Foundation Investigation Report
GWP 5102-06-00
Highway 17 Roadway Protection
for Centreline Culvert Replacement
Station 19+940 Township of Bailloquet

GEOCRES No. 42C-22

File No. 165000656

May 2010

Table of Contents

List of Tables

List of Appendices

FOUNDATION INVESTIGATION REPORT
For
G.W.P 5102-06-00

Highway 17 – Roadway Protection for Centreline Culvert Replacement
Station 19+940
Township of Bailloquet

1.0 Introduction

Stantec was retained by the Ministry of Transportation, Ontario (MTO) to undertake the detailed design for the replacement of an existing centreline culvert at approximately Station 19+940 on Highway 17, 7.7 km north of Highway 101, in the Township of Bailloquet, near Wawa, Ontario.

This Foundation Investigation Report has been prepared specifically and solely for the temporary protection system required for the replacement of the centreline culvert for the following project:

Project Number: GWP 5102-06-00

Project Location: Highway 17, 7.7 km north of Highway 101
Centreline Culvert Replacement, approximate Station 19+940

The work was carried out under Agreement Number 5006-E-0092 with Stantec Consulting Limited, the Detailed Design Consultant for this project.

2.0 Site Description and Geology

Site Location

The site location is shown on the Key Plan inset to Drawing No. 1, provided in Appendix A. It is noted that for project orientation purposes, Highway 17 will be assumed to run north-south at this location, with chainage increasing from north to south.

General Site Description

Within the project limits Highway 17 is classified as a two-lane Rural Arterial Undivided Highway. A third lane (climbing lane) is present in the southbound direction (see Photos 1 and 2 in Appendix A).

This section of Highway 17 has been constructed as a fill. The embankment is approximately 7 m high on the east side and has a 2H:1V side slope (see Photos 3 and 4 in Appendix A). On the west side, the highway is at approximately the same grade as the adjacent property which consists of a gravel parking lot for an automotive dealership (see Photo 1 in Appendix A).

The AADT for this section of Highway 17 was 2,100 in 2008, with 27.5% commercial traffic.

Existing Culvert

The existing culvert is a 1500 mm diameter Corrugated Steel Pipe (CSP) located beneath the roadway at approximately Station 19+940. The culvert is oriented at a 30 degree skew to the perpendicular of Highway 17.

It is understood that the west end of the Highway 17 culvert is connected to a second private culvert buried beneath the property of the Northern Lights Ford Dealership at 1008 Highway 17. The total length of the combined culvert (MTO + private section) is 91.32 m. The inlet of the culvert is located on private property approximately 46 m beyond the MTO right-of-way (see Photos 6 and 7 in Appendix A).

The outlet of the culvert is visible at the base of the embankment on the east side, approximately 7 m below the pavement surface (see Photos 3 and 5 in Appendix A).

Physiographic Description

The site is located within the Canadian Shield.

Based on geological mapping of the area obtained from Quaternary Geology of the Wawa Area, Northeastern Ontario (Ontario Geological Society OFR 6005, 2001), the overburden in the area of this site is characterized by glaciolacustrine deposits of sand and fine sand. Frequent shallow or exposed bedrock is present throughout the region. Bedrock consists of sheared mafic volcanic rock, which is typically basaltic. The topography ranges from moderate to severely rugged, with relief up to 230 m.

Drainage is to the east, toward the Magpie River, which joins with the Michipicoten River before emptying into Lake Superior.

3.0 Method of Investigation

3.1 PAVEMENT INVESTIGATION

A number of shallow boreholes were drilled by Stantec Consulting Limited in October 2007 as part of the Pavement Investigation and Design portion of this project. The Pavement Borehole Records from the area near the proposed culvert replacement are included in Appendix B for information purposes.

3.2 DRILLING INVESTIGATION

The foundation field investigation for the Temporary Protection System required for the culvert replacement consisted of two (2) boreholes. The boreholes were designated BH10-01 and BH10-02 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 on February 9th and 10th, 2010. The boreholes were advanced using a truck-mounted CME 75 drill rig equipped for soil (hollow stem augers) and bedrock (B size core). The drilling equipment was owned and operated by DST Consulting Engineers Inc. of Thunder Bay, Ontario.

The subsurface stratigraphy encountered in each borehole was recorded in the field by Mr. Adam Stamplicoski, A.Sc.T., an experienced Stantec Field Technologist. Split spoon samples were collected at regularly spaced intervals (typically every 760 mm) during the course of Standard Penetration Tests (ASTM D1586). An automatic trip hammer was used during SPT testing. All samples recovered were returned to our Ottawa laboratory for detailed classification and testing. Boreholes were backfilled in accordance with MOE Requirements with bentonite within the bedrock interval and auger cuttings to match observed stratigraphy, then topped with cold patch asphalt.

It was not possible to install piezometers, as the boreholes were located in the passing lane. The water level in the culvert was surveyed on February 10, 2010.

3.3 SURVEY

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 location was surveyed by Stantec personnel with reference to MTO Geodetic Benchmark GBM 93U291. The benchmark is located at approximate Station 19+994. The Geodetic elevation of this benchmark is reported to be 293.821 m.

The locations and elevation of the boreholes are summarized in Table 3.1.

Table 3.1: Borehole Summary

	Borehole	
	BH10-01	**BH10-02**
MTM Zone 13 Coordinates Northing Easting	 5 321 285 243 045	 5 321 276 243 052
Station	19+934	19+946
Offset	2.3 m Rt	2.0 m Rt
Ground Surface Elevation, m	290.3	290.4
Total Depth Drilled, m	13.9	15.4
End of Borehole Elevation, m	276.3	275.0
Depth Augered, m	11.9	11.4
Number of Soil Samples	16	13
Depth Cored, m	2.0	4.0

3.4 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 underwent plasticity testing (1 sample), gradation analysis (11 samples) and moisture content testing (9 samples). Four intact samples of bedrock were tested for unconfined compressive strength.

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 sandy silt fill material overlying well graded gravel with silt and sand fill overlying a poorly graded natural sand with silt and gravel deposit.

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

Relevant Borehole Records from the pavement investigation report for this project along with an explanation of the symbols and terms used for these Borehole Records have been included in Appendix B of this report for completeness.

4.1.1 Pavement Structure

The pavement design report provided by Stantec Consulting Limited indicates the pavement structure consists of asphalt over 340 mm of granular base and 730 mm of granular subbase.

The boreholes drilled for the foundation investigation indicate that the base and subbase materials consist of silty sand with gravel, and extend to a depth of 1.4 m in both boreholes (elevation 288.9 m and 289 m in Boreholes BH10-01 and BH10-02 respectively).

Grain size analysis (see Figure 1 in Appendix C) and moisture content testing on three samples of the material beneath the asphalt yielded the following results:

- 16 % to 36% Gravel
- 48% to 65% Sand
- 16 to 19% Fines
- Moisture Content 3% to 6%

Based on the grain size distribution, the material may be classified as silty sand with gravel. However, as drilling was completed in February, when the ground was frozen, it is likely that the fine-grained nature of this soil is as a result of the augers pulverizing the granular material.

4.1.2 Sandy Silt to Silty Sand Fill

A sandy silt to silty sand fill layer was observed beneath the pavement structure. The fill layer was between 2.7 m and 3.2 m thick, with a base elevation of 285.9 m and 286.2 m (geodetic). SPT ‘N’ values generally ranged from 19 to over 100 blows per 0.3 m, indicating that the deposit is in a compact to very dense state. The higher values were observed near the top of the layer and may reflect frozen conditions.

The results of the gradation analyses on four samples indicate that the fill deposit contained 0% to 4% gravel, 40% to 53% sand, 45% to 46% silt and 3% to 11% clay. The results of the gradation analyses are shown on Figure 2 in Appendix C. Atterberg Limit tests were performed on this deposit, however it was found to be non-plastic. The moisture content ranged from 9% to 11% with an average of 10%.

