



Foundation Investigation Report

Highway 12

Culvert Replacement

Station 10+819

Township of Tay

CV-0219-0012-0001

G.W.P. 2495-04-00

Geocres No. 31D-515

Project No. 122410606

April 2011

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FOUNDATION INVESTIGATION REPORT

For
G.W.P. 2495-04-00

Highway 12 – Culvert Replacement
Station 10+819
Culvert #1 – CV-0219-0012-0001

Township of Tay

Town of Midland

1.0 Introduction

Stantec Consulting Ltd. (Stantec) was retained by the Ainley Group on behalf of the Ministry of Transportation, Ontario (MTO), to undertake the detailed design for the replacement of the existing culvert CV-0219-0012-0001 located at Station 10+819 on Highway 12 in the Township of Tay, Ontario.

This Foundation Investigation Report has been prepared specifically and solely for the replacement of the culvert which is part of the project G.W.P. 2495-04-00. This site is located on Highway 12, 820 m east of Highway 93; approximate Station 10+819.

2.0 Site Description and Geology

Site Location

The site is located on Highway 12, at approximate Station 10+819, shown on the Key Plan inset to Drawing No. 1, provided in Appendix A. It is noted that for project orientation purposes, Highway 12 will be assumed to run east-west, with chainage increasing from west to east.

General Site Description

At the culvert location on Highway 12, the roadway is 2 lanes with an approximate pavement width of 7.5 m and a partially paved shoulder width of about 0.5 m. The embankment at the north end of the culvert is approximately 4.8 m high with a 2H:1V slope. At the south end, the embankment is approximately 4.3 m high with a 4H:1V slope (Photo No. 2 in Appendix A).

It is noted that there are underground utilities in the area.

Existing Culvert

The existing culvert is a 1.1 m diameter Corrugated Steel Pipe (CSP) extending 40.8 m in length (Photos No. 3 & 6 in Appendix A). Water flows from south to north through the culvert. The north end of the culvert (outlet) is at an offset of 16.71 m left of the centerline with an invert

elevation of 222.2 m, the south end (inlet) is 24.13 m right of the centerline with an invert elevation of 222.7 m. At both the north and south end of the culvert, the ditch slopes from east to west. Long grasses are present at both the inlet and outlet, with standing water noted on the north side. Rust was also noted at the base of the culvert, with more severe rotting present at the north end (Photos No. 4 & 7 in Appendix A).

Physiographic Description

The site is located within the physiographic region known as Simcoe Uplands. Major soil types within this section consist of well drained Vasey and Tioga sandy loam, and poorly drained Granby sand loam.

Drainage within this region is north toward Georgian Bay.

3.0 Method of Investigation

3.1 DRILLING INVESTIGATION

The foundation field investigation carried out for the culvert replacement consisted of three (3) boreholes. The boreholes were designated BH11-1 to BH11-3 and their locations are shown on the Borehole Location Plan, Drawing No.1 in Appendix A.

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 from March 22, 2011, to March 24, 2011. Two boreholes were advanced using portable drilling equipment at the inlet and outlet of the culvert. One borehole was advanced in the roadway using a CME-75 truck mount drill rig. Standard Penetration Tests were performed in all holes while collecting soil samples in accordance with ASTM D1586-99.

The subsurface stratigraphy encountered in each borehole was recorded in the field by an experienced Stantec Field Technologist. Split spoon samples were collected at regularly spaced intervals. All samples recovered were returned to our Ottawa laboratory for detailed classification and testing.

Boreholes were backfilled with auger cuttings and bentonite layers to match observed stratigraphy. The road hole was topped with cold patch asphalt.

One standpipe was installed in Borehole BH11-1 on March 23, 2011. The standpipe consisted of 25 mm diameter PVC pipe slotted over the lower 1.5 m. The annulus was backfilled with sand for the lower 2 m. The remainder of the hole was backfilled with bentonite.

3.2 SURVEYING

Borehole locations were established in the field by Stantec personnel relative to the centerline of the existing alignment and the existing culvert. The ground surface elevation at each borehole

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FOUNDATION INVESTIGATION REPORT

location was surveyed by Stantec personnel with reference to a Geodetic Benchmark. The benchmark was the top of 0.18 x 2.0 RIB located east of the culvert on the left side with a geodetic elevation of 226.663 m.

