



**Stantec**

**FINAL  
Foundation Investigation Report**

18<sup>th</sup> Concession Drain Bridge  
Replacement  
Highway 40 (South of Wallaceburg),  
Site 13-45  
Municipality of Chatham-Kent

G.W.P. 3103-03-01

GEOCRES No. 40J9-21

Project No. 165000744  
August 2011

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- Grain Size Distribution
- Plasticity
- Specific Gravity
- Consolidation
- Unified Compression (soil)

**FOUNDATION INVESTIGATION REPORT**  
**For**  
**G.W.P 3103-03-01**

**18<sup>th</sup> Concession Drain Bridge Replacement**  
**Highway 40 (South of Wallaceburg), Site 13-45**  
**Municipality of Chatham-Kent**

## **1.0 Introduction**

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Stantec Consulting Ltd. (Stantec) was retained by the Ministry of Transportation, Ontario (MTO) to undertake the detailed design for the replacement of the 18<sup>th</sup> Concession Drain Bridge on Highway 40 south of the community of Wallaceburg in the Municipality of Chatham-Kent, Ontario.

This Foundation Investigation Report has been prepared specifically and solely for the proposed bridge replacement.

Project Number: G.W.P.: 3103-03-01

Project Location: Highway 40 (Murray Street) near Elbow Line, Chatham-Kent

The work was carried out under Agreement Number 3008-E-0039 with Stantec Consulting Ltd., the Detailed Design Consultant for this project.

## **2.0 Site Description and Geology**

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### Site Location

The site location is shown on the Key Plan inset to Drawing No. 1, provided in Appendix A. The site is located near the intersection of Highway 40 and Elbow Line approximately 2.5 km south of the community of Wallaceburg in the Municipality of Chatham-Kent, Ontario.

### General Site Description

At the project site, Highway 40 crosses the 18<sup>th</sup> Concession Drain with a single span bridge ( $\pm 12.9$  m) which was originally constructed in 1937. Highway 40 runs in the north-south direction with chainage increasing from south to north. 18<sup>th</sup> Concession Drain runs in the NE-SW direction. Highway 40 has a single lane in each direction and the bridge has a deck width of 9.1 m. Elbow line has a staggered intersection with Highway 40 to the south of the bridge. The east leg of Elbow Line is less than 10 m from the bridge while the west leg is approximately 20 m to 30 m from the bridge.

### Physiographic Description and Drainage

The site is located within a physiographic region known as the St. Clair Clay Plains. The region contains extensive clay plains with little relief. Generally, drainage is towards Lake St. Clair to the south-west. Because of the faint relief, dredged ditches and drains are used to facilitate or improve drainage. The prevailing surficial soil deposit consists of Brookston clay loam, a dark-surfaced gleysolic soil developed under a swamp forest of elm. The clayey surficial deposit is underlain by limestone bedrock. In the vicinity of the project site the terrain is fairly flat.

The 18<sup>th</sup> Concession Drain is part of a local drainage canal system which ultimately discharges to Lake St. Clair via Sydenham River and the Chenal Ecarté. At the bridge site, the drainage canal is a linear feature flowing slowly towards the Townline Drain located 400 m to the west.

## **3.0 Investigation Procedures**

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### **3.1 DRILLING INVESTIGATION**

The geotechnical investigation for the bridge foundations for the proposed replacement bridge included four boreholes in the vicinity of the proposed bridge. These boreholes are designated BH11-1 through BH11-4 and are shown on the Borehole Locations and Soil Strata drawing, Drawing No. 1 in Appendix A. One borehole was advanced for each abutment and each bridge approach. Prior to carrying out the investigation, Stantec contacted the public utility authorities to clear the borehole locations of both private and public utilities.

The field drilling program was carried out between April 18 and May 5, 2011. The boreholes were advanced with continuous flight hollow stem augers using a D120 Track-mounted drill rig equipped for soil and bedrock sampling.

The subsurface stratigraphy encountered in each borehole was recorded in the field. Standard Penetration Tests (SPT) were carried out in all holes and split spoon samples were collected. Four Shelby Tube samples were also retrieved. All SPT samples recovered were returned to our Ottawa laboratory for detailed classification and testing. The Shelby Tube samples were sent to the Golder Associates Mississauga laboratory for consolidation and unconfined strength testing.

A standpipe was installed in Borehole BH11-4 after completion of drilling. It consisted of a 50 mm PVC pipe slotted over the lower 5 m. The annulus around the pipe was backfilled with sand for 5.3 m below a clay plug. The upper portion was backfilled with auger cuttings and bentonite to the ground surface. Asphalt was used to create a surface seal.

Bedrock was confirmed by coring HQ size rock cores in Boreholes BH11-2 and BH11-3. Coring was conducted in these boreholes to depths of approximately 3.0 m and 4.2 m, respectively, beneath split-spoon refusal.

Summary information pertaining to the boreholes included in this report is given in Table 3.1.

**Table 3.1: Borehole Information Summary**

	<b>Boreholes</b>			
	<b>BH11-1</b>	<b>BH11-2</b>	<b>BH11-3</b>	<b>BH11-4</b>
Station	31+064	31+077	31+098	31+111
Offset, m	2.4 Lt	1.8 Rt	2.4 Lt	1.9 Rt
Ground Surface Elevation, m	176.6	176.7	176.9	176.9
Total Depth Drilled, m	9.6	28.0	28.6	9.6
End of Borehole Elevation, m	167.0	148.7	148.3	167.3
Depth Augered, m	9.6	25.0	24.4	9.6
Depth Cored and tri-coned, m	0	3.0	4.2	0
Number of Soil Samples	9	16	14	9

Note: The station and offset information are with respect to the centerline chainage of Highway 40

### **3.2 LOCATION AND ELEVATION SURVEY**

The ground surface elevation at each borehole location was surveyed by Stantec personnel on April 27, 2011, with reference to the nearest geodetic benchmark. This benchmark was on a tablet in the east face of the coping on the north concrete abutment of the existing bridge (GBM 3048). The geodetic elevation of this benchmark was 176.74 m. The MTM reference coordinates for this site are with respect to Zone 11.

### **3.3 LABORATORY TESTING**

All the SPT samples were taken to Stantec's Ottawa laboratory where they were subjected to a detailed visual examination by a Geotechnical Engineer.

The geotechnical laboratory testing program is summarized in the following table.

**Table 3.2: Geotechnical Laboratory Testing Program**

Test Description	Number of Samples	Remarks
Moisture Content	55	2 by Golder
Atterberg Limits	15	2 by Golder
Grain Size Distribution	15	2 by Golder
Consolidation (oedometer)	2	By Golder
Unconfined Compression (Soil)	2	By Golder
Specific Gravity	2	By Golder

It is noted that where a value is provided for the percent of clay sized particles, the value represents the percent finer than a nominal size of 0.002 mm.

Two samples were submitted to Parcel Laboratories of Ottawa for analysis of pH, soluble sulphate content, chloride content and resistivity.

Samples remaining after testing will be placed in storage for a period of one year after issuance of the final report. After the storage period, the samples will be discarded unless we are directed otherwise by MTO.

## **4.0 Subsurface Conditions**

### **4.1 SUBSURFACE PROFILE**

The subsurface conditions observed in the four boreholes included in this report are presented in detail on the Borehole Records provided in Appendix B. An explanation of the symbols and terms used to describe the Borehole Records is also provided in Appendix B.

In general, the subsurface stratigraphy consisted of pavement and fill material over silty sand or sandy silt overlying firm to stiff silty clay underlain by a thick deposit of soft to firm silty clay overlying a stiff gravelly clay till over shale bedrock.

A borehole location plan and a stratigraphic section of the soil encountered within the boreholes are provided on Drawing No. 1 in Appendix A.

#### **4.1.1 Pavement and Fill Material**

The pavement structure observed on site included:

Asphalt	150 mm to 380 mm
Sand/Gravel Fill	100 mm (at BH11-1 and BH11-4)
Concrete	200 to 230 mm (at BH11-1, BH11-3, BH11-4)

At Borehole BH11-2 where concrete was not observed, the asphalt is directly underlain by 300 mm of crushed sand and gravel.

#### **4.1.2 Organic Layer / Topsoil**

Within Boreholes BH11-1 and BH11-4, an organic layer was observed directly beneath the concrete; the observed layer thickness was 100 mm and 300 mm at the respective locations.

#### **4.1.3 Silty Sand to Sand/Sandy Silt**

A 400 mm silty sand to sand (SM) layer was observed in Borehole BH11-2. A 300 mm sandy silt (ML) layer was also observed in Borehole BH11-3. A 1.6 m of sandy silt (ML) layer interbedded with clayey silt (CL) was observed in Borehole BH11-4. For these layers, moisture content testing was completed on 7 samples and yielded the range of 4.4% to 22.5%.

#### **4.1.4 Stiff Silty Clay**

A stiff to very stiff layer of silty clay was observed beneath fill or sandy material in all boreholes. The layer was between 1.9 m and 3.5 m thick, with a base elevation ranging from 172.5 m to 174.7 m.

Grain size analysis and Atterberg Limit tests were completed on six samples and moisture content testing on 27 samples. The test results are summarized as follows:

- Gravel 0%
- Sand 1% to 48%
- Fines 52% to 99%
- Liquid Limit 23 to 34
- Plastic Limit 6 to 20
- Moisture Content 21% to 30%

Fines noted above represent both silt size and clay size particles.

The results of laboratory testing indicate that the silty clay layer can be classified as (CL). The grain size distribution curves and Atterberg Limits are shown on Figures 1a to 2d in Appendix C.

The layer was generally observed to be stiff based on pocket penetrometer results which ranged from 70 to 200 kPa and SPT results (typical N values from 3 to 11 blows per 0.3 m).

Two samples retrieved from this layer were analyzed for pH, water soluble sulphates and chloride concentrations, and resistivity. The analysis results are provided in Table 4.1.

**Table 4.1: Results of Chemical Analysis**

Borehole No	Sample No.	Depth (m)	pH	Chloride (µg/g)	Sulphate (µg/g)	Resistivity (Ohm-m)
BH11-2	SS-2	0.76 to 1.4	7.8	661	83	8.36
BH11-3	SS-3	1.5 to 2.1	7.8	395	88	12.8



#### **4.1.5 Soft to Firm Silty Clay**

A deposit of silty clay was observed beneath the stiff silty clay layer in all boreholes. The silty clay layer was fully penetrated at Boreholes BH11-2 and BH11-3 where it was observed to be 21.4 m and 21.2 m thick, with corresponding base elevations of 152.3 m and 153.5 m.

The upper portion of the silty clay, above approximate elevation 172.5 m (4.1 to 4.4 m below ground surface), is generally dryer with a consistency of generally stiff to very stiff.

Below elevation 172.5 m, the silty clay is generally wetter with a consistency of soft to firm.

Grain size analysis and Atterberg Limit tests were completed on seven samples and moisture content testing on nineteen samples. The test results are summarized as follows:

- Gravel 0%
- Sand 0% to 1%
- Fines 99% to 100%
- Liquid Limit 33 to 41
- Plastic Limit 19 to 21
- Specific Gravity 2.74 and 2.75
- Moisture Content 21% to 50%
  - Generally below 40% above elevation 172.5 m
  - Generally above 40% below elevation 172.5 m

Fines noted above represent both silt size and clay size particles.

The results of laboratory testing indicate that the silty clay deposit can be classified as (CI). The grain size distribution curves and Atterberg Limits are shown on Figures 1a to 2d in Appendix C.

Below elevation 172.5, the layer was generally observed to be soft based field vane results which ranged from 18 to 89 kPa (with an average of 23.9 kPa) and SPT results (typical N values from 1 to 5 blows per 0.3 m). Unconfined compressive strength testing on two samples for BH11-2 yielded values of 74 kPa and 19 kPa.

The results of two consolidation tests carried out are included in Appendix C. The results of the consolidation tests are summarized below:

**Table 4.2: Consolidation Test Results**

Sample ID	Sample el.	Moisture Content	Initial Void Ratio/Initial Unit Weight	Estimated Preconsolidation Pressure, P' <sub>c</sub>	Recompression Index, C <sub>r</sub>	Compression Index, C <sub>c</sub>
BH11-2 ST-7	172.1 m	33%	0.9/18.8 kN/m <sup>3</sup>	150 kPa	0.06	0.28
BH11-2 ST-12	164.5 m	49%	1.33/17.2 kN/m <sup>3</sup>	75 kPa	0.13	0.40

#### **4.1.6 Gravelly Clay Till**

A layer of stiff gravelly clay till was observed beneath the silty clay deposit in boreholes BH11-2 and BH11-3. The layer was 0.6 m and 1 m thick, with a base elevation of 151.7 m to 152.5 m.

Moisture content testing was completed on two samples and yielded the values of 36% and 19%. Occasional cobbles were observed in the layer. It is noted that although not observed in the boreholes drilled at this site, boulders are frequently encountered in glacial till deposits. The material can be classified as gravelly clay (CI), till.

## **4.2 BEDROCK**

Dark grey shale bedrock was encountered in Boreholes BH11-2 and BH11-3. The bedrock was confirmed by tri-coning and coring approximately 3 and 4.2 m, respectively, into the bedrock. Bedrock was encountered at elevations of 152.5 and 151.7 m (approximately 25.0 and 24.4 m below existing ground surface).

The rock core recovery ranged between 96 and 100%. The rock quality designation (RQD) ranged between 46 and 83%, indicating generally fair to good rock mass quality. Rock core photographs are provided in Appendix B.

Unconfined compressive strength tests were carried out on one bedrock sample from borehole BH11-2 and two bedrock samples from BH11-3. The results of these tests are summarized in Table 4.3.

**Table 4.3: Unconfined Compressive Strength of Rock Cores**

Borehole No	Ground Surface Elevation (m)	Test Elevation (m)	Unconfined Compressive Strength (MPa)
BH11-2	176.7	150.5	61.8
BH11-3	176.9	150.7	53.6
		149.4	65.1

### **4.3 GROUNDWATER**

A standpipe was installed in Borehole BH11-4 after completion of drilling and the water level was measured on April 28, 2011. The measured groundwater level was at a depth of 2.7 m (Elevation of 174.2 m).

Due to the cohesive nature of the silty clay deposit, the depth to groundwater within boreholes BH11-1 to BH11-3 could not be detected during soil sampling.

Fluctuations in the groundwater level due to seasonal variations or in response to a particular precipitation event should be anticipated. -

### **5.0 Miscellaneous**

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The field work was carried out under the supervision of Mr. Dan Stunden, Technologist, under the direction of Mr. Paul Carnaffan, M.Eng., P.Eng.

The drilling equipment was owned and operated by Walker Drilling Ltd. of Utopia, Ontario.

Geotechnical laboratory testing was carried out at the Stantec Ottawa laboratory and the Golder Associates Mississauga laboratory. Chemical testing on soil samples was carried out by Paracel Laboratories in Ottawa.

This report was prepared by Dr. Kasgin Khaheshi Banab, Ph.D., and reviewed by Dr. Fred Griffiths, Ph.D., P.Eng. and Mr. Raymond Haché, M.Sc., P.Eng., MTO Designated Principal Contact.

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## 6.0 Closure

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A subsurface investigation is a limited sampling of a site. The subsurface conditions given herein are based on information gathered at the specific borehole locations and timeframe described herein. Should any conditions at the site be encountered which differ from those at the borehole locations, we request that we be notified immediately in order to assess the additional information.