This material is classified as sandy silt to silty sand (ML to SM). Trace amounts of gravel and clay were also observed within the fill strata.

4.1.3 Gravel with Silt and Sand Fill

A well graded gravel with silt and sand fill was observed beneath the sandy silt to silty sand fill. The thickness of this layer ranged from 2.6 m to 3.2 m, with a base elevation of 282.6 m and 283.6 m (geodetic). SPT ‘N’ values generally ranged from 13 to 60 blows per 0.3 m, indicating

that the material is in a compact to dense state. An N value in excess of 50 blows per 0.3 m was observed at BH10-02, SS7.

Grain size analysis on a sample of this material indicates that the deposit contained 45% gravel, 44% sand, and 11% fines size particles. The results of the grain size analysis are shown on Figure 3 in Appendix C. Based on this analysis, the fill can be classified as a well graded gravel with silt and sand.

The moisture content of the tested sample was 10%.

4.1.4 Sand with Silt and Gravel

A sand with silt and gravel deposit was observed beneath the fill materials. The thickness of this layer ranged from 3.6 m to 5.2 m, with a base elevation of 278.4 m and 279.0 m (geodetic). SPT 'N' values generally ranged from 5 to 34 blows per 0.3 m, indicating that the deposit varies from a loose to dense state. An N value in excess of 50 blows per 0.3 m was observed at BH10-01, SS-16.

Grain size analysis and moisture content testing on three samples of this material yielded the following results:

- 10 % to 33% Gravel
- 60% to 70% Sand
- 7% to 20% Fines
- Moisture Content 13% to 18%

The results of the grain size analysis are shown on Figure 4 in Appendix C. Based on this analysis, the fill can be classified as sand with silt and gravel.

4.2 BEDROCK

Basalt bedrock was encountered beneath the overburden soils. The top of the bedrock was observed at 278.4 m and 279.0 m (geodetic); 11.4 m to 11.9 m below the top of pavement. The basalt had close to moderate joint spacing which dipped at 20° to 50° from horizontal. The rock was fresh to moderately weathered, with tight infilling.

The top portion (up to 0.5 m) of Borehole BH10-01 was found to be moderately weathered and of very poor quality. Elsewhere, the bedrock quality ranged from poor to good with a Rock Quality Designation (RQD) of between 0% and 81%. The unconfined compressive strength of the rock, which is summarized below in Table 5.1, ranged from 17 MPa to 87 MPa.

Table 4.1: Unconfined Compressive Strength of Rock Cores

Borehole	Depth (m)	Elevation (m)	Unconfined Compressive Strength (MPa)
BH10-1	13.4	276.9	87
BH10-2	12.4	278.0	33
	13.3	277.1	17
	14.5	275.9	34

4.3 GROUNDWATER

The water/ice level in the culvert at the inlet (west side) was observed at about 0.6 m above the invert. The outlet water level could only be estimated due to snow cover.

The embankment fill at this site appears to have been placed on native soils (see Photos 3 and 6 in Appendix A). Therefore, the groundwater elevation should be assumed to correspond to the water level within the culvert which was observed to be near elevation 284.5 on the south and 284.0 m at the north end at the time of the investigation.

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

5.0 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.

This report has been prepared by Laura Bostwick, Paul Carnaffan and Fred Griffiths. A technical review was carried out by Raymond Haché.

Respectively Submitted;

STANTEC CONSULTING LTD.

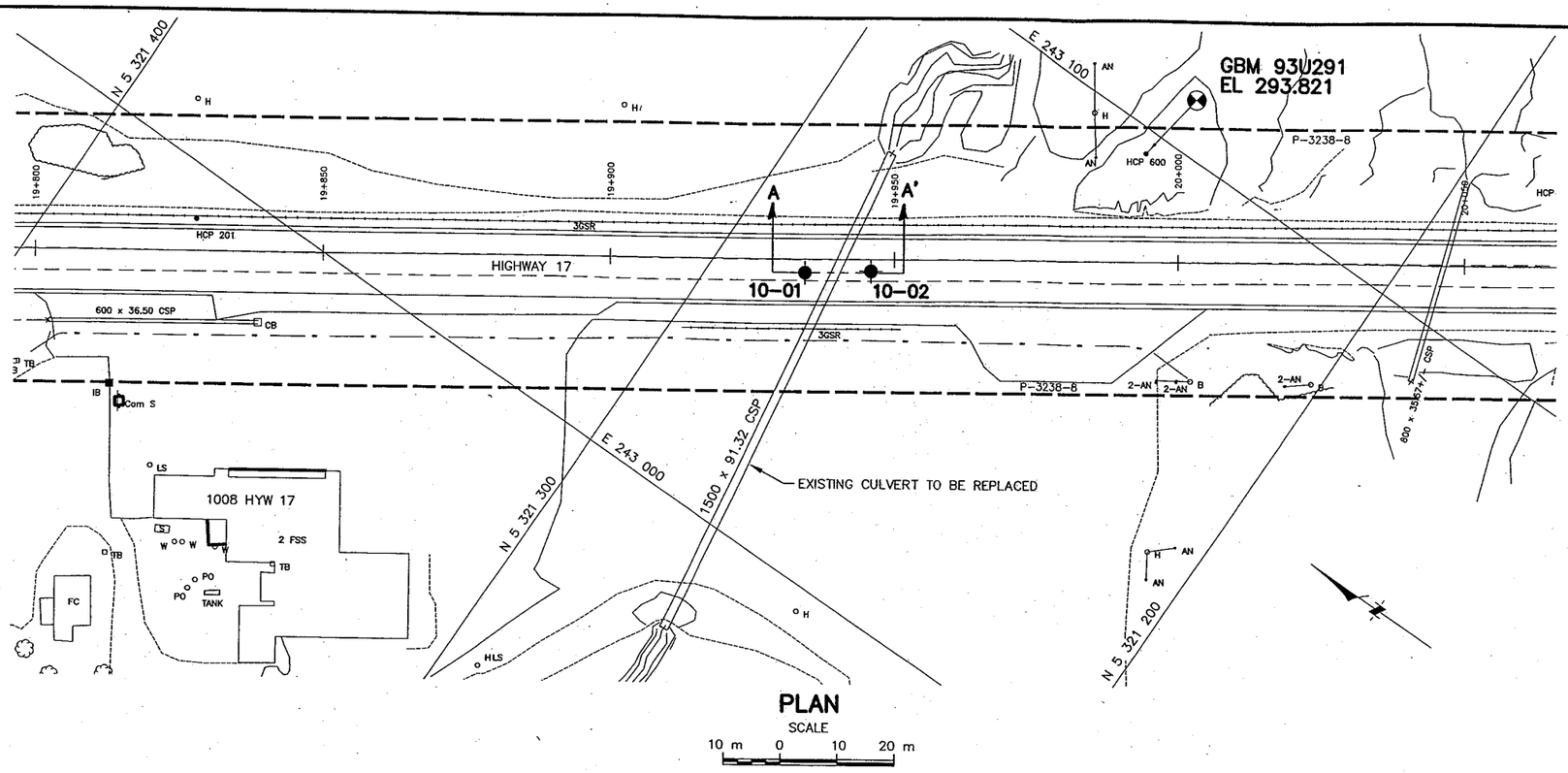
Laura Bostwick, M.Sc.Eng., EIT

Paul Carnaffan, M.Eng., P.Eng.
Associate

Fred J. Griffiths, Ph.D., P.Eng.
Designated Principal MTO Foundation Contact

APPENDIX A

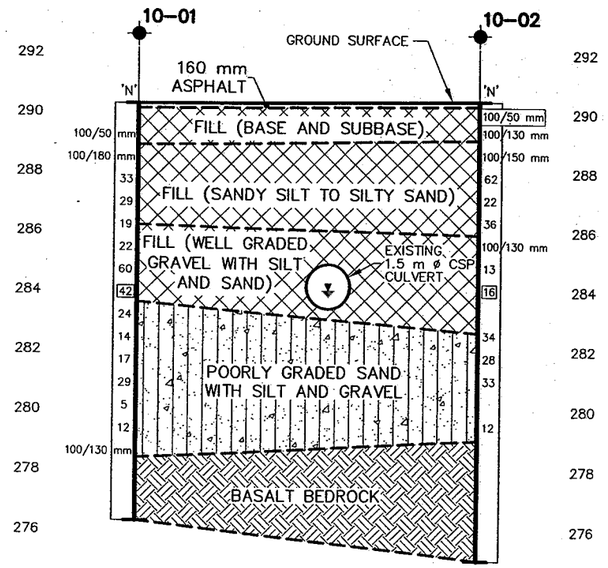
Drawing No. 1 – Borehole Location Plan and Soil Strata
Site Photos