Table 3.1: Borehole Summary

	Boreholes		
	BH11-1	BH11-2	BH11-3
MTM Zone 10 Coordinates			
Northing	4953711	4953697	4953682
Easting	273979	273987	274002
Station	10+819	10+819	10+819
Offset	19.2 m Lt CL	2.5 m Lt CL	17.6 m Rt CL
Ground Surface Elevation, m	222.4	227.4	224.1
Total Depth Drilled, m	4.7	9.3	5.3
End of Borehole Elevation, m	217.8	218.1	218.7
Depth Augered, m	4.7	9.3	5.3
Number of Soil Samples	8	13	11
Depth Cored, m	0	0	0.3

3.3 LABORATORY TESTING

All samples were taken to our Ottawa laboratory where they were subjected to a detailed visual examination by a Geotechnical Engineer. Selected soil samples were submitted for plasticity testing (5 samples), gradation analysis (7 samples) and moisture content testing (37 samples).

It is noted that a nominal size of 0.002 mm has been utilized to distinguish between silt and clay sized particles.

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 boreholes 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 general, the subsurface stratigraphy consists of a pavement structure over a silty sand to silt with sand fill overlying a deposit of clay of high plasticity over a sandy clay till.

Borehole location plans and stratigraphic sections of the soils encountered within the boreholes are provided on Drawing No. 1 in Appendix A.

4.1.1 Pavement Structure

The pavement structure was observed in Borehole 11-2 and consists of 150 mm asphalt over about 750 mm of granular base and granular subbase.

Grain size analysis and moisture content testing on one sample of the subbase material yielded the following results:

- 23% Gravel
- 62% Sand
- 15% Fines (silt and clay size particles)
- Moisture Content 3% to 6%

This material can be classified as silty sand with gravel. The grain size distribution curve is shown on Figure 1 in Appendix C.

4.1.2 Silty Sand to Silt with Sand (Roadway Embankment)

A fill embankment was observed beneath the pavement structure in Borehole BH11-2, below a layer of topsoil in Borehole BH11-3, and at ground surface in Borehole BH11-1. The fill layer was between 0.1 m and 4.3 m thick, with a base elevation between 221.9 m and 222.3 m.

Gradation tests were completed for four samples of the fill deposit as well as moisture content testing on 12 samples. The test results are summarized as follows.

- 0% to 14% Gravel
- 22% to 66% Sand
- 27% to 78% Fines (silt and clay size particles)
- Moisture Content 7% to 29%

The typical moisture content of the embankment fill was in the range of 6 to 17%. In borehole BH11-3 the moisture content at the base of the embankment fill, or immediately above the native clay, was over 20% suggesting that water is perched above the clay layer.

The results of the gradation analyses indicate that the fill material can be classified as silt with sand to silty sand. The grain size distribution curves are shown on Figure 2 in Appendix C.

It is noted that SPT refusal was observed in this deposit. In each instance the borehole was further advanced by augering. Cobbles are present in the fill.

4.1.3 Clay of High Plasticity

A deposit of clay was observed beneath the fill material in all boreholes. The clay layer was between 2.5 m and 3.0 m thick, with a base elevation between 219.2 m and 219.4 m.

A grain size analysis test was completed on one sample, Atterberg Limit tests were completed on three samples and moisture content testing on 15 samples. The test results are summarized as follows.

- 0% Gravel
- 4% Sand
- 96% Fines (silt and clay size particles)
- 64 to 79 Liquid Limit
- 23 to 27 Plastic Limit
- 15% to 42% Moisture Content.

The result of the laboratory testing indicates that the clay deposit can be classified as a clay of high plasticity (CH). The grain size distribution curve and Atterberg Limits are shown on Figures 3 and 5 in Appendix C.

The clay was observed to be generally very stiff based on the SPT results (typical N values from 10 to 22 blows per 0.3 m) and pocket penetrometer results which ranged from 85 to 175 kPa with an average of 130 kPa.

Sand seams were observed within the clay layer.

Two samples of the clay were submitted to Paracel Laboratories in Ottawa, Ontario, for analysis of pH, water soluble sulphate and chloride concentrations, resistivity and % solids. 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)	% Solids
BH11-1	SS2	0.61 – 1.22	7.8	237	25	16.4	71.6
BH11-2	SS4 – SS5	2.28 – 3.66	7.0	686	21	6.79	93.0

4.1.4 Sandy Clay Till

Till material was found in all boreholes beneath the clay deposit; all boreholes were terminated in this layer. The boreholes were terminated in the till at depths varying from 4.7 m to 9.3 m with end of borehole elevations between 217.8 m and 218.7 m.