Respectively Submitted; -

**STANTEC CONSULTING LTD.**



Kasgin Khareshi Banab, Ph.D., EIT



Fred J. Griffiths, Ph.D., P.Eng.  
Principal and Senior Geotechnical Engineer



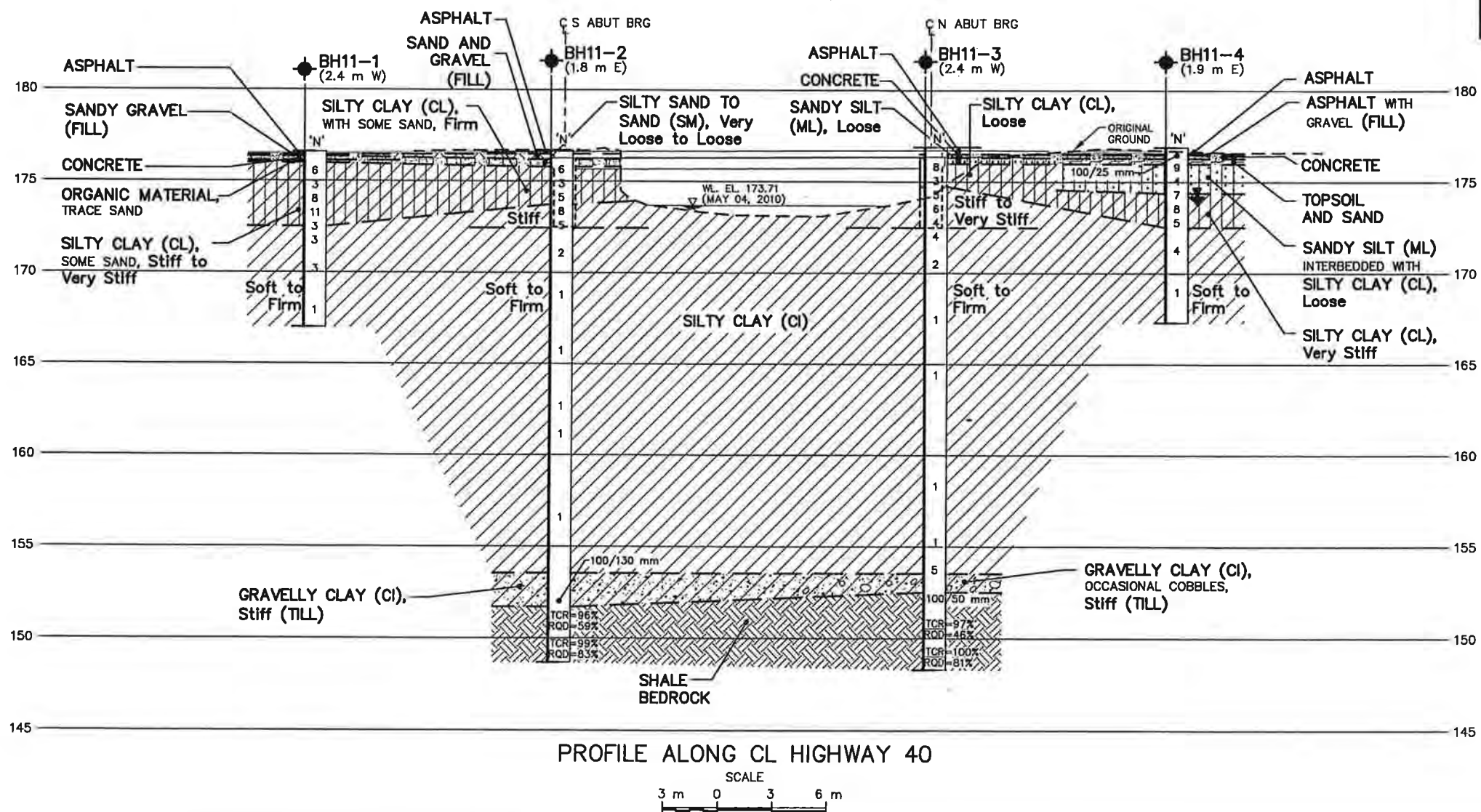
Raymond Haché, M.Sc., P.Eng.  
Principal, Central Canada Practice Lead  
Designated Principal MTO Foundation Contact



## **APPENDIX A**

Drawings No. 1 – Borehole Location Plan and Soil Strata Plot  
Site Photographs





METRIC  
DIMENSIONS ARE IN METRES  
AND/OR MILLIMETRES  
UNLESS OTHERWISE SHOWN

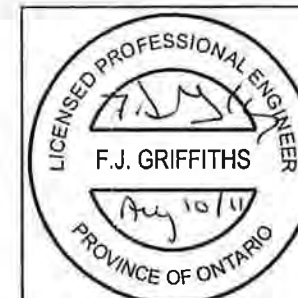
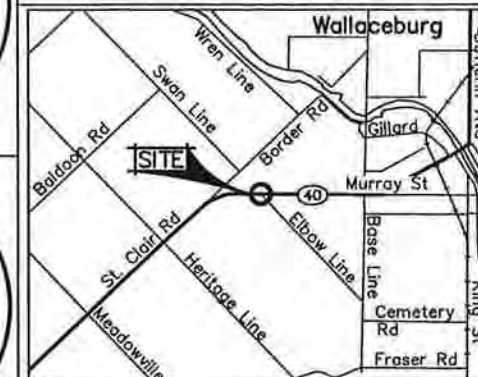


PLATE No  
**CONT**  
**WP** 3103-03-01

**HIGHWAY 40**  
**18th CONC DRAIN BRIDGE**  
**BOREHOLE LOCATIONS & SOIL STRATA**



**KEY PLAN**  
1 km 0 1 2 km

#### LEGEND

- ◆ Bore Hole
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- W.L. at Time of Investigation May 2011
- (1.8 m E) Offset from Road CL

No	ELEVATION	MTM ZONE 11 COORDINATES NORTH	COORDINATES EAST
BH11-1	176.6	4 714 168.2	314 583.8
BH11-2	176.7	4 714 181.5	314 588.3
BH11-3	176.9	4 714 202.2	314 584.5
BH11-4	176.9	4 714 215.4	314 589.1

#### NOTES

The boundaries between soil strata have been established only at Bore Hole locations. Between Bore holes the boundaries are assumed from geological evidence.

This drawing is for subsurface information only. Surface details and features are for conceptual illustration.

NOTE: The complete foundation investigation and design report for this project and other related documents may be examined at the Engineering Materials Office, Downsview. Information contained in this report and related documents is specifically excluded in accordance with the conditions of Section 102-2 of Form 100.

REVISIONS	DATE	BY	DESCRIPTION

GEORES No	40J9-21
HWY No	40
SUB'D KB	CHECKED
DRAWN GBB	CHECKED
DATE	2011-07-07
SITE	13-045
DWG	1





**Photo No. 1a: Concession #18 Drain Bridge at the intersection of HWY 40 and Elbow Line**



**Photo No. 1b: East Elevation of Concession #18 Drain Bridge**





**Photo No. 1c: Barrier Railing System for Concession #18 Drain Bridge**



**Photo No. 1d: Concession #18 Drain Bridge in Murray Street (HWY 40), Chatham-Kent**





## **APPENDIX B**

Symbols and Terms Used on Borehole Records

Borehole Records

Rock Core Photographs

## SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

### SOIL DESCRIPTION

#### Terminology describing common soil genesis:

<i>Topsoil</i>	- mixture of soil and humus capable of supporting vegetative growth
<i>Peat</i>	- mixture of visible and invisible fragments of decayed organic matter
<i>Till</i>	- unstratified glacial deposit which may range from clay to boulders
<i>Fill</i>	- material below the surface identified as placed by humans (excluding buried services)

#### Terminology describing soil structure:

<i>Desiccated</i>	- having visible signs of weathering by oxidization of clay minerals, shrinkage cracks, etc.
<i>Fissured</i>	- having cracks, and hence a blocky structure
<i>Varved</i>	- composed of regular alternating layers of silt and clay
<i>Stratified</i>	- composed of alternating successions of different soil types, e.g. silt and sand
<i>Layer</i>	- > 75 mm in thickness
<i>Seam</i>	- 2 mm to 75 mm in thickness
<i>Parting</i>	- < 2 mm in thickness

#### Terminology describing soil types:

The classification of soil types are made on the basis of grain size and plasticity in accordance with the Unified Soil Classification System (USCS) (ASTM D 2487 or D 2488). The classification excludes particles larger than 76 mm (3 inches). The USCS provides a group symbol (e.g. SM) and group name (e.g. silty sand) for identification.

#### Terminology describing cobbles, boulders, and non-matrix materials (organic matter or debris):

Terminology describing materials outside the USCS, (e.g. particles larger than 76 mm, visible organic matter, construction debris) is based upon the proportion of these materials present:

<i>Trace, or occasional</i>	Less than 10%
<i>Some</i>	10-20%
<i>Frequent</i>	> 20%

#### Terminology describing compactness of cohesionless soils:

The standard terminology to describe cohesionless soils includes compactness (formerly "relative density"), as determined by the Standard Penetration Test N-Value (also known as N-Index). A relationship between compactness condition and N-Value is shown in the following table.

Compactness Condition	SPT N-Value
<i>Very Loose</i>	<4
<i>Loose</i>	4-10
<i>Compact</i>	10-30
<i>Dense</i>	30-50
<i>Very Dense</i>	>50

#### Terminology describing consistency of cohesive soils:

The standard terminology to describe cohesive soils includes the consistency, which is based on undrained shear strength as measured by *in situ* vane tests, penetrometer tests, or unconfined compression tests.

Consistency	Undrained Shear Strength	
	kips/sq.ft.	kPa
<i>Very Soft</i>	<0.25	<12.5
<i>Soft</i>	0.25 - 0.5	12.5 - 25
<i>Firm</i>	0.5 - 1.0	25 - 50
<i>Stiff</i>	1.0 - 2.0	50 - 100
<i>Very Stiff</i>	2.0 - 4.0	100 - 200
<i>Hard</i>	>4.0	>200



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## ROCK DESCRIPTION

### Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	<i>Very Poor</i>
25-50	<i>Poor</i>
50-75	<i>Fair</i>
75-90	<i>Good</i>
90-100	<i>Excellent</i>

Rock quality classification is based on a modified core recovery percentage (RQD) in which all pieces of sound core over 100 mm long are counted as recovery. The smaller pieces are considered to be due to close shearing, jointing, faulting, or weathering in the rock mass and are not counted. RQD was originally intended to be done on NW core; however, it can be used on different core sizes if the bulk of the fractures caused by drilling stresses are easily distinguishable from *in situ* fractures. The terminology describing rock mass quality based on RQD is subjective and is underlain by the presumption that sound strong rock is of higher engineering value than fractured weak rock.

### Terminology describing rock mass:

Spacing (mm)	Joint Classification	Bedding, Laminations, Bands
> 6000	<i>Extremely Wide</i>	-
2000-6000	<i>Very Wide</i>	<i>Very Thick</i>
600-2000	<i>Wide</i>	<i>Thick</i>
200-600	<i>Moderate</i>	<i>Medium</i>
60-200	<i>Close</i>	<i>Thin</i>
20-60	<i>Very Close</i>	<i>Very Thin</i>
<20	<i>Extremely Close</i>	<i>Laminated</i>
<6	-	<i>Thinly Laminated</i>

### Terminology describing rock strength:

Strength Classification	Unconfined Compressive Strength (MPa)
<i>Extremely Weak</i>	< 1
<i>Very Weak</i>	1 – 5
<i>Weak</i>	5 – 25
<i>Medium Strong</i>	25 – 50
<i>Strong</i>	50 – 100
<i>Very Strong</i>	100 – 250
<i>Extremely Strong</i>	> 250

### Terminology describing rock weathering:

Term	Description
<i>Fresh</i>	No visible signs of rock weathering. Slight discolouration along major discontinuities
<i>Slightly Weathered</i>	Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured.
<i>Moderately Weathered</i>	Less than half the rock is decomposed and/or disintegrated into soil.
<i>Highly Weathered</i>	More than half the rock is decomposed and/or disintegrated into soil.
<i>Completely Weathered</i>	All the rock material is decomposed and/or disintegrated into soil. The original mass structure is still largely intact.



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## STRATA PLOT

Strata plots symbolize the soil or bedrock description. They are combinations of the following basic symbols. The dimensions within the strata symbols are not indicative of the particle size, layer thickness, etc.



Boulders  
Cobbles  
Gravel



Sand



Silt



Clay



Organics



Asphalt



Concrete



Fill



Bedrock

## SAMPLE TYPE

SS	Split spoon sample (obtained by performing the Standard Penetration Test)
ST	Shelby tube or thin wall tube
DP	Direct-Push sample (small diameter tube sampler hydraulically advanced)
PS	Piston sample
BS	Bulk sample
WS	Wash sample
HQ, NQ, BQ, etc.	Rock core samples obtained with the use of standard size diamond coring bits.

## WATER LEVEL MEASUREMENT



measured in standpipe, piezometer, or well



inferred

## RECOVERY

For soil samples, the recovery is recorded as the length of the soil sample recovered. For rock core, recovery is defined as the total cumulative length of all core recovered in the core barrel divided by the length drilled and is recorded as a percentage on a per run basis.

## N-VALUE

Numbers in this column are the field results of the Standard Penetration Test: the number of blows of a 140 pound (64 kg) hammer falling 30 inches (760 mm), required to drive a 2 inch (50.8 mm) O.D. split spoon sampler one foot (305 mm) into the soil. For split spoon samples where insufficient penetration was achieved and N-values cannot be presented, the number of blows are reported over sampler penetration in millimetres (e.g. 50/75). Some design methods make use of N value corrected for various factors such as overburden pressure, energy ratio, borehole diameter, etc. No corrections have been applied to the N-values presented on the log.

## DYNAMIC CONE PENETRATION TEST (DCPT)

Dynamic cone penetration tests are performed using a standard 60 degree apex cone connected to A size drill rods with the same standard fall height and weight as the Standard Penetration Test. The DCPT value is the number of blows of the hammer required to drive the cone one foot (305 mm) into the soil. The DCPT is used as a probe to assess soil variability.

