

FINAL REPORT

**Foundation Investigation Report
Proposed New Building at Cartier Patrol Yard
Hwy 144, Sudbury Area
WO 2009-11032
MTO GEOCRES No. 41I-247**

Prepared for:
Ministry of Transportation
Regional Director's Office
Northeastern Region
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cc:

Ministry of Transportation
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Trow Associates Inc.

March 25, 2010

SD000360624e

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FOUNDATION INVESTIGATION

1.1 Introduction

This report presents the results of a geotechnical investigation completed by Trow Associates Inc. (Trow) for the proposed new building located at Cartier Patrol Yard, Cartier Township, Sudbury Area. The proposed structure will consist of a dome or conventional building to replace the existing maple dome on site. It is Trow's understanding that the proposed building will have a footprint of approximately 24 m x 36 m and it is expected to accommodate about 5300 tones of winter sand including the area needed to allow for inside loading.

The work was undertaken under Agreement # 5006-E-0094, Assignment No. 4. The terms of reference were as presented in MTO letter dated August 24, 2009.

The purpose of the investigation is to examine the existing soil conditions within the proposed construction limits. The site specific geotechnical investigation consisted of test borings, borehole logging, and field and laboratory testing. This foundation investigation report has been prepared specifically and solely for the project described herein. It contains the factual results of the investigation and the laboratory testing.

1.2 Site Description and Geological Setting

1.2.1 Site Description

The site is located on the northwest corner of the intersection of King's Highway 144 and Old Cartier Road (i.e., formerly Hwy 544) in Township of Cartier, approximately 58 km north of Sudbury. Currently, there is a maple dome and a salt dome on site. The existing maple dome of about 30 m diameter has been in place for at least 25 years, and it will be replaced by the new building. The salt dome is approximately 13.6 m northwest of the existing maple dome. About 53 m northwest of the maple dome is an about 7 m deep ravine having side slopes of approximately 2 horizontal to 1 vertical.

The site plan is as shown on the drawings in Appendix B.

1.2.2 Geological Setting

According to Bedrock Geology of Ontario Map 2543 (Ministry of Northern Development and Mines, Ontario), the bedrock underlying the site is from the Neo-to Mesozoic geologic era (approximately 2.5 to 3.4 billion years old) and falls under Intrusive Igneous Rocks which consists of massive to foliated granodiorite to granite.

1.3 Investigation Procedures

1.3.1 General

The field work for this investigation was performed between November 17 and November 20, 2009. This consisted of drilling five (5) sampled boreholes (BH-1, BH-2, BH-3, BH-4, and BH-5). The five (5) boreholes were strategically located adjacent to the existing maple dome to permit geotechnical investigation for the foundation of the proposed new building. Drawing No. 1 in Appendix B shows the locations of the five boreholes.

Boreholes BH-1, BH-2, BH-3, BH-4 and BH-5 were advanced using a bombardier mounted CME 55 drill rig, equipped with continuous flight hollow stem augers. All borehole drilling/sampling were operated by a specialist drilling contractor, LandCore Drilling Co. Ltd.

During the drilling, soil samples were obtained using a 51 outside diameter (O.D.) split-spoon sampler in accordance with Standard Penetration Test (SPT) procedures (ASTM D 1586), at intervals shown on the attached borehole logs (Appendix C). The SPT “N” values were recorded and used to provide an assessment of in-situ consistency or relative density of non-cohesive soils. At BH-1, BH-2 and BH-3, sand heaving was encountered at a depth ranging from 9.14 to 12.2 m. In these cases, wash boring was utilized to facilitate taking representative sample at designated elevation with reasonable accuracy. In addition, dynamic cone testing was utilized at BH-4 below 8.2 m depth to verify the soil consistency condition established by the SPT tests in BH-1, BH-2, BH-3 and BH-5.

After completion, boreholes were sealed in accordance with accepted practice for decommissioning of boreholes.

The fieldwork was supervised by a member of Trow’s engineering staff who directed the drilling and sampling operation, logged borehole data in accordance with MTO Soils Classification System for foundation report, and retrieved soil samples for subsequent laboratory testing and identification. All of the recovered soil samples were placed in moisture-proof bags and returned to Trow’s Sudbury and Brampton laboratories for additional visual, textual and olfactory examination.

Details of the soil strata encountered in the boreholes are included in attached borehole log sheets in Appendix C, and plotted on the profiles in Appendix B.

The borehole locations and the ground surface elevations along the cross sections were surveyed by Trow personnel, with reference to the benchmark at the south-east corner of the building (PBM 748076), as shown in the site survey map provided by MTO (PLAN H-698-1444-1) (Elevation 417.367 m).

1.3.2 Laboratory Testing

All samples returned to the laboratory were subjected to visual examination and classification. The laboratory testing program included natural water content (LS-701) and grain size distribution tests (LS703/704) on approximately 25% of the collected soil samples.

The laboratory test results are provided on the attached borehole log sheets in Appendix C. The results of the grain size analyses are presented geographically in Appendix D.

1.4 Subsurface Conditions

The detailed subsurface conditions encountered in the boreholes advanced during this investigation are presented on the borehole log sheets in Appendix C. Laboratory test results are provided in Appendix D. The “Explanation of Terms Used in Report” preceding the borehole logs in Appendix C forms an integral part of and should be read in conjunction with this report.