A grain size analysis test was completed on one sample, Atterberg Limit tests were completed on two samples and moisture content testing on 7 samples. The test results are summarized as follows.

- 0% Gravel
- 34% Sand
- 66% Fines (silt and clay size particles)
- 23 to 32 Liquid Limit
- 13 to 16 Plastic Limit
- Moisture Content 1% to 24%

The till was observed to be cohesive and can be classified as a sandy clay (CL). The grain size distribution curve and Atterberg Limits are shown on Figures 4 and 5 in Appendix C.

The till was observed to be stiff to very stiff based on the SPT results (N values from 13 to >100 blows per 0.3 m).

It is noted that SPT refusal was observed for numerous samples. Cobbles and boulders are frequent in this deposit.

4.2 BEDROCK

Bedrock was not encountered within the depth of exploration during this investigation.

4.3 GROUNDWATER

A standpipe was installed in Borehole BH11-1 on March 23, 2011 at the time of drilling. The water level was measured on March 24, 2011, at a depth of 0.65 m below ground surface corresponding to an elevation of 221.8 m.

Water levels in the culvert at the inlet and outlet were also measured at the time of the investigation. The inlet was found to be dry and the water elevation at the outlet to be 222.2 m.

Fluctuations in the groundwater and culvert water levels should be anticipated due to season variations or in response to a particular precipitation event.

5.0 Miscellaneous

The field work was carried out under the supervision of Mr. Adam Stamplicoski, CET, Senior Technologist, under the direction of Chris McGrath, P.Eng., Geotechnical Engineer.

The portable drilling equipment was supplied and operated by OGS Inc. of Almonte, Ontario. The truck mounted drill rig was supplied and operated by Strong Soil Search Inc. of Claremont, Ontario.

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

This report was prepared by Dr. Fred Griffiths, Ph.D., P.Eng., with the assistance of Ms. Katurah Firdawsi, B.Eng., and reviewed by Mr. Raymond Haché, M.Sc., P.Eng., MTO Designated Principal Contact.

6.0 Closure

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. 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.



Katurah Firdawsi, B.Eng.



Fred J. Griffiths, Ph.D., P.Eng.
Principal



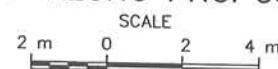
Raymond Haché, M.Sc., P.Eng.
Designated Principal MTO Foundation Contact



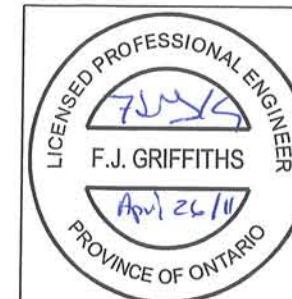
APPENDIX A




Drawing No. 1 – Borehole Location Plan and Soil Strata

Site Photos



SHEET



LEGEND			
 Bore Hole  Water Level at Time of Investigation, March 24, 2011  Offset from Section Line A-A'			
<p>N Blows/0.3m (Std Pen Test, 475 J/blow)</p> <p>(4.0 m S) Offset from Section Line A-A'</p>			
No	ELEVATION	MTM_ZONE 10 NORTH	COORDINATES EAST
11-1	222.4	4 953 711.3	273 978.9
11-2	227.4	4 953 696.9	273 987.3
11-3	224.1	4 953 682.0	274 001.6

==NOTES==

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

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

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	
GEOCES No 31D-515				
HWY No 12				DIST
SUBM'D KF	CHECKED		DATE 2011/04/14	SITE
DRAWN GBB	CHECKED		APPROVED	DWG 1



Photo No. 1: Hwy 12 – Culvert 10+820 (South Side looking south)



Photo No. 2: Hwy 12 – Culvert 10+820 (South Side looking north)



Photo No. 3: Hwy 12 – Culvert 10+820 (South Side)



Photo No. 4: Hwy 12 – Culvert 10+820 (South Side Interior)



Photo No. 5: Hwy 12 – Culvert 10+820 (North Side looking north)



Photo No. 6: Hwy 12 – Culvert 10+820 (North Side)



Photo No. 7 Hwy 12 – Culvert 10+820 (North Side Interior)

APPENDIX B

Symbols and Terms Used on Borehole Records

Borehole Records

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



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.