PLAN

SCALE

10 m 0 10 20 m



PROFILE A–A' AT CULVERT

SCALE

2 m 0 2 4 m

METRIC

DIMENSIONS ARE IN METRES AND/OR MILLIMETRES UNLESS OTHERWISE SHOWN

PLATE No

CONT 2010-5121

WP 5102-06-00

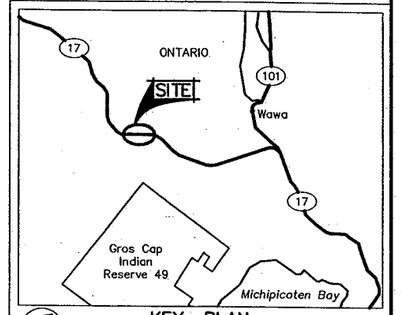
HWY 17 CULVERT REPLACEMENT

STA TO STA

BOREHOLE LOCATIONS & SOIL STRATA

SHEET

Stantec



KEY PLAN

3 km 0 3 6 km

LEGEND

- Bore Hole
- N Blows/0.3m (Std Pen Test, 475 J/blow)
- WL at time of investigation Feb 2010

No	ELEVATION	MTM ZONE 13 COORDINATES NORTH	EAST
10-01	290.3	5 321 285	243 045
10-02	290.4	5 321 276	243 052

LICENSED PROFESSIONAL ENGINEER
PAUL CARMAFFAN
90415075
May 21/10
PROVINCE OF ONTARIO

LICENSED PROFESSIONAL ENGINEER
P.J. GRIFFITHS
May 21/10
PROVINCE OF ONTARIO

NOTE

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

GEOCRES No 42C-22

HWY No 17			DIST
SUBM'D LB	CHECKED	DATE 2010-03-22	SITE 46-129
DRAWN GBB	CHECKED	APPROVED PC	DWG 1

MINISTRY OF TRANSPORTATION, ONTARIO PH-D-707 88-05

DRAWING NAME: 165000656-1
CREATED: GBB
MODIFIED: 10/05/17

Photo No. 1: BH10-1 looking north.

Photo No. 2: Highway 17 looking northbound from culvert.

Photo No. 3: East side of culvert and embankment.

Photo No. 4: East embankment looking north.

Photo No. 5: East end of existing culvert at 19+940.

Photo No. 6: West end of existing culvert at 19+940.

Photo No. 7: West end of existing culvert at 19+940.

p:\2010\165000656 - hwy 17 wawa\report\site photo pages.docx

APPENDIX B

Symbols and Terms Used on Borehole and Test Pit Records
Borehole Records
Rock Core Logs
Rock Core Photos
2007 Pavement Investigation Borehole Records

SYMBOLS AND TERMS USED ON BOREHOLE AND TEST PIT RECORDS

SOIL DESCRIPTION

Terminology describing common soil genesis:

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

Terminology describing soil structure:

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

Trace, or occasional	Less than 10%
Some	10-20%
Frequent	> 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
Very Loose	<4
Loose	4-10
Compact	10-30
Dense	30-50
Very Dense	>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
Very Soft	<0.25	<12.5
Soft	0.25 - 0.5	12.5 - 25
Firm	0.5 - 1.0	25 - 50
Stiff	1.0 - 2.0	50 – 100
Very Stiff	2.0 - 4.0	100 - 200
Hard	>4.0	>200

ROCK DESCRIPTION

Terminology describing rock quality:

RQD	Rock Mass Quality
0-25	*Very Poor*
25-50	*Poor*
50-75	*Fair*
75-90	*Good*
90-100	*Excellent*

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	*Extremely Wide*	-
2000-6000	*Very Wide*	*Very Thick*
600-2000	*Wide*	*Thick*
200-600	*Moderate*	*Medium*
60-200	*Close*	*Thin*
20-60	*Very Close*	*Very Thin*
<20	*Extremely Close*	*Laminated*
<6	-	*Thinly Laminated*

Terminology describing rock strength:

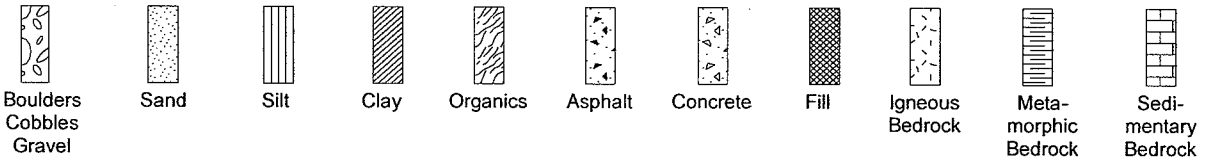
Strength Classification	Unconfined Compressive Strength (MPa)
Extremely Weak	< 1
Very Weak	1 – 5
Weak	5 – 25
Medium Strong	25 – 50
Strong	50 – 100
Very Strong	100 – 250
Extremely Strong	> 250

Terminology describing rock weathering:

Term	Description
Fresh	No visible signs of rock weathering. Slight discolouration along major discontinuities
Slightly Weathered	Discolouration indicates weathering of rock on discontinuity surfaces. All the rock material may be discoloured.
Moderately Weathered	Less than half the rock is decomposed and/or disintegrated into soil.
Highly Weathered	More than half the rock is decomposed and/or disintegrated into soil.
Completely Weathered	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 | Igneous Bedrock | Meta-morphic Bedrock | Sedi-mentary 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)

	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 BH10-01 1 OF 2 METRIC

W.P. 5102-06-00 LOCATION N 5321285 E 243045, Township of Bailloquet, near Wawa, ON ORIGINATED BY AS

DIST HWY 17 BOREHOLE TYPE Splitspoons, Hollow Stem Augers, NQ Coring Equipment COMPILED BY AS

DATUM Geodetic DATE 2.9.10 - 2.9.10 CHECKED BY PC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES NUMBER	TYPE	'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE; 20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
290.3	Asphalt										
0.0 290.1	160 mm ASPHALT										
0.2	Silty sand with gravel, brown, FILL		1	BS	-		290		o		20 61 (19)
288.9			2	SS	100/ 50 mm				o		36 48 (16)
1.4	Sandy silt to silty sand, brown, FILL		3	SS	100/ 180 mm		289				
			4	SS	33		288		o		1 41 (58)
			5	SS	29		287				4 48 45 3
286.2											
4.1	Well graded gravel with silt and sand, brown, FILL		6	SS	19		286				
			7	SS	22				o		45 44 (11)
			8	SS	60		285				
283.6			9	SS	42		284				
6.7	Poorly graded SAND with silt and gravel, compact, brown		10	SS	24		283				
			11	SS	14				o		23 70 (7)
			12	SS	17		282				

