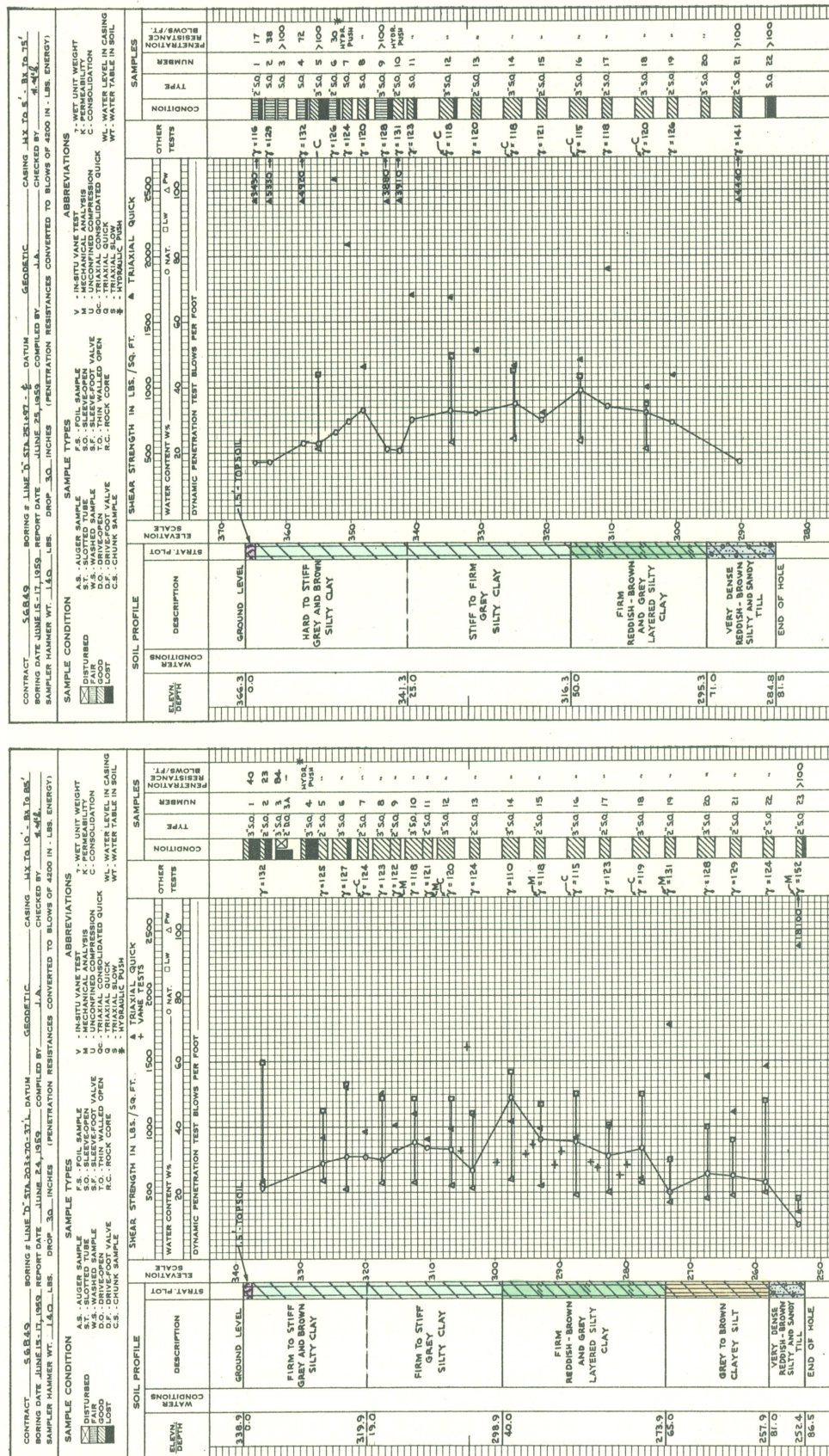
OFFICE REPORT ON SOIL EXPLORATION

APPENDIX 1
FIGURE 15
PROJECT-S6849



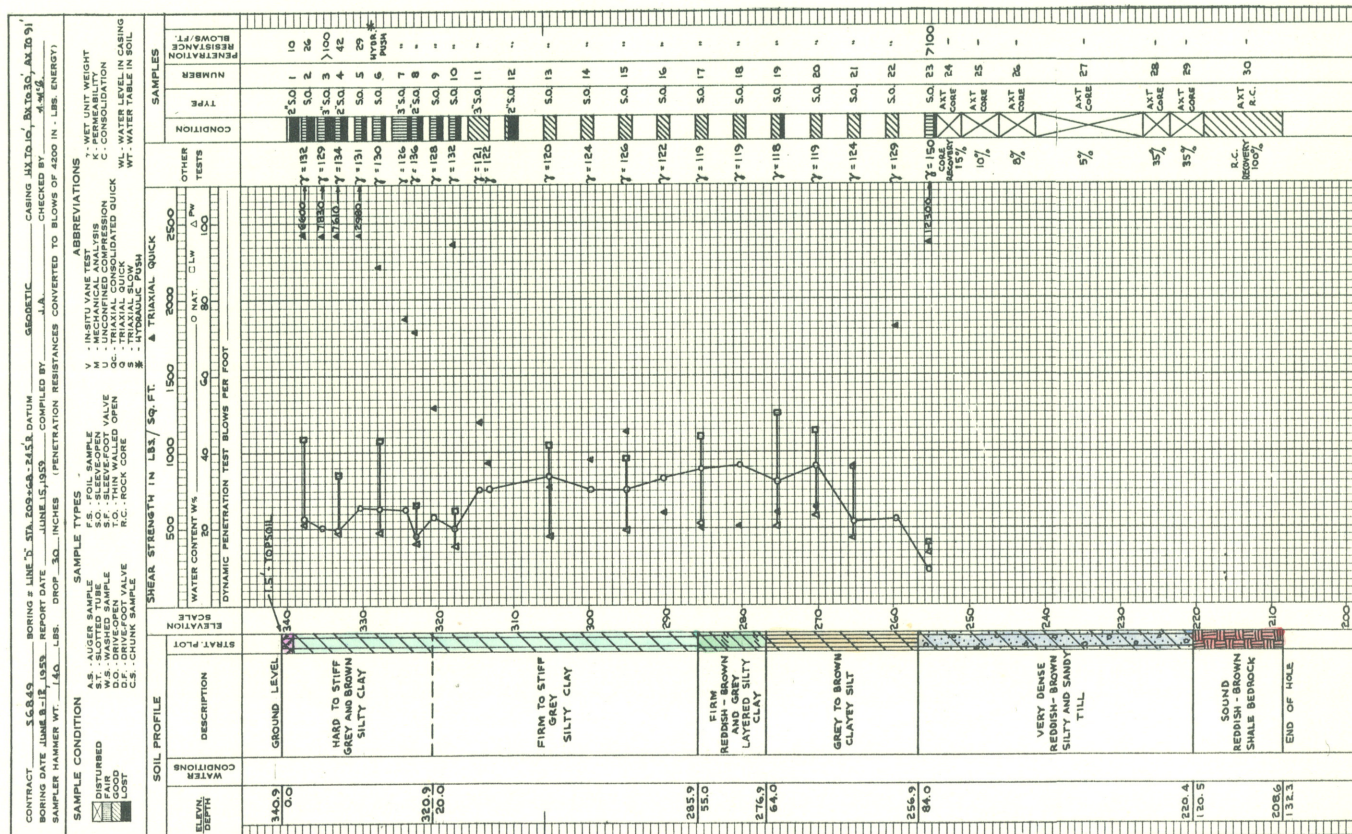
GEOCON

APPENDIX 1
FIGURE 5
PROJECT S6849



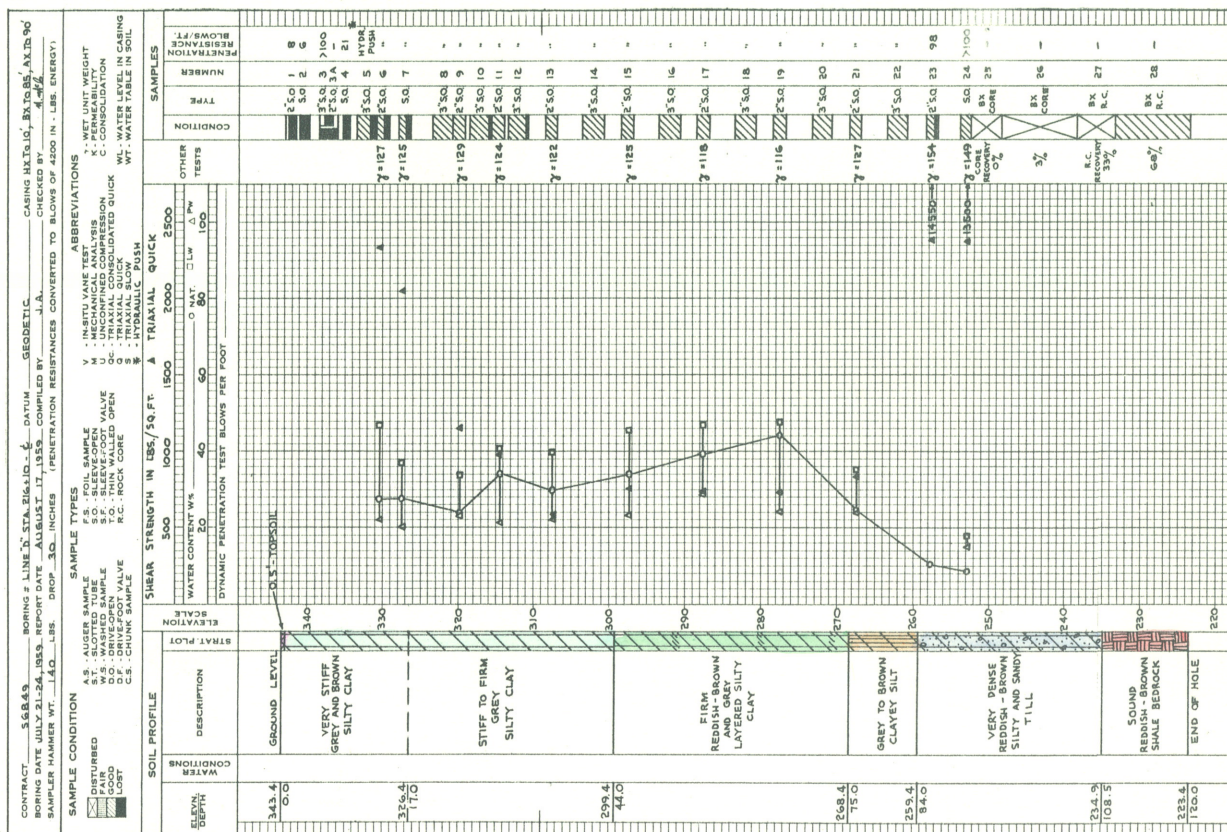
GEOCON

APPENDIX I
FIGURE 4
PROJECT-S6849



GEOCON

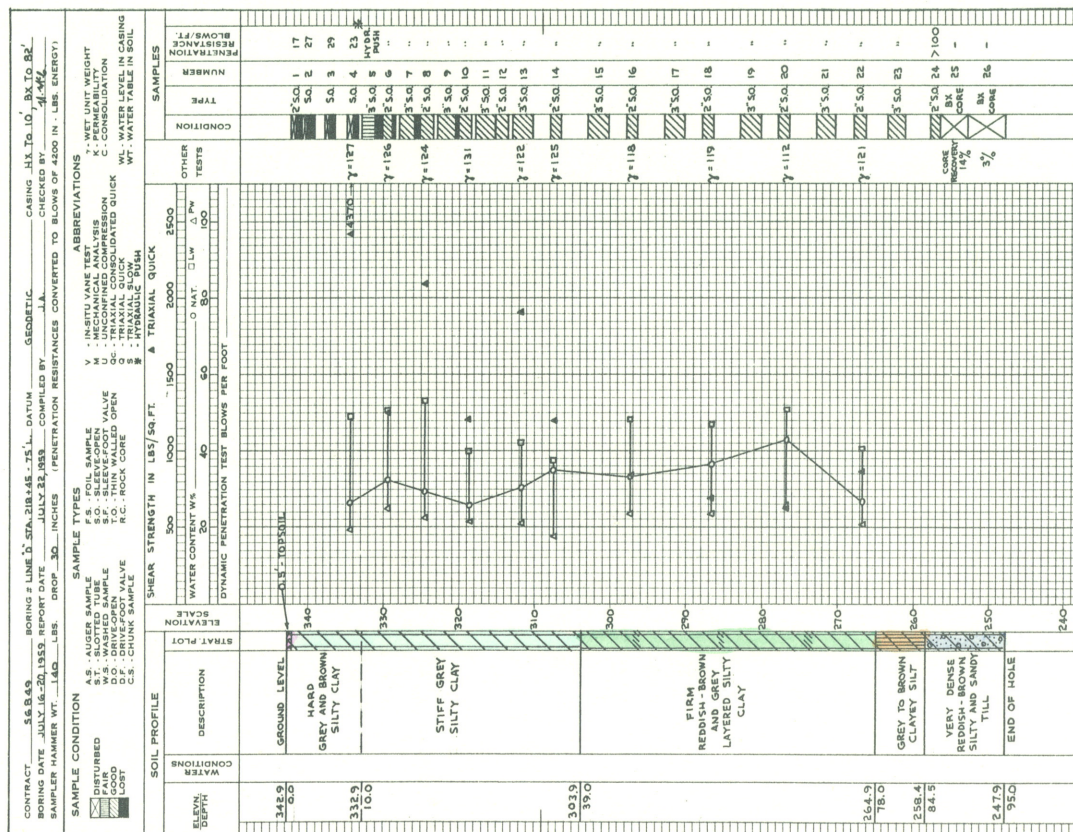
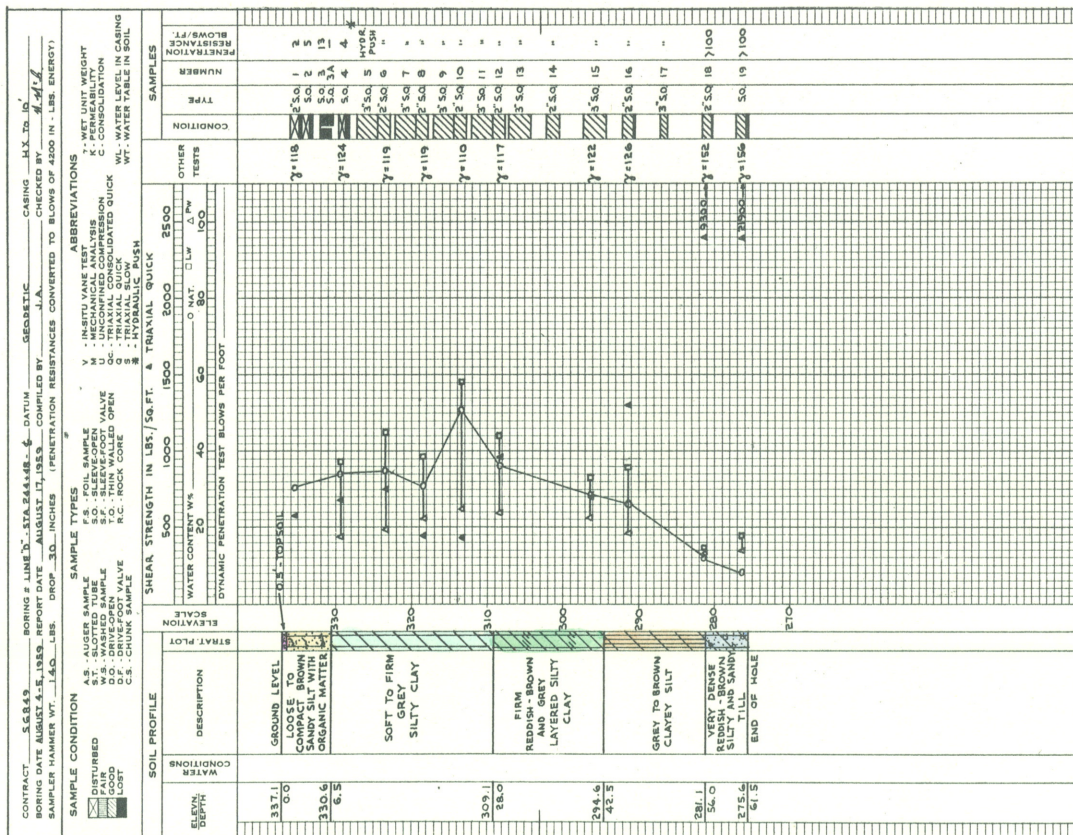
APPENDIX I
FIGURE 12
PROJECT-S6849