## OTHER TESTS

S	Sieve analysis
H	Hydrometer analysis
k	Laboratory permeability
$\gamma$	Unit weight
$G_s$	Specific gravity of soil particles
CD	Consolidated drained triaxial
CU	Consolidated undrained triaxial with pore pressure measurements
UU	Unconsolidated undrained triaxial
DS	Direct Shear
C	Consolidation
$Q_u$	Unconfined compression
$I_p$	Point Load Index ( $I_p$ on Borehole Record equals $I_p(50)$ in which the index is corrected to a reference diameter of 50 mm)

	Single packer permeability test; test interval from depth shown to bottom of borehole
	Double packer permeability test; test interval as indicated
	Falling head permeability test using casing
	Falling head permeability test using well point or piezometer



Stantec

# RECORD OF BOREHOLE No BH 11-1

1 OF 1

METRIC

W.P. 3103-03-01 LOCATION 18<sup>th</sup> Concession Drain Bridge, Chatham-Kent N: 4 714 168 E: 314 584 ORIGINATED BY DS  
DIST HWY 40 BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler COMPILED BY JF  
DATUM Geodetic DATE 2011 04 19 - 2011 04 19 CHECKED BY SG,KB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT W <sub>p</sub>	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W <sub>L</sub>	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
176.6	Asphalt							20 40 60 80 100	10 20 30					GR SA SI CL
0.0	150 mm ASPHALT							○ UNCONFINED      × FIELD VANE						
176.4								● QUICK TRIAXIAL      × LAB VANE						
176.3	Sandy gravel, blackish brown, FILL							20 40 60 80 100						
0.3	230 mm CONCRETE													
176.1	Organic material, trace sand, moist		1	BS			176							
176.0	SILTY CLAY (CL), some sand													
0.6	Dark grey		2	SS	6									
	Stiff to very stiff													
			3	SS	3		175							0 11 66 23
			4	SS	8		174							
			5	SS	11		173							
			6	SS	3		172							0 0 66 34
172.5	SILTY CLAY (CI)													pp = 125 kPa
4.1	Grey, moist to wet		7	SS	3		171							
	Soft to firm		8	SS	3		170							
							169							
			9	SS	1		168							0 0 58 42
							167							
167.0	End of Borehole													pp = pocket penetrometer
9.6														

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

# RECORD OF BOREHOLE No BH 11-2

1 OF 3

METRIC

W.P. 3103-03-01 LOCATION 18<sup>th</sup> Concession Drain Bridge, Chatham-Kent N: 4 714 182 E: 314 588 ORIGINATED BY DS  
 DIST HWY 40 BOREHOLE TYPE Hollow Stem Augers, Splittspoon Sampler, HQ Rock Core COMPILED BY JF  
 DATUM Geodetic DATE 2011 05 02 - 2011 05 05 CHECKED BY SG,KB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT w <sub>p</sub>	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w <sub>L</sub>	UNIT WEIGHT γ kN/m <sup>3</sup>	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa						
176.7	Asphalt							20 40 60 80 100						
0.0 176.5	200 mm ASPHALT							20 40 60 80 100						
0.2	FILL: brown crushed sand and gravel													
176.2														
0.5	SILTY SAND to SAND (SM) Grey to brown, black from 0.9 m to 1.1 m Very loose to loose		1	BS			176							
175.8														
0.9	SILTY CLAY (CL) with some sand  Dark grey to black  Stiff		2	SS	6									
			3	SS	3		175							0 48 40 12
			4	SS	5		174							
173.7														
3.0	SILTY CLAY (CI)  Grey to olive  Stiff		5	SS	8		173							0 2 57 41 pp = 70 kPa
			6	SS	5									
172.4							172							
4.3	SILTY CLAY (CI)  Grey  Soft to firm		7	ST				6.6%						0 0 68 32 G <sub>s</sub> = 2.74
			8	SS	2		171							
							170							
								3.0						
			9	SS	1		169							0 0 49 51
							168							
								2.0						
			10	ST			167							

Continued Next Page

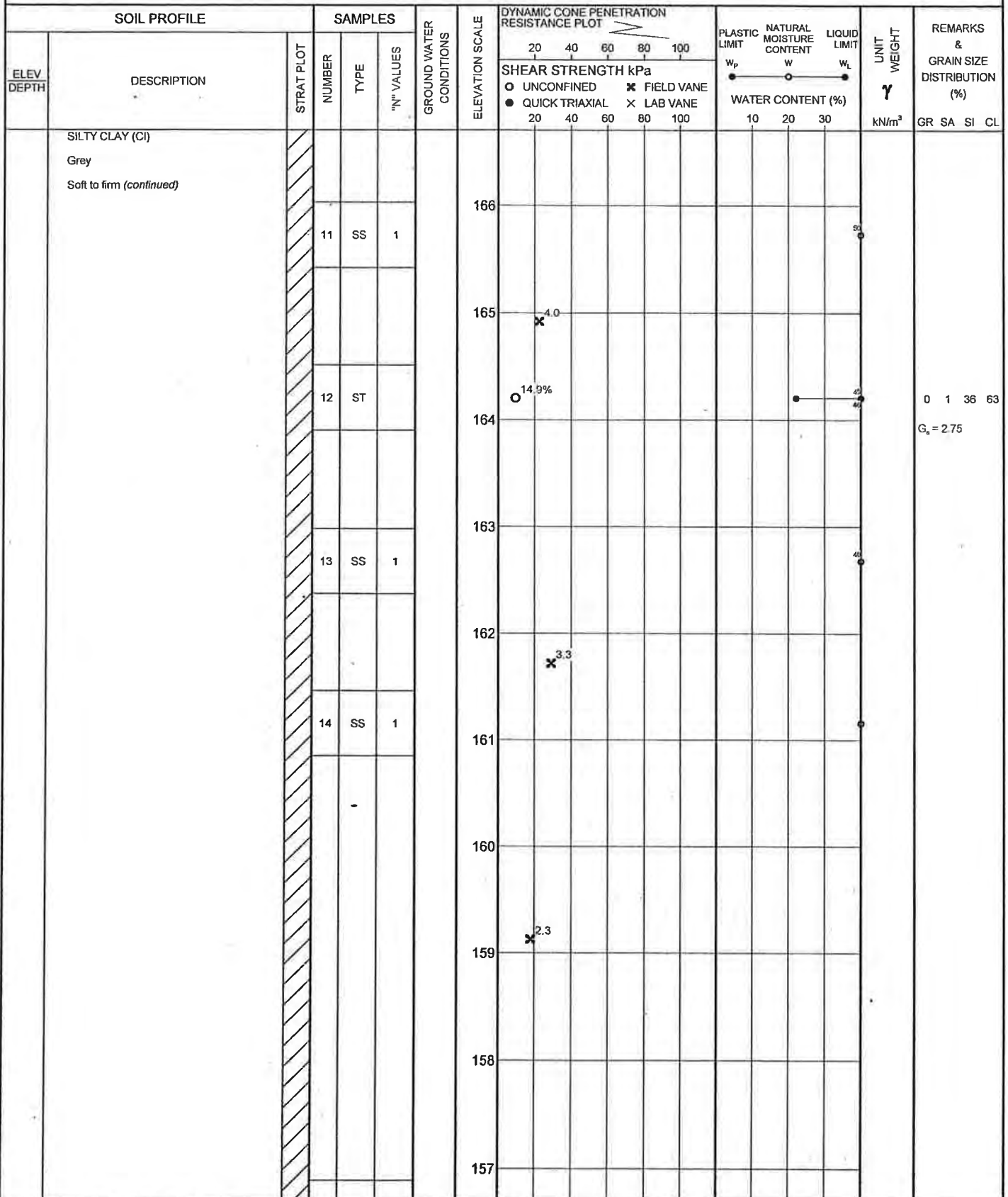
✕ 3.0 ✕ 3.0: Numbers refer to Sensitivity ○ 3% STRAIN AT FAILURE

# RECORD OF BOREHOLE No BH 11-2

2 OF 3

METRIC

W.P. 3103-03-01 LOCATION 18<sup>th</sup> Concession Drain Bridge, Chatham-Kent N: 4 714 182 E: 314 588 ORIGINATED BY DS  
DIST HWY 40 BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler, HQ Rock Core COMPILED BY JF  
DATUM Geodetic DATE 2011 05 02 - 2011 05 05 CHECKED BY SG,KB



Continued Next Page

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







## METRIC

W.P. 3103-03-01

**LOCATION** 18<sup>th</sup> Consession Drain Bridge, Chatham-Kent

N: 4 714 202 E: 314 585

ORIGINATED BY DS

DIST HWY 40

**BOREHOLE TYPE** Hollow Stem Augers, Splitspoon Sampler, HQ Rock Core

COMPILED BY JF

DATUM Geodetic

DATE 2011 04 20 - 2011 04 26

CHECKED BY SG,KB

[illegible]

Continued Next Page

**x<sup>3</sup>, x<sup>3</sup>:** Numbers refer to Sensitivity

○ 3% STRAIN AT FAILURE



# RECORD OF BOREHOLE No BH 11-3

3 OF 3

METRIC

W.P. 3103-03-01 LOCATION 18<sup>th</sup> Concession Drain Bridge, Chatham-Kent N: 4 714 202 E: 314 585 ORIGINATED BY DS  
 DIST HWY~ 40 BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler, HQ Rock Core COMPILED BY JF  
 DATUM Geodetic DATE 2011 04 20 - 2011 04 26 CHECKED BY SG,KB

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT		PLASTIC LIMIT   NATURAL MOISTURE CONTENT   LIQUID LIMIT			UNIT WEIGHT  γ  kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%)  GR   SA   SI   CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa		W <sub>p</sub>	W	W <sub>L</sub>		
								○ UNCONFINED ● QUICK TRIAXIAL	✕ FIELD VANE ✕ LAB VANE					
							20   40   60   80   100	20   40   60   80   100						
	SILTY CLAY (CI) Brown to grey, moist to wet Soft to firm (continued)													
			12	SS	1									
			13	SS	5									
153.5 23.4	Gravelly Clay (CI), TILL Grey, moist to wet Stiff -Occasional cobbles													
152.5 24.4	SHALE bedrock  -Dark grey -Fair to good rock mass quality -Strong intact rock strength -Closely spaced joints dipped at 0-20 deg. -Slightly weathered joints		14	SS	100/ 50mm									
			15	HQ										
			16	HQ										
148.3 28.6	End of Borehole													pp = pocket penetrometer

ONTARIO MTO STANTEC 165000744 - HIGHWAY 40 - CHATHAM-KENT.GPJ ONTARIO MOT.GDT 8/4/11

# RECORD OF BOREHOLE No BH 11-4

1 OF 1

METRIC

W.P. 3103-03-01

LOCATION 18<sup>th</sup> Concession Drain Bridge, Chatham-Kent

N: 4 714 215 E: 314 589 ORIGINATED BY DS

DIST HWY 40

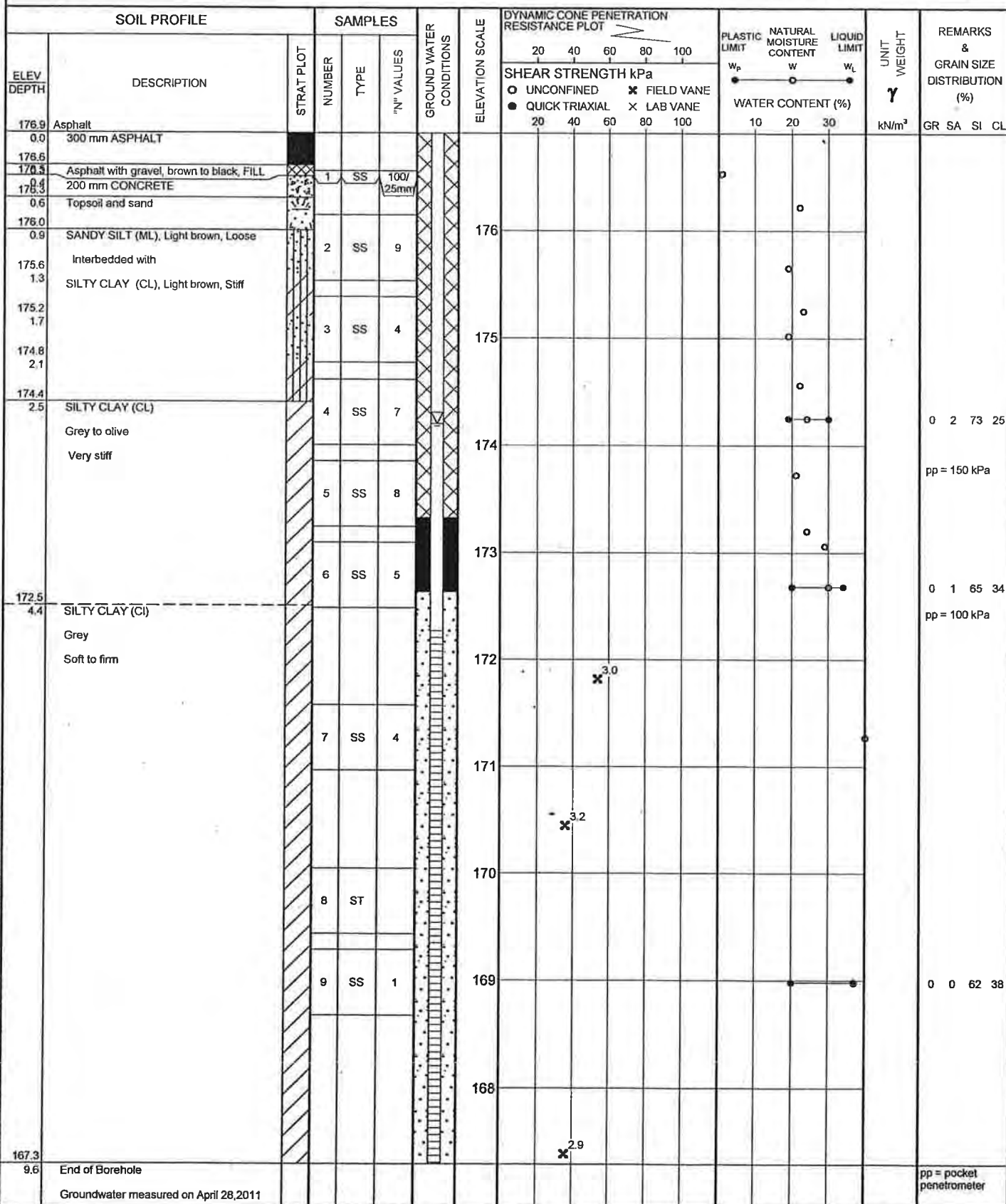
BOREHOLE TYPE Hollow Stem Augers, Splitspoon Sampler

COMPILED BY JF

DATUM Geodetic

DATE 2011 04 18 - 2011 04 18

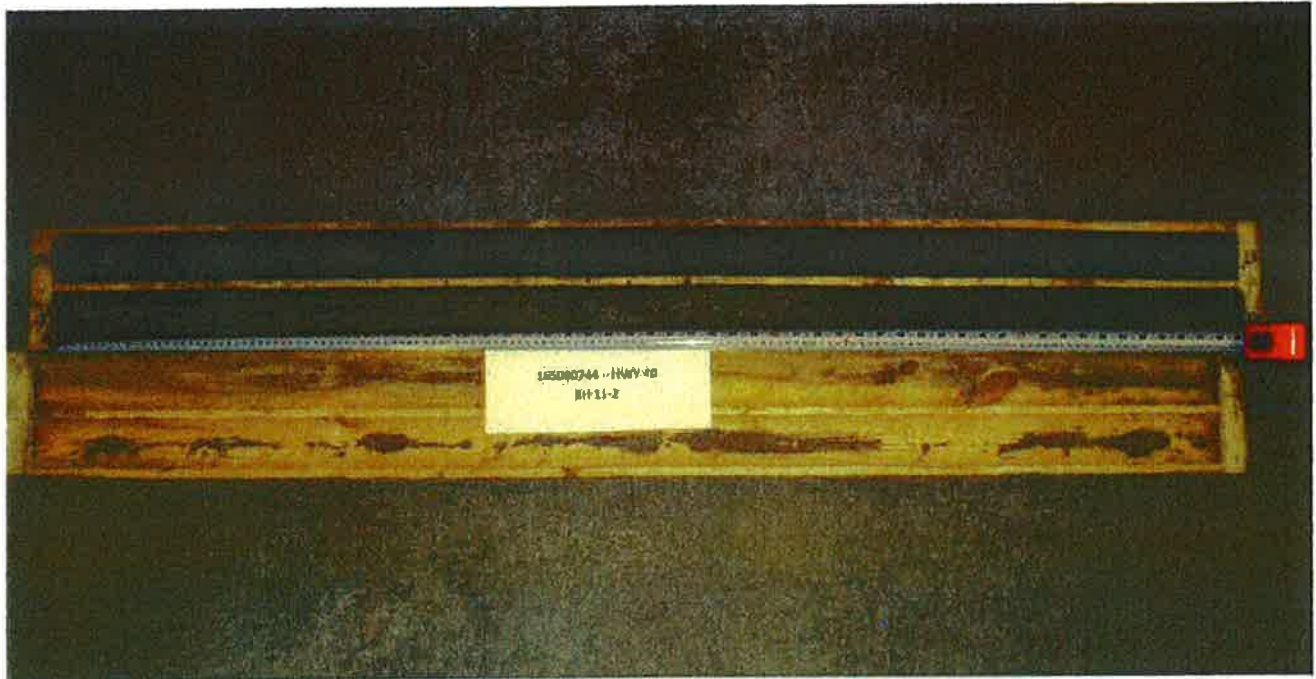
CHECKED BY SG,KB



Numbers refer to Sensitivity 3% STRAIN AT FAILURE

ONTARIO MTO STANTEC 165000744 - HIGHWAY 40 - CHATHAM-KENT.GPJ ONTARIO MOT.GDT 8/4/11





**Photo No. 1: BH 11-2 – Elev. 151.7 – 148.7 m**



**Photo No. 2: BH 11-3 – Elev. 151.3 – 148.3 m**

v:\01224\active\other\_pc\_projects\165000744\photos\rock photos\final\165000744\_photo\_pages.doc