Continued Next Page

✖³, ×³: Numbers refer to Sensitivity O^3% STRAIN AT FAILURE

Stantec

RECORD OF BOREHOLE No BH10-01 2 OF 2 METRIC

W.P. 5102-06-00 LOCATION N 5321285 E 243045, Township of Bailloquet, near Wawa, ON ORIGINATED BY AS

DIST _____ HWY 17 BOREHOLE TYPE Splitspoons, Hollow Stem Augers, NQ Coring Equipment COMPILED BY AS

DATUM Geodetic DATE 2.9.10 - 2.9.10 CHECKED BY PC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa (○ UNCONFINED ✖ FIELD VANE ● QUICK TRIAXIAL × LAB VANE) (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Poorly graded SAND with silt and gravel, compact, brown *(continued)*						281				
	Grades to silty SAND, compact, brown		13	SS	29						
			14	SS	5		280				
			15	SS	12				○		10 70 (20)
278.4			16	SS	100/ 130 mm		279				
11.9	Grey BASALT bedrock - very poor quality - moderately weathered		17	NQ							REC=100 RQD=22
277.8							278				
12.4	Grey BASALT bedrock - good quality - unweathered - close to moderate joint spacing - joint with dipping orientation 20-50° - smooth planar and tight filling		18	NQ							REC=100 RQD=81
276.3							277				
13.9	End of Borehole										

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

ONTARIO MTO STANTEC 165000656 HWY 17 WAWA CULVERT.GPJ ONTARIO MOT.GDT 4/7/10

Stantec

RECORD OF BOREHOLE No BH10-02 1 OF 2 METRIC

W.P. 5102-06-00 LOCATION N 5321276 E 243052, Township of Bailloquet, near Wawa, ON ORIGINATED BY AS

DIST HWY 17 BOREHOLE TYPE Splitspoons, Hollow Stem Augers, NQ Coring Equipment COMPILED BY AS

DATUM Geodetic DATE 2.10.10 - 2.10.10 CHECKED BY PC

SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT 20 40 60 80 100 / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE, 20 40 60 80 100	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L — WATER CONTENT (%) 10 20 30	UNIT WEIGHT γ	REMARKS & GRAIN SIZE DISTRIBUTION (%)			
ELEV / DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES					kN/m³	GR	SA	SI	CL
290.4 0.0	Asphalt													
290.3 0.2	160 mm ASPHALT													
	Silty sand with gravel, brown, FILL		1	SS	100/ 50 mm		290		O		16	65		(19)
			2	SS	100/ 130 mm									
289.1 1.4	Sandy silt to silty sand, brown, FILL						289							
			3	SS	100/ 150 mm						3	40	46	11
			4	SS	62		288							
			5	SS	22		287		O		0	53		(47)
			6	SS	36		286							
285.9 4.6	Well graded gravel with silt and sand, brown, FILL		7	SS	100/ 130mm									
			8	SS	13		285							
			9	SS	16		284							
282.6 7.8	Poorly graded SAND with silt and gravel, compact, brownish grey		10	SS	34		283							
			11	SS	28		282							

Continued Next Page

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

Stantec

RECORD OF BOREHOLE No BH10-02 2 OF 2 METRIC

W.P. 5102-06-00 LOCATION N 5321276 E 243052, Township of Bailloquet, near Wawa, ON ORIGINATED BY AS

DIST HWY 17 BOREHOLE TYPE Splitspoons, Hollow Stem Augers, NQ Coring Equipment COMPILED BY AS

DATUM Geodetic DATE 2.10.10 - 2.10.10 CHECKED BY PC

ELEV / DEPTH	DESCRIPTION	STRAT PLOT	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: 'N' VALUES	GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT (20 40 60 80 100) / SHEAR STRENGTH kPa: O UNCONFINED, ● QUICK TRIAXIAL, ✖ FIELD VANE, × LAB VANE (20 40 60 80 100)	PLASTIC LIMIT w_P / NATURAL MOISTURE CONTENT w / LIQUID LIMIT w_L / WATER CONTENT (%) (10 20 30)	UNIT WEIGHT γ kN/m³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
	Poorly graded SAND with silt and gravel, compact, brownish grey *(continued)*		12	SS	33		281				
							280				
			13	SS	12				o		33 60 (7)
279.0											
11.4	Grey BASALT bedrock - poor to fair quality - unweathered - close to very close moderate joint spacing - joint with dipping orientation 20-50° - smooth planar and tight filling		14	NQ			279				REC=92 RQD=35
			15	NQ			278				REC=100 RQD=45
			16	NQ			277				REC=100 RQD=0
			17	NQ			276				REC=93 RQD=62
275.0											
15.4	End of Borehole										

✖³, ×³: Numbers refer to Sensitivity O³% STRAIN AT FAILURE

ONTARIO MTO STANTEC 165000656 HWY 17 WAWA CULVERT.GPJ ONTARIO MOT.GDT 4/7/10

Stantec
2781 Lancaster Road, Suite 200
Ottawa, ON K1B 1A7
Tel: (613) 738-0708 Fax: (613) 738-0721

Field Core Log

Client: MTO
Project: Highway 17 Wawa Culvert
Contractor: DST Consulting Engineers

Project No.: 165000656
Date: February 12, 2010
Borehole No.: 10-1
Logger: Kenton Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
11.86m	16	100%	22%	12.44m	Basalt, grey	-	M	1	S	D	VC/C	SP	----	T	----	----
12.44m	17	100%	81%	13.92m	Basalt, grey	H	U	1	S	D	C/M	SP	----	T	----	----

STRENGTH (MPa)
VH = Very High = >200
H = High = 50-200
M = Medium = 15-50
L = Low = 4-15
VL = Very Low = 1-4

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20^0
D = Dipping = 20-50^0
V = n-Vertical = >50^0

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

P:\2010\165000656 - Hwy 17 Wawa\Rock Core Logs\165000656-Field Core Logs

2781 Lancaster Road, Suite 200
Ottawa, ON K1B 1A7
Tel: (613) 738-0708 Fax: (613) 738-0721

Stantec

Field Core Log

Client: MTO
Project: Highway 17 Wawa Culvert
Contractor: DST Consulting Engineers

Project No.: 165000656
Date: February 12, 2010
Borehole No.: 10-2
Logger: Kenton Power

DEPTH FROM	RUN NO.	% CORE RECOVERY	% RQD	DEPTH TO	GENERAL DESCRIPTION (Rock Type/s, %, Colour, Texture, etc.)	STRENGTH	WEATHERING	DISCONTINUITIES							OCCASIONAL FEATURES	DRILLING OBSERVATIONS
								NO. OF SETS	TYPE/S	ORIENTATION	SPACING	ROUGHNESS	APERTURE	FILLING		
11.38m	15	92%	35%	12.04m	Basalt, grey	-	S	1	S	D	VC/C	SP	----	T	----	----
12.04m	16	100%	45%	13.56m	Basalt, grey	M	U	1	S	D	VC/C	SP	----	T	----	----
13.56m	17	100%	0%	13.87m	Basalt, grey	-	U	1	S	D	VC/C	SP	----	T	----	----
13.87m	18	93%	62%	15.39m	Basalt, grey	M	U	1	S	D	C	SP	----	T	----	----

STRENGTH (MPa)
VH = Very High = >200
H = High = 50-200
M = Medium = 15-50
L = Low = 4-15
VL = Very Low = 1-4

WEATHERING
U = Unweathered = No Signs
S = Slightly = Oxidized
M = Moderately = Discoloured
H = Highly = Friable
C = Completely = Soil-like

DISCONTINUITY TYPE
B = Bedding Joint
J = Cross Joint
F = Fault
S = Shear Plane

SPACING
VW = Very Wide = >3m
W = Wide = 1-3 m
M = Moderate = 0.3-1 m
C = Close = 5-30 cm
VC = Very Close = <5 cm

ORIENTATION
F = Flat = 0-20°
D = Dipping = 20-50°
V = n-Vertical = >50°

ROUGHNESS
RU = Rough Undulating
RP = Rough Planar
SU = Smooth Undulating
SP = Smooth Planar
LU = Slickensided Undulating
LP = Slickensided Planar

FILLING
T = Tight, Hard
O = Oxidized
SA = Slightly Altered, Clay Free
S = Sandy, Clay Free
Si = Sandy, Silty, Minor Clay
NC = Non-softening Clay
SC = Swelling, Soft Clay

P:\2010\165000656 - Hwy 17 Wawa\Rock Core Logs\165000656-Field Core Logs

Photo No. 1: BH10-1 (a).