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
γ	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)



Stantec

	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

RECORD OF BOREHOLE No BH 11-1

1 OF 1

METRIC

W.P. 2495-04-00 LOCATION Culvert Crossing - East of Brebeuf Rd, Midland, ON N: 4 953 711 E: 273 979 ORIGINATED BY AS
DIST HWY 12 BOREHOLE TYPE Portable Drilling Equipment, Splitspoon Sampler COMPILED BY JF
DATUM Geodetic DATE 2011 03 23 - 2011 03 23 CHECKED BY CM

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 (%)		
								○ UNCONFINED	× FIELD VANE	● QUICK TRIAXIAL	× LAB VANE									
222.4	Tall Grass																			
220.0	Silty sand, brown, FILL - trace organics CLAY of high plasticity (CH)		1	SS	3		222										PP = 110 kPa			
0.1	Very stiff Brown		2	SS	16															
	- sand seams		3	SS	14		221										PP = 135 kPa			
			4	SS	22		220										0 4 33 63 PP = 135 kPa			
			5	SS	14												PP = 147 kPa			
219.4	SANDY CLAY (CL), trace gravel (Till)		6	SS	13		219													
3.1	Stiff to very stiff Brown		7	SS	22												0 34 38 28			
	- occasional cobbles		8	SS	100/ 230mm		218													
217.8	End of Borehole Standpipe Installed																PP = Pocket Penetrometer			
4.7																				

RECORD OF BOREHOLE No BH 11-2

1 OF 1

METRIC

W.P. 2495-04-00 LOCATION Culvert Crossing - East of Brebeuf Rd, Midland, ON N: 4 953 697 E: 273 987 ORIGINATED BY AS
 DIST HWY 12 BOREHOLE TYPE Solid Stem Augers, Splitspoon Sampler COMPILED BY JF
 DATUM Geodetic DATE 2011 03 24 - 2011 03 24 CHECKED BY CM

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									
								20	40	60	80	100					
227.4	Asphalt																
227.0	150 mm ASPHALT																
0.2	Silty sand (SM) with gravel, FILL																
	Dense		1	SS	42		227										23 62 (15)
	Brown																
226.5	Silt (ML) with sand, FILL																
0.9	Dense		2	SS	30		226										0 22 70 8
	Brown																
			3	SS	32												
224.9	Silty sand (SM) with gravel, occasional cobbles, FILL		4	SS	100/ 200mm		225										
2.5	Dense																
	Brown		5	SS	100/ 130mm		224										
			6	SS	48		223										14 59 (27)
			7	SS	30												
222.2	CLAY of high plasticity (CH)																
5.2	Very stiff						222										
	Brown		8	SS	20												
	- sand seams		9	SS	15		221										PP = 172 kPa
			10	SS	10		220										PP = 110 kPa
			11	SS	19												
219.3	SANDY CLAY (CL), trace gravel (Till)																
8.1	Stiff to very stiff						219										
	Brown		12	SS	100/ 180mm												
	- occasional cobbles																
			13	SS	100/ 180mm												
218.1	End of Borehole																PP = Pocket Penetrometer
9.3																	

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

RECORD OF BOREHOLE No BH 11-3

1 OF 1

METRIC

W.P. 2495-04-00 LOCATION Culvert Crossing - East of Brebeuf Rd, Midland, ON N: 4 953 682 E: 274 002 ORIGINATED BY AS
DIST HWY 12 BOREHOLE TYPE Portable Drilling Equipment, Splitspoon Sampler COMPILED BY JF
DATUM Geodetic DATE 2011 03 22 - 2011 03 22 CHECKED BY CM