GEOCON

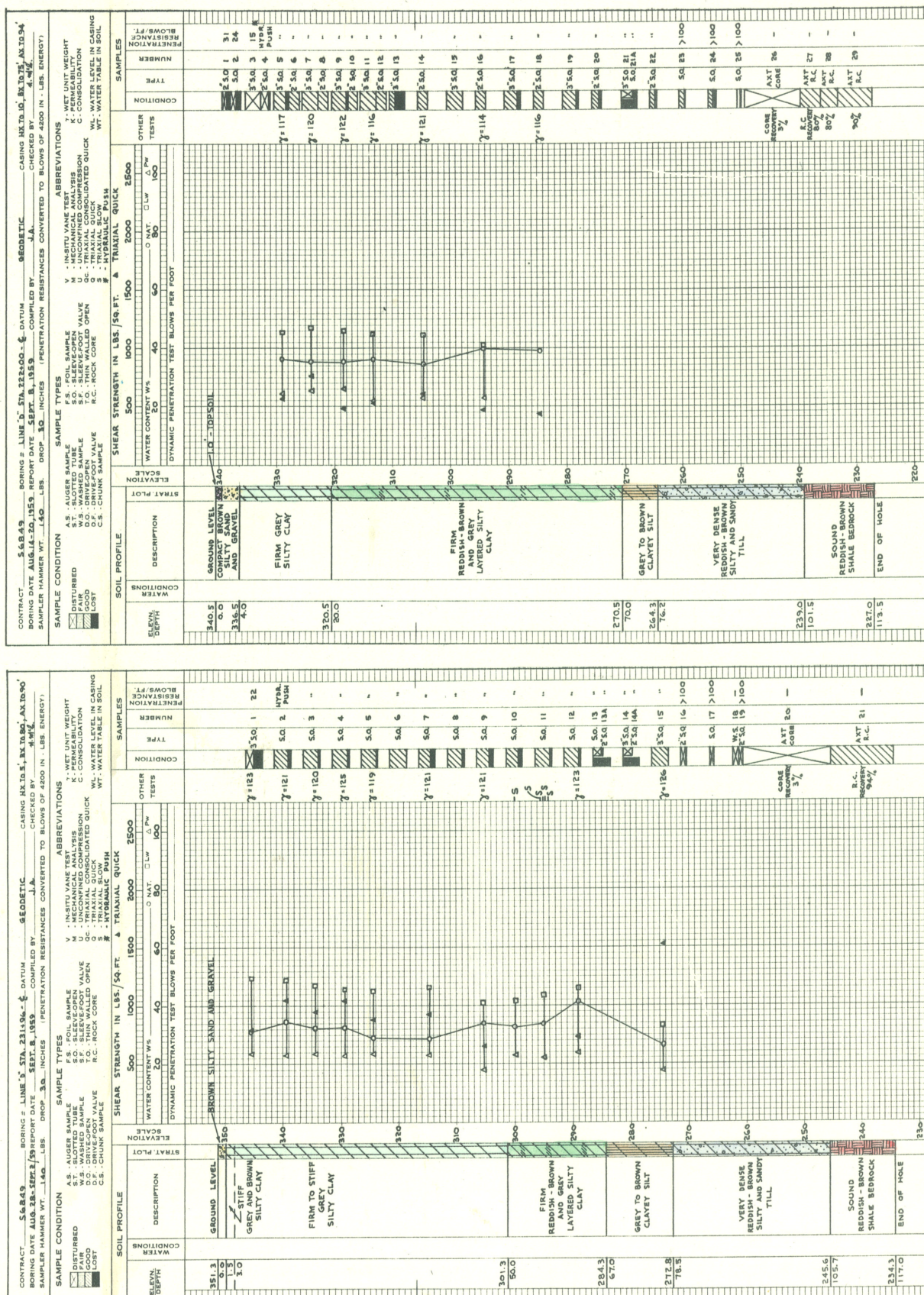
OFFICE REPORT ON SOIL EXPLORATION

APPENDIX I
FIGURE II
PROJECT-S6849



GEOCON

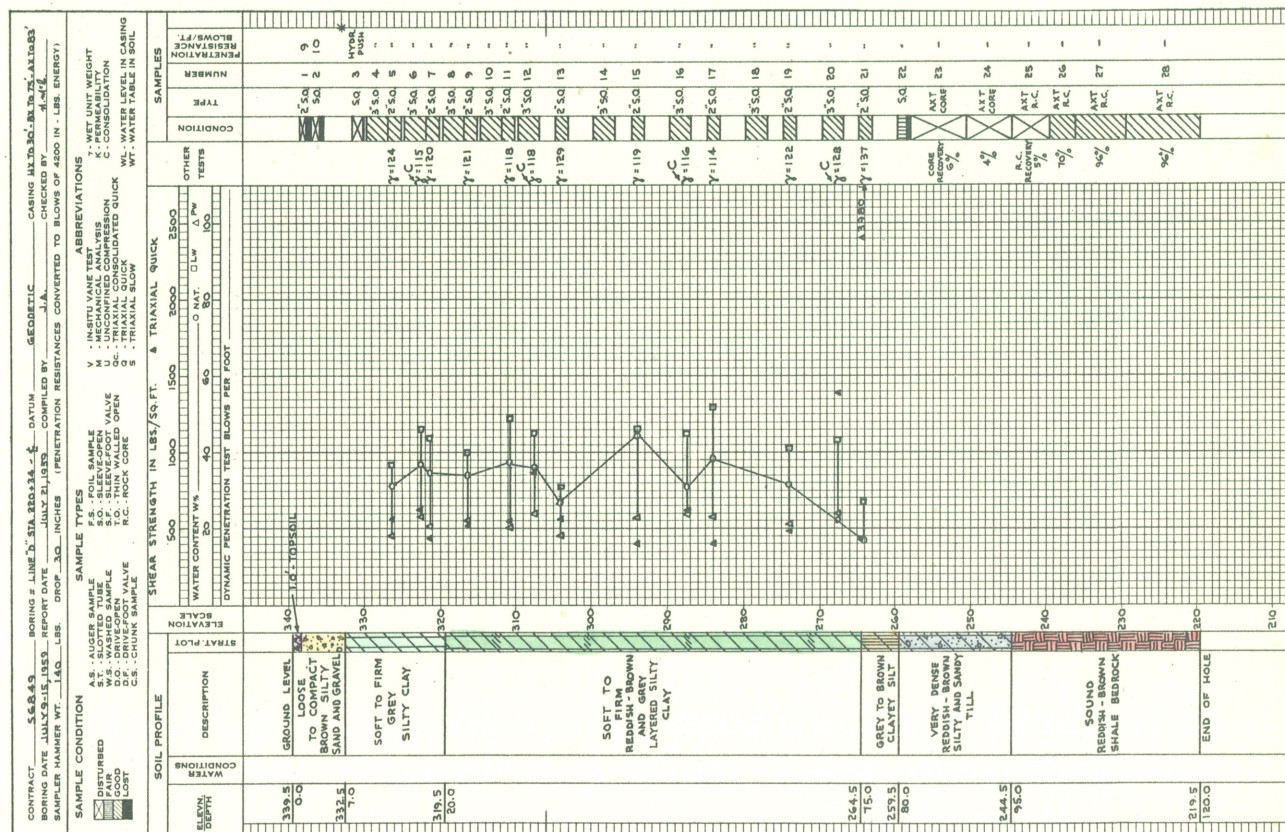
APPENDIX I
FIGURE 14
PROJECT-S6849



APPENDIX I
FIGURE 9
PROJECT-S6849



APPENDIX I
FIGURE 10
PROJECT-S6849

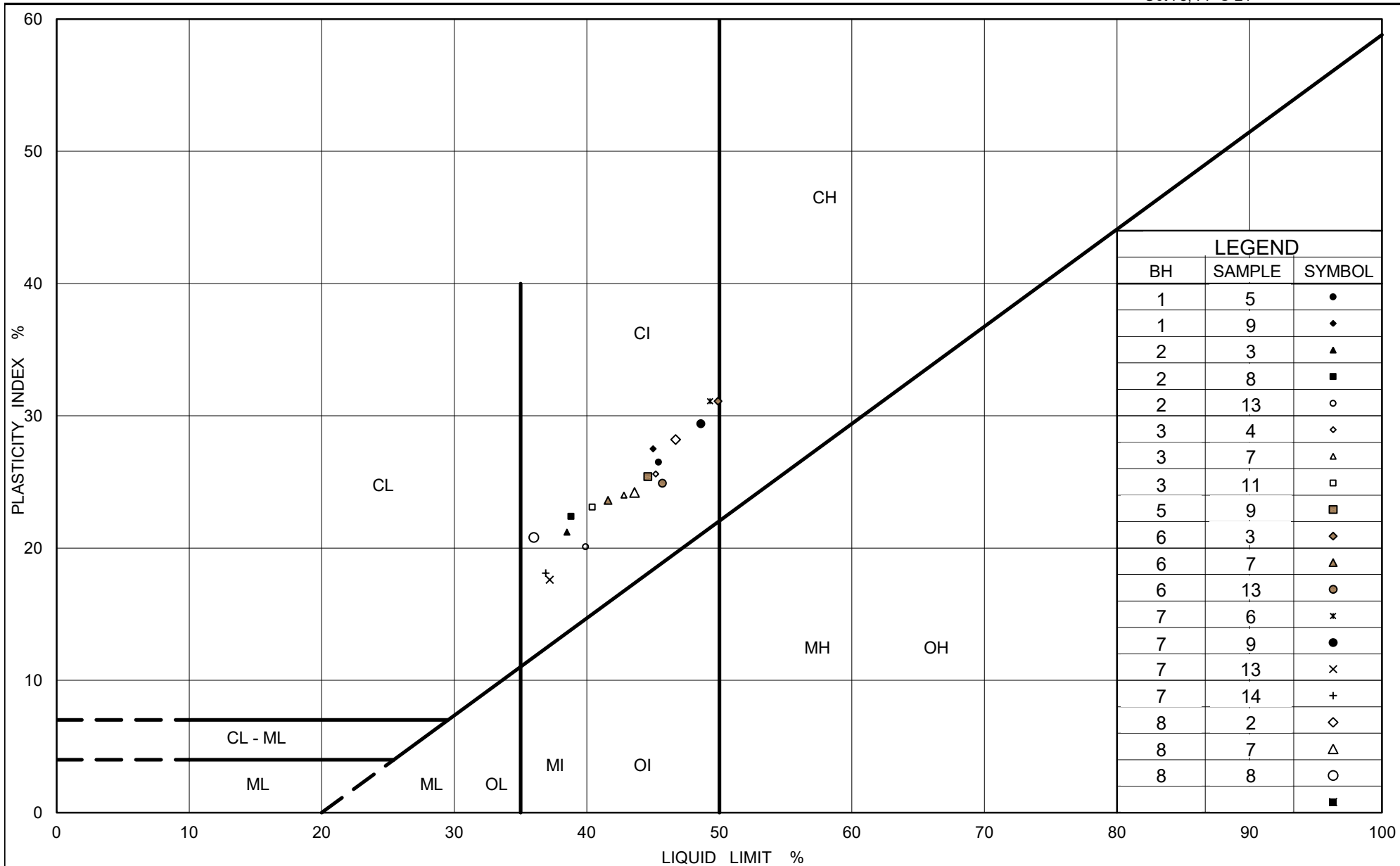


GEOCON



APPENDIX D

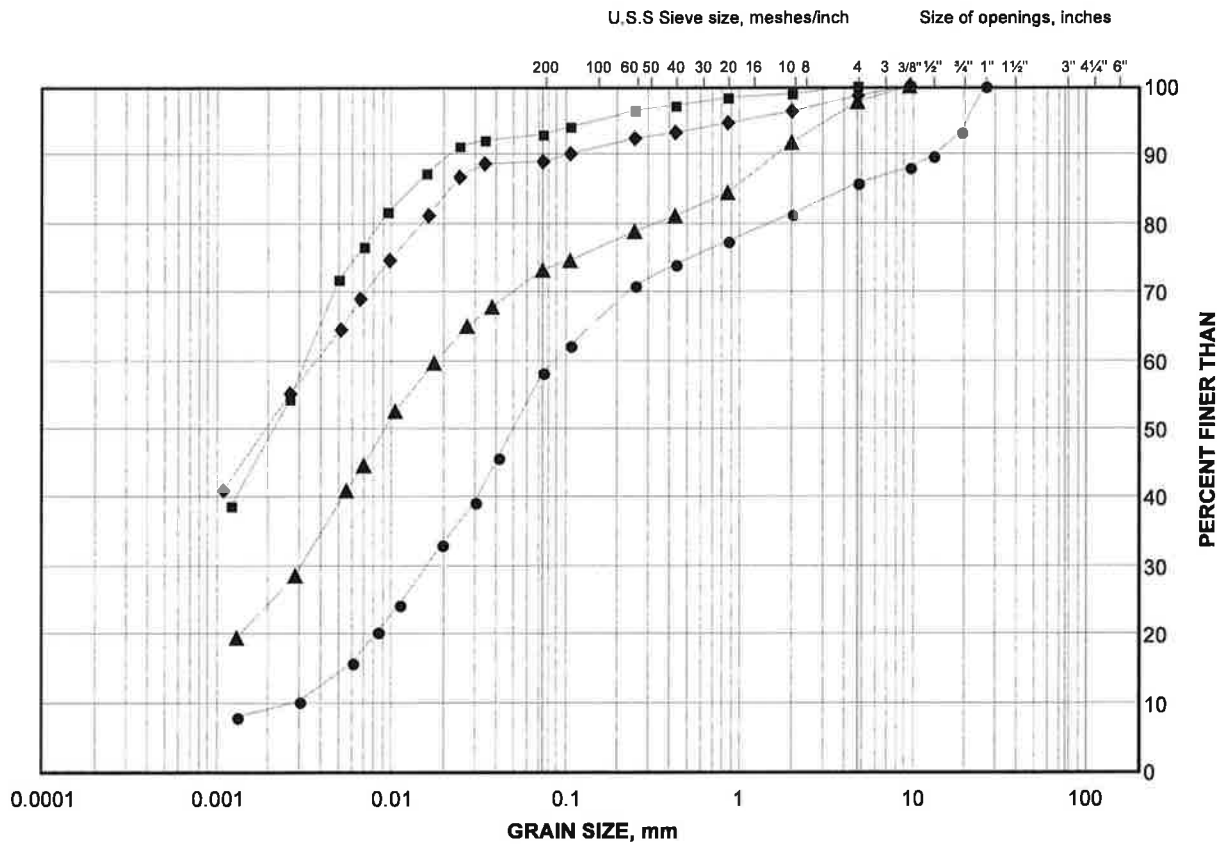
Laboratory Test Results from Previous Investigations



GRAIN SIZE DISTRIBUTION

Clayey Silt to Silt

FIGURE B7



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

LEGEND

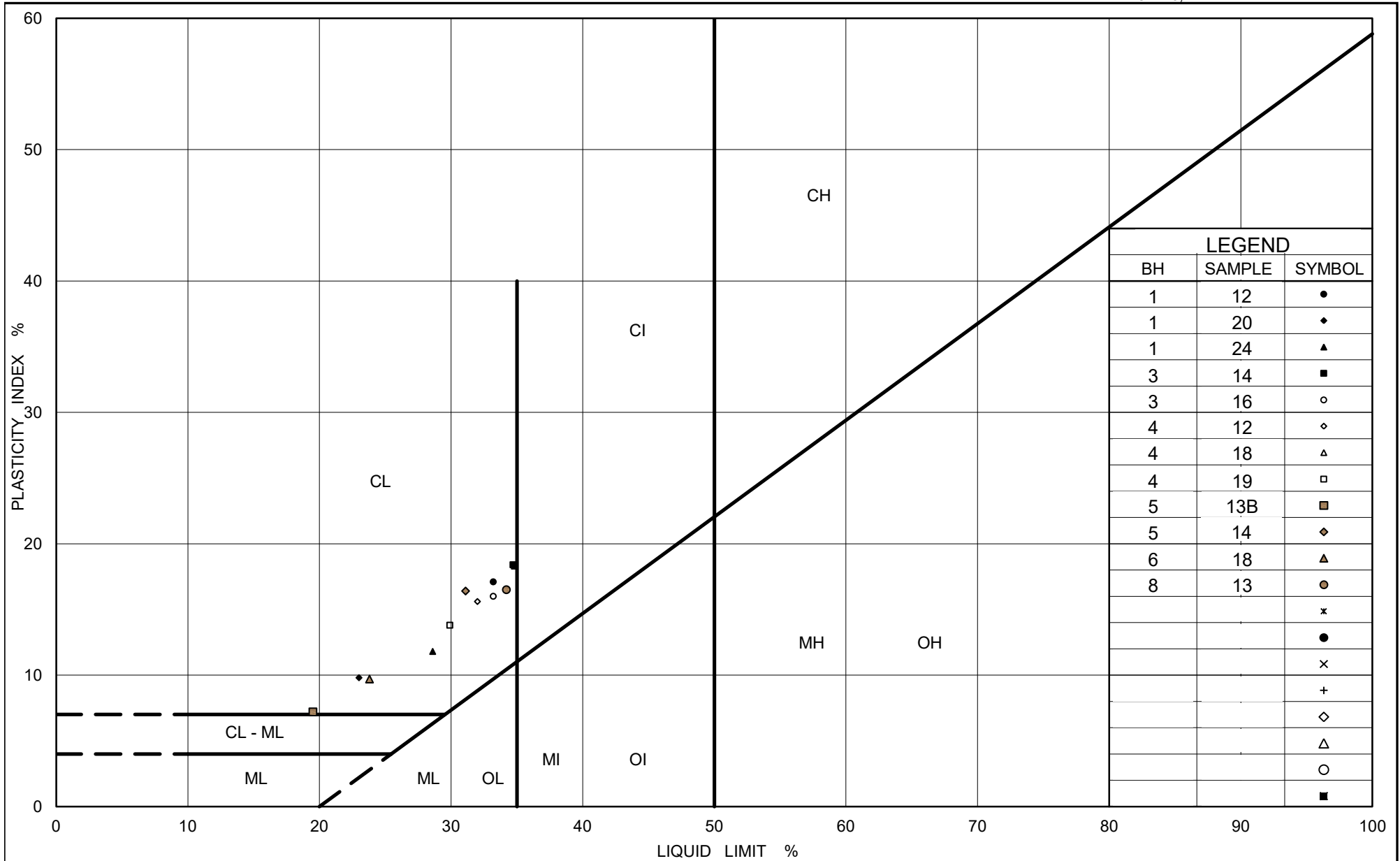
SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	1	14	90.1
■	3	16	86.0
◆	4	18	89.0
▲	1	20	81.7