## **APPENDIX C**

### **Laboratory Test Results**

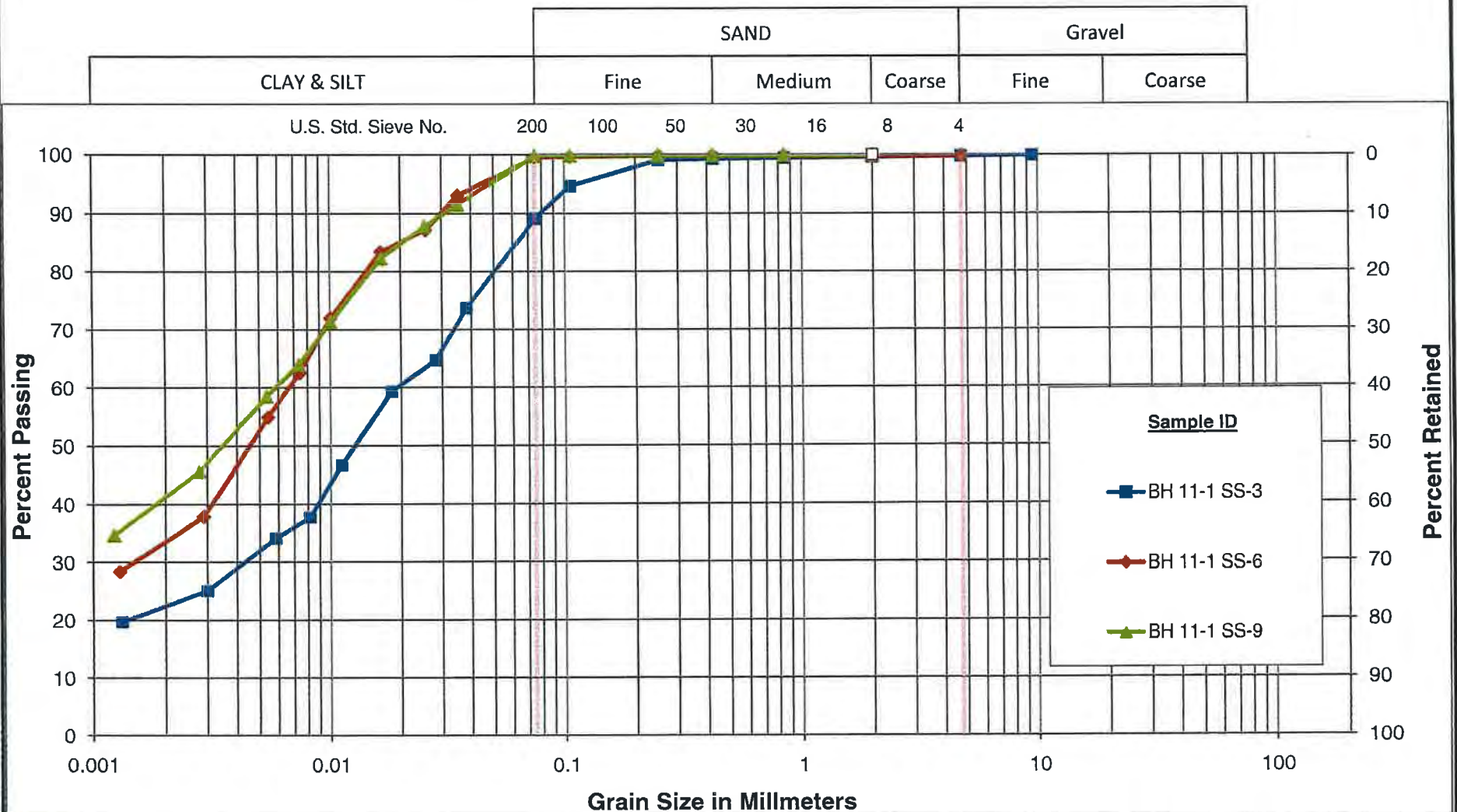
**Figures 1a – 1d: Grain Size Distribution Plots**

**Figure 2a-2d: Plasticity Chart**

### **Laboratory Testing by Golder**

- Grain Size Distribution
- Plasticity
- Specific Gravity
- Consolidation
- Unified Compression (soil)

# Unified Soil Classification System



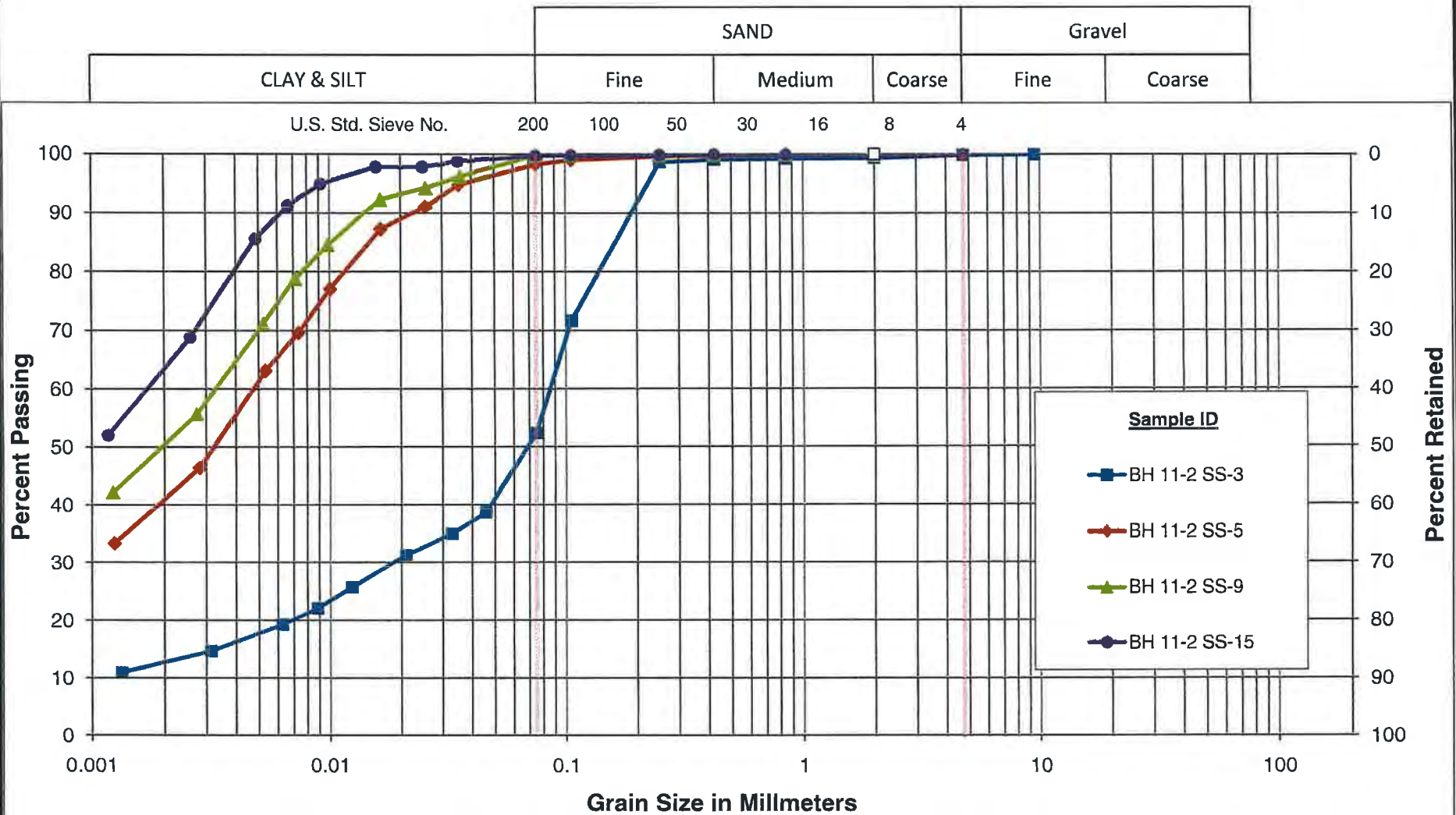
**GRAIN SIZE DISTRIBUTION**  
Silty Clay (CI, CL)

Figure No. 1a

Project No. 165000744



# Unified Soil Classification System



## GRAIN SIZE DISTRIBUTION

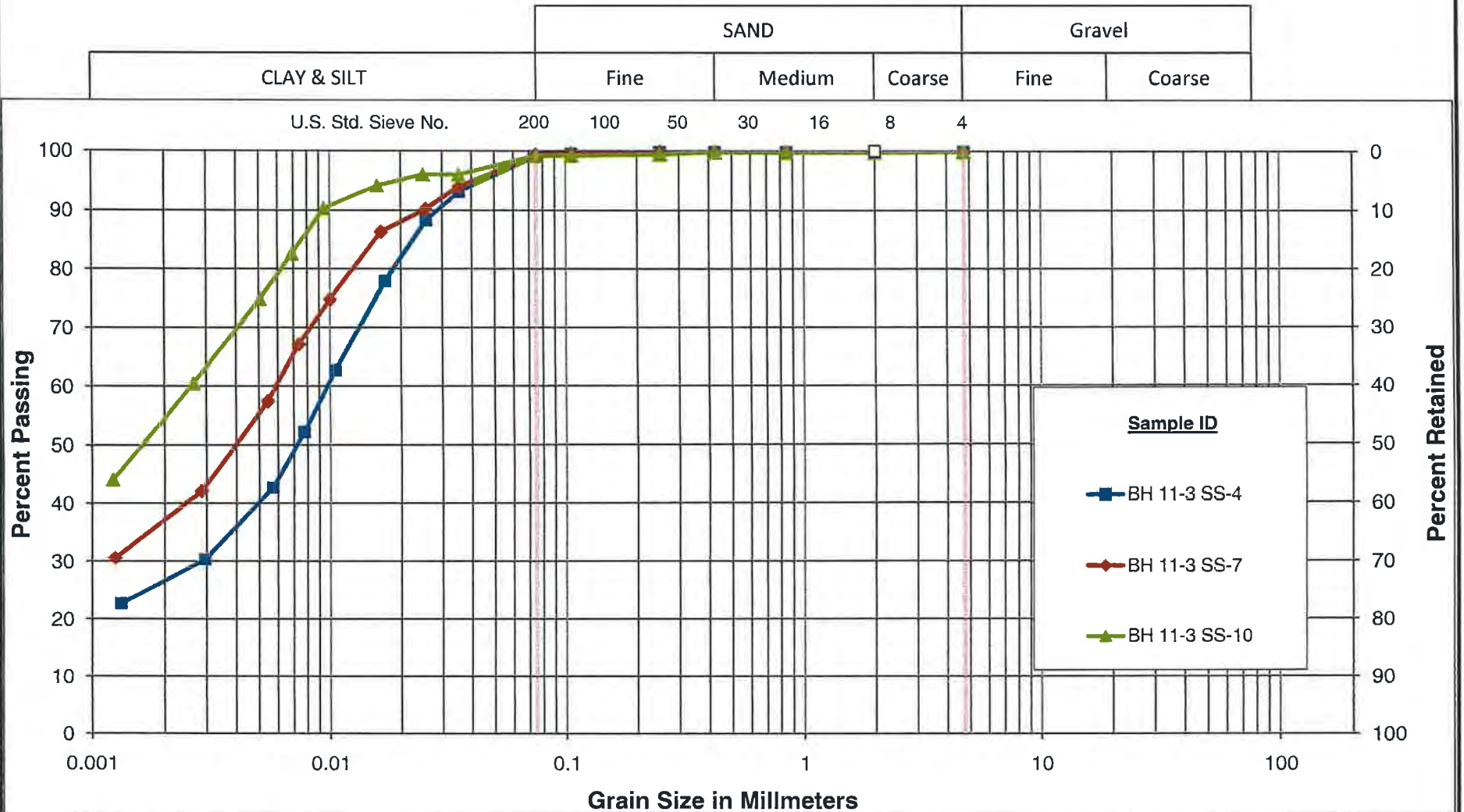
Silty Clay (CI, CL)