Photo No. 2: BH10-1 (b).

Photo No. 3: BH10-2 (a).

Photo No. 4: BH10-2 (b).

GEOTECHNICAL SURVEY DATA

DATE OF SURVEY	TYPE OF SURVEY
October 17th, 2007 to October 18th, 2007	Truck Mounted Power Auger, Skid Steer Mounted Power Auger SPT's by DST Technologies Inc.

NOTES:

. CONDITIONS AND PAVEMENT DEPTHS APPLY ONLY TO THE TIME OF THE SURVEY.

. THE BOUNDARIES BETWEEN STRATA HAVE BEEN ESTABLISHED ONLY AT BOREHOLE LOCATIONS. BETWEEN BOREHOLES, THE BOUNDARIES ARE ASSUMED.

. SOILS ARE DESCRIBED ACCORDING TO THE M.T.O. CLASSIFICATION SYSTEM.

. PAVEMENT CORE LOCATIONS WERE ESTABLISHED USING RANDOM NUMBERS UNLESS OTHERWISE SPECIFIED.

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

. ABBREVIATIONS ARE PER OPSD 100.060

ADDITIONAL ABBREVIATIONS:

L/M/HSFH	Low/Medium/High Susceptibility to Frost Heave
MWD	Maximum Wet Density
w	Water Content
w_L	Liquid Limit
I_P	Plasticity Index $= w_L - w_P$
w_{opt}	Optimum Moisture Content
w_P	Plastic Limit
C_u	Undrained Shear Strength
S_t	Sensitivity $= \frac{\text{Undrained shear strength}}{\text{Remoulded shear strength}}$

G.W.P. 5102-06-00	CONTRACT	Highway 17 Centerline Culvert Replacement

Accep	acceptable	Gry	grey	Quant	quantity
Agg	aggregate	H	heavy	Reinf	reinforced
Amor	amorphous	Hi	highly	RF	rock fill
Asph	asphalt	HM	hot mix	RSS	remoulded shear strength
BH	borehole	HP	high plasticity	Sa (y)	sand (y)
Bl	blue	Ip	plasticity index	Sat	saturated
Bld (y)	boulder (y)	L	loose	SH	shale
Blds	boulders	Liq	liquid	Sh Rk	shot rock
Blk	black	Lo	loam	Si (y)	silt (y)
Br	brown	Lt	light	Sl (y)	slight (ly)
BR	bedrock	Matl	material	SP	slight plasticity
BU	break up	Max	maximum	SSM	select subgrade material
CF	channel face	MDD	maximum dry density	St	sensitivity
Cl (y)	clay (ey)	Med	medium	Stn (y)	stone (y)
Co	coarse	Mod	moderate	Stks	streaks
Cob	cobbles	Mott	mottled	Surf	surface
Comp	compact	MP	medium plasticity	Temp	temperature
Conc	concrete	Mrl	marl	TH	test hole
Contam	contaminated	Mul	mulch	TP	test pit
Cord	corduroy	MWD	maximum wet density	Tps	topsoil
Cr	crushed	NFP	no further progress	Tr	trace
D	dense	NFP (blds)	no further progress (boulders)	Unreinf	unreinforced
Decomp	decomposed	Num	numerous	USS	undisturbed shear strength
Dk	dark	Ob	overburden	Varv	varved
D_R	relative density	Occ	occasional	VF	very fine
E	earth	Ora	orange	w	field moisture content
F	fine	Org	organic	W	with
FB	frost boil	Org M	organic matter	W_L	liquid limit
FH	frost heave	Pavt	pavement	Wd (y)	wood (y)
Fib	fibrous	Pedo	pedological	Weath	weathered
Fr Wat	free water	Pen Mac	penetration macadam	Wopt	optimum moisture content
Gr (y)	gravel (ly)	Poss	possible	Wp	plastic limit
Gran	granular	PST	prime and surface treated	WT	water table
Grn	green	Psty	polystyrene	Yel	yellow

SUSCEPTIBILITY TO FROST HEAVING

HSFH – High
MSFH – Medium
LSFH – Low

ONTARIO PROVINCIAL STANDARD DRAWING | Nov 2006 | Rev 1

ABBREVIATIONS

GEOTECHNICAL

OPSD 100.060

Appendix B: Borehole Logs

19+920, 12 Lt D – 2.8

0	-	350	Tps
350	-	850	Br Co Sa & Gr, Moist
		850	NFP (blds)

19+920, 22 Lt D – 6.0

0	-	80	Br Co Sa & Gr, Moist
80	-	750	Br Co Sa Num Cob, Moist
		750	NFP (blds)

19+920, 4.5 Rt D 0

0	-	50	Br Co Sa and Gr , Moist
50	-	400	Br Co Sa & Gr, Occ Cob Moist
		400	NFP (blds)

19+925, 4.5 Lt D 0

0	-	70	Asph
70	-	280	Cr Gran & Sa, Moist
280	-	760	Br Sa & Cr Gr, Num Cob, very dense, Moist N = 60
760	-	1.5	

Sample **07MTO1902**
% Passing

26.5 mm	= 100
19.6 mm	= 100
9.50 mm	= 78
4.75 mm	= 66
300 µm	= 32
75 µm	= 19
w	= 5 %

LSFH
Accep "SSM"

1.5	-	3.3	Br Si F Sa W Gr, dense, Dry N = 50, 18, 35, Wet @ 3.3

19+925, 8 Lt D – 1.9

0	-	50	Br Co Sa & Gr, Moist
50	-	650	Br Co Sa, Num Cob, very dense, Moist
		650	NFP (blds)

19+925, 4.5 Rt D 0

0	-	40	Asph
40	-	275	Br Sa & Cr Gran , Moist
275	-	900	Br Sa W Si Num Cob, very dense, Moist N = 67
900	-	3.3	Br Si F Sa W Gr, dense to very loose, Moist N = 39, 6, 9

19+930, 30 Lt D – 6.3

0	-	80	Tps
80	-	150	Lt Br Si Sa W Gr, Moist
150	-	440	Br Co Sa W Gr, Moist
440	-	900	Br Co Sa Occ Cob, Moist

Wet @ 80mm

19+930, 72 Rt D – 4.2

0	-	260	Br Si Sa W Gr Occ Cob, Moist
260	-	480	Br Sa & Gr, Moist
480	-	1.0	Br Co Sa Num Cob, Wet
1.0	-	1.1	Br Gr Num Cob, Moist
		1.1	NFP (blds)

19+933, 82 Rt D 4.2

0	-	300	Br Si Sa W Gr Occ Cob, Moist
300	-	750	Br Si Co Sa W Gr, Occ Cob, Moist
750	-	1.0	Grey Si F Sa, Occ Cob, Moist
1.0	-	1.2	Br Sa & Gr, Num Cob, Moist

Wet @ 300mm

19+933, 10 Lt D – 3.0

0	-	750	Br Co Sa & Gr, Moist

Sample **MTO1912**
% Passing

26.5 mm	= 100
19.6 mm	= 91
9.50 mm	= 66
4.75 mm	= 51
300 µm	= 22
75 µm	= 13
w	= 5 %