Project Number: 10-1111-0058

Checked By: *JPD*

Golder Associates

Date: 02-Sep-11



Ministry of
Transportation

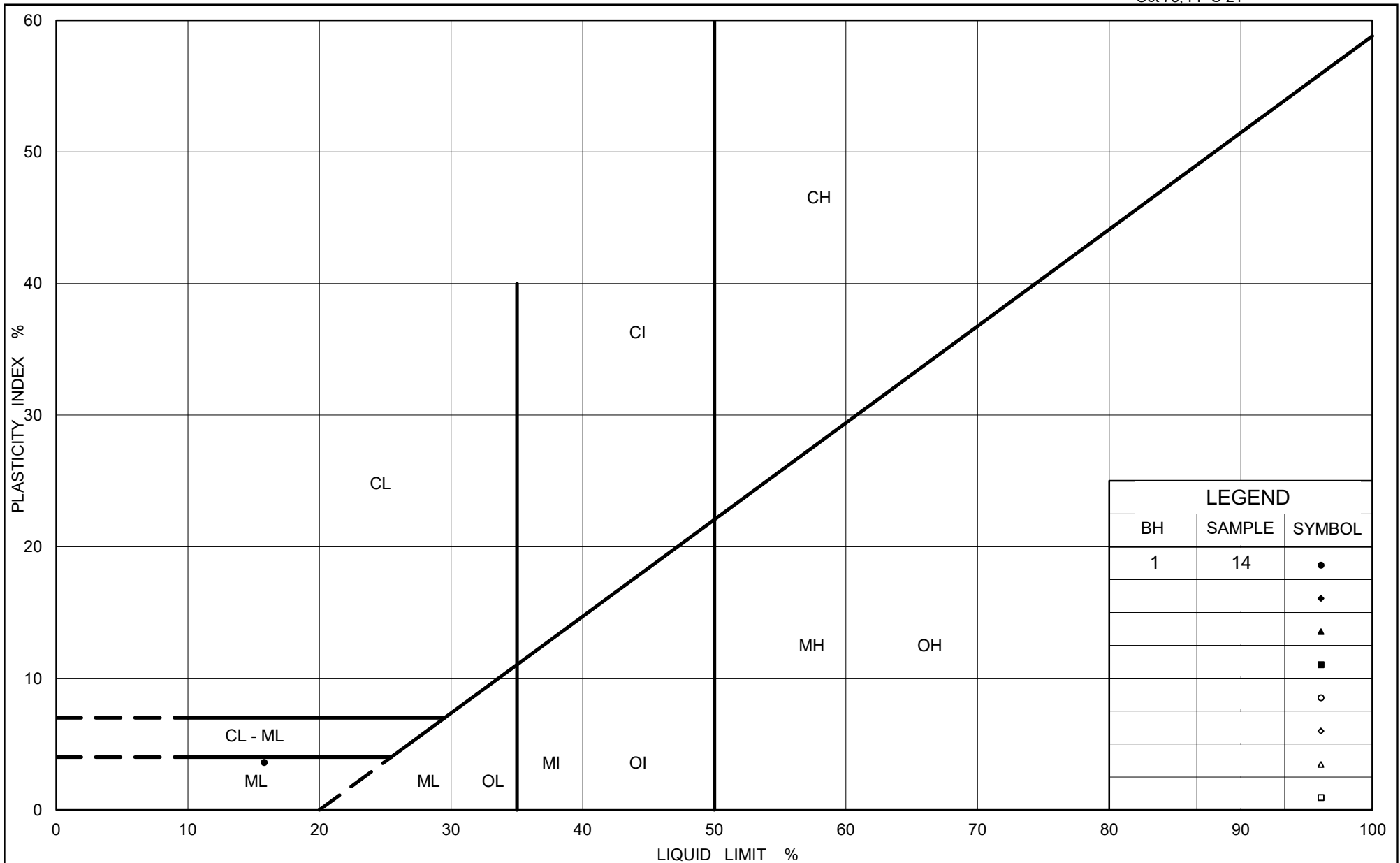
Ontario

PLASTICITY CHART Clayey Silt

Figure No. B8

Project No. 10-1111-0058

Checked By: JPD



Ministry of Transportation

Ontario

PLASTICITY CHART Clayey Silt to Silt

Figure No. B9

Project No. 10-1111-0058

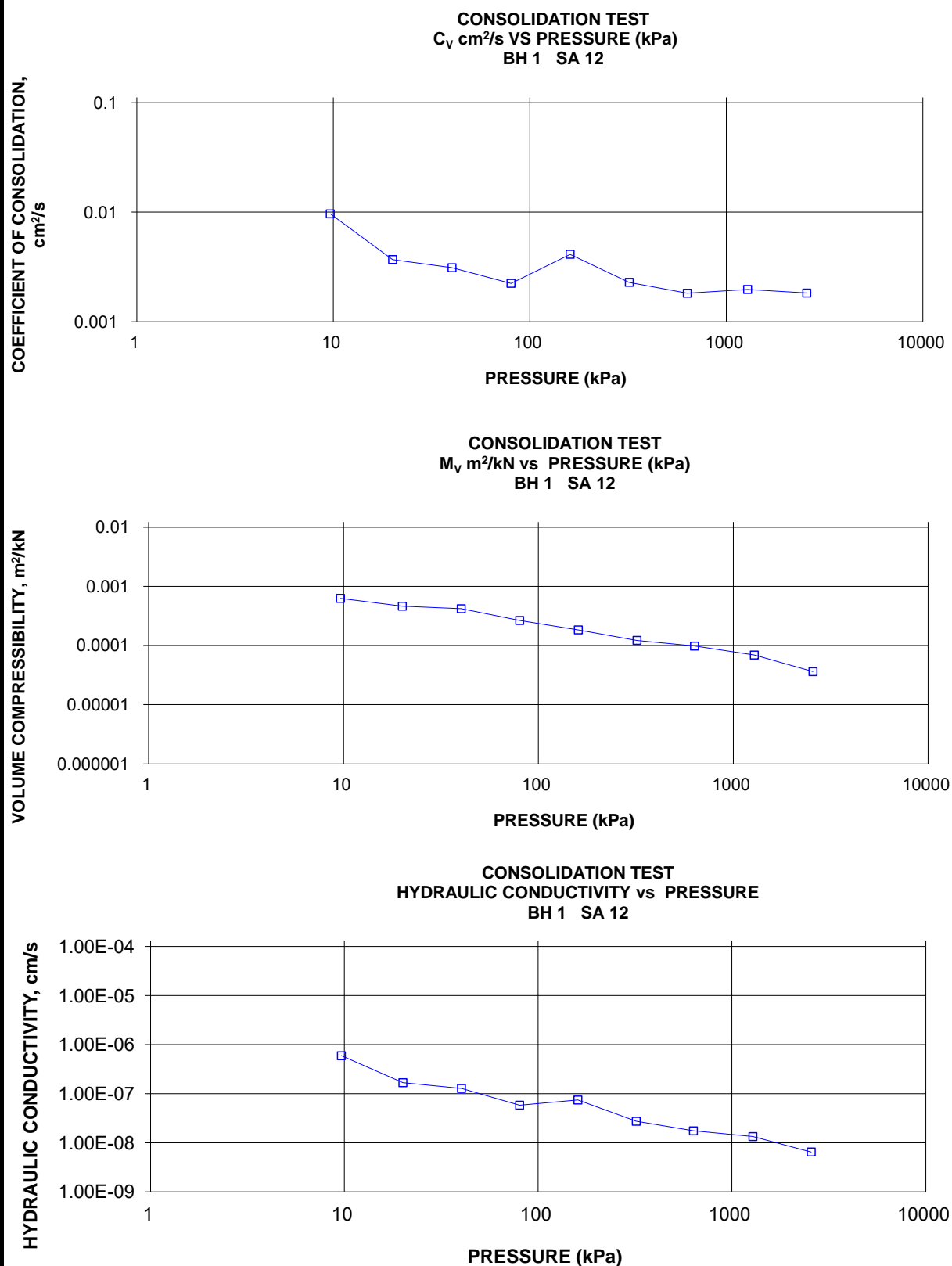
Checked By: JPD

CONSOLIDATION TEST SUMMARY					FIGURE B10A		
Clayey Silt to Silt							
SAMPLE IDENTIFICATION							
Project Number	10-1111-0058			Sample Number	12		
Borehole Number	1			Sample Depth, m	10.7-11.1		
TEST CONDITIONS							
Test Type	Standard			Load Duration, hr	24		
Oedometer Number	5						
Date Started	4/01/2011						
Date Completed	4/14/2011						
SAMPLE DIMENSIONS AND PROPERTIES - INITIAL							
Sample Height, cm	1.90			Unit Weight, kN/m ³	20.61		
Sample Diameter, cm	6.32			Dry Unit Weight, kN/m ³	16.75		
Area, cm ²	31.33			Specific Gravity, measured	2.81		
Volume, cm ³	59.50			Solids Height, cm	1.154		
Water Content, %	23.04			Volume of Solids, cm ³	36.16		
Wet Mass, g	125.02			Volume of Voids, cm ³	23.34		
Dry Mass, g	101.61			Degree of Saturation, %	100.3		
TEST COMPUTATIONS							
	Corr.		Average				
Pressure	Height	Void	Height	t ₉₀	c _v	m _v	k
kPa	cm	Ratio	cm	sec	cm ² /s	m ² /kN	cm/s
0.00	1.899	0.645	1.899				
4.60	1.900	0.646	1.899				
9.65	1.894	0.641	1.897	79	9.66E-03	6.26E-04	5.92E-07
20.04	1.885	0.633	1.889	205	3.69E-03	4.61E-04	1.67E-07
40.20	1.869	0.619	1.877	240	3.11E-03	4.18E-04	1.27E-07
80.20	1.849	0.602	1.859	327	2.24E-03	2.65E-04	5.81E-08
160.35	1.821	0.578	1.835	173	4.13E-03	1.83E-04	7.41E-08
320.71	1.784	0.545	1.802	301	2.29E-03	1.22E-04	2.73E-08
632.60	1.726	0.495	1.755	359	1.82E-03	9.78E-05	1.74E-08
1282.84	1.641	0.422	1.683	305	1.97E-03	6.89E-05	1.33E-08
2565.68	1.553	0.345	1.597	296	1.83E-03	3.61E-05	6.46E-09
1282.84	1.567	0.357	1.560				
320.71	1.600	0.386	1.583				
80.20	1.653	0.432	1.626				
20.04	1.702	0.475	1.677				
4.61	1.743	0.510	1.722				
Note: k calculated using cv based on t ₉₀ values. Sample swelled under 10kPa							
SAMPLE DIMENSIONS AND PROPERTIES - FINAL							
Sample Height, cm	1.74			Unit Weight, kN/m ³	22.30		
Sample Diameter, cm	6.32			Dry Unit Weight, kN/m ³	18.25		
Area, cm ²	31.33			Specific Gravity, measured	2.81		
Volume, cm ³	54.61			Solids Height, cm	1.154		
Water Content, %	22.18			Volume of Solids, cm ³	36.16		
Wet Mass, g	124.15			Volume of Voids, cm ³	18.45		
Dry Mass, g	101.61						
Prepared By: LFG					Golder Associates		
					Checked By: JPD		

CONSOLIDATION TEST SUMMARY

Clayey Silt to Silt

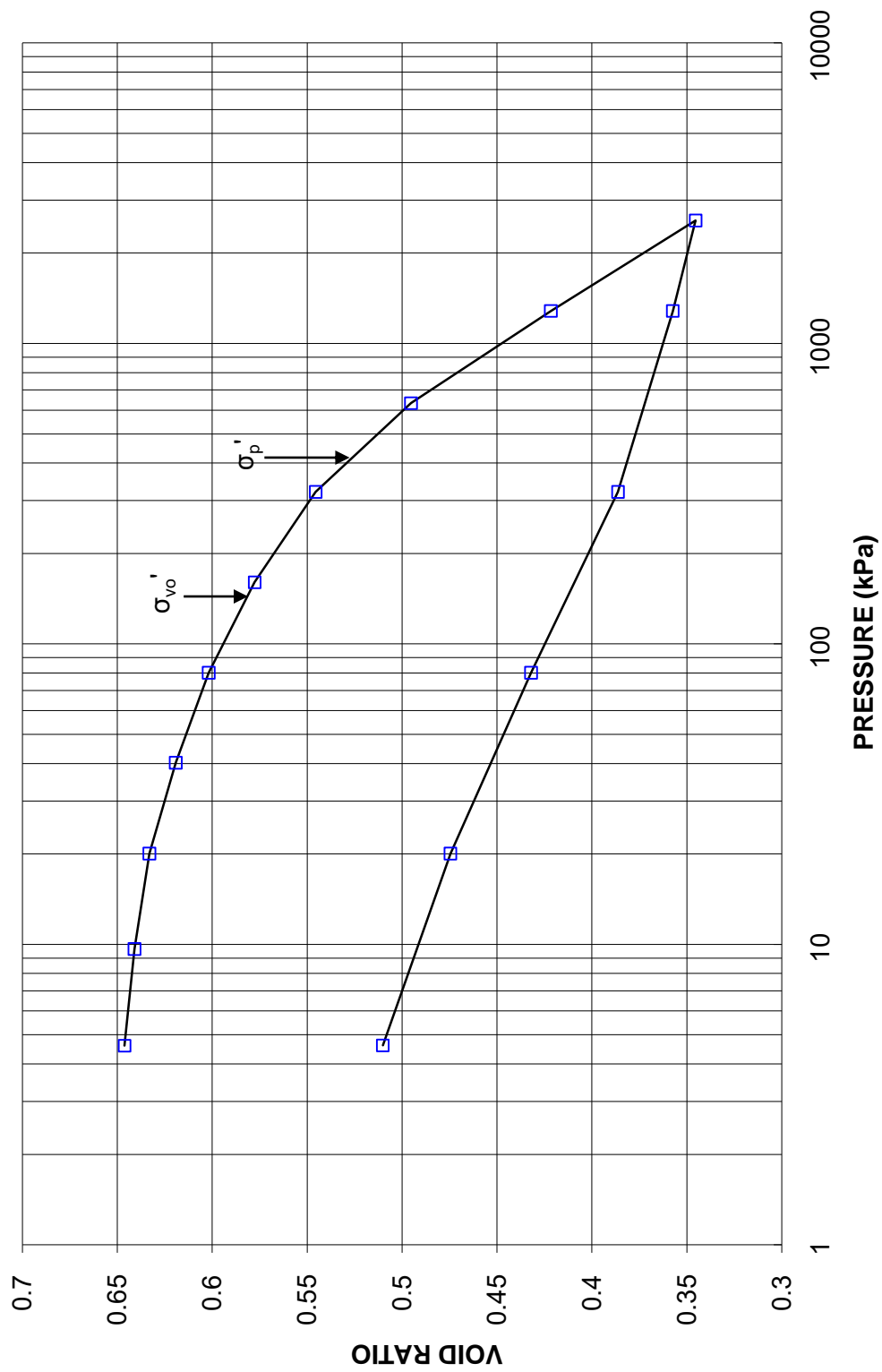
FIGURE B10B



CONSOLIDATION TEST VOID RATIO VS LOG PRESSURE

FIGURE B10C

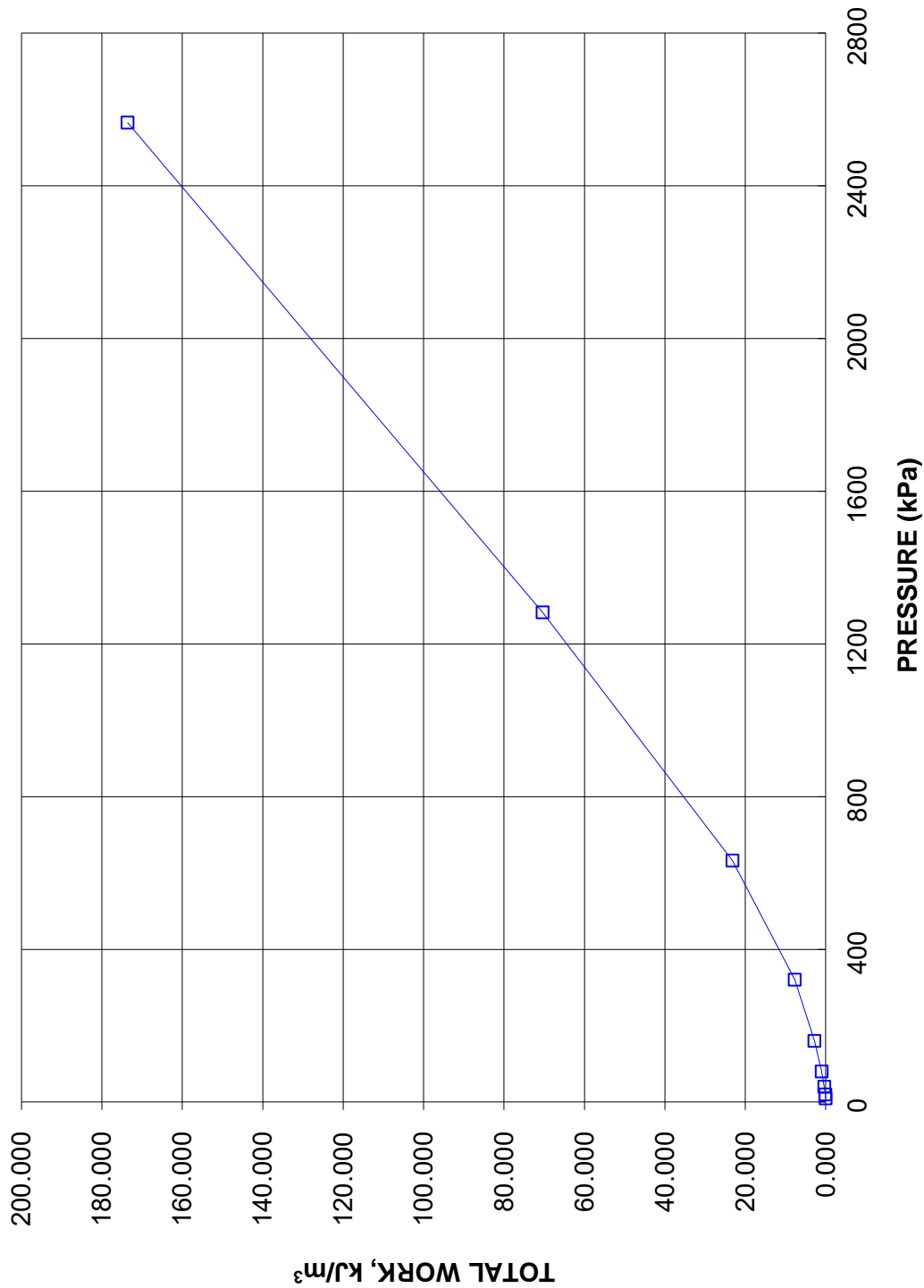
CONSOLIDATION TEST
VOID RATIO vs PRESSURE
BH 1 SA 12