Figure No. 1b

Project No. 165000744



# Unified Soil Classification System

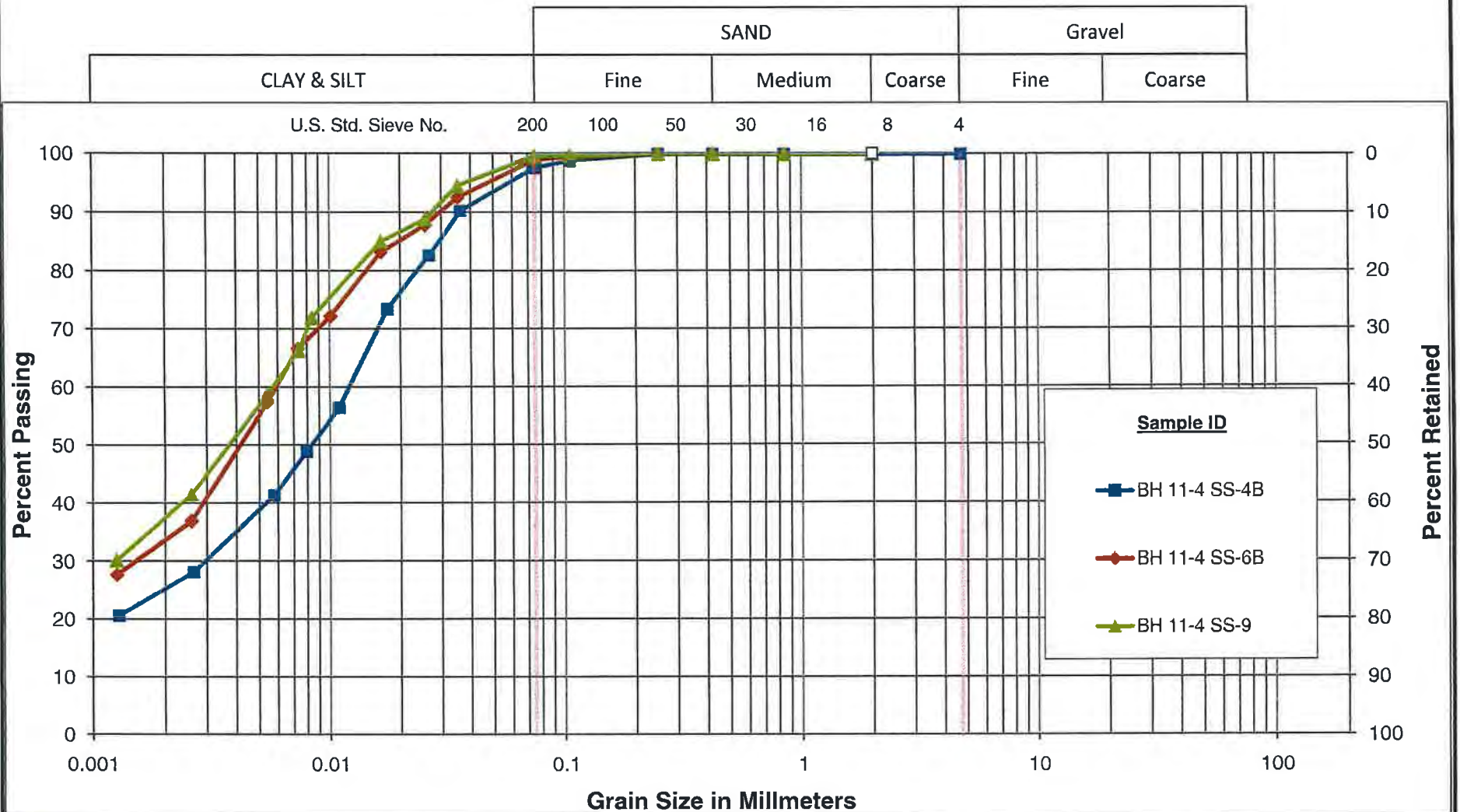


**GRAIN SIZE DISTRIBUTION**  
Silty Clay (CI, CL)

Figure No. 1c

Project No. 165000744

# Unified Soil Classification System

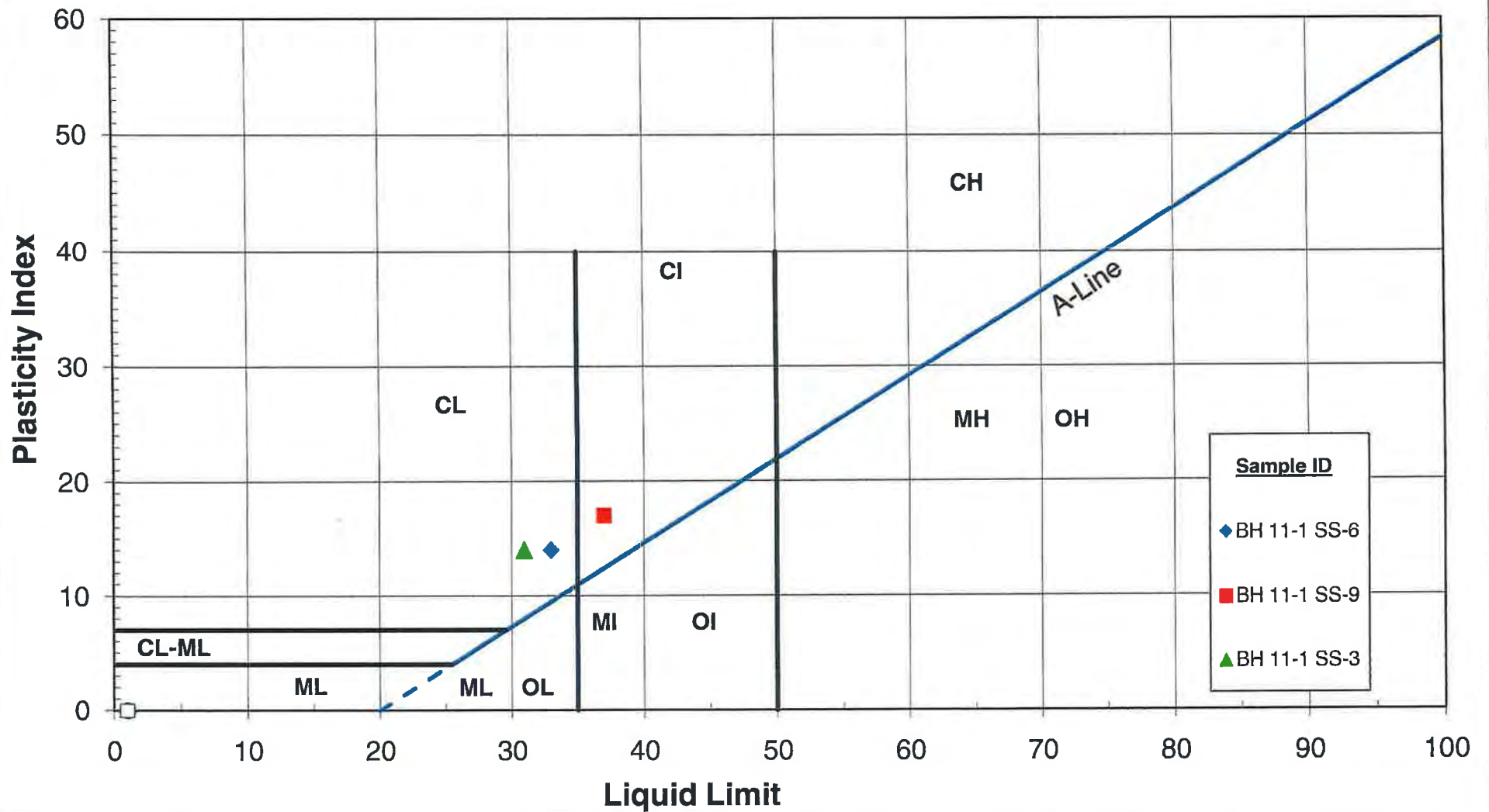


## GRAIN SIZE DISTRIBUTION

Silty Clay (CI, CL)

Figure No. 1d

Project No. 165000744

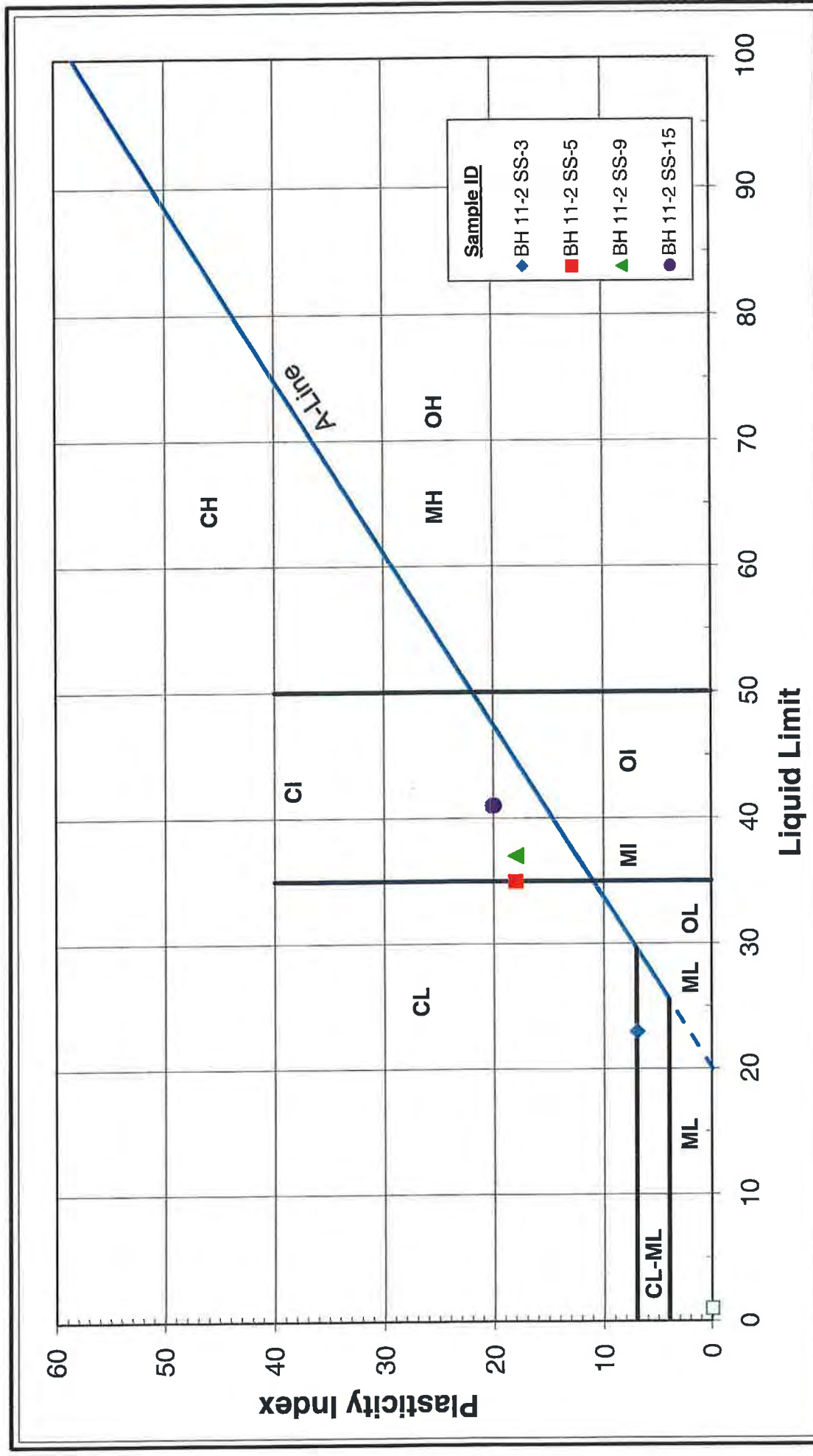


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## PLASTICITY CHART

Figure No. 2a

Project No. 165000744



**Figure No. 2b**

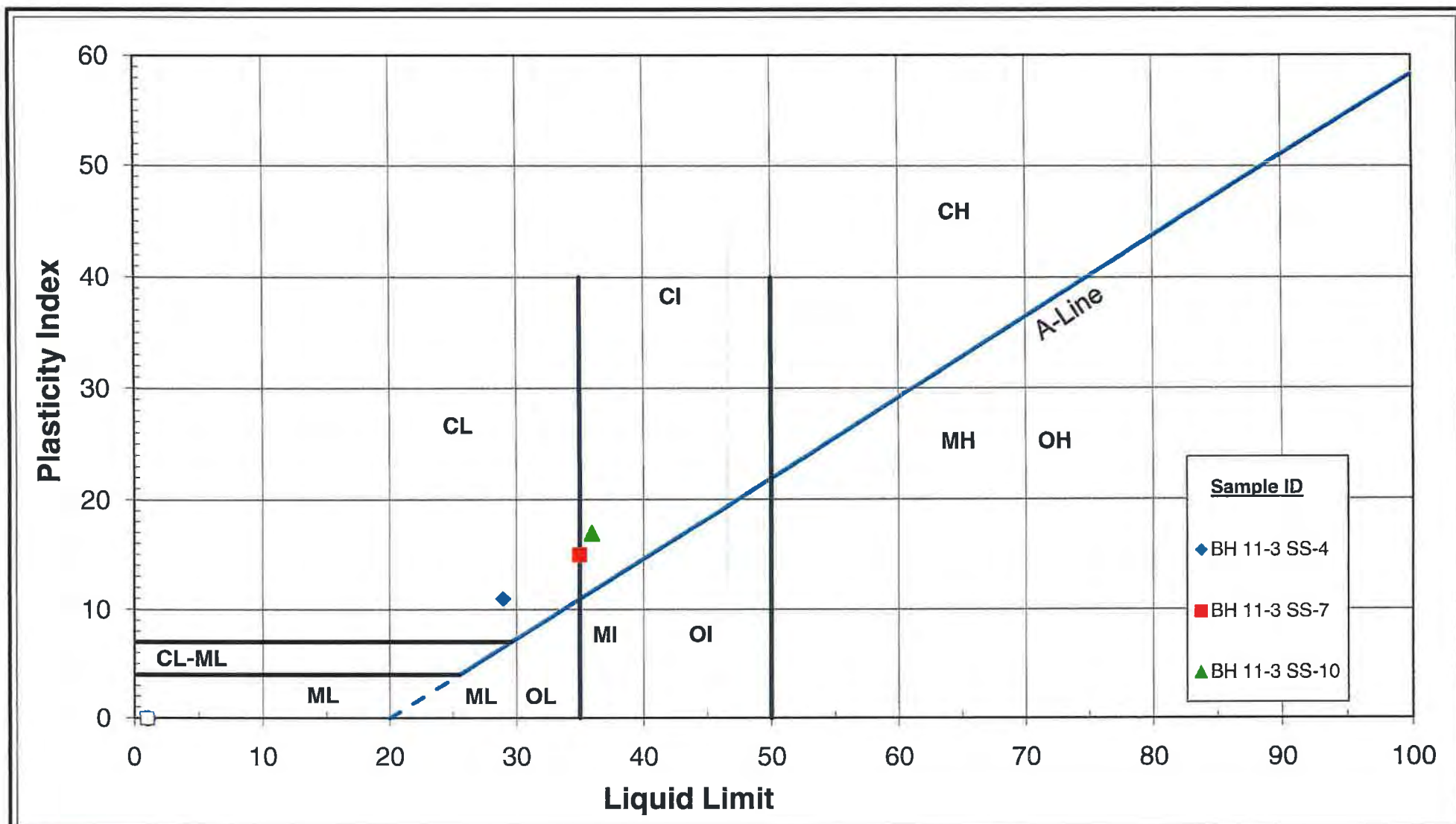
Project No. 165000744

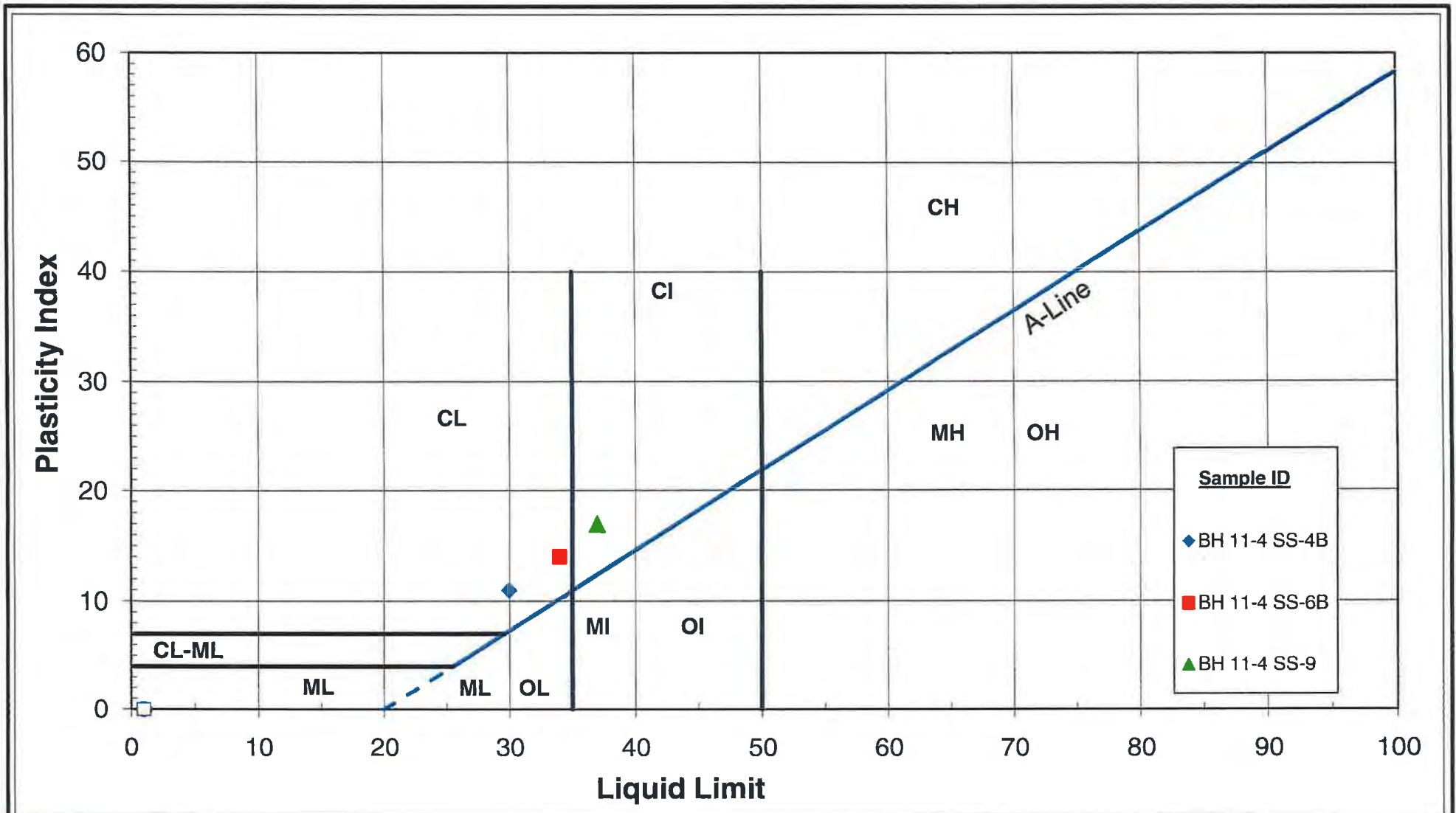
# PLASTICITY CHART



**Stantec**







Stantec

## PLASTICITY CHART

Figure No. 2d

Project No. 165000744



May 31, 2011

Project No. 11-1183-0023

165000744

Simon Gudina  
Stantec  
200-2781 Lancaster Road  
Ottawa, Ontario  
K1B 1A7

#### GEOTECHNICAL LABORATORY TESTING

Dear Sir

This letter reports the results of laboratory testing carried out on the samples received at our office in Mississauga. The results of the tests are summarized in the attached tables and figures.