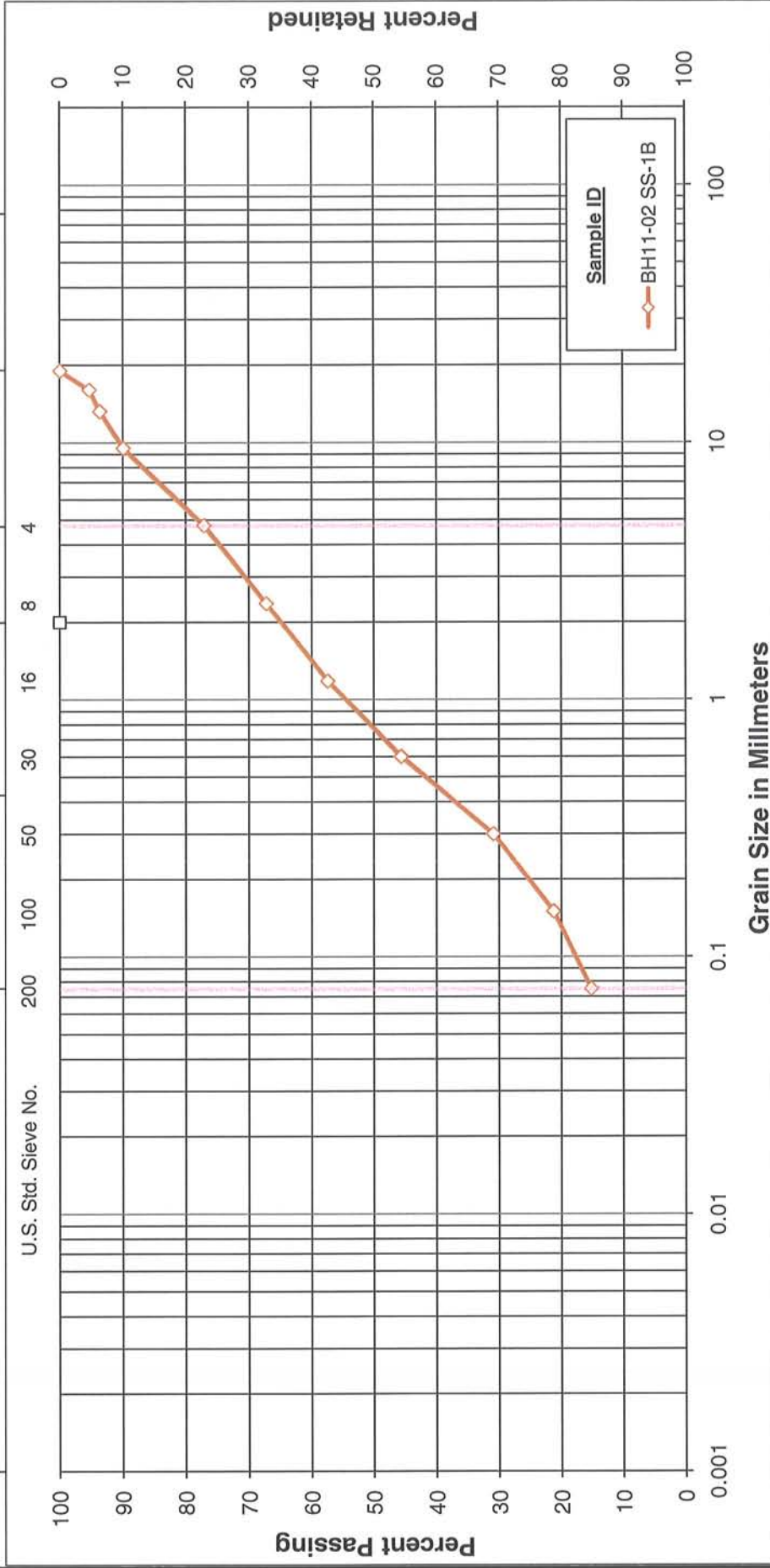
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)	
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa								WATER CONTENT (%)
								○ UNCONFINED	✕ FIELD VANE							
						● QUICK TRIAXIAL ✕ LAB VANE										
						20 40 60 80 100			10 20 30							
224.1	Tall Grass														GR SA SI CL	
224.0	75 mm TOPSOIL															
0.1	Silty sand (SM), trace gravel, FILL		1	SS	8		224									
	Loose to dense															
	Brown		2	SS	42		223								5 66 (29)	
222.6	Sandy silt (ML), trace gravel, FILL		3	SS	20											
1.4	Compact															
	Greyish brown		4	SS	26		222								2 36 36 26	
221.9	CLAY of high plasticity (CH)															
2.2	Very stiff		5	SS	17		221								PP = 123 kPa	
	Brown		6	SS	21										PP = 147 kPa	
	- sand seams		7	SS	13		220								PP = 147 kPa	
	- stiff below 2.1 m		8	SS	10										PP = 110 kPa	
219.3	SANDY CLAY (CL), trace gravel (Till)		9	BQ			219								PP = 86 kPa	
4.7	Stiff to very stiff		10	SS	100/ 130mm											
218.7	Brown															
5.3	- frequent cobbles and boulders		11	SS	100/ 20mm											
	End of Borehole														PP = Pocket Penetrometer	