**CONSOLIDATION TEST
TOTAL WORK VS PRESSURE**

FIGURE B10D

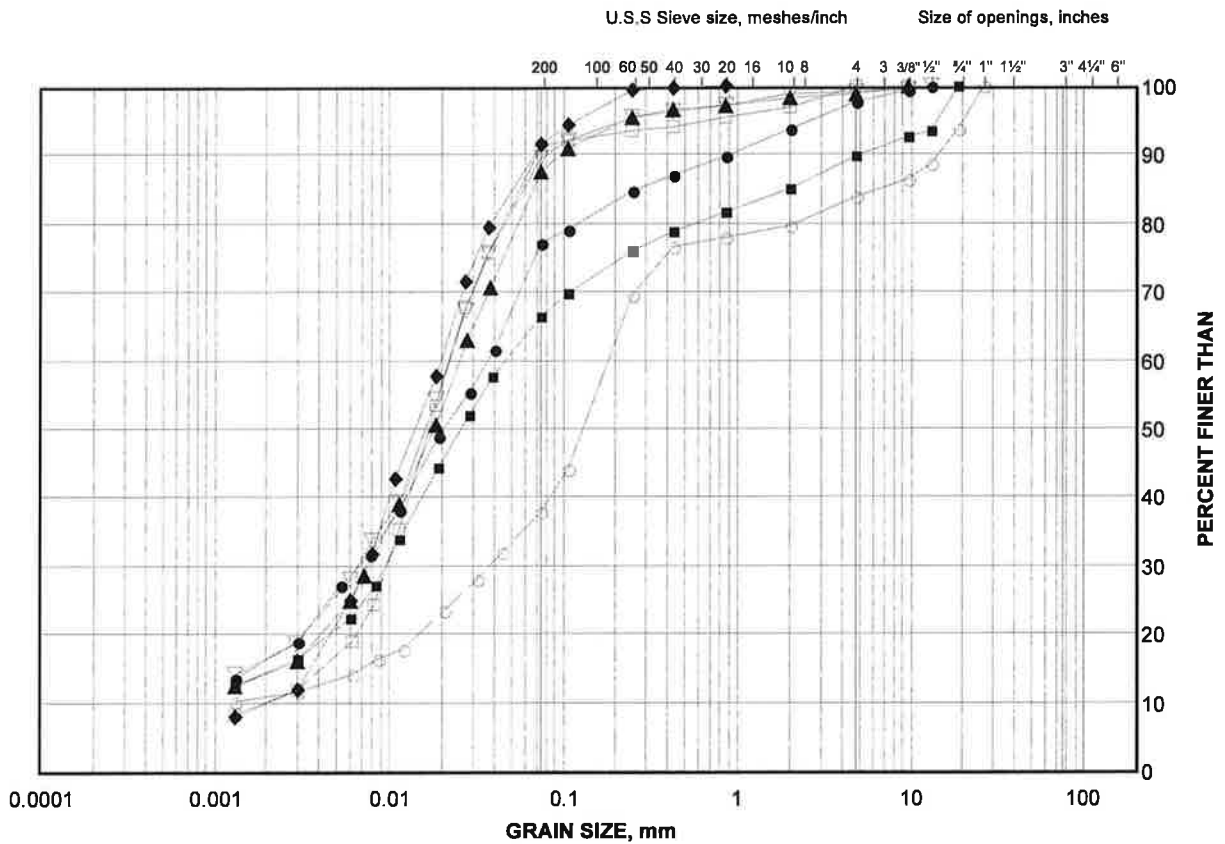
**CONSOLIDATION TEST
TOTAL WORK, kJ/m³ vs PRESSURE
BH 1 SA 12**



GRAIN SIZE DISTRIBUTION

Silt to Sandy Silt to Silty Sand Till

FIGURE B13A



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

LEGEND

SYMBOL	BOREHOLE	SAMPLE	ELEVATION(m)
●	5	17	83.8
■	3	19	81.4
◆	2	19B	81.2
▲	3	21	78.4
▽	2	21	78.4
○	4	22	82.9
□	1	26	72.5

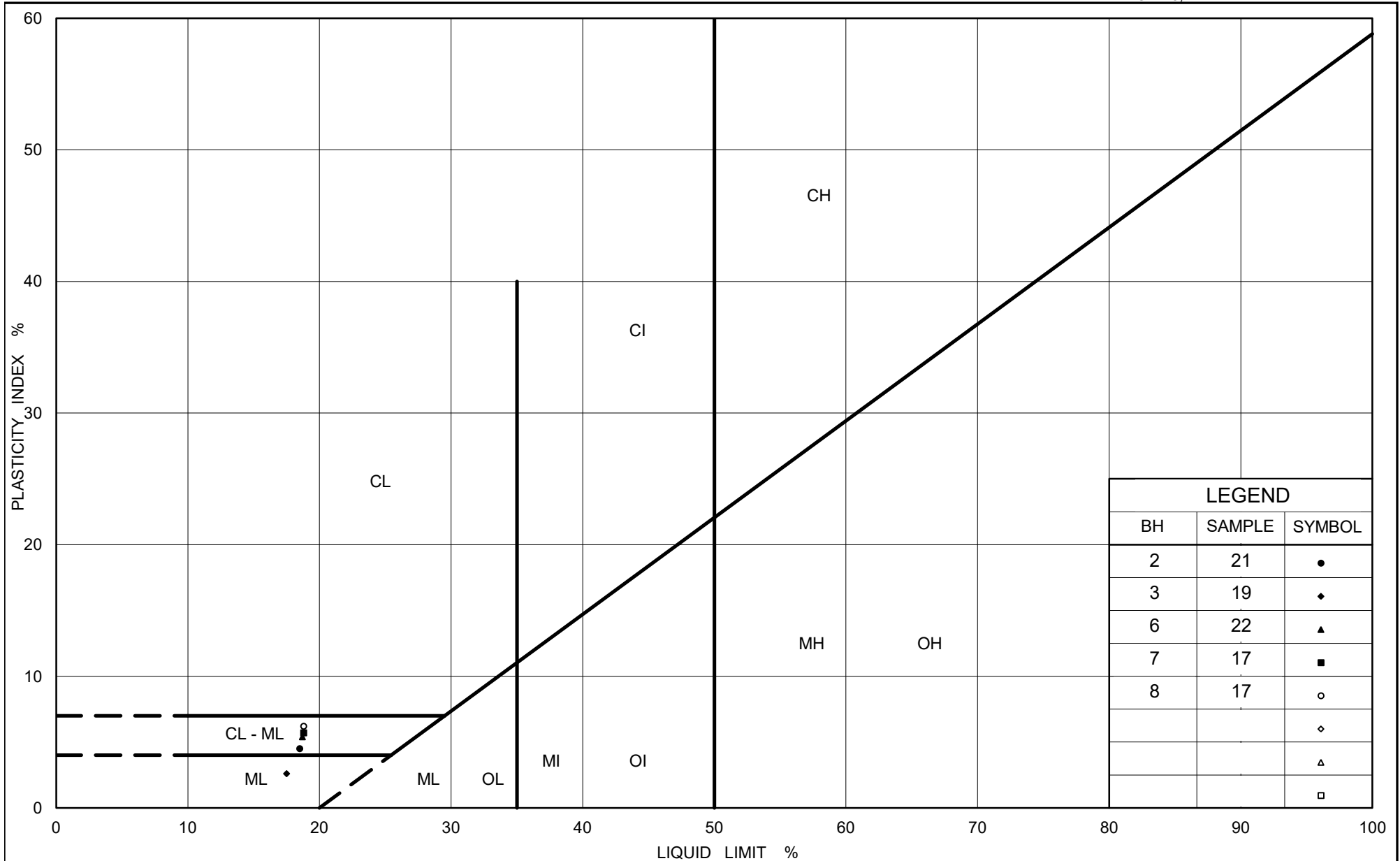
Project Number : 10-1111-0058

Checked By:

JP

Golder Associates

Date: 02-Sep-11



Ministry of Transportation

Ontario

PLASTICITY CHART

Silt (Sligh Plasticity) to Sandy Silt

Figure No. B14

Project No. 10-1111-0058

Checked By: JPD

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B16A****SAMPLE IDENTIFICATION**

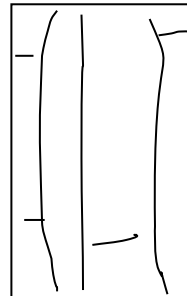
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	1
BOREHOLE NUMBER	4	SAMPLE DEPTH, m	34.18-34.45

TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.47

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	11.75	WATER CONTENT, (specimen) %	1.62
SAMPLE DIAMETER, cm	4.75	UNIT WEIGHT, kN/m ³	25.68
SAMPLE AREA, cm ²	17.72	DRY UNIT WT., kN/m ³	25.28
SAMPLE VOLUME, cm ³	208.22	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	545.55	VOID RATIO	0.05
DRY WEIGHT, g	536.87		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	20.1
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REMARKS:

DATE:

3/31/2011

UNCONFINED COMPRESSION TEST
ASTM D7012-07

FIGURE B16B



BEFORE COMPRESSION



AFTER COMPRESSION

Date 3/31/2011
Project 10-1111-0058

Golder Associates

Drawn AH
Chkd. JPD

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B17A****SAMPLE IDENTIFICATION**

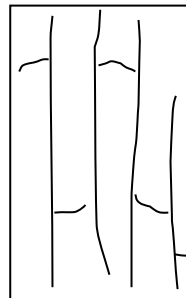
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	2
BOREHOLE NUMBER	5	SAMPLE DEPTH, m	32.49-32.60

TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST, min	>2 <15	L/D	2.18

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	10.45	WATER CONTENT, (specimen) %	2.35
SAMPLE DIAMETER, cm	4.80	UNIT WEIGHT, kN/m ³	25.04
SAMPLE AREA, cm ²	18.10	DRY UNIT WT., kN/m ³	24.47
SAMPLE VOLUME, cm ³	189.10	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	483.06	VOID RATIO	0.08
DRY WEIGHT, g	471.97		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	12.3
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REMARKS:

DATE:

3/31/2011

UNCONFINED COMPRESSION TEST

ASTM D7012-07

FIGURE B17B



BEFORE COMPRESSION



AFTER COMPRESSION

Date 3/31/2011

Project 10-1111-0058

Golder Associates

Drawn AH

Chkd. JPD

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B18A****SAMPLE IDENTIFICATION**

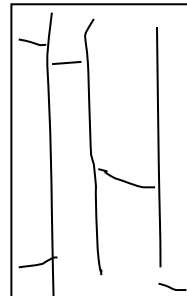
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	3
BOREHOLE NUMBER	5	SAMPLE DEPTH, m	34.15-34.28

TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.47

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	11.85	WATER CONTENT, (specimen) %	1.77
SAMPLE DIAMETER, cm	4.80	UNIT WEIGHT, kN/m ³	25.37
SAMPLE AREA, cm ²	18.10	DRY UNIT WT., kN/m ³	24.93
SAMPLE VOLUME, cm ³	214.43	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	554.96	VOID RATIO	0.06
DRY WEIGHT, g	545.29		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	18.4
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REMARKS:

DATE:

3/31/2011

UNCONFINED COMPRESSION TEST
ASTM D7012-07

FIGURE B18B



BEFORE COMPRESSION



AFTER COMPRESSION

Date 3/31/2011
Project 10-1111-0058

Golder Associates

Drawn AH
Chkd IPD

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B19A****SAMPLE IDENTIFICATION**

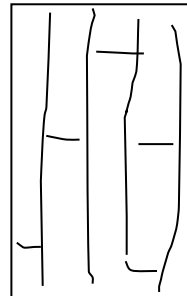
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	4
BOREHOLE NUMBER	7	SAMPLE DEPTH, m	28.10-28.31

TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.53

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	15.20	WATER CONTENT, (specimen) %	2.10
SAMPLE DIAMETER, cm	6.00	UNIT WEIGHT, kN/m ³	25.88
SAMPLE AREA, cm ²	28.27	DRY UNIT WT., kN/m ³	25.34
SAMPLE VOLUME, cm ³	429.77	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	1134.43	VOID RATIO	0.04
DRY WEIGHT, g	1111.06		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	22.0
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REMARKS:

DATE:

3/31/2011

UNCONFINED COMPRESSION TEST
ASTM D7012-07

FIGURE B19B



BEFORE COMPRESSION



AFTER COMPRESSION

Date 3/31/2011
Project 10-1111-0058

Golder Associates

Drawn AH
Chkd IPD

UNCONFINED COMPRESSION TEST (UC)**ASTM D 7012-07****FIGURE B20A****SAMPLE IDENTIFICATION**

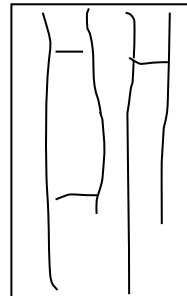
PROJECT NUMBER	10-1111-0058	SAMPLE NUMBER	5
BOREHOLE NUMBER	7	SAMPLE DEPTH, m	32.0-32.14

TEST CONDITIONS

MACHINE SPEED, mm/min	-	TYPE OF SPECIMEN	Rock Core
DURATION OF TEST,min	>2 <15	L/D	2.31

SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	13.60	WATER CONTENT, (specimen) %	1.81
SAMPLE DIAMETER, cm	5.90	UNIT WEIGHT, kN/m ³	26.16
SAMPLE AREA, cm ²	27.34	DRY UNIT WT., kN/m ³	25.70
SAMPLE VOLUME, cm ³	371.82	SPECIFIC GRAVITY, assumed	2.70
WET WEIGHT, g	992.26	VOID RATIO	0.03
DRY WEIGHT, g	974.67		

VISUAL INSPECTION**FAILURE SKETCH****TEST RESULTS**

STRAIN AT FAILURE, %	-	COMPRESSIVE STRESS, MPa	32.5
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REMARKS:

DATE:

3/31/2011

UNCONFINED COMPRESSION TEST

ASTM D7012-07

FIGURE B20B



BEFORE COMPRESSION



AFTER COMPRESSION

Date 3/31/2011
Project 10-1111-0058

Golder Associates

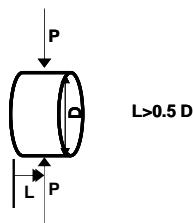
Drawn AH
Chkd IPD

**TABLE B1
POINT LOAD TESTS ON ROCK SAMPLES**

Borehole Number	Sample Number	Sample Depth (m)	Sample Elevation (m)	Bedrock Description	Test Type	Is (50mm) (MPa)	Approx. ⁽¹⁾ UCS (MPa)
2	1	33.4	74.2	Queenston Shale	Axial	0.603	5
2	2	35.3	72.3	Queenston Shale	Axial	2.247	19
3	3	32.5	75.1	Queenston Shale	Axial	0.991	8
4	4	33.4	77.2	Queenston Shale	Axial	1.561	13
4	5	34.6	76.0	Queenston Shale	Axial	5.451	45
5	6	26.9	78.2	Queenston Shale	Axial	3.505	29
5	7	31.3	73.8	Queenston Shale	Axial	1.504	12
5	8	33.2	71.9	Queenston Shale	Axial	4.731	39
7	9	27.7	84.5	Queenston Shale	Axial	2.063	17
7	10	31.7	80.5	Queenston Shale	Axial	2.157	18
⁽¹⁾ $I_{s50} \times C$ (the value of C was estimated based on the $I_s(50)$ point load test results and the UCS tests) from ISRM. The estimated C value = 8.3 ("Suggested Methods for Determining Point Load Strength", International Society for Rock Mechanics Commission on Testing Methods, Int. J. Rock. Mech. Min. Sci. and Geomechanical Abstr., Vol 22, No. 2 1985, pp. 51-60.							

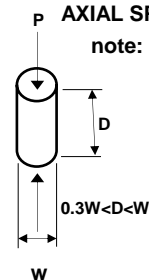
DIAMETRAL SPECIMEN SHAPE REQUIREMENTS

note: Diametral tests are perpendicular to core axis
(planes of weakness)



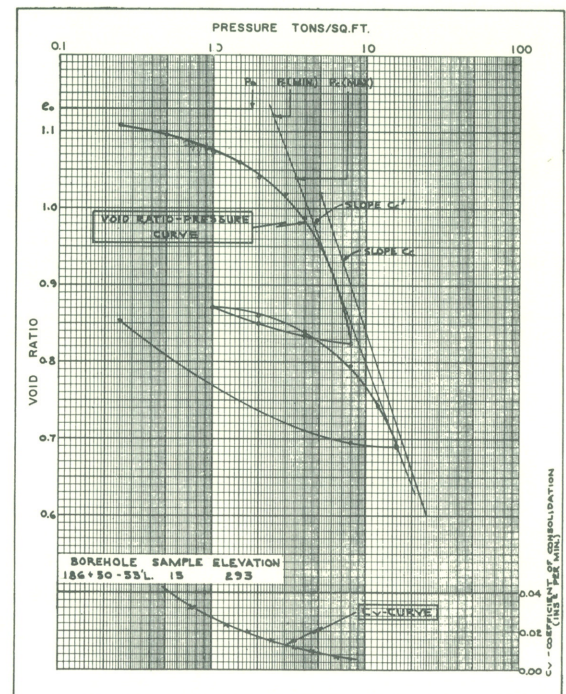
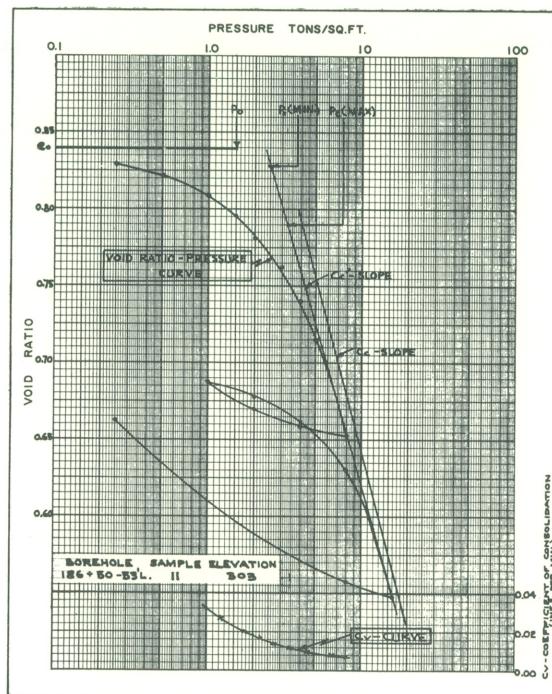
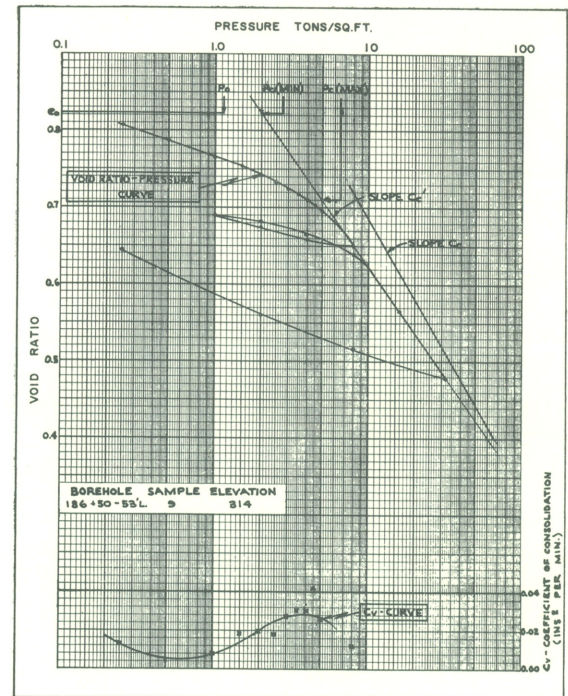
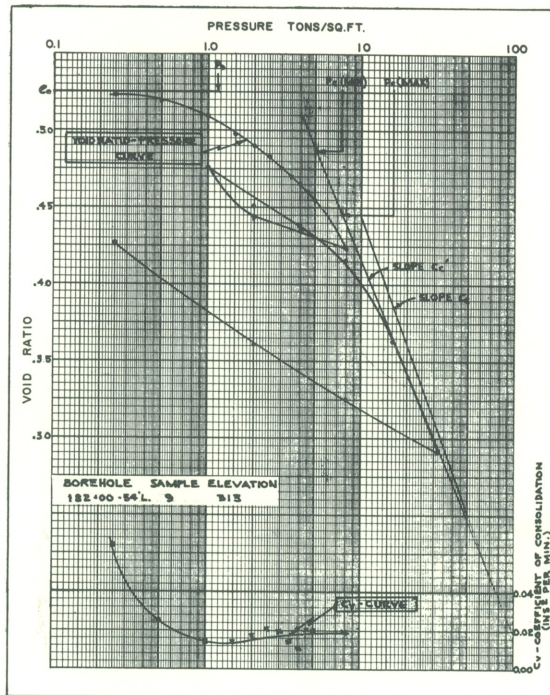
AXIAL SPECIMEN SHAPE REQUIREMENTS

note: Axial tests are parallel to core axis
(planes of weakness)