A borehole location plan and cross section soil profiles are provided in Appendix B. It should be noted that the stratigraphic boundaries indicated on the borehole log and cross section soil profiles are inferred from non-continuous sampling, observations of drilling progress and results of Standard Penetration Tests. These boundaries typically represent transitions from one soil type to another and should not be regarded as exact planes of geological change. Further, subsurface conditions may vary between and beyond the borehole locations.

In general, the stratigraphic sequence at the site typically consists of sand and gravel followed by sand overlying boulder/broken rock.

A summary of the soil and groundwater conditions encountered in the boreholes is provided below.

1.4.1 Asphalt

At BH-4 and BH-5, asphaltic concrete was encountered at ground surface. The thickness of the asphaltic concrete layer ranges from 38 to 40 mm, and the top elevation of this layer is between about 417.4 m and 417.3 m.

1.4.2 Sand and Gravel

Sand and gravel was encountered at all boreholes. At BH-1, BH-2 and BH-3 the sand and gravel was encountered at ground surface, while at BH-4 and BH-5 it was found below surface asphalt. The thickness of the sand and gravel ranges from 0.8 m to 9.1 m. This layer extends from elevation of about 417.3 m to 408.0 m.

The composition of this layer is sand and gravel, trace to some silt, with occasional cobbles. The sand and gravel is brown in color, and dry to wet. Uncorrected STP “N” value ranges from 10 to 100 blows per 300 mm, classifying the material as compact to very dense in compactness condition.

Laboratory testing performed on selected samples consisted of moisture content and grain size distribution tests. The test results are as follows:

Moisture Content:

- 5% to 15%

Grain Size Distribution:

- 17% to 54% gravel;
- 39% to 72% sand; and
- 3% to 21% silt and clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheet in Appendix C. The results of the grain size distribution tests are also provided on Figures 1 and 2 in Appendix D.

1.4.3 Sand

Sand was encountered in BH-1, BH-2, BH-3, and BH-5. This sand layer has a thickness ranging from about 5.2 m to 11.0 m. It extends to depths between 9.1 m and 15.3 m, corresponding to approximate Elevations of 408.0 and 402.0 m, respectively.

The deposit consists of sand, trace to some gravel, and trace to some silt. At BH-2, the sand layer contains trace to some dark brown organic silt (possible fill) and extends down to about 3.1 m depth from the existing ground surface. The sand is brown to grey in color, and moist to wet. Uncorrected SPT “N” values range from 4 to 100 blows per 300 mm, classifying the sand as very loose to very dense in compactness condition.

Laboratory testing performed on selected samples consisted of moisture content and grain size distribution tests. The test results are as follows:

Moisture Content:

- 18% to 22%

Grain Size Distribution:

- 0% to 7% gravel;
- 74% to 92% sand; and
- 8% to 26% silt and clay

The results of the moisture content and grain size distribution tests are provided on the record of borehole sheet in Appendix C. The results of the grain size distribution tests are also provided on Figures 3 and 4 in Appendix D.

1.4.4 Boulder/Broken Rock

Beneath the sand layer, boulder was encountered at BH-1, BH-2 and BH-3. The fractured rock or boulders extend from about 11.0 m depth (approximately Elevation of 406.1 m) to 18.6 m depth at the borehole termination. Appendix E includes the photos of broken rock recovered.

1.5 Groundwater Conditions

The groundwater levels at the site were estimated from the sign of wet-spoon during field borehole drilling and the change of the sample moist contents in depth. The ground water levels encountered in the boreholes are also shown in Table 1.1. It should be noted that the groundwater level is subject to seasonal fluctuations.

Table 1.1 Groundwater levels at the site

Borehole No.	Date of drilling	Water level	
		Depth, (m)	Elevation, (m)
BH-1	November/18/2009	6.1	411.2
BH-2	November/19/2009	6.1	411.0
BH-3	November/20/2009	6.1	411.1
BH-4	November/20/2009	7.6	409.7
BH-5	November/17/2009	6.1	411.3


1.6 Closure

A soil investigation is a limited sampling of a site. The information is collected at specific borehole locations and can be extrapolated to an approximate limited area around the borehole. The extent of the limited area depends on the variability of the soil and groundwater conditions as influenced by geological processes and the construction activities. Should any conditions at the site be encountered which differ from those reported at the test locations, we require that we be notified immediately in order to allow reassessment of our recommendations. It may then be necessary to carry out additional field work and analyses.

This Foundation Investigation Report has been prepared by S. Micic, Ph.D., P.Eng and G. Qu, Ph.D., and reviewed by S. Gonsalves, M.Eng., P.Eng., Designated MTO Foundation Contact.

Yours truly,

Trow Associates Inc.


G. Qu, Ph.D.
Geotechnical Specialist


Silvana Micic, Ph.D., P.Eng.
Geotechnical Engineer



Encl.