APPENDIX C

Laboratory Test Results

Unified Soil Classification System

CLAY & SILT		SAND			Gravel	
		Fine	Medium	Coarse	Fine	Coarse



GRAIN SIZE DISTRIBUTION

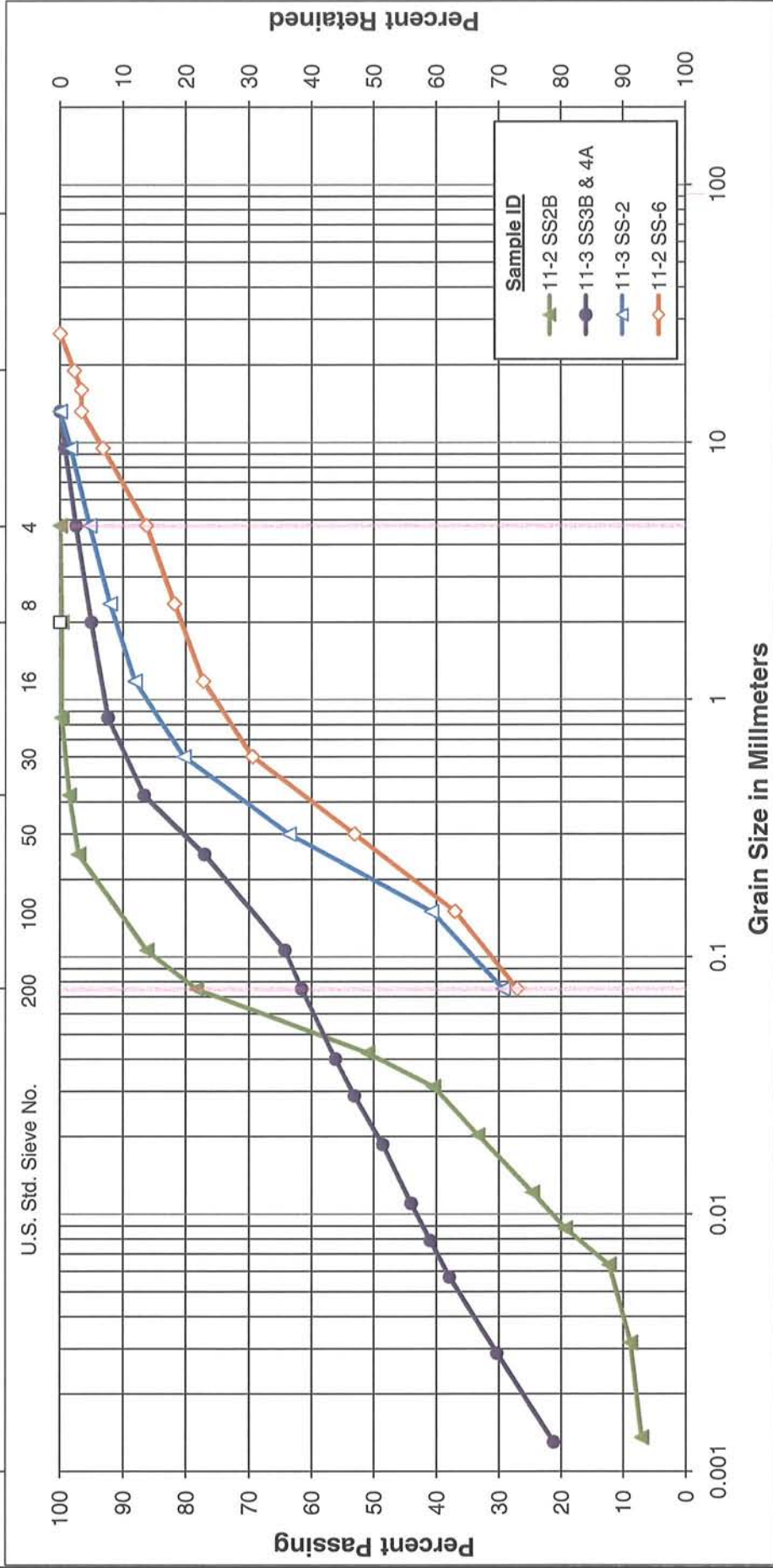
Pavement Structure Granulars

Figure No. 1

Project No. 122410606