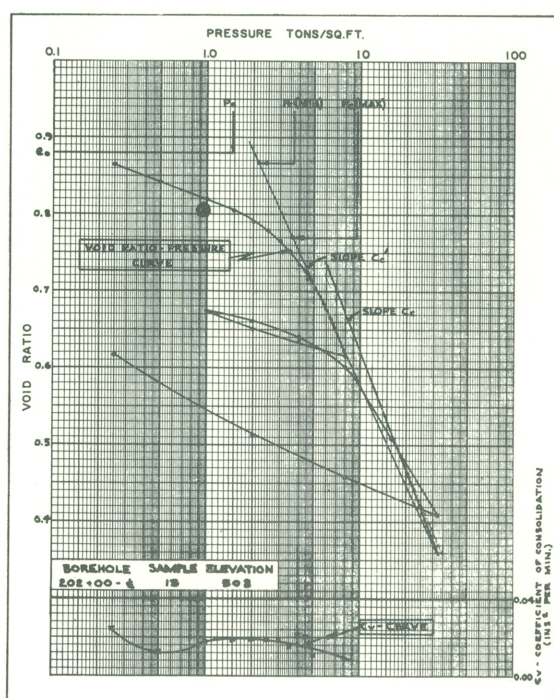
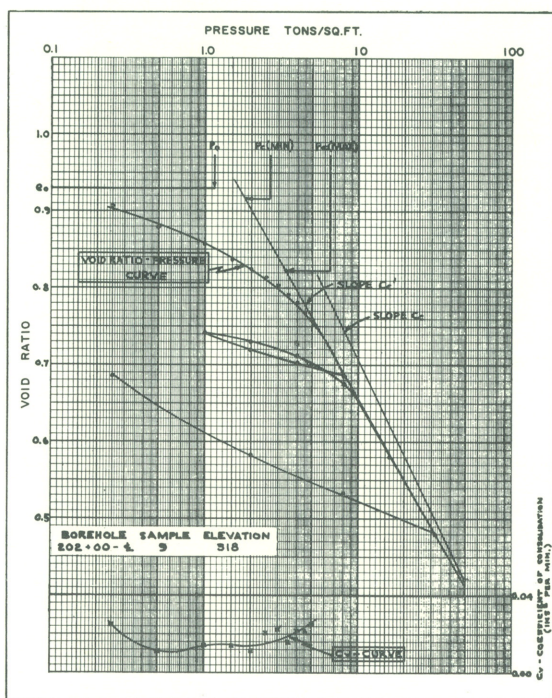
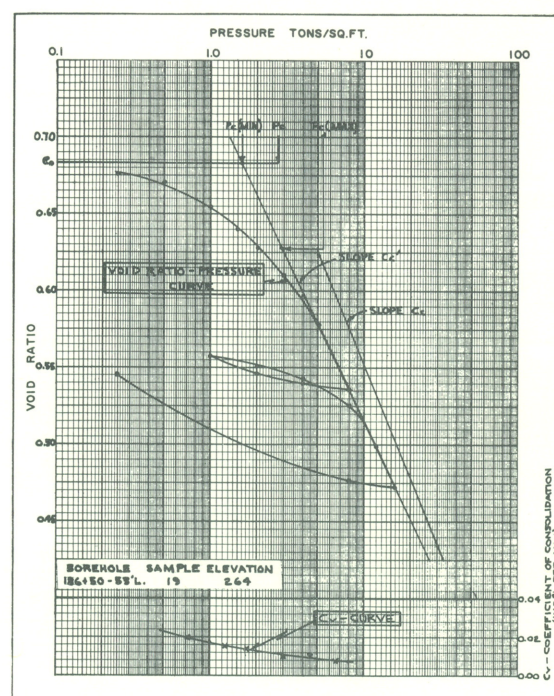
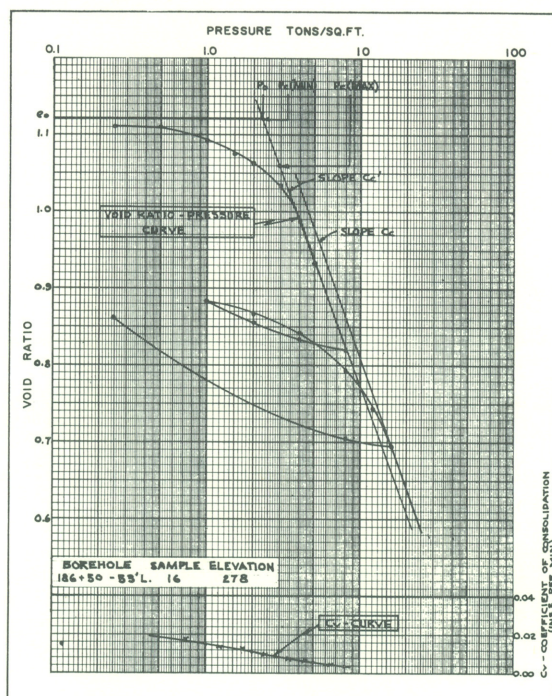
VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

APPENDIX II
FIGURE 14
PROJECT S6849



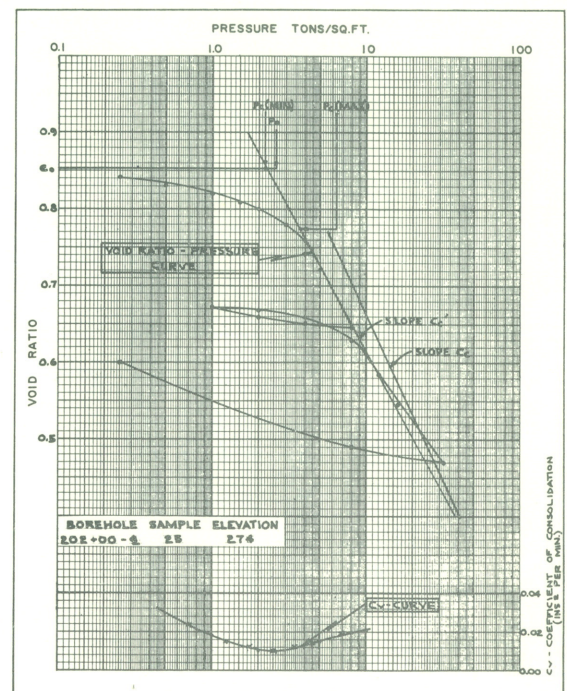
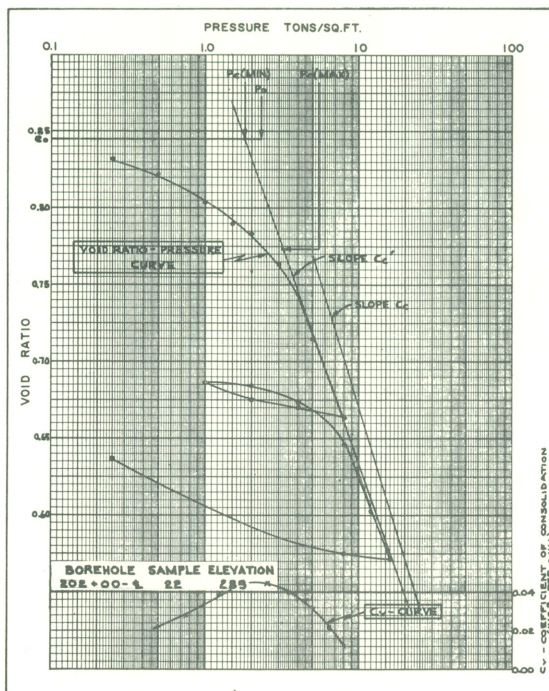
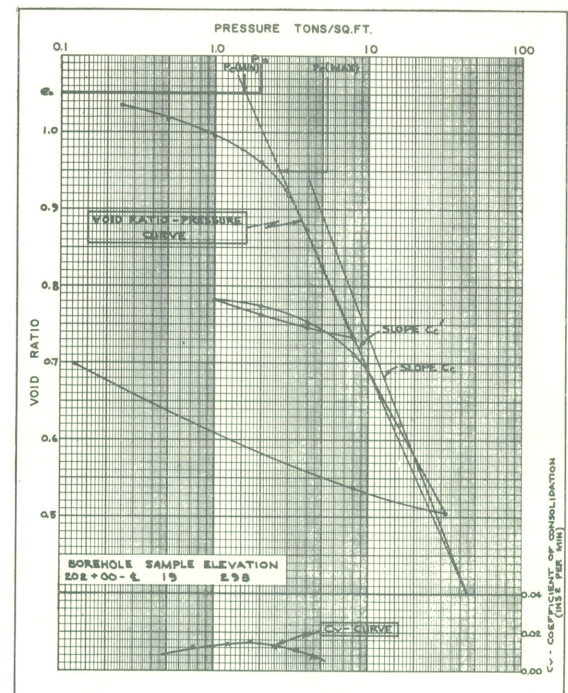
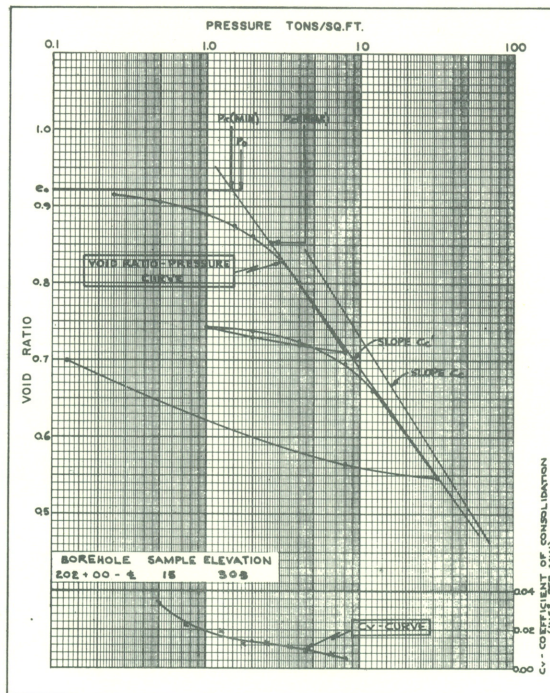
VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

APPENDIX II
FIGURE 15
PROJECT S6849



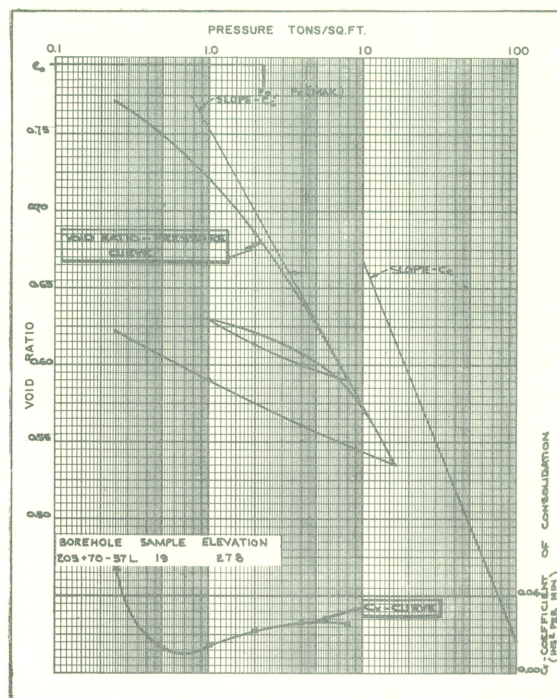
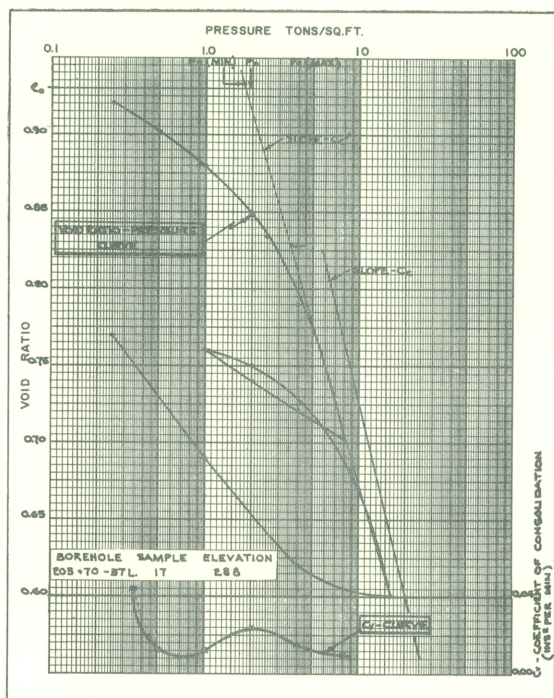
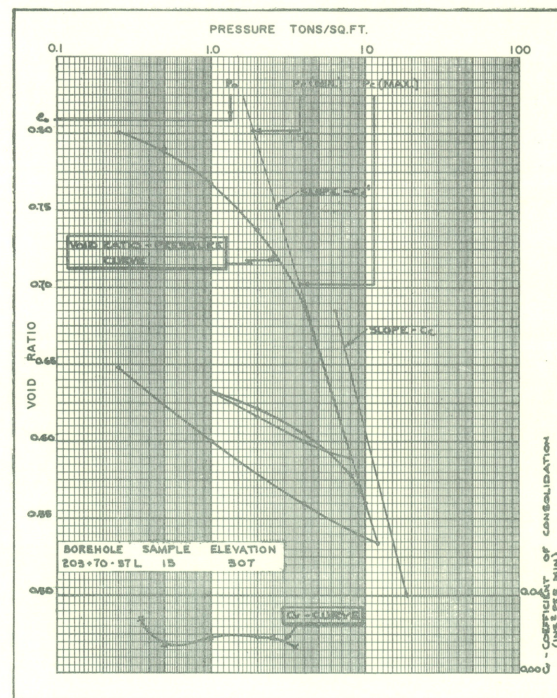
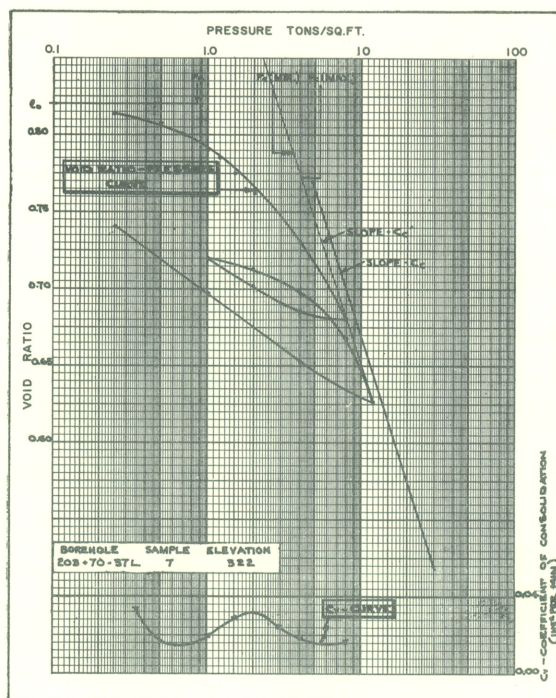
VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