S.E. Gonsalves, M.Eng., P.Eng.
Principal Engineer
Designated MTO Foundation Contact



APPENDIX A: PHOTOGRAPHS



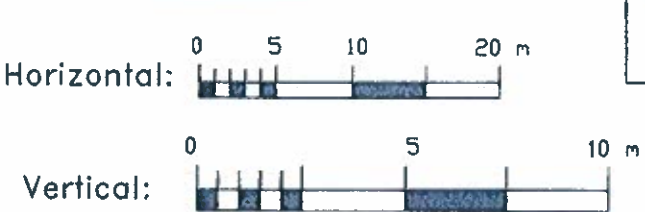
Photograph 1 SITE VIEW (BH-2 facing northeast)



Photograph 2 SITE VIEW (BH-4, facing east)

APPENDIX B : DRAWING

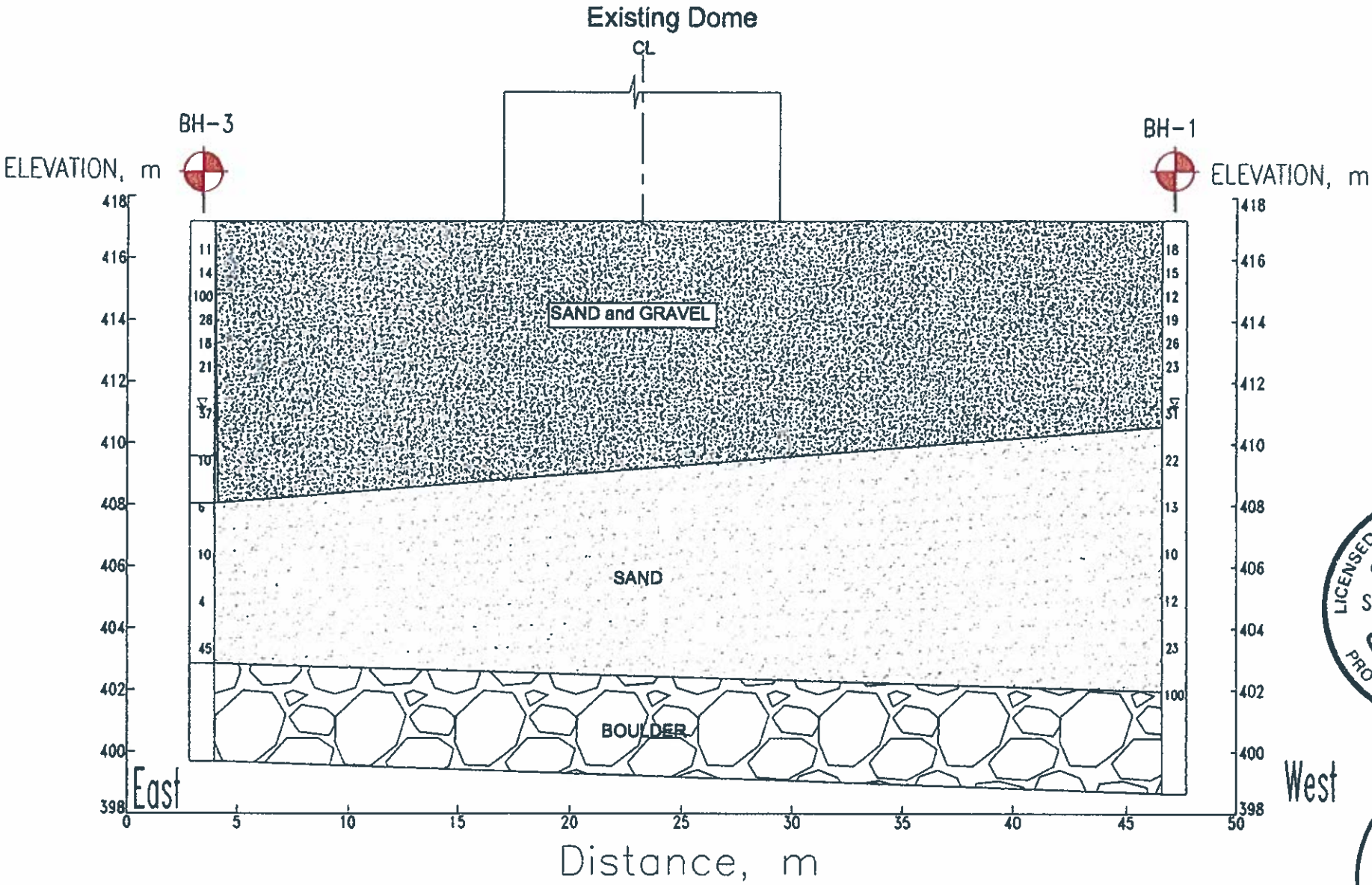
A-A Cross Section



DIMENSIONS ARE IN METERS
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

WO No. 2009-11032
Geocres No. 411-247

N
SHEET
2

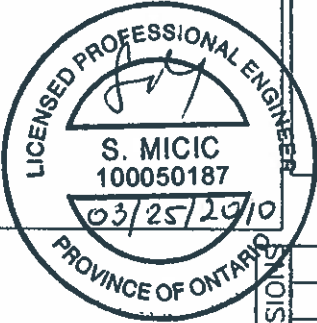


LEGEND

- BOREHOLE
- Water Level

NOTES

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing to be read with subject report.
- This drawing is for subsurface information only. Surface details and features are for conceptual illustration only.
- Borehole locations are approximate.
- Water level was assumed at where the wet-spoon was first encountered during borehole drilling in November 2009.