Unified Soil Classification System

CLAY & SILT	SAND			Gravel	
	Fine	Medium	Coarse	Fine	Coarse



GRAIN SIZE DISTRIBUTION

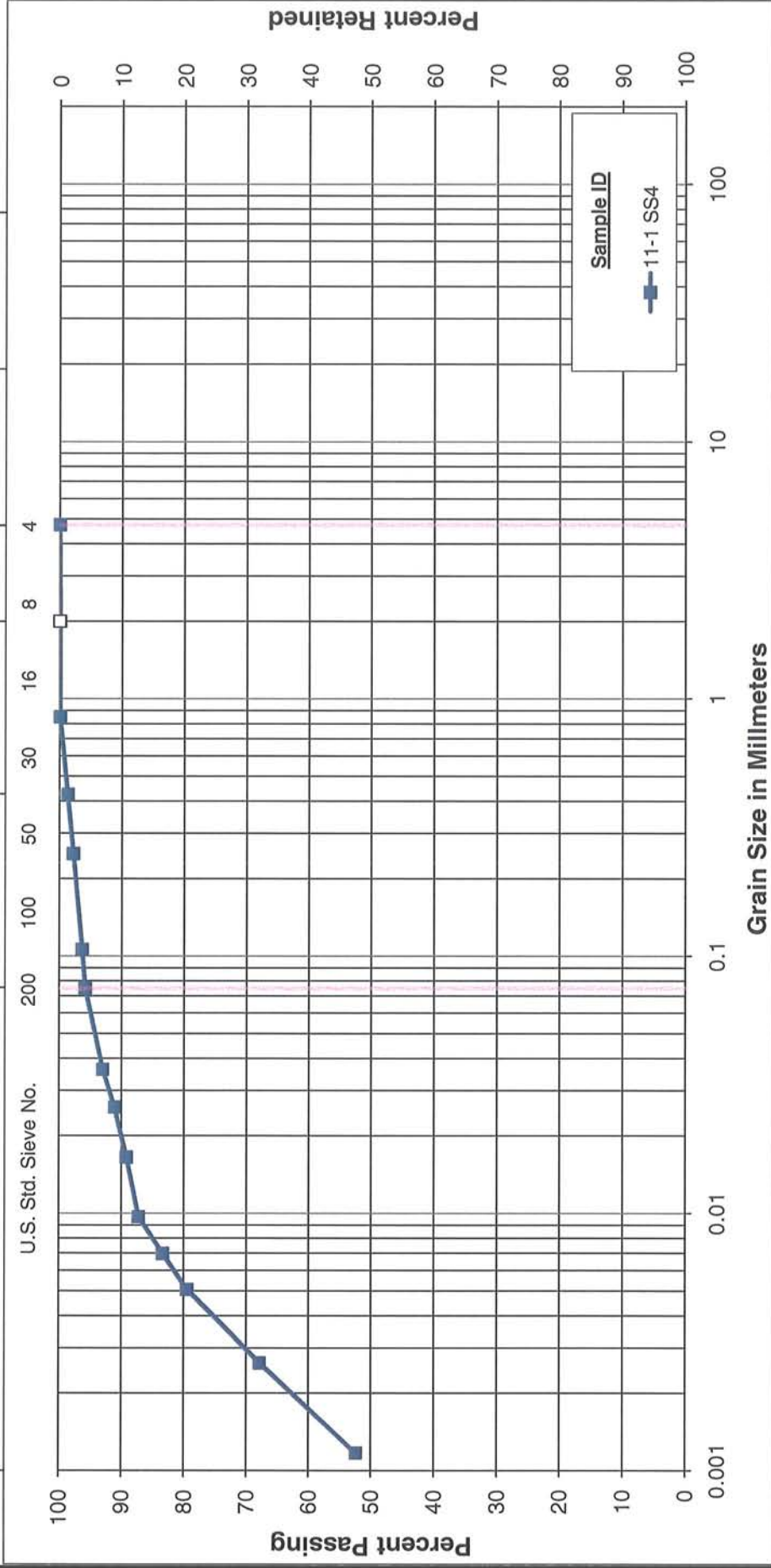
Fill

Figure No. 2

Project No. 122410606

Unified Soil Classification System

CLAY & SILT		SAND			Gravel	
		Fine	Medium	Coarse	Fine	Coarse