APPENDIX II
FIGURE 16
PROJECT S6849



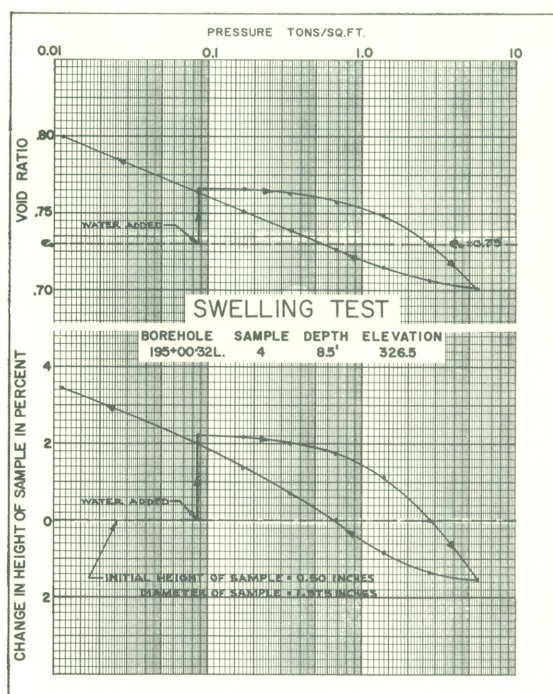
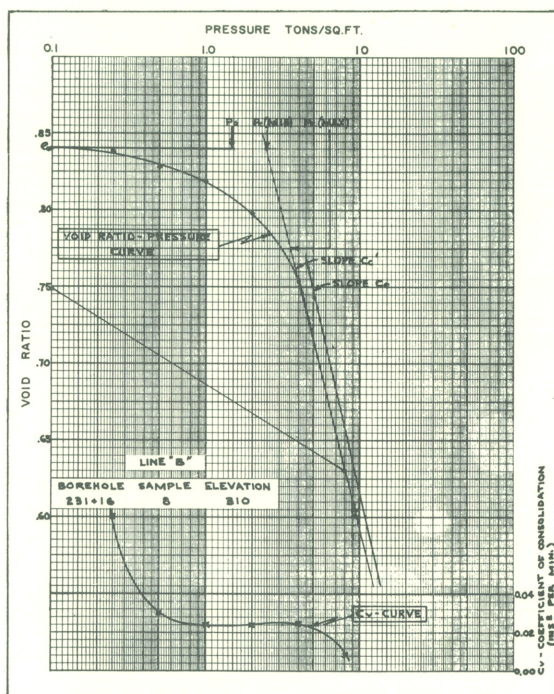
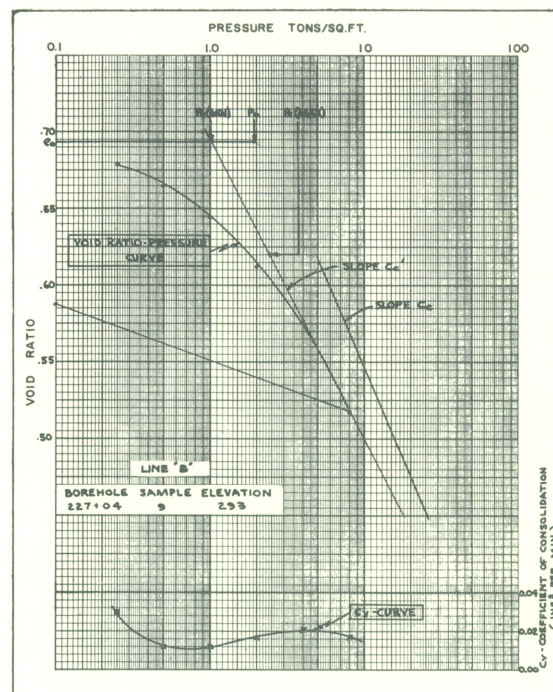
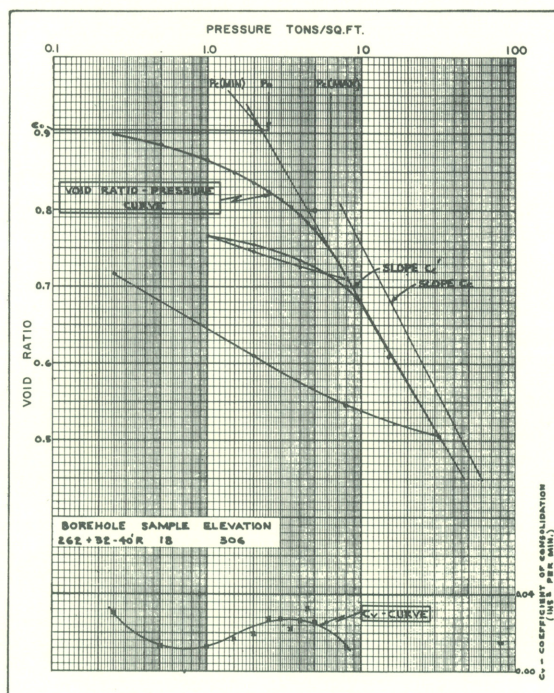
VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

APPENDIX II
FIGURE 17
PROJECT S6849



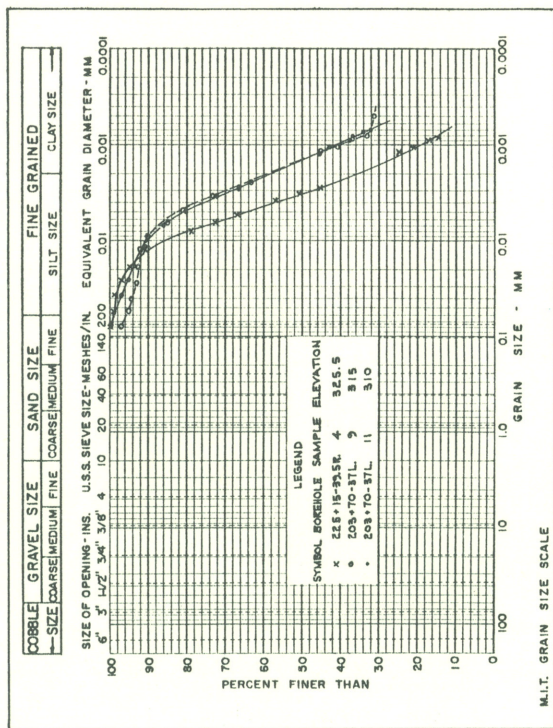
VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

APPENDIX II
FIGURE 23
PROJECT S6849

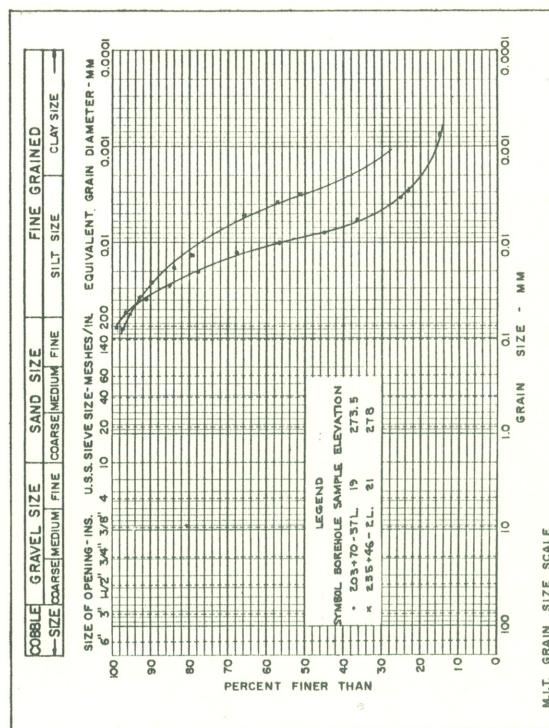


GRAIN SIZE DISTRIBUTION

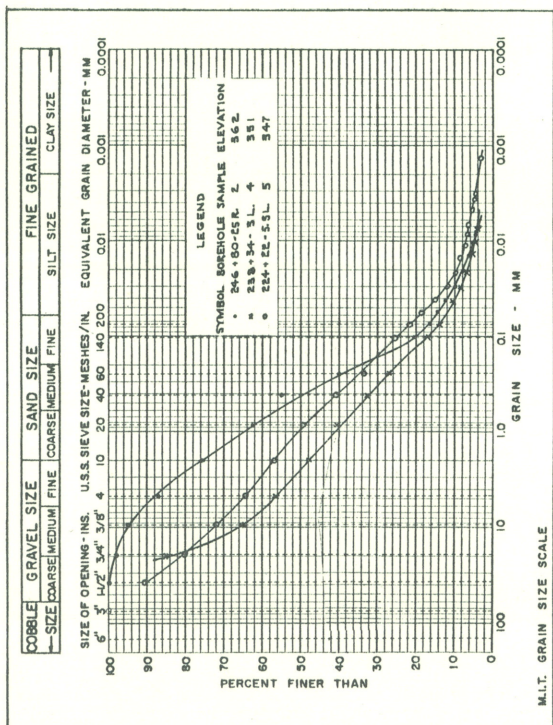
APPENDIX II
FIGURE I
PROJECT S6849



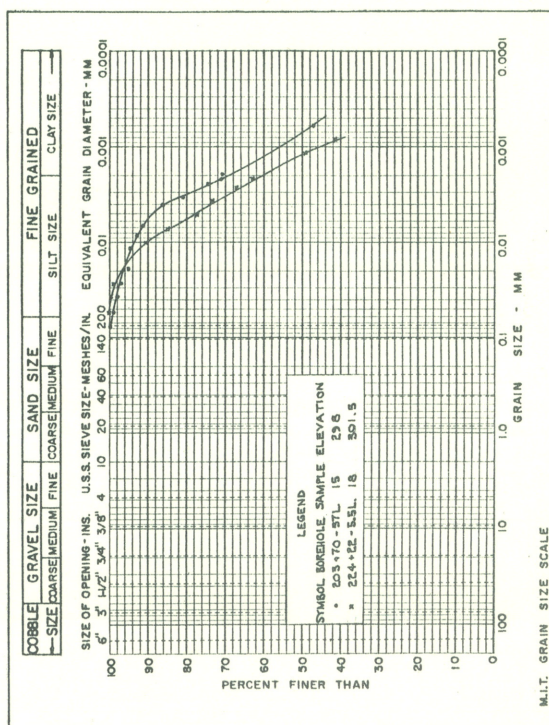
GREY SILTY CLAY



GREY TO BROWN CLAYEY SILT



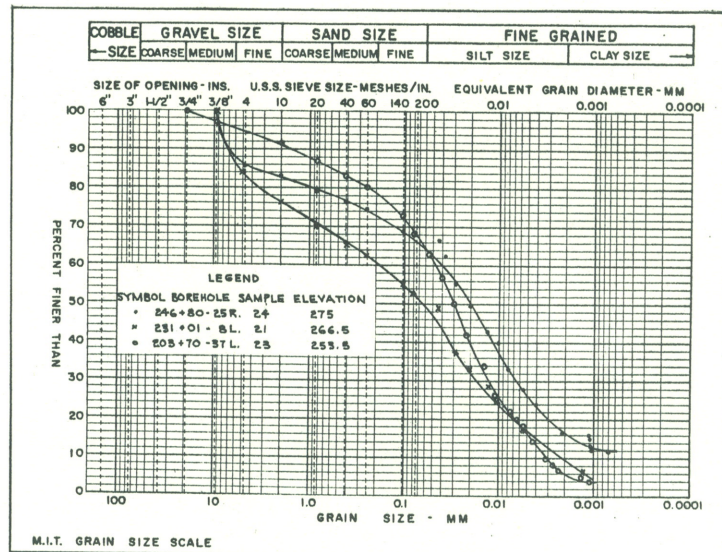
BROWN SILTY SAND & GRAVEL



LAYERED SILTY CLAY

GRAIN SIZE DISTRIBUTION

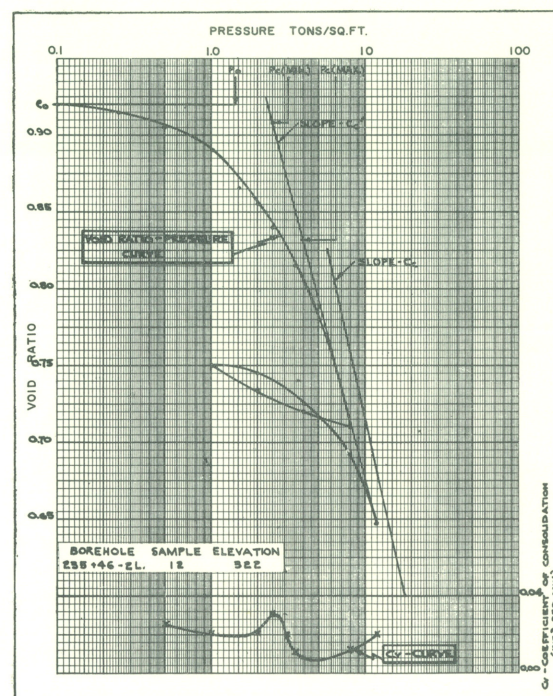
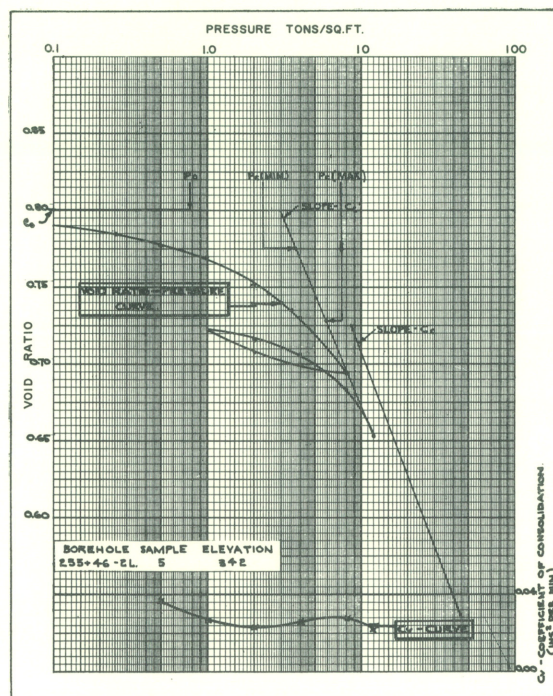
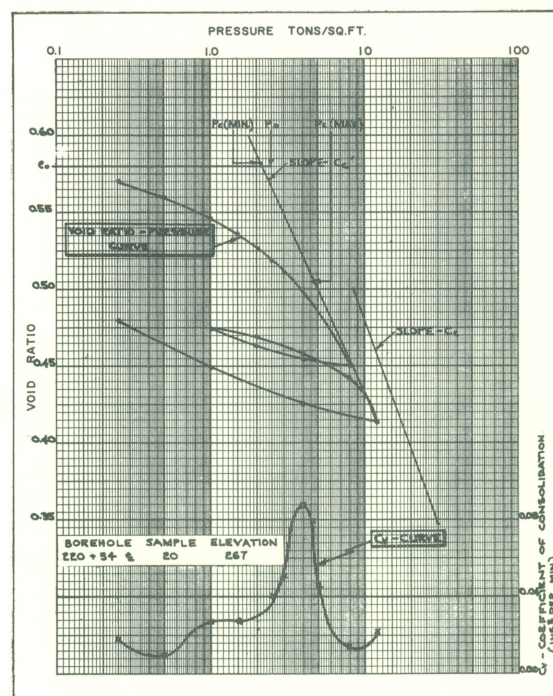
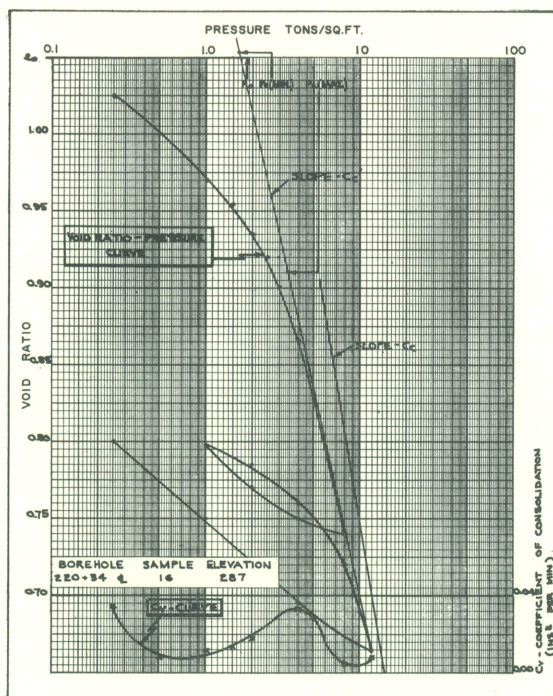
APPENDIX II
FIGURE 2
PROJECT S6849



VERY DENSE SILTY & SANDY TILL

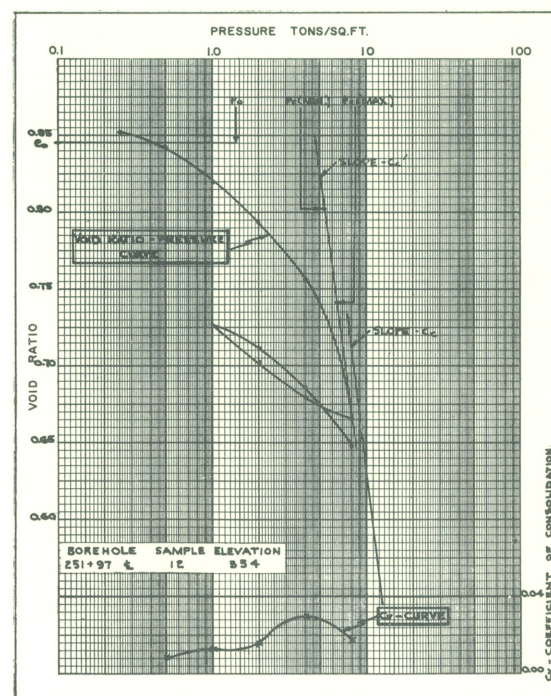
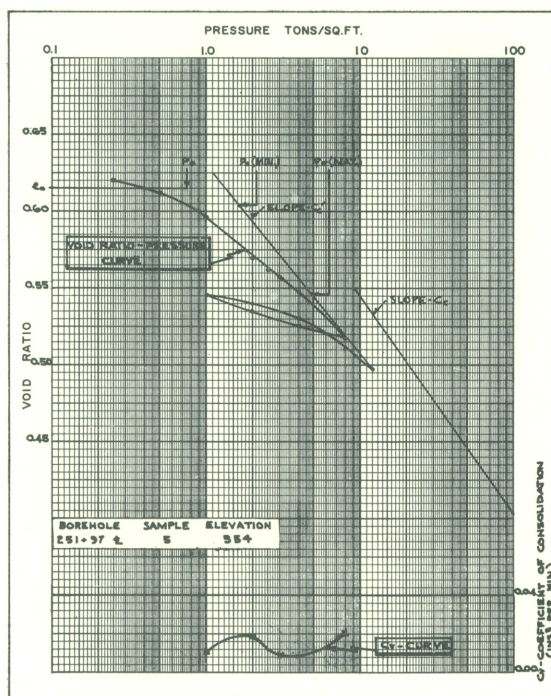
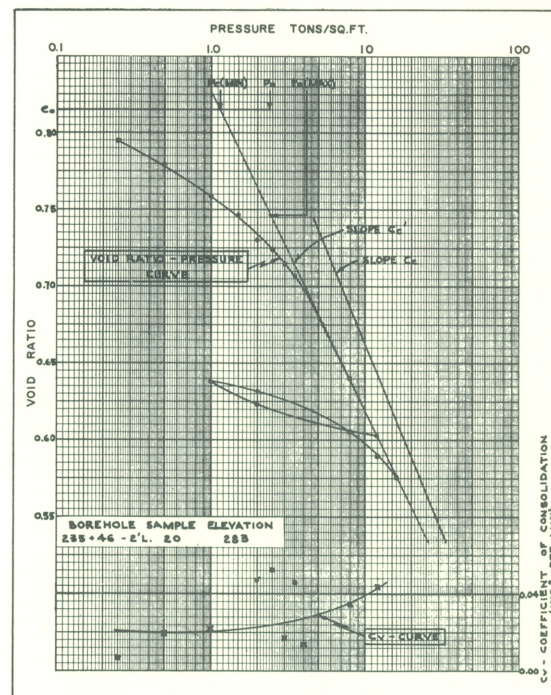
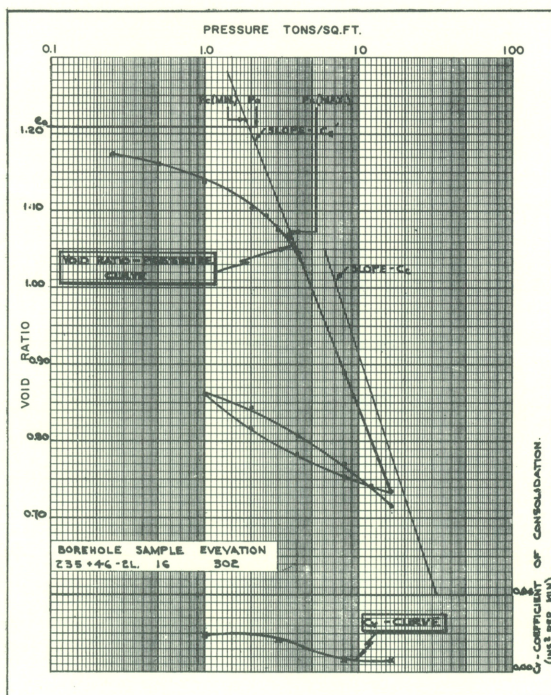
VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