REVISION	DATE	BY	DESCRIPTION

SOIL STRATA SYMBOLS

- SAND
- BOULDER

SAND AND GRAVEL

Trow Associates Inc.
56 QUEEN STREET EAST, SUITE 301
BRAMPTON, ONTARIO, L6V 4M8
(905) 796-3200

PROJECT TITLE AND LOCATION:
**Proposed New Building at
Cartier Patrol Yard,
Sudbury**

DRAWING TITLE:
A-A CROSS-SECTION

PROJECT NO.	2009-11032	DWN.	GQ
SCALE	AS NOTED	CHKD.	SM
DATE	Dec. 2009	DWG. No.	2

B-B Cross Section

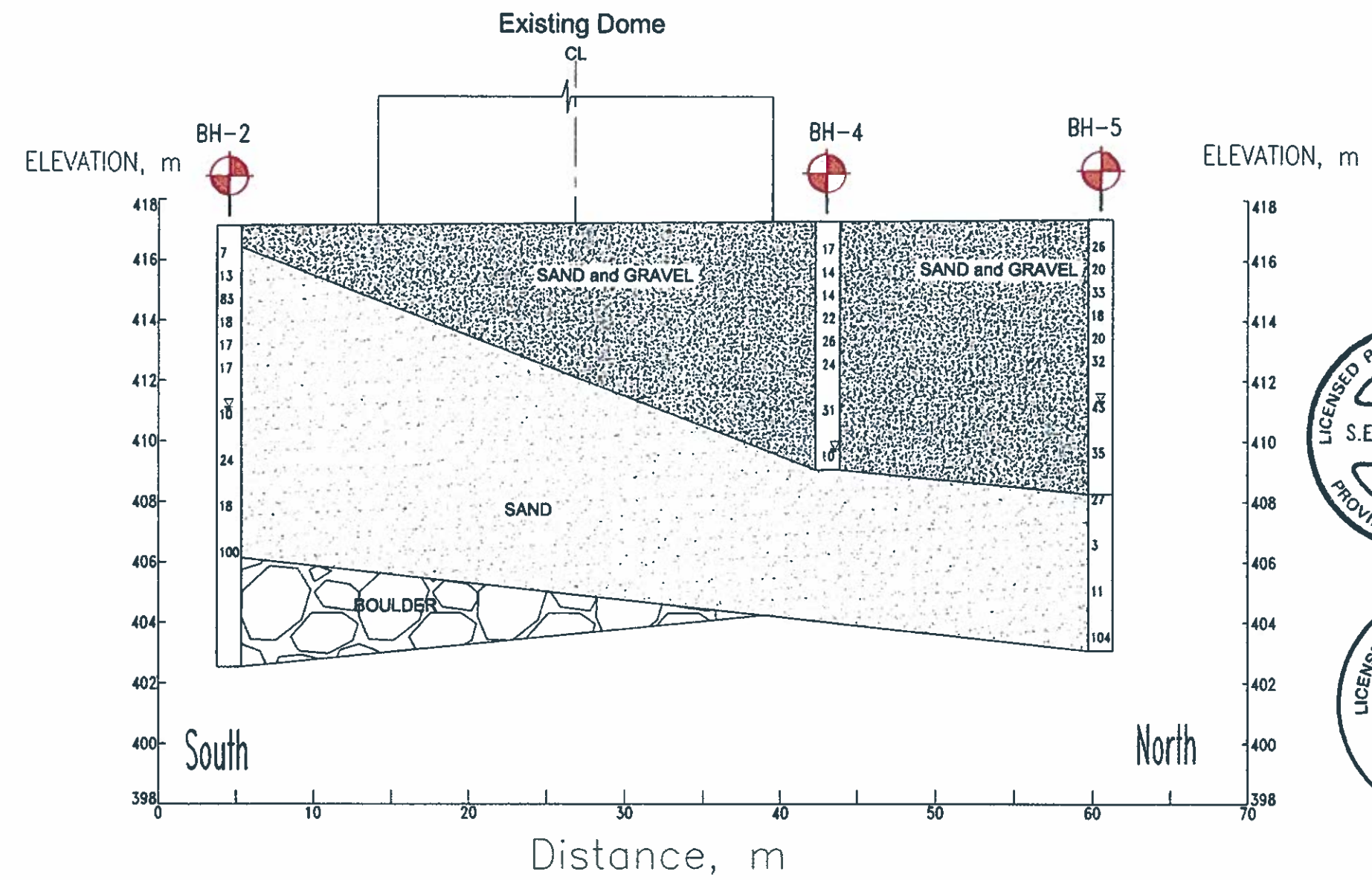
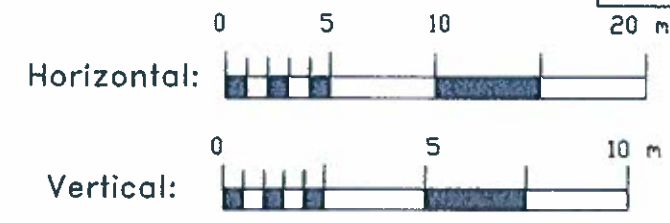
DIMENSIONS ARE IN METERS
AND/OR MILLIMETERS
UNLESS OTHERWISE SHOWN

WO No. 2009-11032
Geocres No. 411-247



SHEET

3



LEGEND

- BOREHOLE
- Water Level

-NOTES-

- The boundaries between soil strata have been established only at Borehole locations. Between Boreholes the boundaries are assumed from geological evidence.
- This drawing to be read with subject report.
- This drawing is for subsurface information only.
- Surface details and features are for conceptual illustration only.
- Borehole locations are approximate.
- Water level was assumed at where the wet-spoon was first encountered during borehole drilling in November 2009.