LSFH
Accep "SSM"

750	-	1.5	Br Sa Si, Tr Cl, Tr Gr, Moist

Sample **07MTO1911**
% Passing

9.50 mm	= 100
4.75 mm	= 97
2.00 mm	= 94
425 µm	= 89
75 µm	= 77
5 µm	= 4
2 µm	= 3
w	= 5 %

K Factor = 0.54
HSFH

Appendix B: Borehole Logs

19+935, 4.5 Lt D 0

0	-	40	Asph
40	-	600	Cr Gran & Sa, Moist

Sample **07MTO1910**
% Passing
26.5 mm = 100
19.6 mm = 98
9.50 mm = 77
4.75 mm = 63
300 µm = 27
75 µm = 16
w = 4 %
LSFH
Accep "SSM"

600	-	1.5	Br Sa & Gr, very dense, Num Cob, Moist N = 67

Sample **MTO1904**
% Passing
26.5 mm = 100
19.6 mm = 97
9.50 mm = 75
4.75 mm = 62
300 µm = 28
75 µm = 17
w = 6%
LSFH
Accep "SSM"

1.5	-	3.3	Br Si F Sa W Gr, dense to loose, Moist N = 39, 6, 9

19+940, 4.5 Lt D 0

0	-	35	Asph
35	-	265	Cr Gran and Sa , Moist
265	-	1.52	Br Sa & Gr, Num Cob, very dense, Moist N = 57
1.5	-	6.1	Br Si Sa Occ Cob, compact to dense, Dry N = 34, 23, 21, 33, 52, 11
1.5	-	2.3	

Sample **MTO1905**
% Passing
9.50 mm = 97
4.75 mm = 91
2.00 mm = 86
425 µm = 82
75 µm = 67
5 µm = 8
2 µm = 3
w = 6 %
K Factor = 0.50
HSFH

2.3	-	3.1	

Sample **MTO1913**
% Passing
4.75 mm = 100
2.00 mm = 100
425 µm = 100
75 µm = 70
5 µm = 6
2 µm = 3
w = 15 %
K Factor = 0.60
HSFH

3.1	-	3.8	

Sample **MTO1906**
% Passing
9.50 mm = 99
4.75 mm = 98
2.00 mm = 96
425 µm = 93
75 µm = 58
5 µm = 5
2 µm = 3
w =12 %
K Factor = 0.48
HSFH

3.8	-	4.6	

Sample **MTO1907**
% Passing
9.50 mm = 100
4.75 mm = 99
2.00 mm = 98
425 µm = 96
75 µm = 56
5 µm = 5
2 µm = 3
w = 16 %
HSFH

4.6	-	6.1	Gr and Sa tr Si, moist, Wet At 5.5

Sample **MTO1908**
% Passing
26.5 mm = 100
19.6 mm = 90
9.50 m = 54m
4.75 mm = 43
300 µm = 21
175 µm = 14
w = 6 %
LSFH

6.1	-	7.6	Br Co Sa W Gr, Moist N = 24

Sample **MTO1909**
% Passing
26.5 mm = 100
19.6 mm = 100
9.50 mm = 91
4.75 mm = 83
300 µm = 22
75 µm = 13
w = 8 %
MSFH
Accep "SSM"

19+940, 25 Lt D – 6.6

0	-	100	Br Co Sa Num Cob, Moist
100	-	320	Grey Si Sa Occ Cob, Wet
320	-	570	Br Si Sa, Occ Cob, Moist
570	-	900	Br Co Sa W Gr, Moist

Appendix B: Borehole Logs

19+940 40 Lt D – 6.9

0	-	200	Tps
200	-	420	Br Co Sa W Gr, Moist
420	-	700	Br Co Sa W Si, Num Cob ,Wet

19+945, 4.5 Lt D 0

0	-	35	Asph
35	-	750	Cr Gran and Sa, Moist
			Sample **MTO1915**
			% Passing
			26.5 mm = 92
			19.6 mm = 79
			9.50 mm = 59
			4.75 mm = 47
			300 µm = 20
			75 µm = 12
			w = 5 %
			LSFH
			Accept "SSM"
750	-	1.2	Br Sa & Gr, Num Cob, very dense, Moist, N = 83
1.2	-	2.3	Br Si Sa, Num Cob, dense, Moist N = 39
2.3	-	3.1	Br Sa & Si Tr Cl, Tr Gr
			Sample **MTO1916**
			% Passing
			9.50 mm = 100
			4.75 mm = 98
			2.00 mm = 97
			425 µm = 96
			75 µm = 67
			5 µm = 3
			2 µm = 2
			w = 14 %
			K Factor = 0.58
			HSFH
3.1	-	3.3	Br Sa & Si, Tr Gr, loose, Moist N = 10, 7

19+945, 25 Lt D – 6.6

0	-	200	Tps
200	-	300	Br Co Sa & Gr, Moist
300	-	990	Grey Si Sa & Gr, Moist

19+950, 4.5 Lt D 0

0	-	35	Asph
35	-	265	Br Sa And Cr Gran, Moist
265	-	1.1	Br Sa & Gr, Num Cob, very dense, Moist N = 88
1.1	-	3.3	Br Gr & Sa, Num Cob, compact, Moist N = 13, 27, 14

19+950, 70 Rt D – 4.1

0	-	250	Br Si Sa W Gr Occ Cob, Moist
250	-	300	Br Sa & Gr Occ Cob, Moist
300	-	920	Br Si Co Sa W Gr Occ Cob, Wet @ 300
920	-	1.2	Br Sa & Gr, Dry

19+953, 82 Rt D – 4.0

0	-	300	Br Si Sa, Num Cob, Moist
300	-	940	Br Co Si Sa, Num Cob, Wet
940	-	1.1	Br Sa & Gr, Occ Cob, Wet

19+955, 4.5 Lt D 0

0	-	40	Asph
40	-	270	Cr Gran and Sa Moist
270	-	1.2	Br Sa & Gr, Num Cob, very dense, Moist N = 77
1.2	-	3.3	Lt Br Si Sa, Dense, Dry N = 25, 49, 19 Cob @ 2.0

19+960, 20 Lt D + 1.0

0	-	150	Br Co Sa & Gr, Moist
150	-	220	Br Si Sa W Gr, Moist
220	-	300	Br Gr, Num Cob, Moist
		300	NFP BR

19+ 970, 30 Lt D + 1.3

0	-	500	Br Co Sa & Gr, Wet @ 50mm
500	-	920	Br Co Sa W Si Some Gr, Moist
920	-	1.1	Br Cl Si & Sa, Num Cob, Moist