APPENDIX II
FIGURE 19
PROJECT S6849



VOID RATIO - PRESSURE CURVES CONSOLIDATION TEST

APPENDIX II
FIGURE 20
PROJECT S6849





APPENDIX E

Vertical Seismic Profiling Test Results

DATE 15 June, 2016**PROJECT No.** 10-1111-0058**TO** MMM Group Limited**FROM** Adam Ramer, Christopher Phillips**EMAIL** aramer@golder.com;
cphillips@golder.com**VERTICAL SEISMIC PROFILING TEST RESULTS
GARDEN CITY SKYWAY
ST. CATHERINES, ONTARIO**

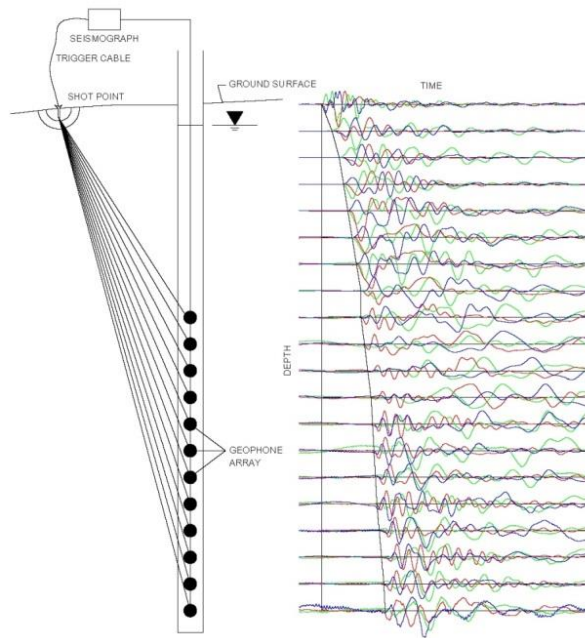
This memorandum presents the results of the Vertical Seismic Profiling (VSP) testing carried out at the Garden City Skyway in St. Catharines, Ontario. VSP testing was carried out in boreholes E8 and W13 on June 17, 2015. Borehole E8 was drilled to an approximate depth of 33.5 m below the existing pavement surface and then cased above 33 m with a PVC pipe grouted in place. Borehole W13 was drilled to an approximate depth of 39.9 m below ground surface and the cased above 33.5 m with a PVC pipe and grouted in place.

Methodology

For the VSP method, seismic energy is generated at the ground surface by an active seismic source and recorded by a geophone located in a nearby borehole at a known depth. The active seismic source can be either compression or shear wave. The time required for the energy to travel from the source to the receiver (geophone) provides a measurement of the average compression or shear-wave seismic velocity of the medium between the source and the receiver. Data obtained from different geophone depths are used to calculate a detailed vertical seismic velocity profile of the subsurface in the immediate vicinity of the test borehole.

The high resolution results of a VSP survey are often used for earthquake engineering site classification, as per the 2010 National Building Code of Canada.





Example 1: Layout and resulting time traces from a VSP survey.

Fieldwork

The fieldwork was carried out on June 17, 2015, by personnel from the Golder Mississauga office.

Both compression and shear-wave seismic sources were used and both were located between 1 and 2 m from the boreholes. The seismic source for the compression wave test consisted of a 9.9 kilogram sledge hammer vertically impacted on a metal plate. The plate was located 1.36 m from BH-W13 and 1.20 m from BH-E8. The seismic source for the shear-wave test consisted of a 3 metre long, 150 millimetre by 150 millimetre wooden beam, weighted by a vehicle and horizontally struck with a 9.9 kilogram sledge hammer on alternate ends of the beam to induce polarized shear waves. The shear source was located at the same distance from each borehole, and coupled to the ground surface by parking a vehicle on top of it. Test measurements started at ground surface and were recorded in the borehole with a 3-component receiver spaced at 1-metre intervals below the ground surface to a maximum depth of the casing (33 m in BH-E8 and 31 m in BH-W13).

The seismic records collected for each source location were stacked a minimum of five times to minimize the effects of ambient background seismic noise on the collected data. The data was sampled at 0.020833 millisecond intervals and a total time window of 0.341 seconds was collected for each seismic shot.

Data Processing

Processing of the VSP test results consisted of the following main steps:

- 1) Combination of seismic records to present seismic traces for all depth intervals on a single plot for each seismic source and for each component;
- 2) Low Pass Filtering of data to remove spurious high frequency noise;
- 3) First break picking of the compression and shear-wave arrivals; and,
- 4) Calculation of the average compression and shear-wave velocity to each tested depth interval.

Processing of the VSP data was completed using the SeisImager/SW software package (Geometrics Inc.). The seismic records are presented on the following four plots and show the first break picks of the compression wave (Figures 1 and 2) and shear wave arrivals (Figures 3 and 4) overlaid on the seismic waveform traces recorded at the different geophone depths for boreholes E8 and W13. The arrivals were picked on the vertical component for the compression source and on the two horizontal components for the shear source.

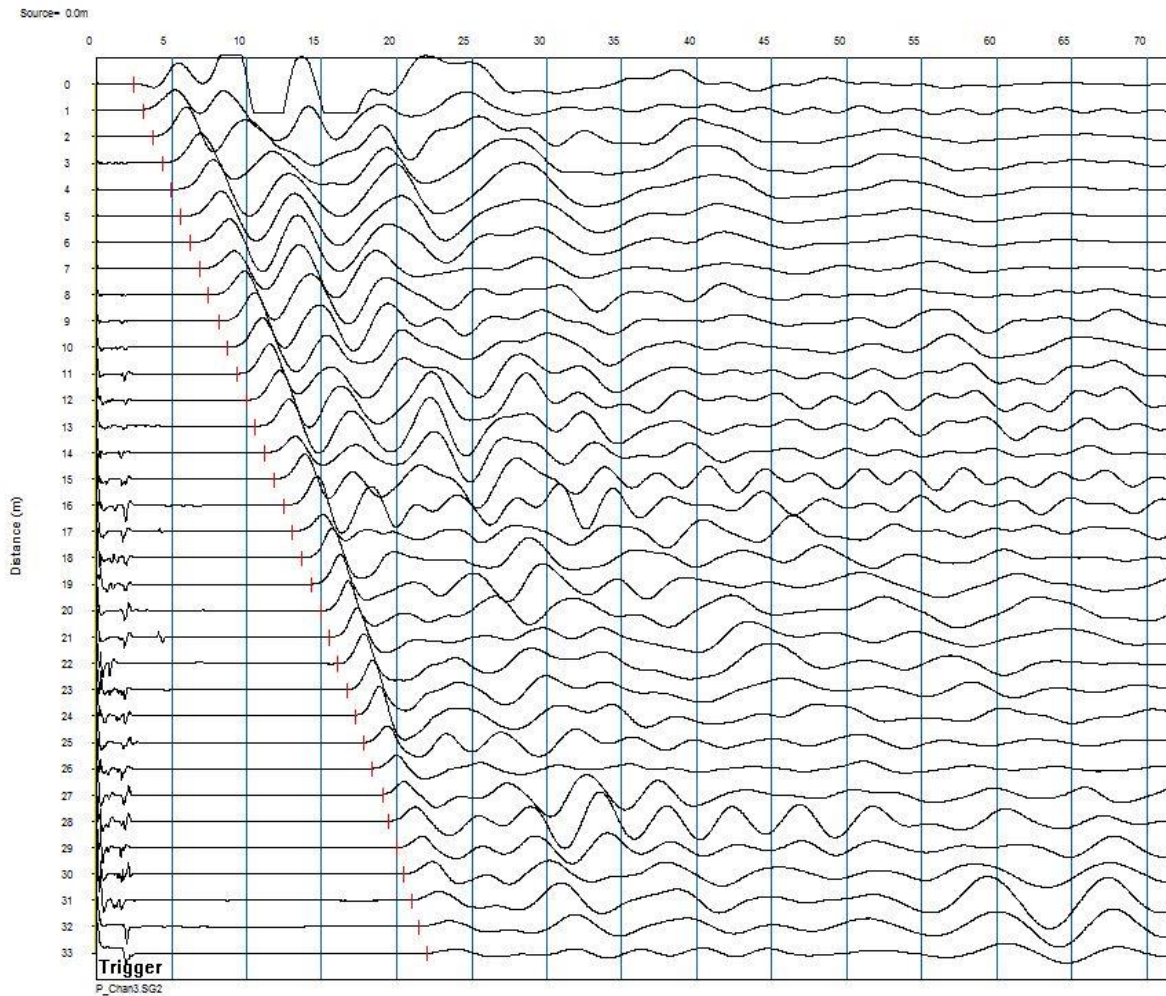


Figure 1: First break picking of compression wave arrivals (red) along the seismic traces recorded at each receiver depth of borehole E8.

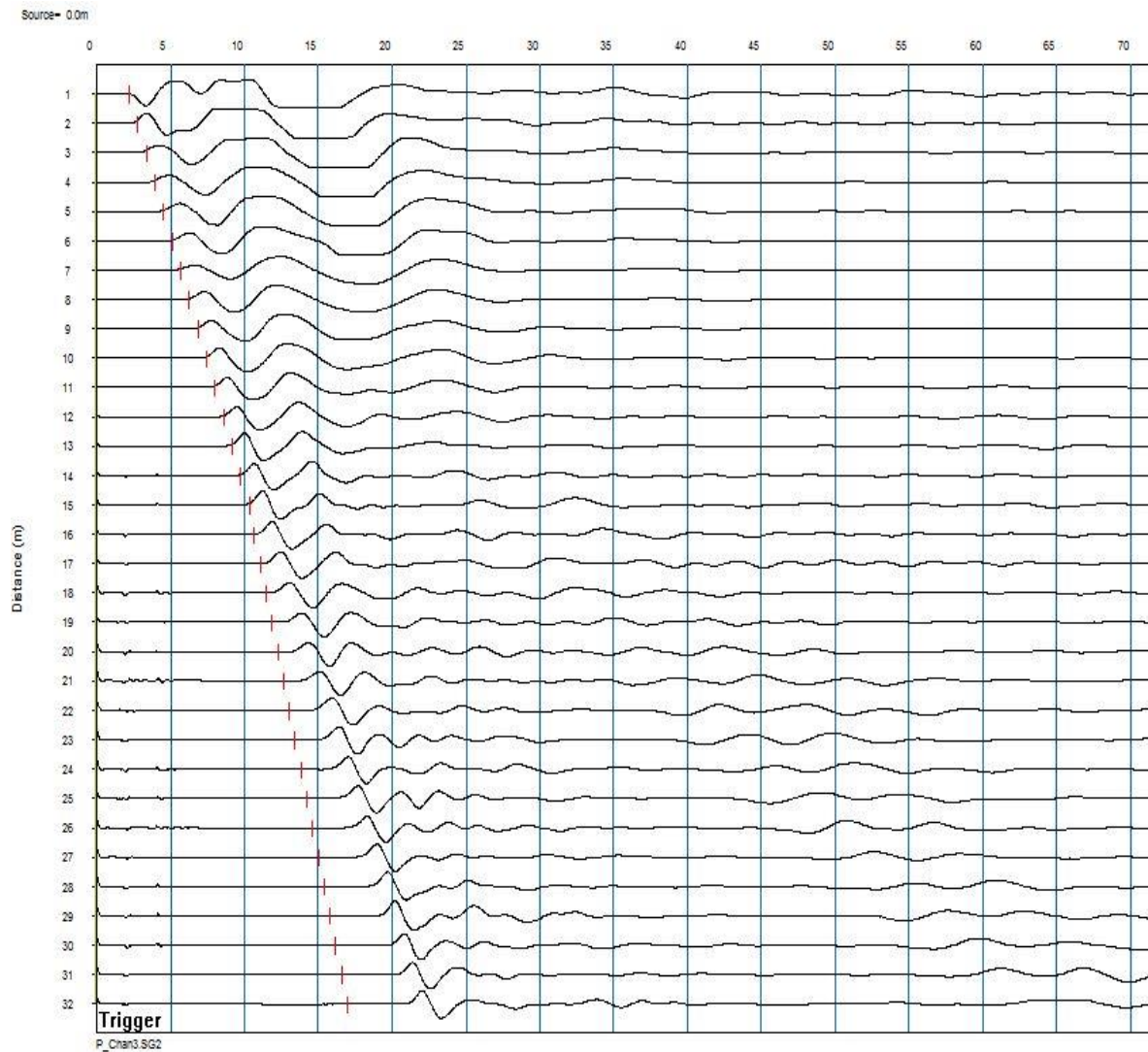


Figure 2: First break picking of compression wave arrivals (red) along the seismic traces recorded at each receiver depth of borehole W13.

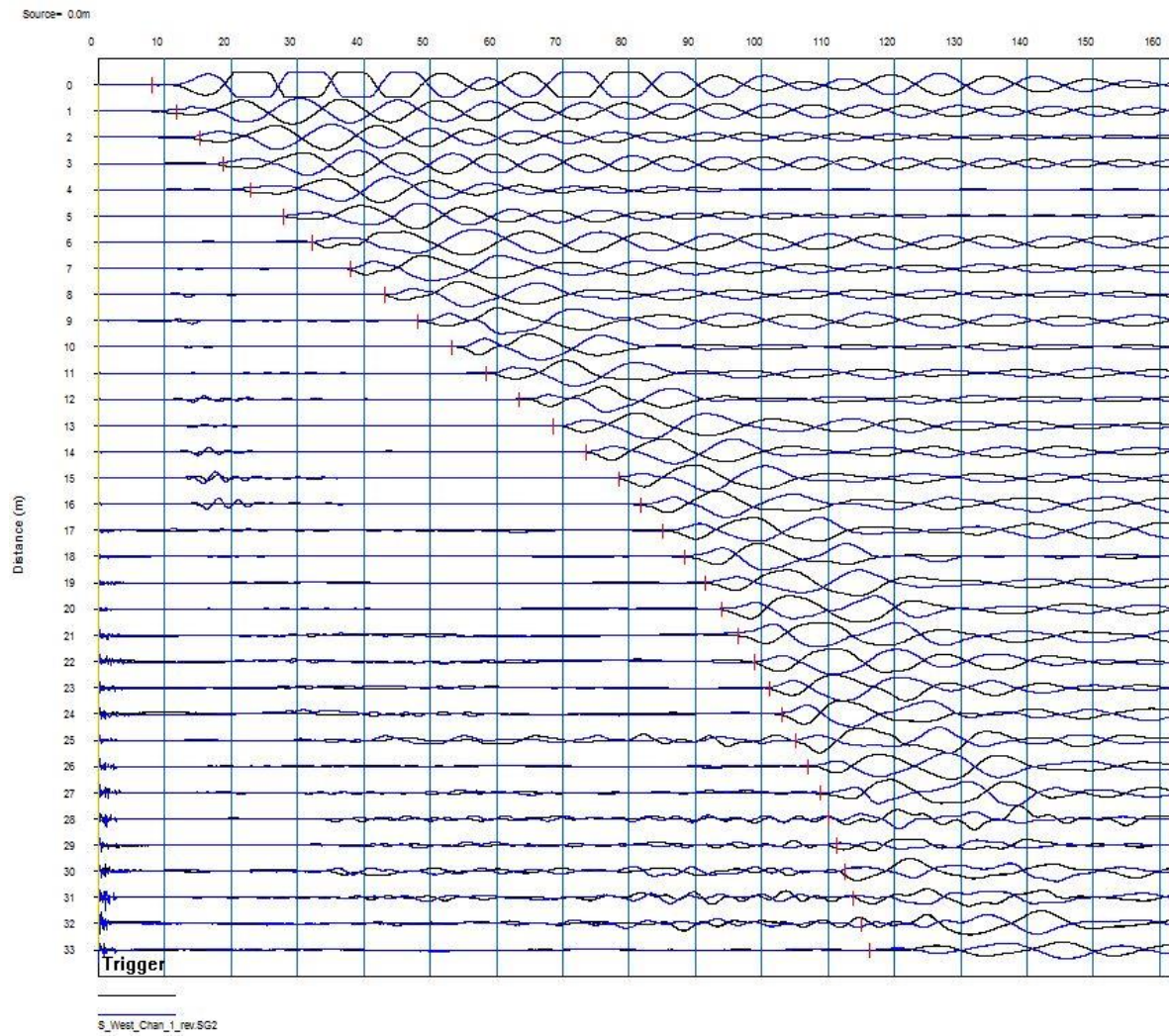


Figure 3: First break picking of shear wave arrivals (red) along the seismic traces recorded at each receiver depth of borehole E8.