The testing services reported herein have been performed in accordance with the indicated recognized standard, unless noted otherwise. This report is for the sole use of the designated client. This report constitutes a testing service only and does not represent any results interpretation or opinion regarding specification compliance or material suitability.

We trust that the results are sufficient for your current requirements. If you have any questions, please do not hesitate to call us.

**GOLDER ASSOCIATES LTD.**

Marijana Manojlovic  
Laboratory Manager

MM/lg



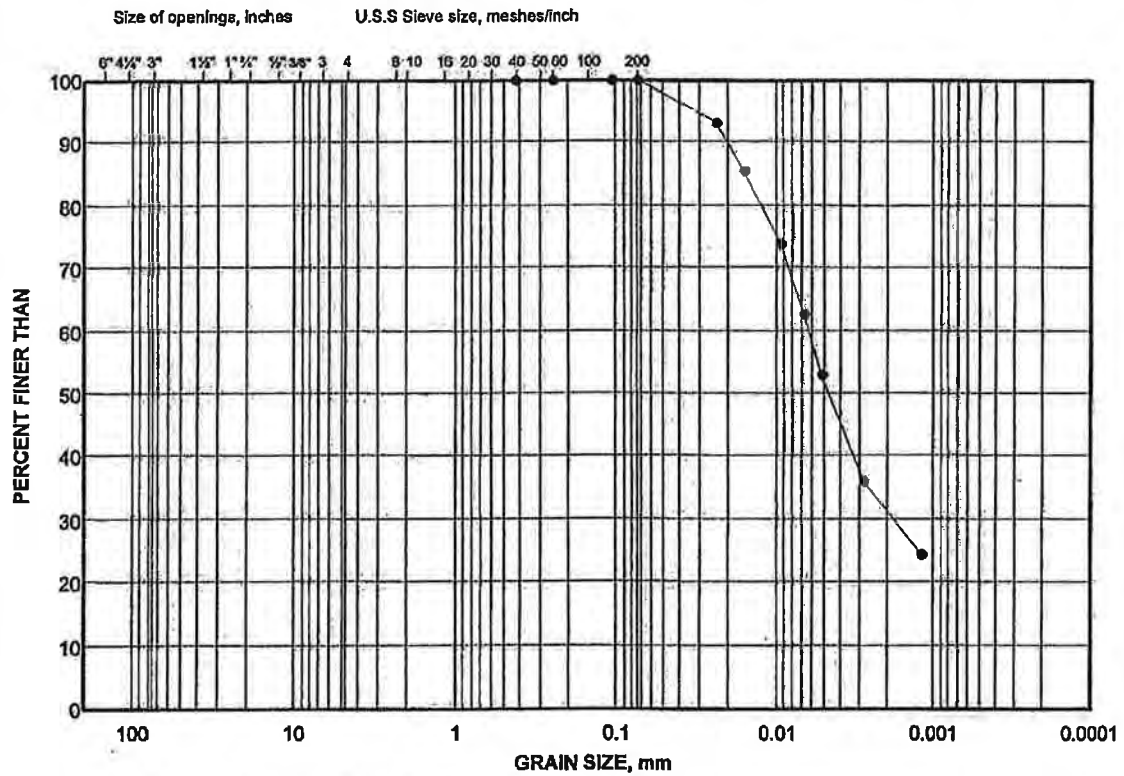
Golder Associates Ltd.  
2390 Argentia Road, Mississauga, Ontario, Canada L5N 5Z7  
Tel: +1 (905) 567 4444 Fax: +1 (905) 567 6581 [www.golder.com](http://www.golder.com)

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# GRAIN SIZE DISTRIBUTION

FIGURE



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

## LEGEND

SYMBOL	BOREHOLE	SAMPLE	DEPTH(m)
•	11-2	ST-7	4.6

Project Number: 11-1183-0023

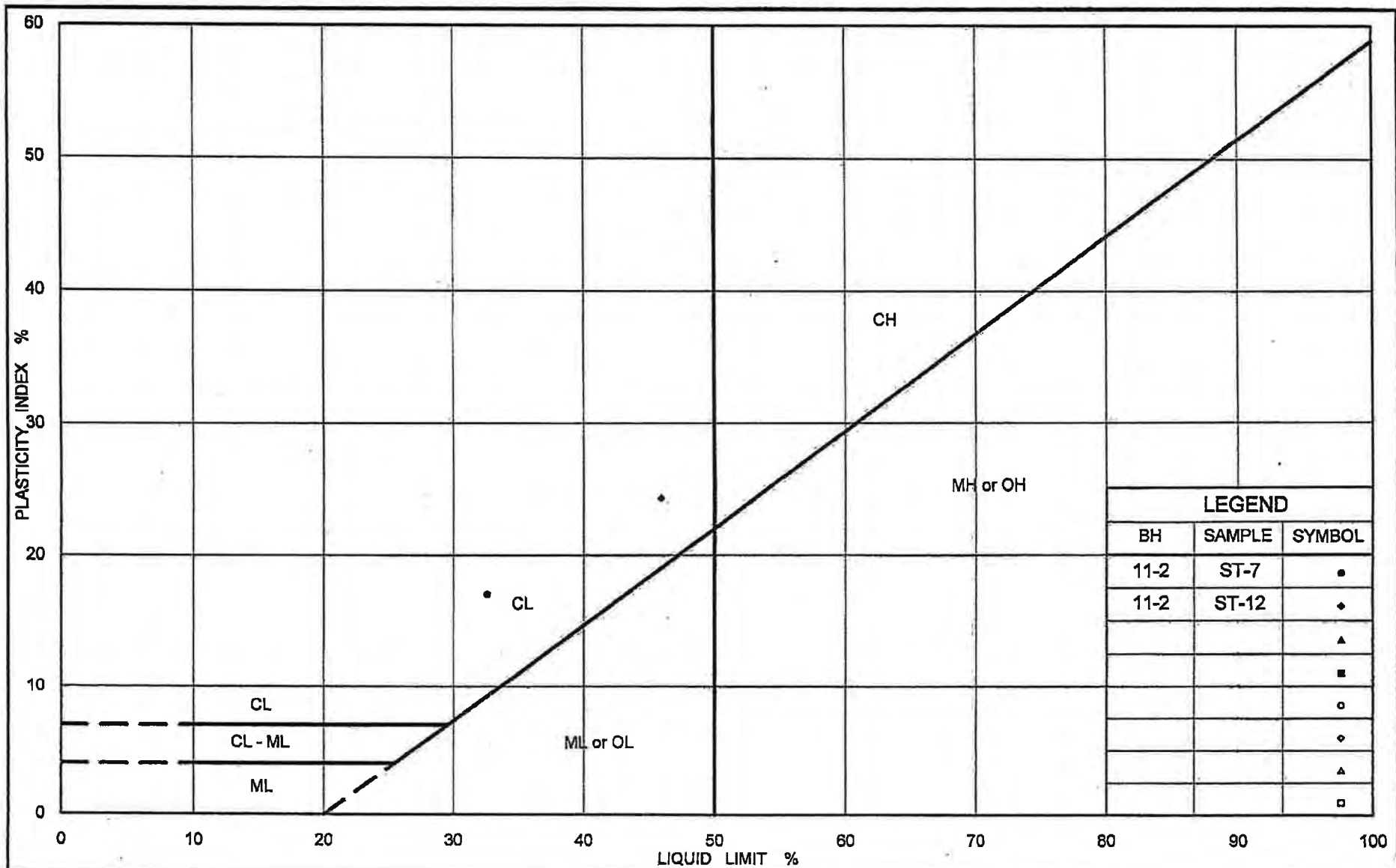
Checked By: *[Signature]*

Golder Associates

Date: 26-May-11







## PLASTICITY CHART

Figure No.

Project No. 11-1183-0023

Checked By:


*Handwritten signature*

## **SPECIFIC GRAVITY TEST RESULTS**

### **ASTM D 854-06 TEST METHOD A**

PROJECT NUMBER	11-1183-0023	
PROJECT NAME	Stantec / Lab Testing / 165000744	
DATE TESTED	May, 2011	
Borehole	Sample	Specific
No.	No.	Gravity
11-2	ST-7	2.74
11-2	ST-12	2.75

Note: Test carried out on soil particles  $\leq 4.75\text{mm}$  using distilled water.

Checked By: 

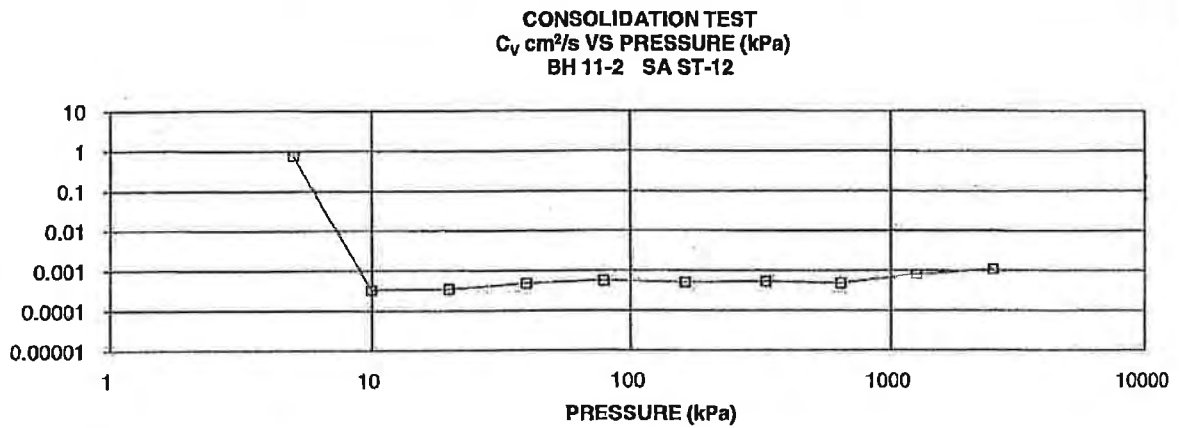
**Golder Associates**

CONSOLIDATION TEST SUMMARY					FIGURE		
<b>SAMPLE IDENTIFICATION</b>							
Project Number	11-1183-0023			Sample Number	ST-12		
Borehole Number	11-2			Sample Depth, m	12.2		
<b>TEST CONDITIONS</b>							
Test Type	Standard			Load Duration, hr	24		
Oedometer Number	9						
Date Started	5/09/2011						
Date Completed	5/23/2011						
<b>SAMPLE DIMENSIONS AND PROPERTIES - INITIAL</b>							
Sample Height, cm	1.90			Unit Weight, kN/m <sup>3</sup>	17.20		
Sample Diameter, cm	6.33			Dry Unit Weight, kN/m <sup>3</sup>	11.58		
Area, cm <sup>2</sup>	31.47			Specific Gravity, measured	2.75		
Volume, cm <sup>3</sup>	59.79			Solids Height, cm	0.816		
Water Content, %	48.51			Volume of Solids, cm <sup>3</sup>	25.68		
Wet Mass, g	104.88			Volume of Voids, cm <sup>3</sup>	34.11		
Dry Mass, g	70.62			Degree of Saturation, %	100.4		
<b>TEST COMPUTATIONS</b>							
Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	c <sub>v</sub> cm <sup>2</sup> /s	m <sub>v</sub> m <sup>2</sup> /kN	k cm/s
0.00	1.900	1.328	1.900				
5.00	1.890	1.316	1.895	1	7.61E-01	1.05E-03	7.85E-05
9.96	1.878	1.301	1.884	2306	3.26E-04	1.27E-03	4.07E-08
19.91	1.853	1.271	1.866	2160	3.42E-04	1.32E-03	4.43E-08
40.00	1.814	1.223	1.834	1500	4.75E-04	1.02E-03	4.76E-08
79.47	1.759	1.156	1.787	1215	5.57E-04	7.33E-04	4.00E-08
160.63	1.681	1.060	1.720	1245	5.04E-04	5.06E-04	2.50E-08
328.63	1.582	0.939	1.631	1070	5.27E-04	3.10E-04	1.60E-08
641.54	1.483	0.817	1.532	1033	4.82E-04	1.66E-04	7.86E-09
1262.67	1.389	0.702	1.436	560	7.81E-04	7.97E-05	6.09E-09
2507.36	1.296	0.588	1.342	346	1.10E-03	3.94E-05	4.26E-09
1262.67	1.316	0.612	1.306				
328.63	1.373	0.683	1.344				
79.47	1.443	0.769	1.408				
19.91	1.513	0.854	1.478				
5.00	1.581	0.937	1.547				
Note: k calculated using cv based on t <sub>90</sub> values. Specimen taken 7cm from the bottom of sample							
<b>SAMPLE DIMENSIONS AND PROPERTIES - FINAL</b>							
Sample Height, cm	1.58			Unit Weight, kN/m <sup>3</sup>	18.94		
Sample Diameter, cm	6.33			Dry Unit Weight, kN/m <sup>3</sup>	13.92		
Area, cm <sup>2</sup>	31.47			Specific Gravity, measured	2.75		
Volume, cm <sup>3</sup>	49.75			Solids Height, cm	0.816		
Water Content, %	36.09			Volume of Solids, cm <sup>3</sup>	25.68		
Wet Mass, g	96.11			Volume of Voids, cm <sup>3</sup>	24.07		
Dry Mass, g	70.62						
<div style="display: flex; justify-content: space-between;"> <span>Prepared By: LFG</span> <span><b>Golder Associates</b></span> <span>Checked By: </span> </div>							