GRAIN SIZE DISTRIBUTION

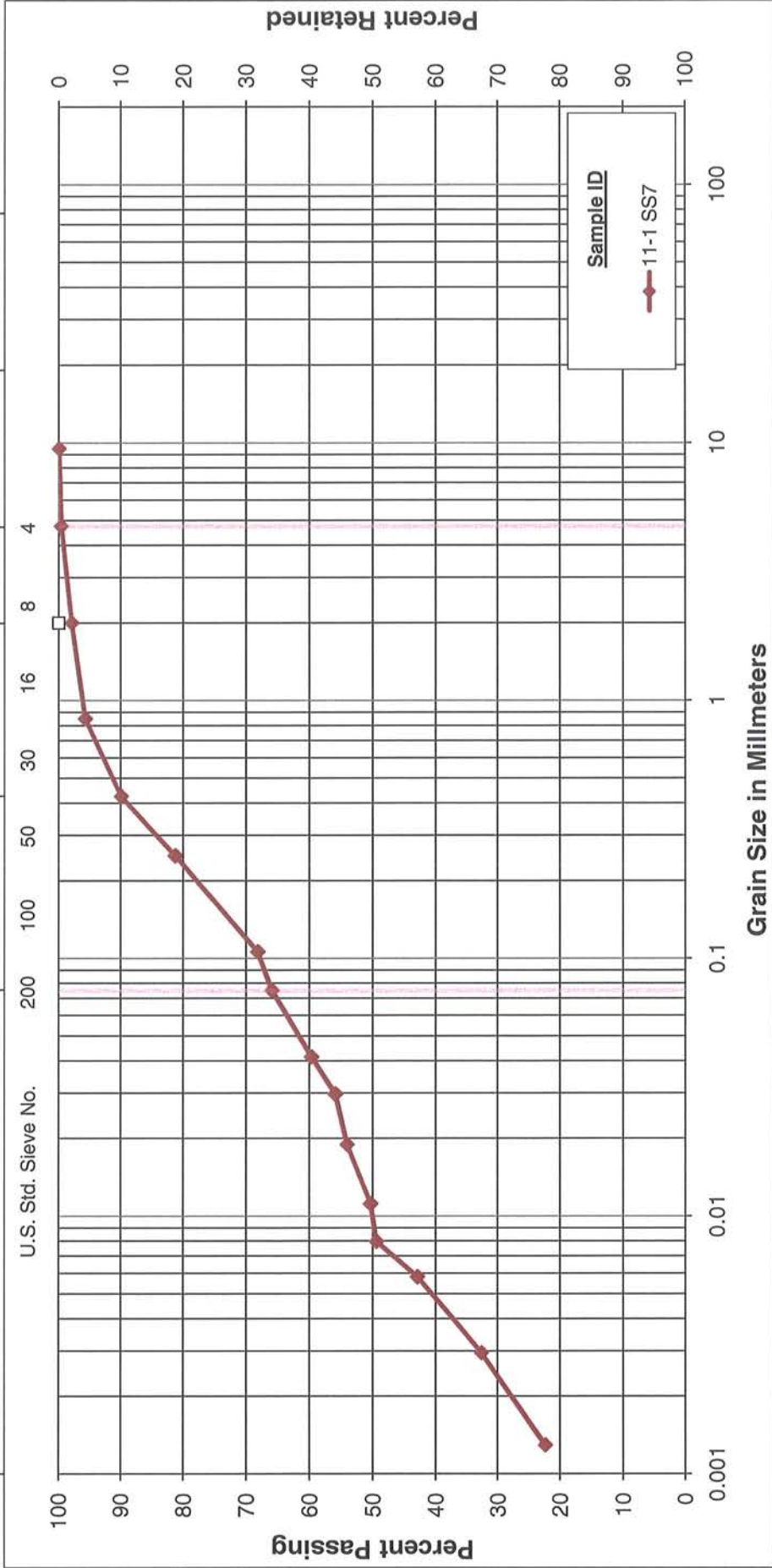
Fat Clay (CH)

Figure No. 3

Project No. 122410606

Unified Soil Classification System

CLAY & SILT		SAND			Gravel	
		Fine	Medium	Coarse	Fine	Coarse



GRAIN SIZE DISTRIBUTION

Till

Figure No. 4

Project No. 122410606