REVISIONS	DATE	BY	DESCRIPTION

SOIL STRATA SYMBOLS:	SAND	SAND AND GRAVEL
	BOULDER	

TROW Associates Inc.
56 QUEEN STREET EAST, SUITE 301
BRAMPTON, ONTARIO, L6V 4M8
(905) 796-3200

PROJECT TITLE AND LOCATION:
**Proposed New Building at
Cartier Patrol Yard,
Sudbury**

DRAWING TITLE:
B-B CROSS-SECTION

PROJECT NO. 2009-11032	DWN.: GQ
SCALE: AS NOTED	CHKD.: SM
DATE: Dec. 2009	DWG. No. 3

APPENDIX C : BOREHOLE LOGS

EXPLANATION OF TERMS USED IN REPORT

N-VALUE: THE STANDARD PENETRATION TEST (SPT) N-VALUE IS THE NUMBER OF BLOWS REQUIRED TO CAUSE A STANDARD 51mm O.D SPLIT BARREL SAMPLER TO PENETRATE 0.3m INTO UNDISTURBED GROUND IN A BOREHOLE WHEN DRIVEN BY A HAMMER WITH A MASS OF 63.5kg, FALLING FREELY A DISTANCE OF 0.76m. FOR PENETRATIONS OF LESS THAN 0.3m N-VALUES ARE INDICATED AS THE NUMBER OF BLOWS FOR THE PENETRATION ACHIEVED. AVERAGE N-VALUE IS DENOTED THUS \bar{N} .

DYNAMIC CONE PENETRATION TEST: CONTINUOUS PENETRATION OF A CONICAL STEEL POINT (51mm O.D. 60° CONE ANGLE) DRIVEN BY 475J IMPACT ENERGY ON 'A' SIZE DRILL RODS. THE RESISTANCE TO CONE PENETRATION IS MEASURED AS THE NUMBER OF BLOWS FOR EACH 0.3m ADVANCE OF THE CONICAL POINT INTO THE UNDISTURBED GROUND.

SOILS ARE DESCRIBED BY THEIR COMPOSITION AND CONSISTENCY OR DENSENESS.

CONSISTENCY: COHESIVE SOILS ARE DESCRIBED ON THE BASIS OF THEIR UNDRAINED SHEAR STRENGTH (c_u) AS FOLLOWS:

C_u (kPa)	0 – 12	12 – 25	25 – 50	50 – 100	100 – 200	>200
	VERY SOFT	SOFT	FIRM	STIFF	VERY STIFF	HARD

DENSENESS: COHESIONLESS SOILS ARE DESCRIBED ON THE BASIS OF DENSENESS AS INDICATED BY SPT N VALUES AS FOLLOWS:

N (BLOWS/0.3m)	0 – 5	5 – 10	10 – 30	30 – 50	>50
	VERY LOOSE	LOOSE	COMPACT	DENSE	VERY DENSE

ROCKS ARE DESCRIBED BY THEIR COMPOSITION AND STRUCTURAL FEATURES AND/OR STRENGTH.

RECOVERY: SUM OF ALL RECOVERED ROCK CORE PIECES FROM A CORING RUN EXPRESSED AS A PERCENT OF THE TOTAL LENGTH OF THE CORING RUN.

MODIFIED RECOVERY: SUM OF THOSE INTACT CORE PIECES, 100mm+ IN LENGTH EXPRESSED AS A PERCENT OF THE LENGTH OF THE CORING RUN. THE ROCK QUALITY DESIGNATION (RQD), FOR MODIFIED RECOVERY IS:

RQD (%)	0 – 25	25 – 50	50 – 75	75 – 90	90 – 100
	VERY POOR	POOR	FAIR	GOOD	EXCELLENT

JOINT AND BEDDING:

SPACING	50mm	50 – 300mm	0.3m – 1m	1m – 3m	>3m
JOINTING	VERY CLOSE	CLOSE	MOD. CLOSE	WIDE	VERY WIDE
BEDDING	VERY THIN	THIN	MEDIUM	THICK	VERY THICK

ABBREVIATIONS AND SYMBOLS

FIELD SAMPLING

SS	SPLIT SPOON	TP	THINWALL PISTON
WS	WASH SAMPLE	OS	OSTERBERG SAMPLE
ST	SLOTTED TUBE SAMPLE	RC	ROCK CORE
BS	BLOCK SAMPLE	PH	TW ADVANCED HYDRAULICALLY
CS	CHUNK SAMPLE	PM	TW ADVANCED MANUALLY
TW	THINWALL OPEN	FS	FOIL SAMPLE