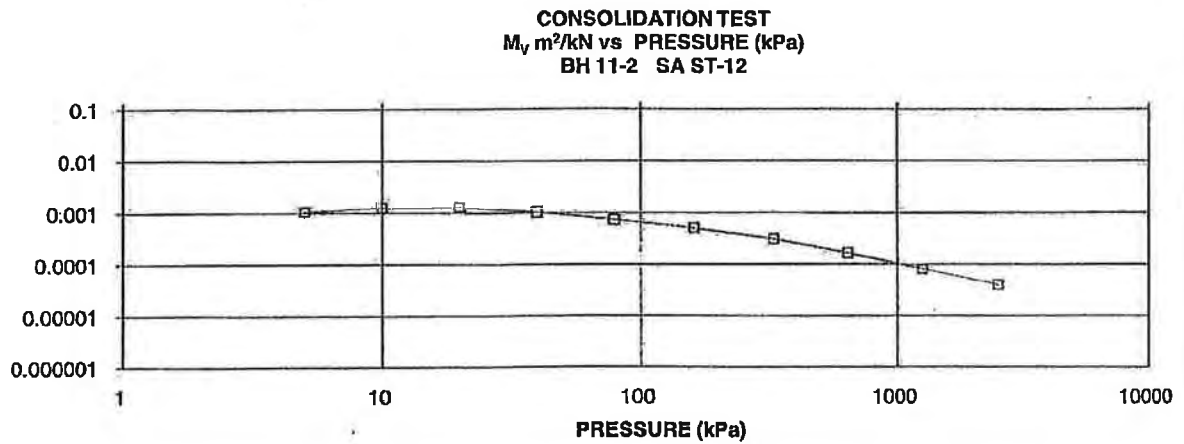
# CONSOLIDATION TEST SUMMARY

FIGURE

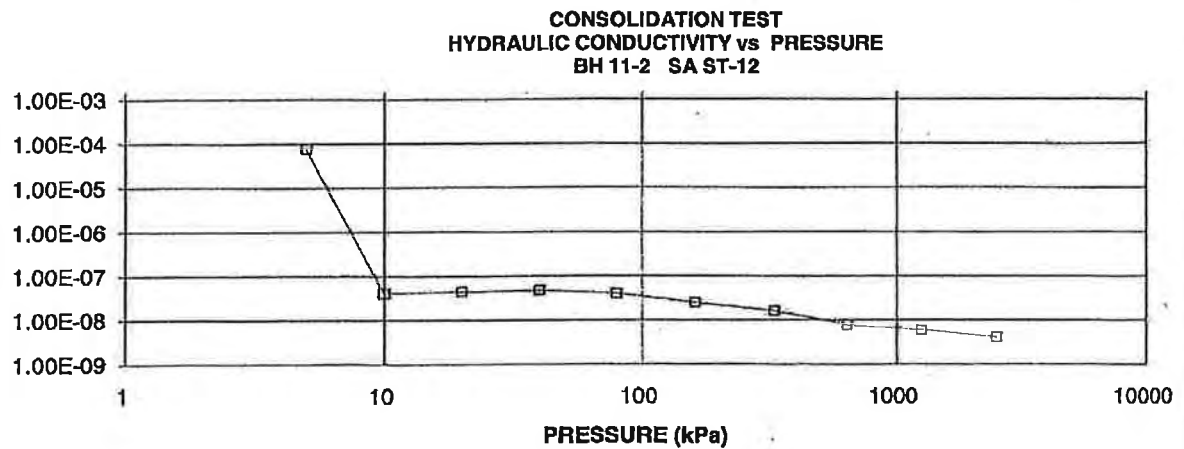
COEFFICIENT OF CONSOLIDATION,  
cm<sup>2</sup>/s



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



HYDRAULIC CONDUCTIVITY,  
cm/s



Project No. 11-1183-0023

Prepared By: LFG

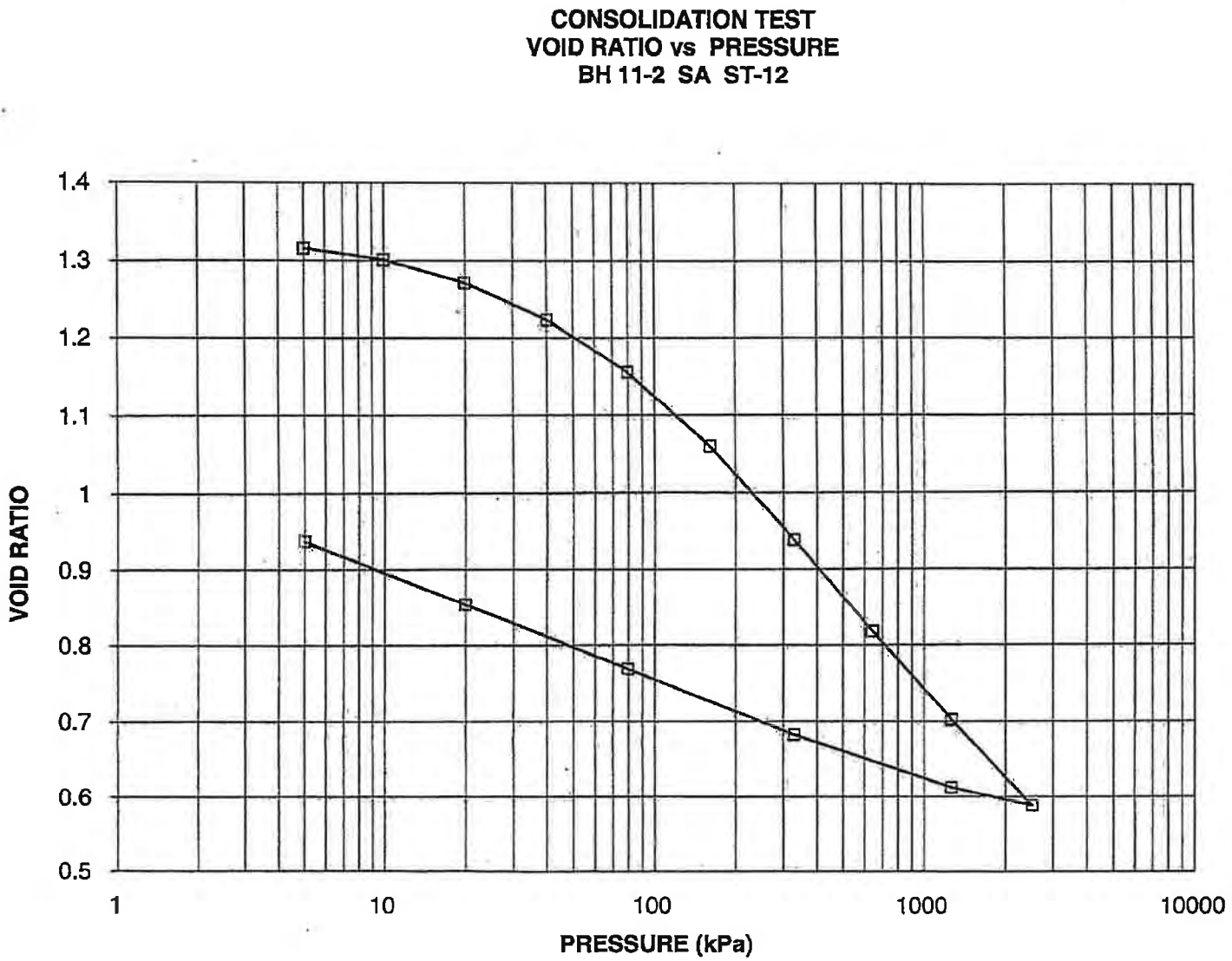
Golder Associates

Checked By: *[Signature]*



CONSOLIDATION TEST  
VOID RATIO VS LOG PRESSURE

FIGURE



Project No. 11-1183-0023

Prepared By: LFG

Golder Associates

Checked By:

*WJH*

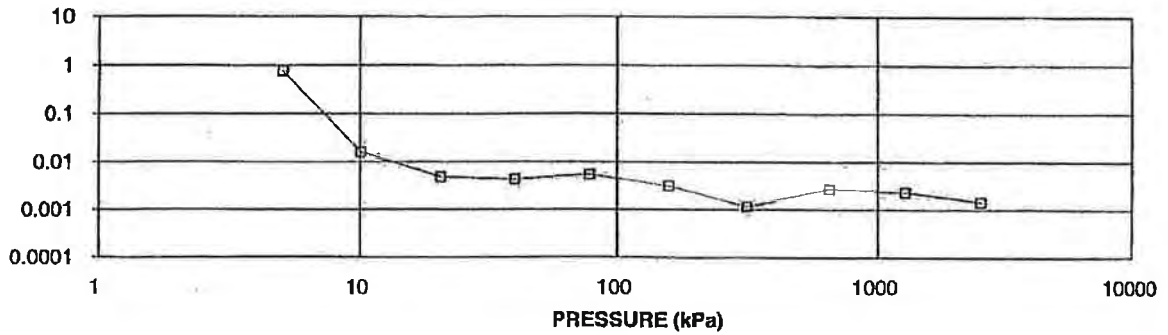
CONSOLIDATION TEST SUMMARY					FIGURE		
<b>SAMPLE IDENTIFICATION</b>							
Project Number	11-1183-0023	Sample Number	ST-7				
Borehole Number	11-2	Sample Depth, m	4.6				
<b>TEST CONDITIONS</b>							
Test Type	Standard	Load Duration, hr	24				
Oedometer Number	7						
Date Started	5/09/2011						
Date Completed	5/23/2011						
<b>SAMPLE DIMENSIONS AND PROPERTIES - INITIAL</b>							
Sample Height, cm	1.89	Unit Weight, kN/m <sup>3</sup>	18.78				
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m <sup>3</sup>	14.12				
Area, cm <sup>2</sup>	31.48	Specific Gravity, measured	2.74				
Volume, cm <sup>3</sup>	59.62	Solids Height, cm	0.995				
Water Content, %	33.07	Volume of Solids, cm <sup>3</sup>	31.32				
Wet Mass, g	114.21	Volume of Voids, cm <sup>3</sup>	28.30				
Dry Mass, g	85.83	Degree of Saturation, %	100.3				
<b>TEST COMPUTATIONS</b>							
Pressure kPa	Corr. Height cm	Void Ratio	Average Height cm	t <sub>90</sub> sec	c <sub>v</sub> cm <sup>2</sup> /s	m <sub>v</sub> m <sup>2</sup> /kN	k cm/s
0.00	1.894	0.903	1.894				
5.03	1.893	0.902	1.894	1	7.60E-01	9.45E-05	7.04E-06
10.06	1.892	0.902	1.893	47	1.62E-02	9.45E-05	1.50E-07
20.49	1.879	0.888	1.886	154	4.89E-03	6.68E-04	3.21E-07
40.01	1.868	0.878	1.874	173	4.30E-03	2.89E-04	1.22E-07
78.95	1.853	0.862	1.860	135	5.44E-03	2.14E-04	1.14E-07
156.68	1.822	0.831	1.837	228	3.14E-03	2.09E-04	6.43E-08
312.29	1.752	0.760	1.787	581	1.16E-03	2.38E-04	2.71E-08
655.96	1.657	0.665	1.704	235	2.62E-03	1.46E-04	3.75E-08
1278.12	1.582	0.590	1.619	240	2.32E-03	6.35E-05	1.44E-08
2522.42	1.497	0.505	1.540	346	1.45E-03	3.58E-05	5.10E-09
1278.12	1.508	0.515	1.503				
312.29	1.534	0.542	1.521				
78.95	1.569	0.577	1.552				
20.49	1.607	0.615	1.588				
5.03	1.642	0.651	1.625				
Note: k calculated using cv based on t <sub>90</sub> values. Specimen swelled under 10kPa							
<b>SAMPLE DIMENSIONS AND PROPERTIES - FINAL</b>							
Sample Height, cm	1.64	Unit Weight, kN/m <sup>3</sup>	20.29				
Sample Diameter, cm	6.33	Dry Unit Weight, kN/m <sup>3</sup>	16.28				
Area, cm <sup>2</sup>	31.48	Specific Gravity, measured	2.74				
Volume, cm <sup>3</sup>	51.70	Solids Height, cm	0.995				
Water Content, %	24.64	Volume of Solids, cm <sup>3</sup>	31.32				
Wet Mass, g	106.98	Volume of Voids, cm <sup>3</sup>	20.38				
Dry Mass, g	85.83						
<div style="display: flex; justify-content: space-between;"> <span>Prepared By: LFG</span> <span><b>Golder Associates</b></span> <span>Checked By: </span> </div>							

# CONSOLIDATION TEST SUMMARY

FIGURE

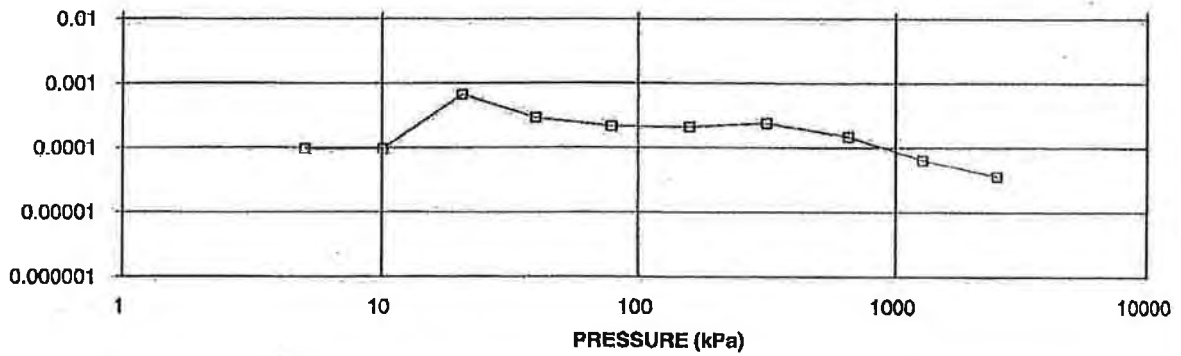
CONSOLIDATION TEST  
 $C_v$  cm<sup>2</sup>/s VS PRESSURE (kPa)  
 BH 11-2 SA ST-7

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



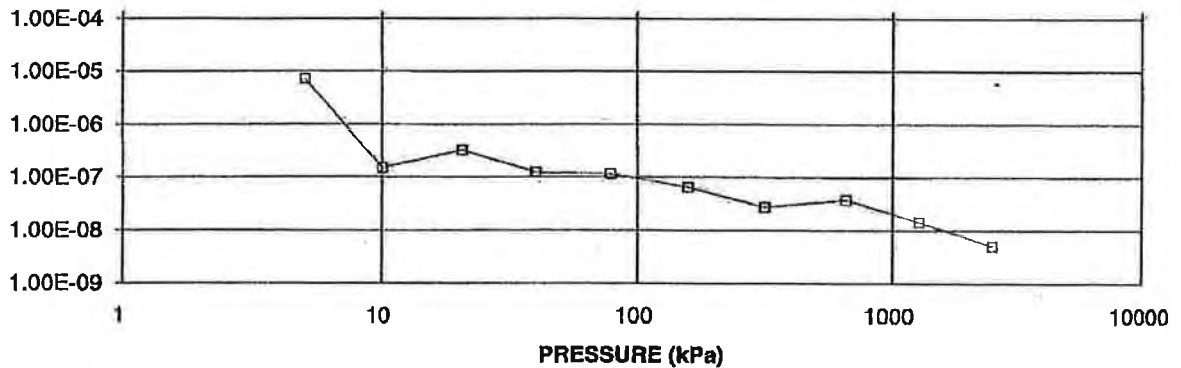
CONSOLIDATION TEST  
 $M_v$  m<sup>2</sup>/kN vs PRESSURE (kPa)  
 BH 11-2 SA ST-7