19+990, 12 Lt D + 0.8

0	-	80	Tps
80	-	120	Lt Br Si Sa W Gr, Num Cob, Moist
		120	NFP BR

20+010, 15 Lt D + 0.7

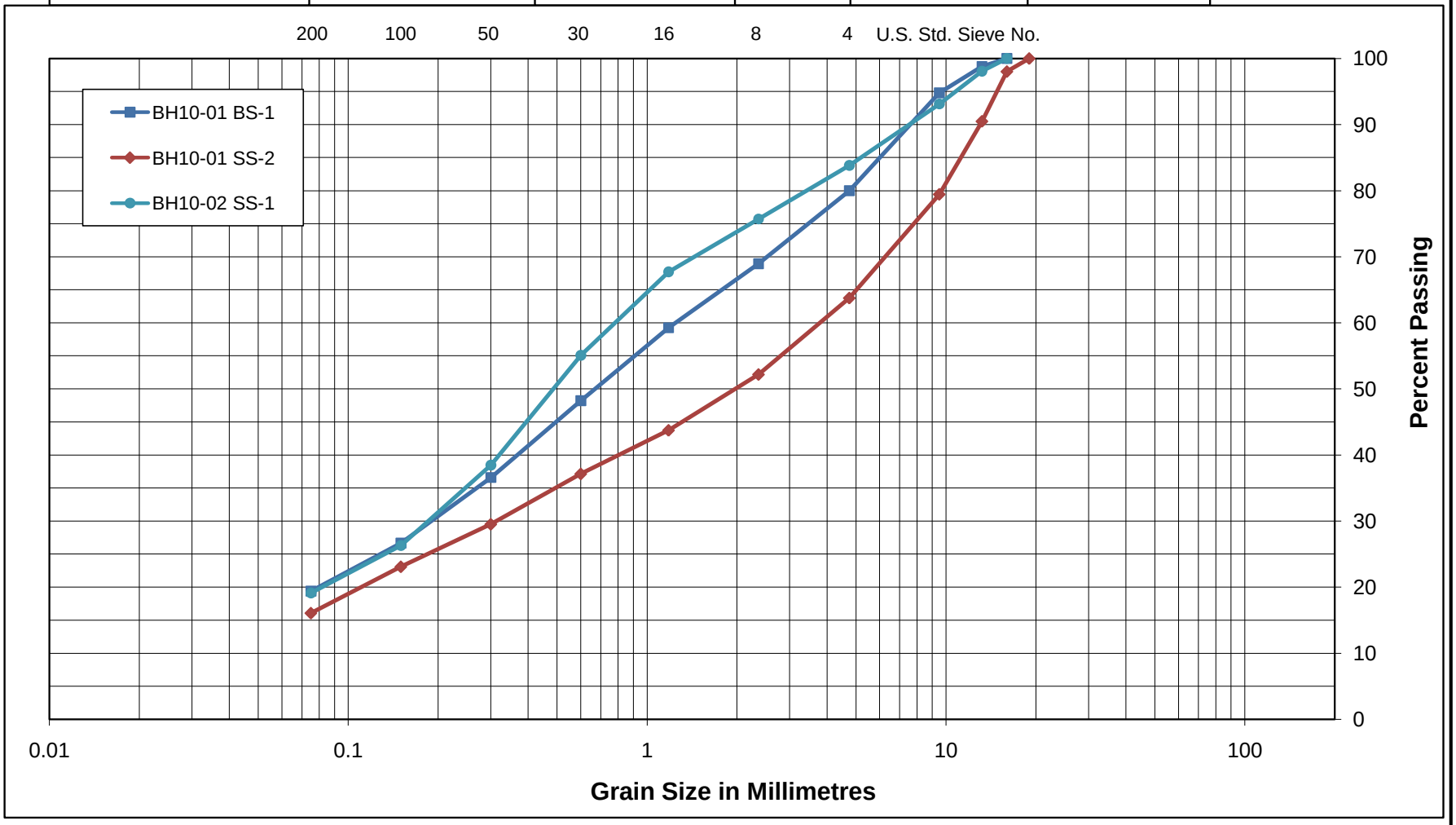
0	-	50	Tps, Moist
50	-	100	Lt Br Si Sa, W Gr, Moist
		100	NFP BR