STRESS AND STRAIN

u_w	kPa	PORE WATER PRESSURE
r_u	1	PORE PRESSURE RATIO
σ	kPa	TOTAL NORMAL STRESS
σ'	kPa	EFFECTIVE NORMAL STRESS
τ	kPa	SHEAR STRESS
$\sigma_1, \sigma_2, \sigma_3$	kPa	PRINCIPAL STRESSES
ϵ	%	LINEAR STRAIN
$\epsilon_1, \epsilon_2, \epsilon_3$	%	PRINCIPAL STRAINS
E	kPa	MODULUS OF LINEAR DEFORMATION
G	kPa	MODULUS OF SHEAR DEFORMATION
μ	1	COEFFICIENT OF FRICTION

MECHANICAL PROPERTIES OF SOIL

m_v	kPa^{-1}	COEFFICIENT OF VOLUME CHANGE
c_c	1	COMPRESSION INDEX
c_s	1	SWELLING INDEX
c_a	1	RATE OF SECONDARY CONSOLIDATION
c_v	m^2/s	COEFFICIENT OF CONSOLIDATION
H	m	DRAINAGE PATH
T_v	1	TIME FACTOR
U	%	DEGREE OF CONSOLIDATION
σ'_{vo}	kPa	EFFECTIVE OVERBURDEN PRESSURE
σ'_p	kPa	PRECONSOLIDATION PRESSURE
τ_f	kPa	SHEAR STRENGTH
c'	kPa	EFFECTIVE COHESION INTERCEPT
ϕ'	°	EFFECTIVE ANGLE OF INTERNAL FRICTION
c_u	kPa	APPARENT COHESION INTERCEPT
ϕ_u	°	APPARENT ANGLE OF INTERNAL FRICTION
τ_R	kPa	RESIDUAL SHEAR STRENGTH
τ_r	kPa	REMOULDED SHEAR STRENGTH
S_i	1	SENSITIVITY = c_u / τ_r

PHYSICAL PROPERTIES OF SOIL

P_s	kg/m^3	DENSITY OF SOLID PARTICLES	e	1, %	VOID RATIO	e_{min}	1, %	VOID RATIO IN DENSEST STATE
γ_s	kN/m^3	UNIT WEIGHT OF SOLID PARTICLES	n	1, %	POROSITY	I_D	1	DENSITY INDEX = $\frac{e_{\text{max}} - e}{e_{\text{max}} - e_{\text{min}}}$
P_w	kg/m^3	DENSITY OF WATER	w	1, %	WATER CONTENT	D	mm	GRAIN DIAMETER
γ_w	kN/m^3	UNIT WEIGHT OF WATER	s_r	%	DEGREE OF SATURATION	D_n	mm	N PERCENT – DIAMETER
P	kg/m^3	DENSITY OF SOIL	w_L	%	LIQUID LIMIT	C_u	1	UNIFORMITY COEFFICIENT
γ'	kN/m^3	UNIT WEIGHT OF SOIL	w_p	%	PLASTIC LIMIT	h	m	HYDRAULIC HEAD OR POTENTIAL
P_d	kg/m^3	DENSITY OF DRY SOIL	w_s	%	SHRINKAGE LIMIT	q	m^3/s	RATE OF DISCHARGE
γ_d	kN/m^3	UNIT WEIGHT OF DRY SOIL	I_p	%	PLASTICITY INDEX = $(w_L - w_p)$	v	m/s	DISCHARGE VELOCITY
P_{sat}	kg/m^3	DENSITY OF SATURATED SOIL	I_L	1	LIQUIDITY INDEX = $(w - w_p) / I_p$	i	1	HYDRAULIC GRADIENT
γ_{sat}	kN/m^3	UNIT WEIGHT OF SATURATED SOIL	I_C	1	CONSISTENCY INDEX = $(w_L - w) / I_p$	k	m/s	HYDRAULIC CONDUCTIVITY
P'	kg/m^3	DENSITY OF SUBMERGED SOIL	e_{max}	1, %	VOID RATIO IN LOOSEST STATE	j	kN/m^2	SEEPAGE FORCE
γ'	kN/m^3	UNIT WEIGHT OF SUBMERGED SOIL						

RECORD OF BOREHOLE No BH-1

1 OF 1

METRIC

W.P. WO: 2009-11032 GEOCRETS No. 411-241 LOCATION N 5173528.8 E 262121.5 ORIGINATED BY PR
 DIST HWY 144 BOREHOLE TYPE CME Hollow Stem Auger/Diamond COMPILED BY GQ
 DATUM Geodetic DATE 11.17.09 - 11.18.09 CHECKED BY SM

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 (%)		
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa									
								20	40	60						80	100
417.3																	
0.0	SAND and GRAVEL (GW), trace to some silt, brown, moist to wet, compact to dense		1	AS											38 55 (7)		
			2	SS	18												
			3	SS	15												
	- fine sand occurred from 2.3 to 3.0 m depth.		4	SS	12												
			5	SS	19										29 63 (8)		
			6	SS	26												
			7	SS	23												
			8	SS	31										54 39 (7)		
409.7																	
7.6	SAND (SM), trace to some gravel, trace to some silt, brown, wet, compact to dense		9	SS	22												
			10	SS	13												
			11	SS	10												
	- Wash boring blow 11.3 m (due to heaving sand)		12	SS	12										0 74 (26)		
	- grey sand, very wet		13	SS	23												
	- coarse sand and gravel, grey, very wet		14	SS	100												
402.0																	
15.3	BOULDER / BROKEN ROCK																
	DIAMOND DRILLING STARTED AT ~ 15.3 m DEPTH																
	1st Run (from 15.3 to 15.7 m depth): - no water return;																
	2nd Run (from 15.7 to 16.8 m depth): - 40% water return;																
398.7																	
18.6	3rd Run (from 16.8 to 18.6 m depth): - no water return; BOREHOLE TERMINATED AT ~ 18.6 m DEPTH																
	NOTES: 1. This drawing is to be read with the subject report and project number as presented above. 2. Interpretation assistance by Trow is required before use by others. 3. A local benchmark was employed (PBM748076, Elev=417.367m, Location: Tablet SE Corner 73.4 LT 21+942.7).																