VOLUME COMPRESSIBILITY,  $m^2/kN$



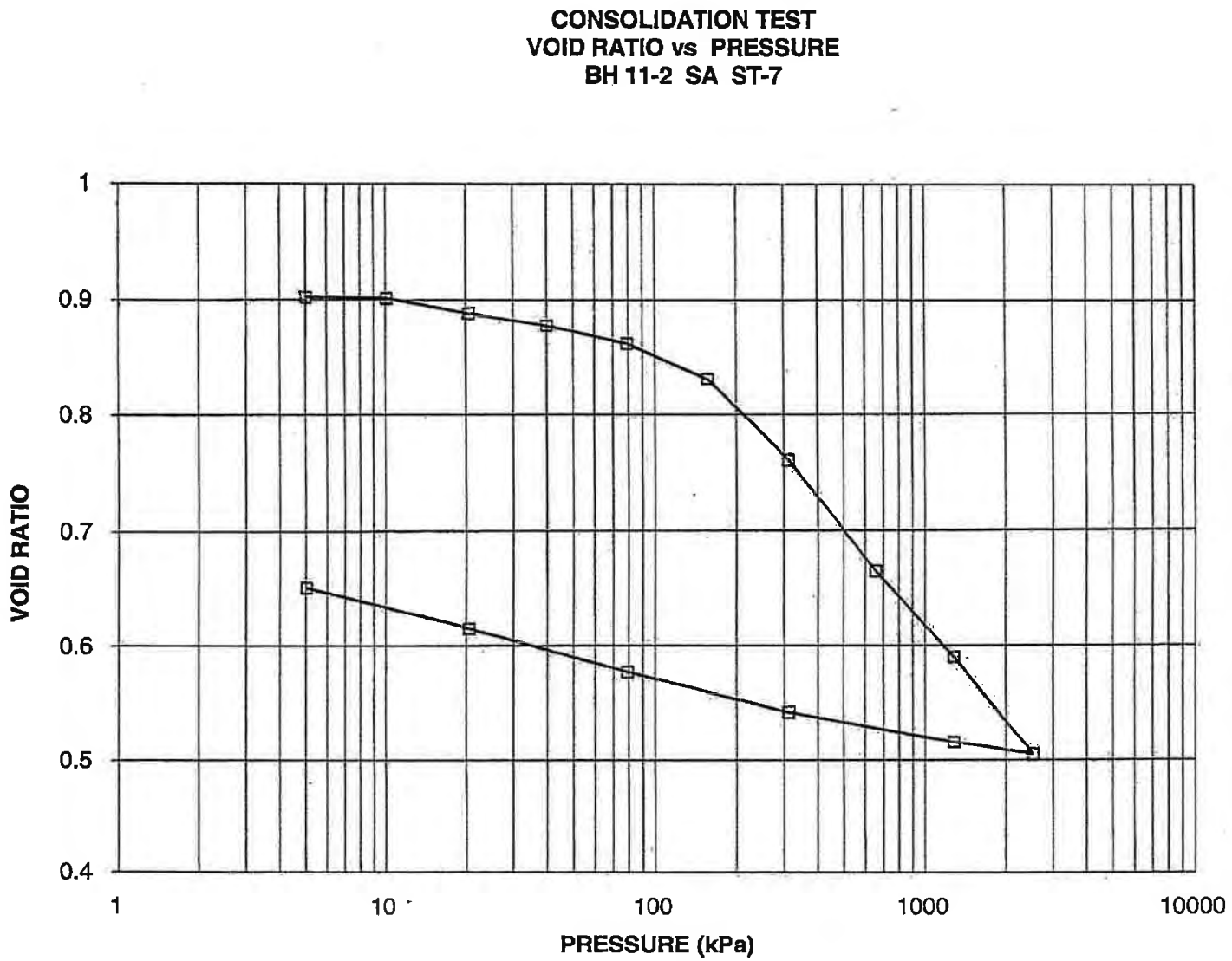
CONSOLIDATION TEST  
 HYDRAULIC CONDUCTIVITY vs PRESSURE  
 BH 11-2 SA ST-7

HYDRAULIC CONDUCTIVITY,  
 $cm/s$



CONSOLIDATION TEST  
VOID RATIO VS LOG PRESSURE

FIGURE



Project No. 11-1183-0023

Prepared By: LFG

Golder Associates

Checked By:

*WJ*

# UNCONFINED COMPRESSION TEST (UC)

ASTM D 2166 - 06

## SAMPLE IDENTIFICATION

PROJECT NUMBER	11-1183-0023	SAMPLE NUMBER	ST-7
BOREHOLE NUMBER	11-2	SAMPLE DEPTH, m	4.6

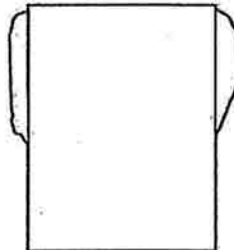
## TEST CONDITIONS

MACHINE SPEED, mm/min	2.80	TYPE OF SPECIMEN	Thin wall tube sample
RATE OF AXIAL STRAIN, %/min	2.00	L/D	2.04

## SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	14.01	WATER CONTENT, (specimen) %	31.10
SAMPLE DIAMETER, cm	6.87	UNIT WEIGHT, kN/m <sup>3</sup>	19.19
SAMPLE AREA, cm <sup>2</sup>	37.07	DRY UNIT WT., kN/m <sup>3</sup>	14.64
SAMPLE VOLUME, cm <sup>3</sup>	519.33	SPECIFIC GRAVITY, measured	2.74
WET WEIGHT, g	1016.70	VOID RATIO	0.83
DRY WEIGHT, g	775.50		

## FAILURE SKETCH



## TEST RESULTS

STRAIN AT FAILURE, %	6.6	COMPRESSIVE STRESS, kPa	74
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REMARKS: Specimen taken 30cm from top of the sample. DATE: 5/9/2011

Checked By: *ML*

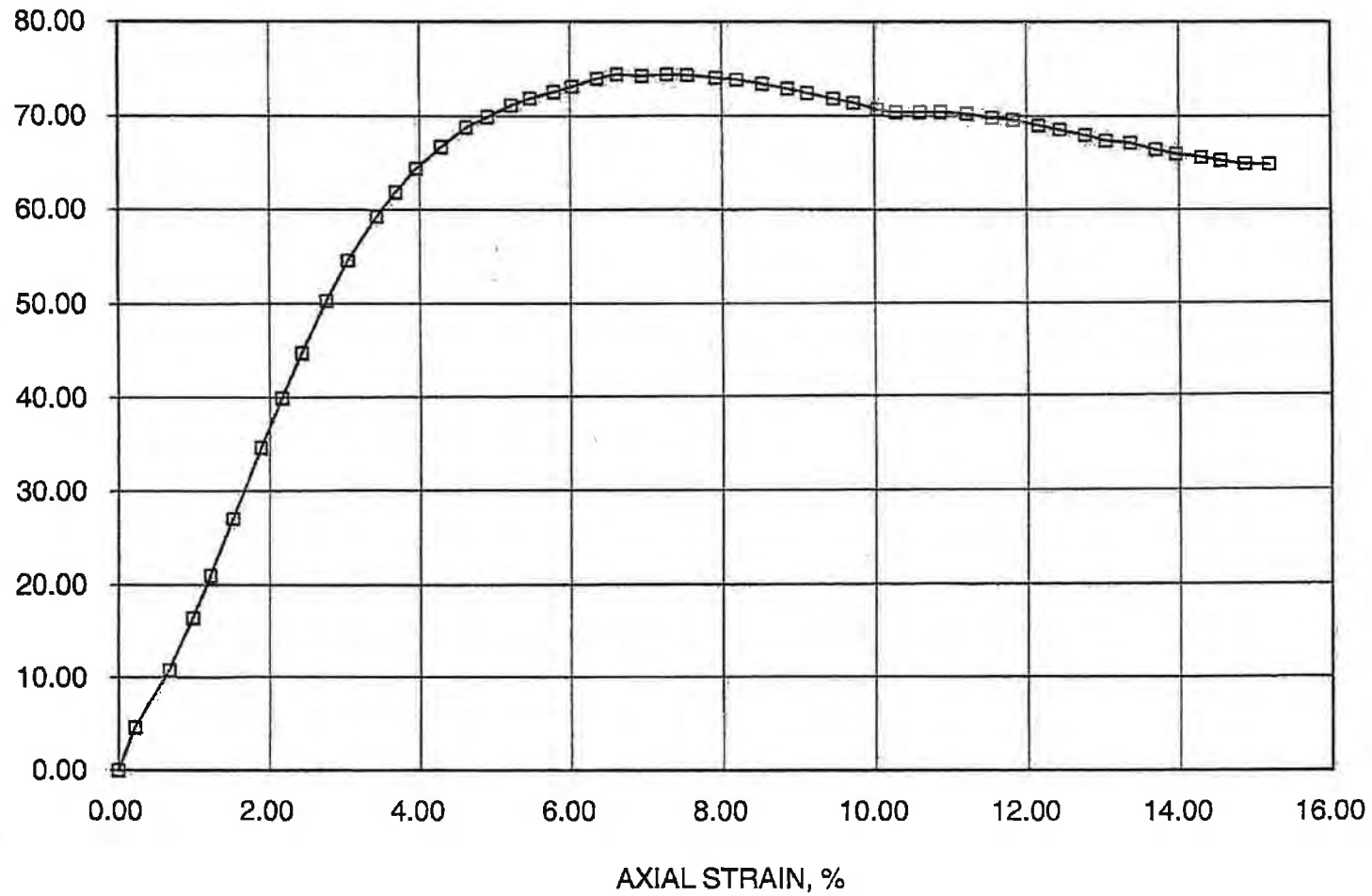
Golder Associates



# UNCONFINED COMPRESSION TEST (UC)

FIGURE

Borehole 11-2 Sample ST-7 Depth 4.6m



Project No. 11-1183-0023

DEVIATOR STRESS, kPa

Checked By: *WU*

# UNCONFINED COMPRESSION TEST (UC)

ASTM D 2166 - 06

## SAMPLE IDENTIFICATION

PROJECT NUMBER	11-1183-0023	SAMPLE NUMBER	ST-12
BOREHOLE NUMBER	11-2	SAMPLE DEPTH, m	12.2

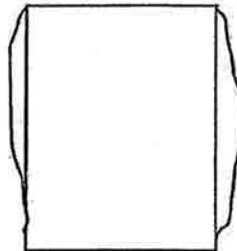
## TEST CONDITIONS

MACHINE SPEED, mm/min	2.78	TYPE OF SPECIMEN	Thin wall tube sample
RATE OF AXIAL STRAIN, %/min	2.00	L/D	2.01

## SPECIMEN INFORMATION

SAMPLE HEIGHT, cm	13.90	WATER CONTENT, (specimen) %	44.70
SAMPLE DIAMETER, cm	6.90	UNIT WEIGHT, kN/m <sup>3</sup>	17.51
SAMPLE AREA, cm <sup>2</sup>	37.39	DRY UNIT WT., kN/m <sup>3</sup>	12.10
SAMPLE VOLUME, cm <sup>3</sup>	519.76	SPECIFIC GRAVITY, measured	2.75
WET WEIGHT, g	928.20	VOID RATIO	1.23
DRY WEIGHT, g	641.47		

## FAILURE SKETCH



## TEST RESULTS

STRAIN AT FAILURE, %	14.9	COMPRESSIVE STRESS, kPa	19
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REMARKS: Specimen taken 27cm from top of the sample. DATE: 5/9/2011

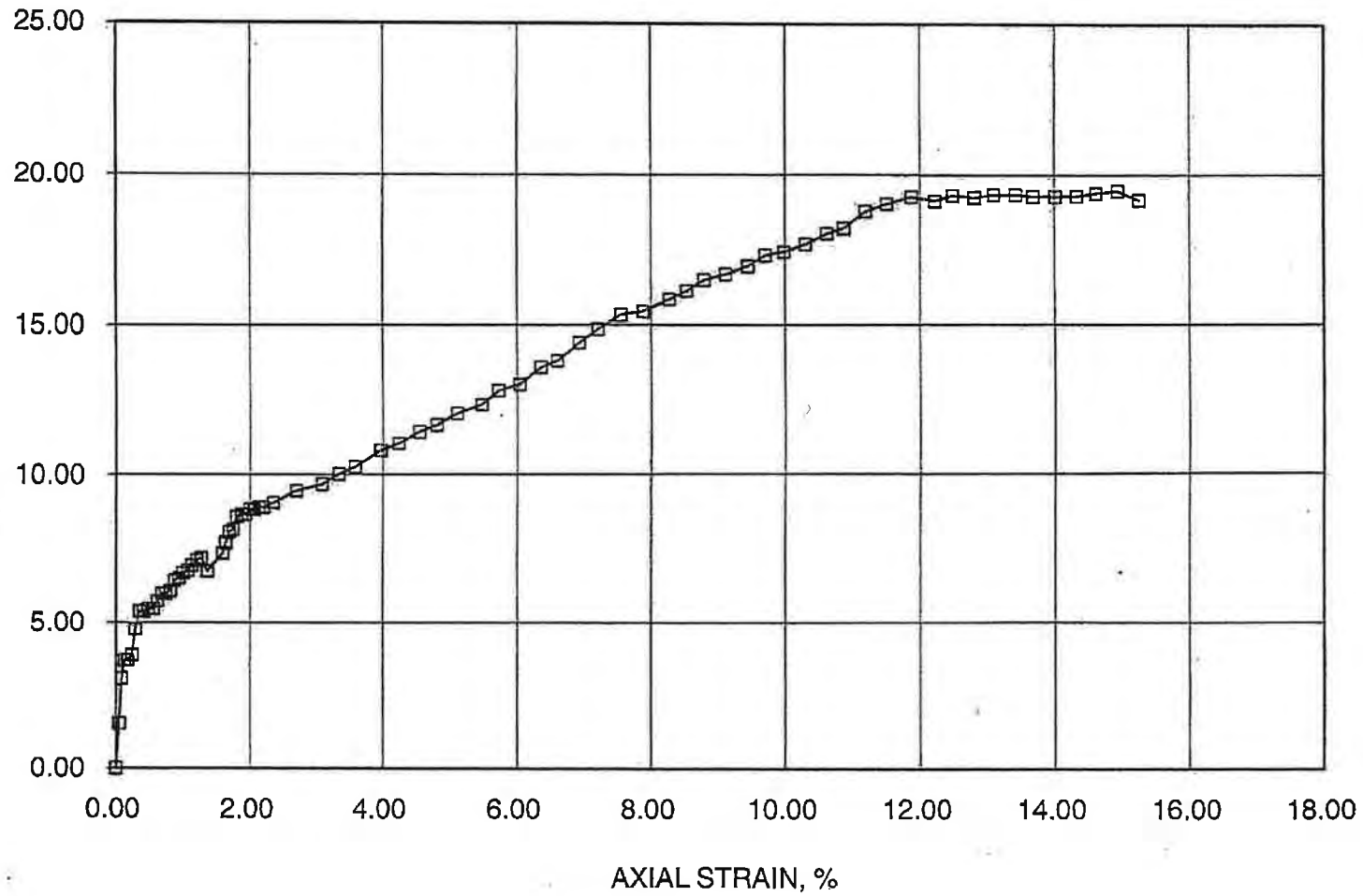
Checked By: *MM*

Golder Associates

UNCONFINED COMPRESSION TEST (UC)

FIGURE

Borehole 11-2 Sample ST-12 Depth 12.2m



Project No. 11-1183-0023

Checked By: *MM*