APPENDIX C

Laboratory Test Results

Unified Soil Classification System

CLAY & SILT	SAND			Gravel	
	Fine	Medium	Coarse	Fine	Coarse



Stantec

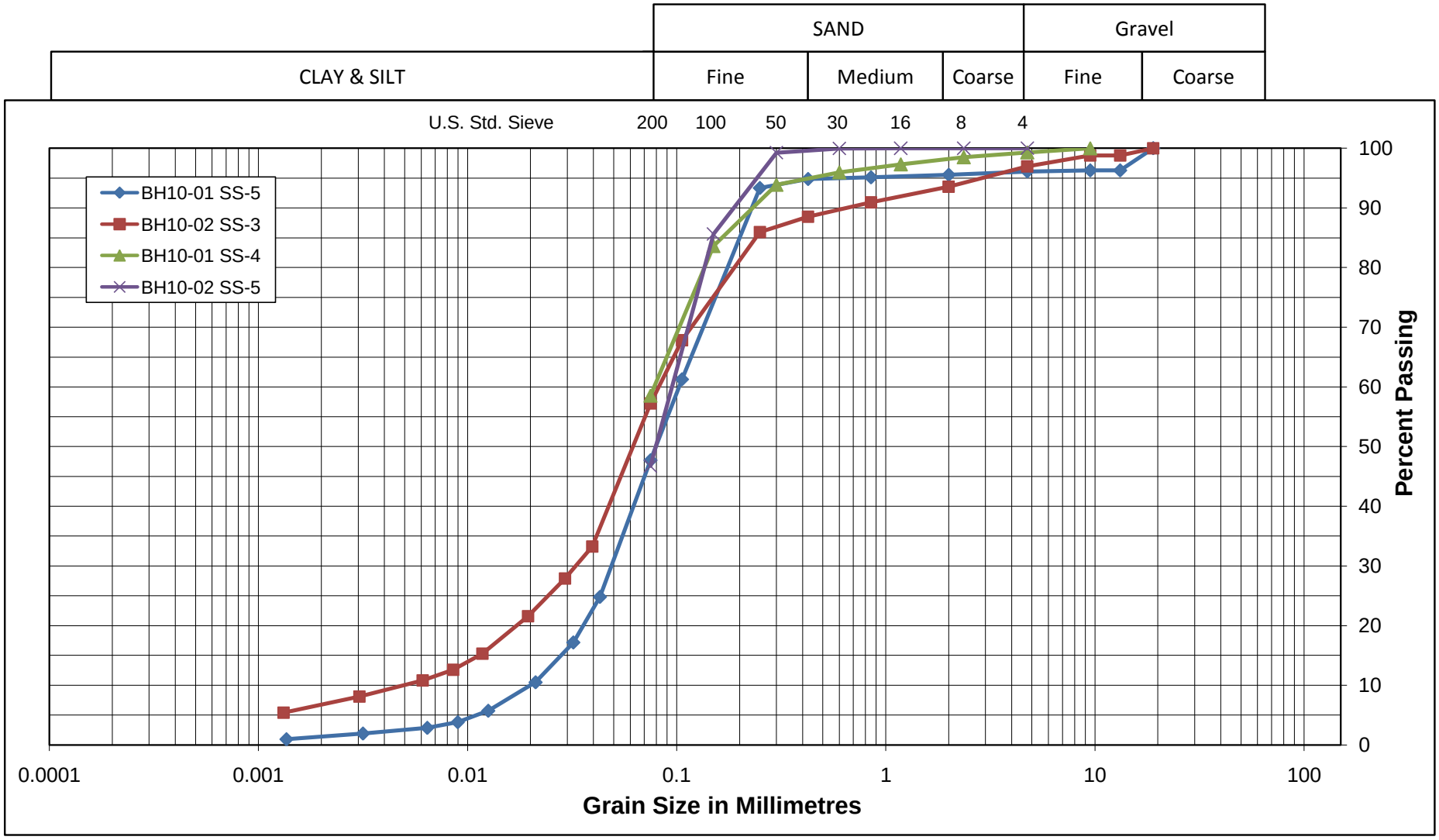
GRAIN SIZE DISTRIBUTION

Base and Subbase Materials

Figure No. 1

Project No. 165000656

Unified Soil Classification System



Stantec

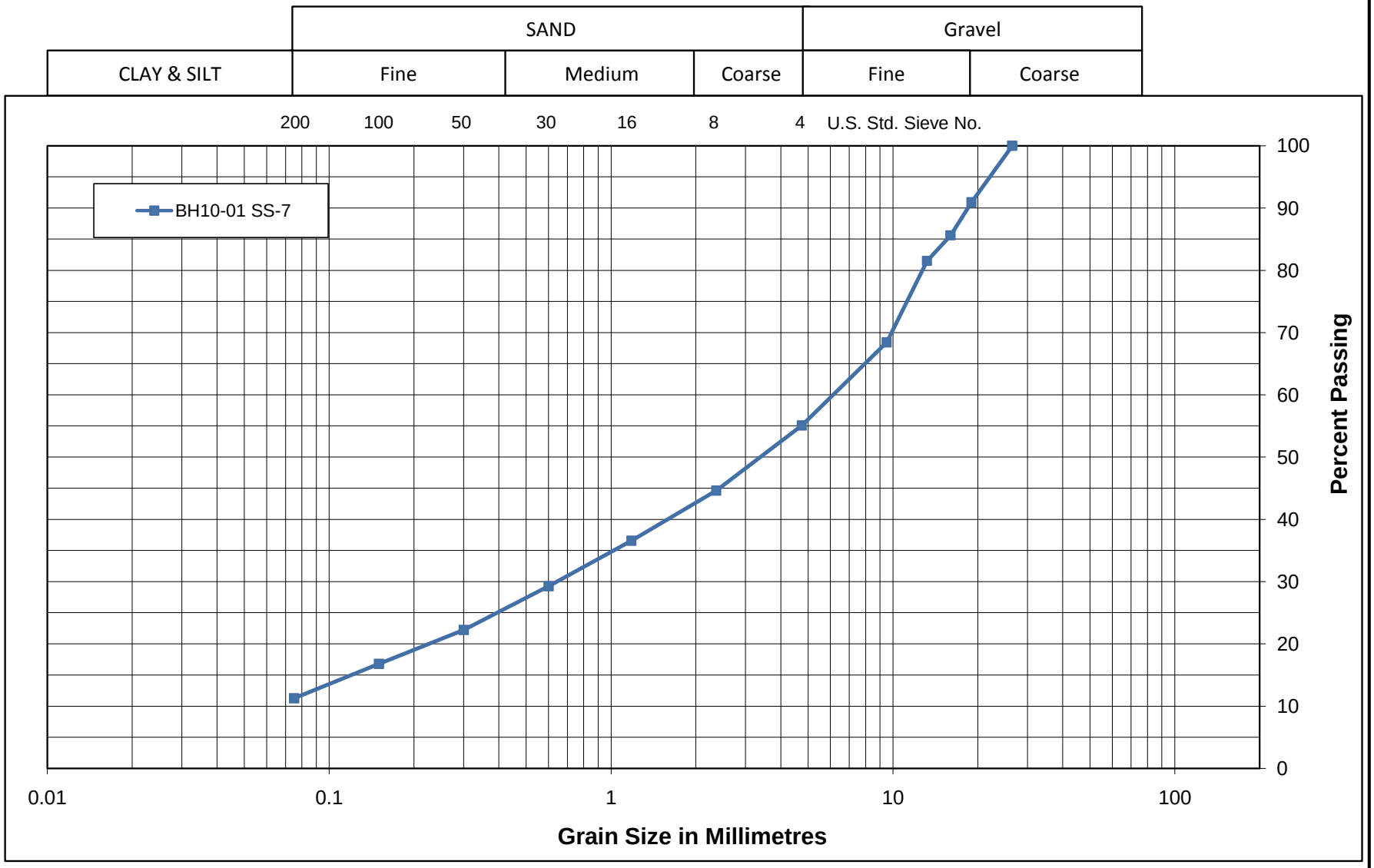
GRAIN SIZE DISTRIBUTION

Sandy Silt to Silty Sand Fill

Figure No. 2

Project No. 165000656

Unified Soil Classification System



Stantec

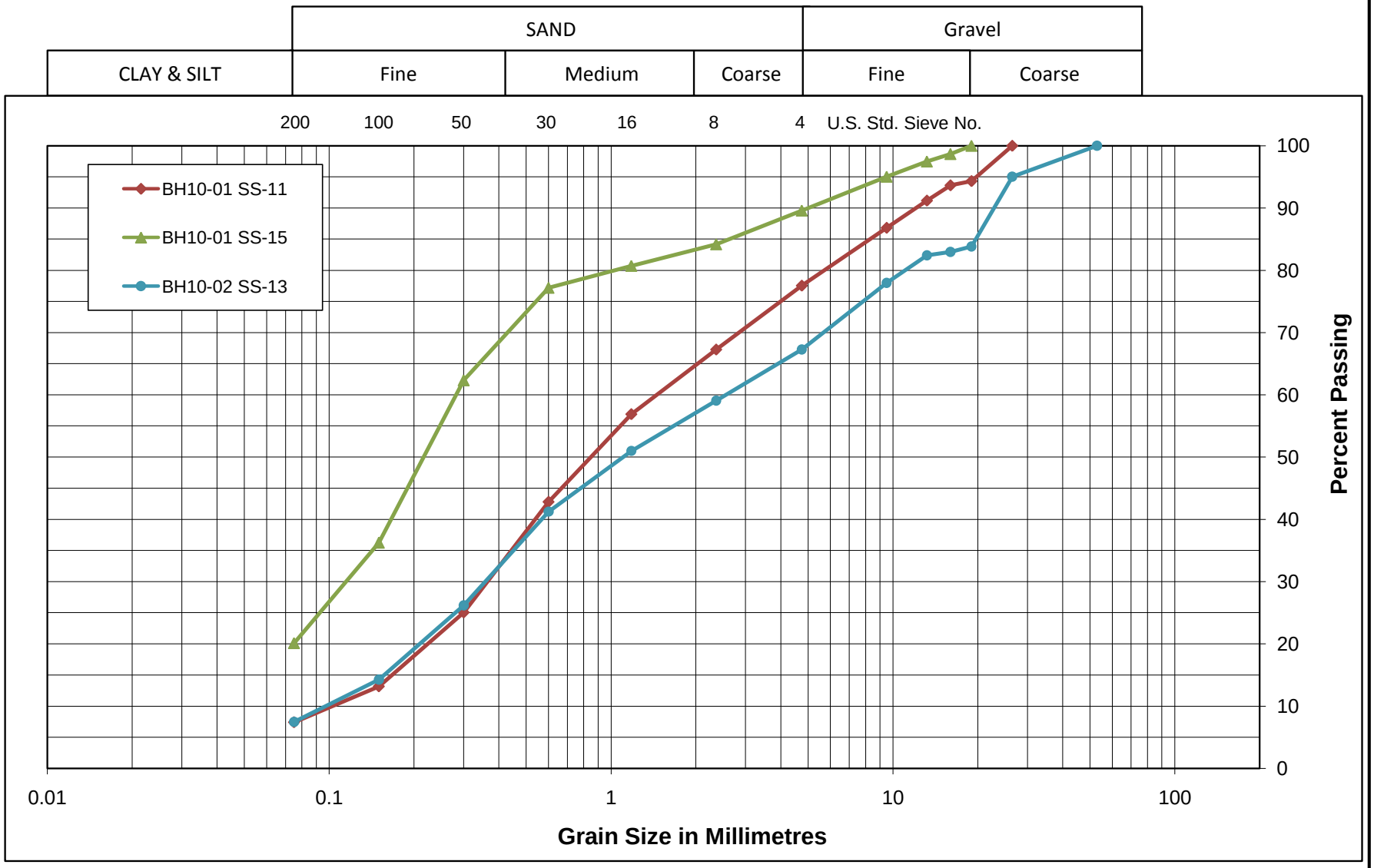
GRAIN SIZE DISTRIBUTION

Well-Graded Gravel with Silt and Sand Fill

Figure No. 3

Project No. 165000656

Unified Soil Classification System



Stantec

GRAIN SIZE DISTRIBUTION

Poorly-Graded Sand with Silt and Gravel

Figure No. 4

Project No. 165000656