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

ON_MOT_CARTIER 03.GPJ ON_MOT_GDT 3/25/10

RECORD OF BOREHOLE No BH-2

1 OF 1

METRIC

W.P. WO: 2009-11032 GEOCRES No. 411-241 LOCATION N 5173502.6 E 262137.0 ORIGINATED BY PR
 DIST HWY 144 BOREHOLE TYPE CME Hollow Stem Auger/Diamond COMPILED BY GQ
 DATUM Geodetic DATE 11.19.09 - 11.19.09 CHECKED BY SM

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												
417.1							20	40	60	80	100							
0.0	SAND and GRAVEL (GW), brown, moist		1	AS		▽												
416.3																		
0.8	SAND (SM), trace to some gravel, trace to some dark brown organic silt (possible fill), with suspected cobbles. brown, moist, loose to very dense. - Suspected cobble at split spoon's tip		2	SS	7		416									12 72 (16)		
			3	SS	13													
			4	SS	83													
414.1							414											
3.1	SAND (SW), trace to some gravel, trace silt. brown, moist, compact.		5	SS	18													
			6	SS	17													
			7	SS	17													
							412											
411.0																		
6.1	SAND (SP), trace gravel, trace silt. brown, wet, compact to very dense.		8	SS	10	410												
			9	SS	24													
	- Wash boring blow 9.14 m (due to heaving sand)		10	SS	18	408									0 92 (8)			
406.1	- Coarse gravel, grey, wet, and suspected boulder and cobble below 10.5 m		11	SS	100	406												
11.0	BOULDER / BROKEN ROCK																	
	DIAMOND DRILLING STARTED AT ~ 11 m DEPTH 1st Run (from 11.0 to 12.2 m depth): - 30% water return; 2nd Run (from 12.2 to 13.1 m depth): - 30% water return; 3rd Run (from 13.1 to 14.6 m depth): - 40% water return; BOREHOLE TERMINATED AT ~ 14.6 m DEPTH					404												
402.5																		
14.6																		

NOTES:
1. This drawing is to be read with the subject report and project number as presented above.
2. Interpretation assistance by Trow is required before use by others.
3. A local benchmark was employed (PBM748076, Elev=417.367m, Location: Tablet SE Corner 73.4 LT 21+942.7).

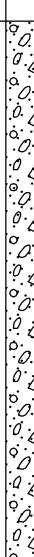


NOTES:
 1. This drawing is to be read with the subject report and project number as presented above.
 2. Interpretation assistance by Trow is required before use by others.
 3. A local benchmark was employed (PBM748076, Elev=417.367m, Location: Tablet SE Corner 73.4 LT 21+942.7).

RECORD OF BOREHOLE No BH-3

1 OF 1

METRIC

W.P. WO: 2009-11032 GEOCRETS No. 411-241 LOCATION N 5173514.0 E 262162.8 ORIGINATED BY PR
 DIST HWY 144 BOREHOLE TYPE CME Hollow Stem Auger/Diamond COMPILED BY GQ
 DATUM Geodetic DATE 11.19.09 - 11.20.09 CHECKED BY SM

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									
417.2							20	40	60	80	100								
0.0	SAND and GRAVEL(SW-SM), trace silt, occasional cobble, brown, moist to wet, compact to very dense.		1	AS		▽													
			2	SS	11														
			3	SS	14														
	- suspected cobbles at spoon tip		4	SS	100														
			5	SS	28														
			6	SS	18														
			7	SS	21														
	- wet spoon		8	SS	37														
			9	SS	10														
408.0																			
9.1	SAND (SM), coarse sand, trace to some gravel, trace to some silt, brown to grey, wet, very loose to dense.		10	SS	6														
			11	SS	10														
	- Wash boring blow 12.2 m (due to heaving sand)		12	SS	4														
402.8			13	SS	45														
14.3	BOULDER / BROKEN ROCK																		
	DIAMOND DRILLING STARTED AT ~ 14.3 m DEPTH																		
	1st Run (from 14.34 to 14.9 m depth): - 10% water return;																		
	2nd Run (from 14.9 to 15.2 m depth): - 10% water return;																		
	3rd Run (from 15.2 to 16.0 m depth): - 10% water return;																		
399.7																			
17.5	4th Run (from 16.0 to 16.6 m depth): - 5% water return; 5th Run (from 16.6 to 17.5 m depth): - 10% water return; BOREHOLE TERMINATED AT ~ 17.5 m																		
	NOTES: 1. This drawing is to be read with the subject report and project number as presented above. 2. Interpretation assistance by Trow is required before use by others. 3. A local benchmark was employed (PBM748076, Elev=417.367m, Location: Tablet SE Corner 73.4 LT 21+942.7).																		