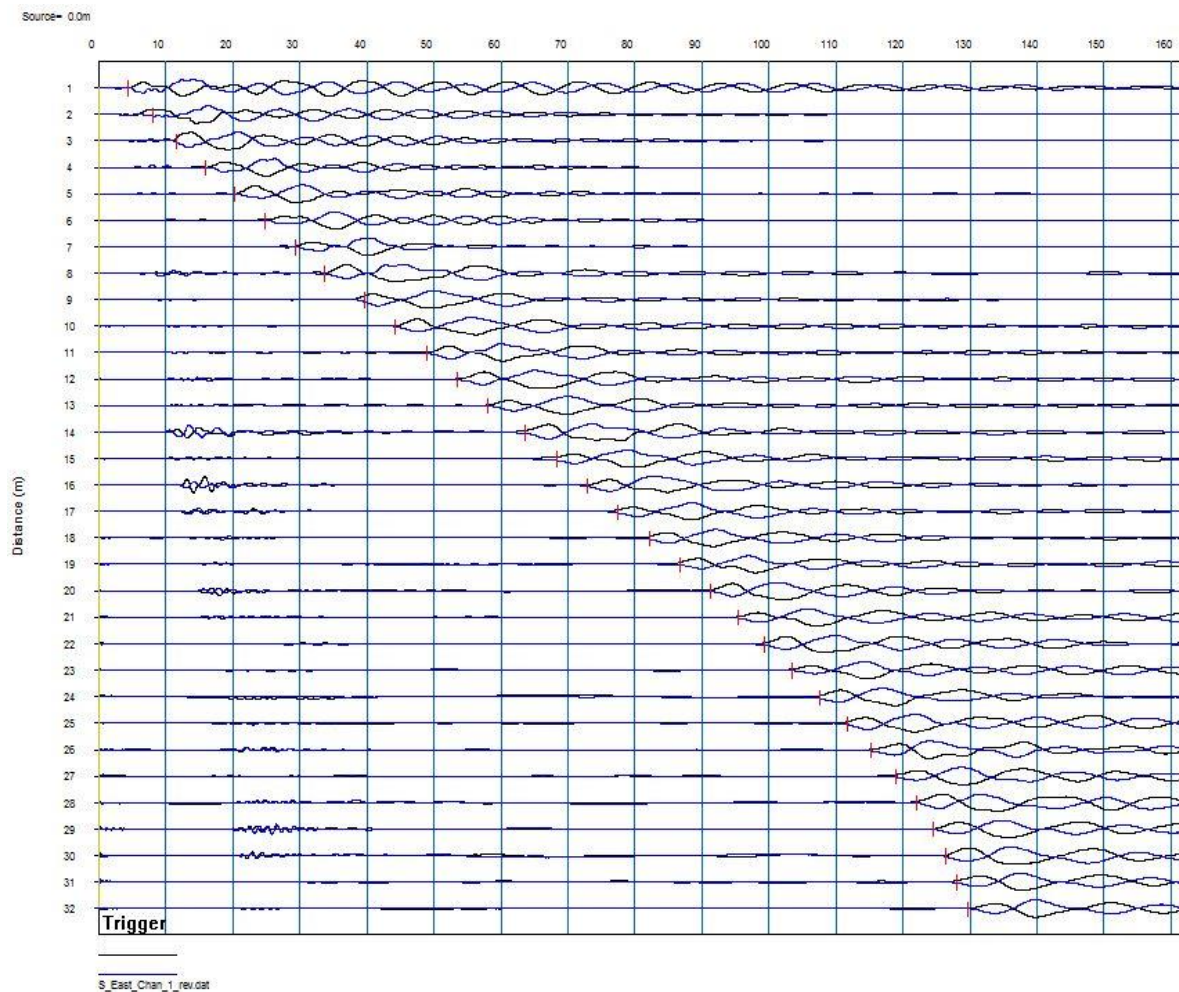


Figure 4: First break picking of shear wave arrivals (red) along the seismic traces recorded at each receiver depth of borehole W13.

Results

The VSP results are summarized in Tables 1 and 2. The shear wave and compression wave layer velocities, at the field collected metre intervals, were calculated by best fitting a theoretical travel time model to the field data collected at half metre intervals. The depths presented on the table are relative to ground surface.

The estimated dynamic engineering moduli, based on the calculated wave velocities, are also presented in Tables 1 and 2. The engineering moduli were calculated using an estimated bulk density, based on the borehole log. For glacial till down from 1 to 27 metres in both boreholes the bulk density of 1600 kg/m³ was used. For the bedrock down to the bottom of the boreholes at 31 and 33 metres, a bulk density of 2,650 kilogram per cubic metre was used.

The average shear wave velocity from ground surface to a depth of 30 metres was measured to be 267 metres per second in BH-E8 and 239 metres per second in BH-W13.

Limitations

This technical memorandum was prepared for the exclusive use of the client. The memo, which specifically includes all tables, figures and attachments, is based on data and information collected by Golder Associates Ltd. and is based solely on the conditions of the properties at the time of the work, supplemented by historical information and data obtained by Golder Associates Ltd. as described in this memo.

Golder Associates Ltd. has relied in good faith on all information provided and does not accept responsibility for any deficiency, misstatements, or inaccuracies contained in the reports as a result of omissions, misinterpretation, or fraudulent acts of the persons contacted or errors or omissions in the reviewed documentation.

The services performed, as described in this memo, were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

Any use which a third party makes of this memo, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Golder Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this memo.

The findings and conclusions of this memo are valid only as of the date of this memo. If new information is discovered in future work, including excavations, borings, or other studies, Golder Associates Ltd. should be requested to re-evaluate the conclusions of this memo, and to provide amendments as required.

Closure

We trust that these results meet your current needs. If you have any questions or require clarification, please contact the undersigned at your convenience.

Yours truly,

GOLDER ASSOCIATES LTD.

Adam Ramer
Geophysics Group

Christopher Phillips, M.Sc., P.Geo
Associate, Senior Geophysicist



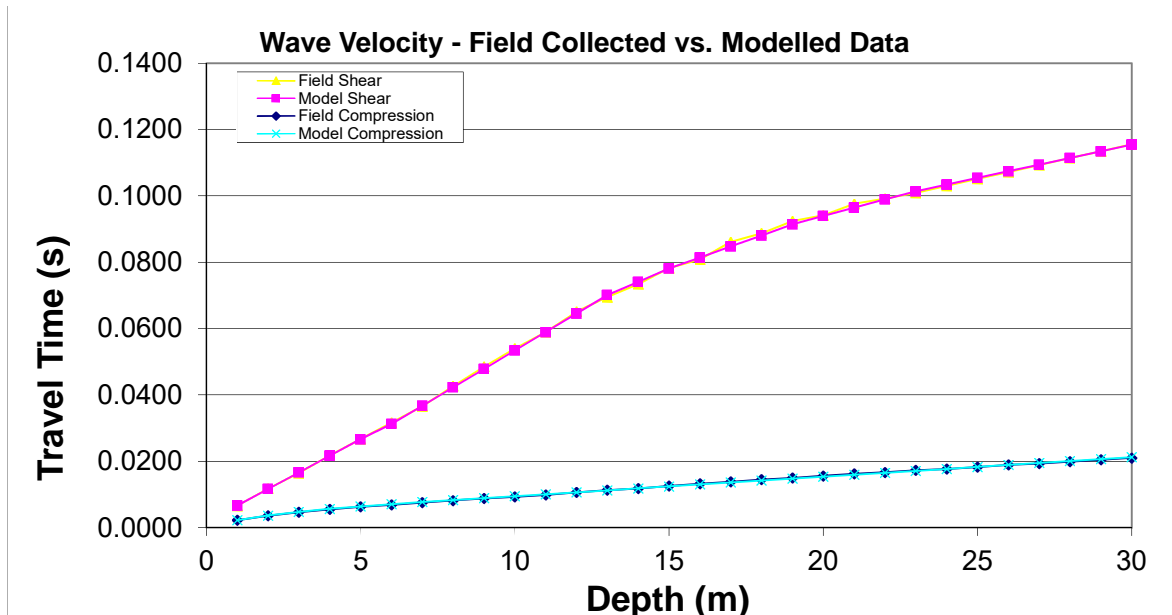
AR/CRP/jl

\\golder.gds\gal\mississauga\active\2010\1111\10-1111-0058 mrc - gcs - st catharines\2400-6 reporting\pre-draft\10-1111-0058 tech memo 2016\june15 garden city skyway vsp.docx

Attachment: Table 1 – Shear Wave Velocity Profile at BH-14-1
Table 2 – Shear Wave Velocity Profile at BG W13

TABLE 1
SHEAR WAVE VELOCITY PROFILE AT BOREHOLE E8

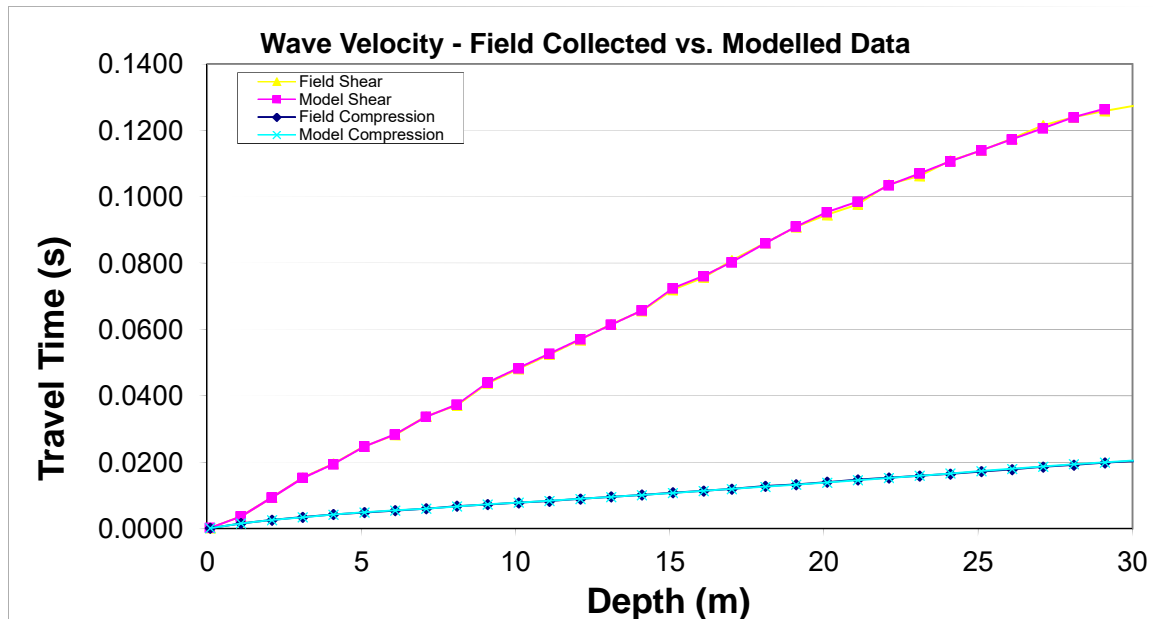
Layer Depth (m)				Estimated Bulk Density (kg/m ³)	Dynamic Engineering Properties			
Top	Bottom	Compressional Wave (m/s)	Shear Wave (m/s)		Poissons Ratio	Shear Modulus (MPa)	Deformation Modulus (MPa)	Bulk Modulus (MPa)
0.0	1	450	150	1990	0.44	45	129	343
1.0	2	720	200	1990	0.46	80	232	925
2.0	3	900	200	1990	0.47	80	235	1506
3.0	4	1100	200	1990	0.48	80	236	2302
4.0	5	1400	200	1990	0.49	80	237	3794
5.0	6	1400	220	1990	0.49	96	287	3772
6.0	7	1600	180	1990	0.49	64	193	5008
7.0	8	1700	180	1990	0.49	64	193	5665
8.0	9	1700	180	1990	0.49	64	193	5665
9.0	10	1700	180	1990	0.49	64	193	5665
10.0	11	1700	180	1990	0.49	64	193	5665
11.0	12	1700	180	1990	0.49	64	193	5665
12.0	13	1700	180	1990	0.49	64	193	5665
13.0	14	1700	250	1990	0.49	124	370	5585
14.0	15	1700	250	1990	0.49	124	370	5585
15.0	16	1700	300	1990	0.48	179	532	5512
16.0	17	1700	300	1990	0.48	179	532	5512
17.0	18	1700	300	1990	0.48	179	532	5512
18.0	19	1700	300	1990	0.48	179	532	5512
19.0	20	1700	400	1990	0.47	318	937	5327
20.0	21	1700	400	1990	0.47	318	937	5327
21.0	22	1700	400	1990	0.47	318	937	5327
22.0	23	1700	400	1990	0.47	318	937	5327
23.0	24	1700	500	1990	0.45	498	1445	5088
24.0	25	1700	500	1990	0.45	498	1445	5088
25.0	26	1700	500	1990	0.45	498	1445	5088
26.0	27	1700	500	1990	0.45	498	1445	5088
27.0	28	1700	500	1990	0.45	498	1445	5088
28.0	29	1700	500	1990	0.45	498	1445	5088
29.0	30	1700	500	1990	0.45	498	1445	5088
30.0	31	1700	500	1990	0.45	498	1445	5088
31.0	32	1700	500	1990	0.45	498	1445	5088
32.0	33	1700	500	1990	0.45	498	1445	5088

**Notes**

1. Depth Presented relative to ground surface.
2. This Table to be analyzed in conjunction with the accompanying report.

TABLE 2
SHEAR WAVE VELOCITY PROFILE AT BOREHOLE W13

Layer Depth (m)				Estimated Bulk Density (kg/m ³)	Dynamic Engineering Properties			
Top	Bottom	Compressional Wave (m/s)	Shear Wave (m/s)		Poissons Ratio	Shear Modulus (MPa)	Deformation Modulus (MPa)	Bulk Modulus (MPa)
0.0	0.1	630	360	1990	0.26	258	649	446
0.1	1.1	680	290	1990	0.39	167	465	697
1.1	2.1	1000	175	1990	0.48	61	181	1909
2.1	3.1	1200	170	1990	0.49	58	171	2789
3.1	4.1	1250	240	1990	0.48	115	339	2957
4.1	5.1	1480	190	1990	0.49	72	214	4263
5.1	6.1	1800	270	1990	0.49	145	432	6254
6.1	7.1	1800	190	1990	0.49	72	215	6352
7.1	8.1	1450	270	1990	0.48	145	430	3991
8.1	9.1	1600	150	1990	0.50	45	134	5035
9.1	10.1	1900	230	1990	0.49	105	314	7044
10.1	11.1	1950	230	1990	0.49	105	314	7427
11.1	12.1	1700	230	1990	0.49	105	314	5611
12.1	13.1	1700	230	1990	0.49	105	314	5611
13.1	14.1	1700	230	1990	0.49	105	314	5611
14.1	15.1	1600	150	1990	0.50	45	134	5035
15.1	16.1	1600	270	1990	0.49	145	431	4901
16.1	17.01	1600	220	1990	0.49	96	287	4966
17.0	18.1	1600	190	1990	0.49	72	214	4999
18.1	19.1	1600	200	1990	0.49	80	238	4988
19.1	20.1	1600	230	1990	0.49	105	314	4954
20.1	21.1	1450	320	1990	0.47	204	601	3912
21.1	22.1	1450	200	1990	0.49	80	237	4078
22.1	23.1	1450	280	1990	0.48	156	462	3976
23.1	24.1	1450	280	1990	0.48	156	462	3976
24.1	25.1	1450	300	1990	0.48	179	529	3945
25.1	26.1	1450	300	1990	0.48	179	529	3945
26.1	27.1	1450	300	1990	0.48	179	529	3945
27.1	28.1	1450	300	1990	0.48	179	529	3945
28.1	29.1	1800	400	1990	0.47	318	939	6023
29.1	30.1	1800	480	1990	0.46	458	1340	5836
30.1	31.1	1800	480	1990	0.46	458	1340	5836

**Notes**

1. Depth Presented relative to ground surface.
2. This Table to be analyzed in conjunction with the accompanying report.

2015 National Building Code Seismic Hazard Calculation

INFORMATION: Eastern Canada English (613) 995-5548 français (613) 995-0600 Facsimile (613) 992-8836
Western Canada English (250) 363-6500 Facsimile (250) 363-6565

June 17, 2016

Site: 43.1674 N, 79.2007 W User File Reference: Garden City Skyway

Requested by: , Golder Associates Ltd.

National Building Code ground motions: 2% probability of exceedance in 50 years (0.000404 per annum)

Sa(0.05)	Sa(0.1)	Sa(0.2)	Sa(0.3)	Sa(0.5)	Sa(1.0)	Sa(2.0)	Sa(5.0)	Sa(10.0)	PGA (g)	PGV (m/s)
0.333	0.390	0.319	0.235	0.156	0.072	0.032	0.0076	0.0030	0.206	0.121

Notes. Spectral ($S_a(T)$, where T is the period in seconds) and peak ground acceleration (PGA) values are given in units of g (9.81 m/s^2). Peak ground velocity is given in m/s . Values are for "firm ground" (NBCC 2015 Site Class C, average shear wave velocity 450 m/s). NBCC2015 and CSAS6-14 values are specified in **bold** font. Three additional periods are provided - their use is discussed in the NBCC2015 Commentary. Only 2 significant figures are to be used. *These values have been interpolated from a 10-km-spaced grid of points. Depending on the gradient of the nearby points, values at this location calculated directly from the hazard program may vary. More than 95 percent of interpolated values are within 2 percent of the directly calculated values.*

Ground motions for other probabilities:

Probability of exceedance per annum	0.010	0.0021	0.001
Probability of exceedance in 50 years	40%	10%	5%
Sa(0.05)	0.012	0.084	0.166
Sa(0.1)	0.019	0.108	0.203
Sa(0.2)	0.021	0.091	0.168
Sa(0.3)	0.019	0.069	0.124
Sa(0.5)	0.015	0.049	0.084
Sa(1.0)	0.0073	0.025	0.041
Sa(2.0)	0.0031	0.012	0.019
Sa(5.0)	0.0006	0.0025	0.0042
Sa(10.0)	0.0004	0.0011	0.0017
PGA	0.011	0.057	0.107
PGV	0.0091	0.036	0.064

References

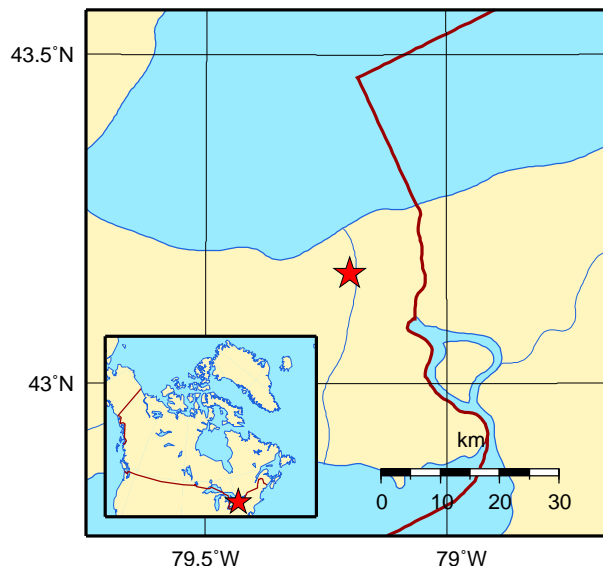
National Building Code of Canada 2015 NRCC no. 56190;
Appendix C: Table C-3, Seismic Design Data for Selected Locations in Canada

User's Guide - NBC 2015, Structural Commentaries NRCC no. xxxxxx (in preparation)
Commentary J: Design for Seismic Effects

Geological Survey of Canada Open File 7893 Fifth Generation Seismic Hazard Model for Canada: Grid values of mean hazard to be used with the 2015 National Building Code of Canada

See the websites www.EarthquakesCanada.ca and www.nationalcodes.ca for more information

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