ON_MOT_CARTIER 03.GPJ ON_MOT_GDT 3/25/10

RECORD OF BOREHOLE No BH-4

1 OF 1

METRIC

W.P. WO: 2009-11032 GEOCREs No. 411-241 LOCATION N 5173539.3 E 262148.6 ORIGINATED BY PR
 DIST HWY 144 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY GQ
 DATUM Geodetic DATE 11.20.09 - 11.20.09 CHECKED BY SM

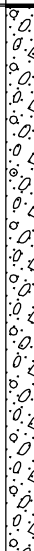
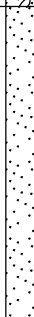
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT			PLASTIC LIMIT W _P	NATURAL MOISTURE CONTENT W	LIQUID LIMIT W _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa							
417.3								20 40 60 80 100							
410.0	ASPHALT, (~ 38 mm) SAND and Gravel (SP-SM), trace to some silt, dry to wet, compact to dense.		1	AS											
			2	SS	17										
			3	SS	14										
			4	SS	14										
			5	SS	22										
			6	SS	26										
			7	SS	24										
			8	SS	31										
			9	SS	10										
409.1	- wet spoon														
8.2	BOREHOLE TERMINATED AT ~ 8.2 m DEPTH														
															</

RECORD OF BOREHOLE No BH-5

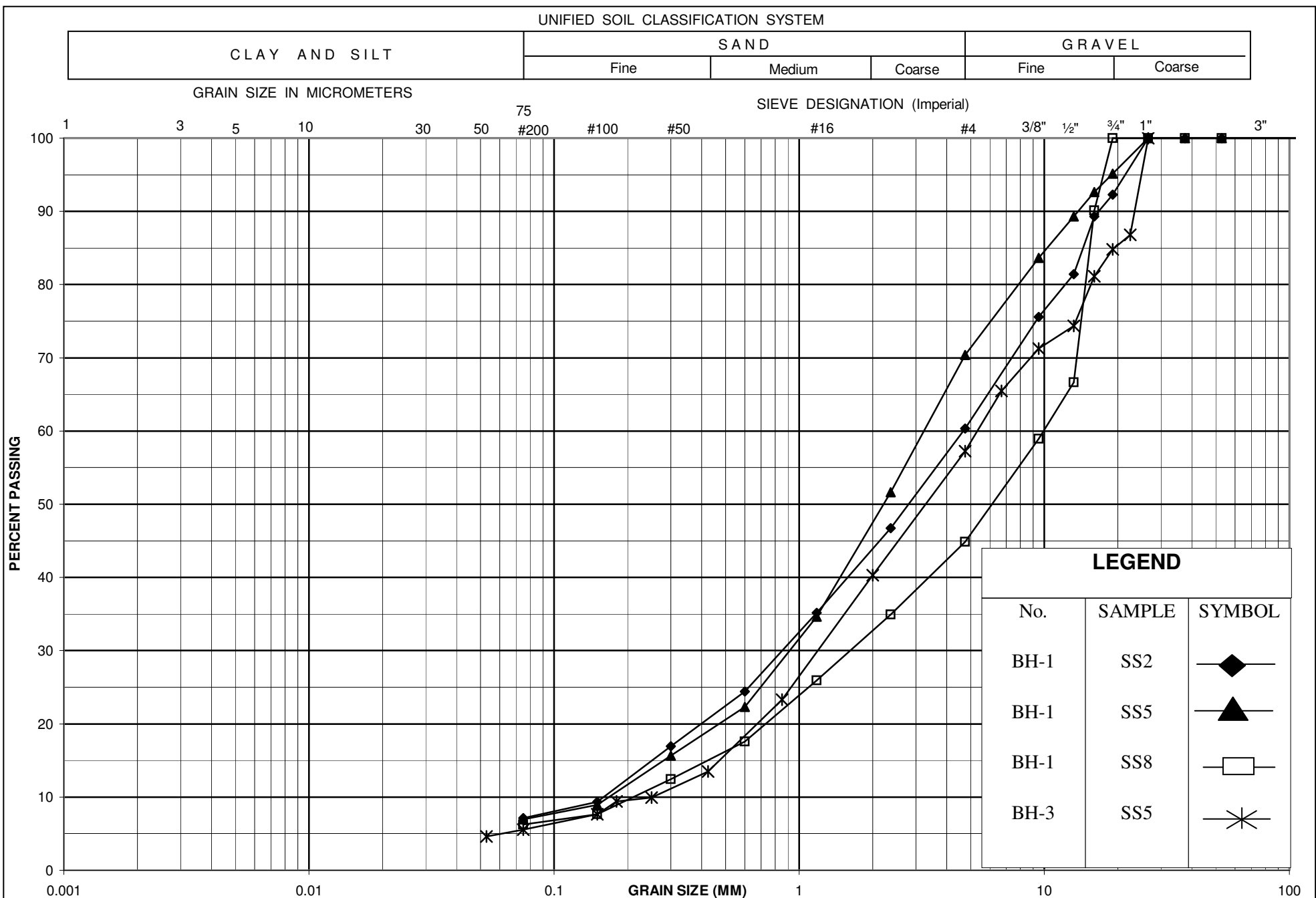
1 OF 1

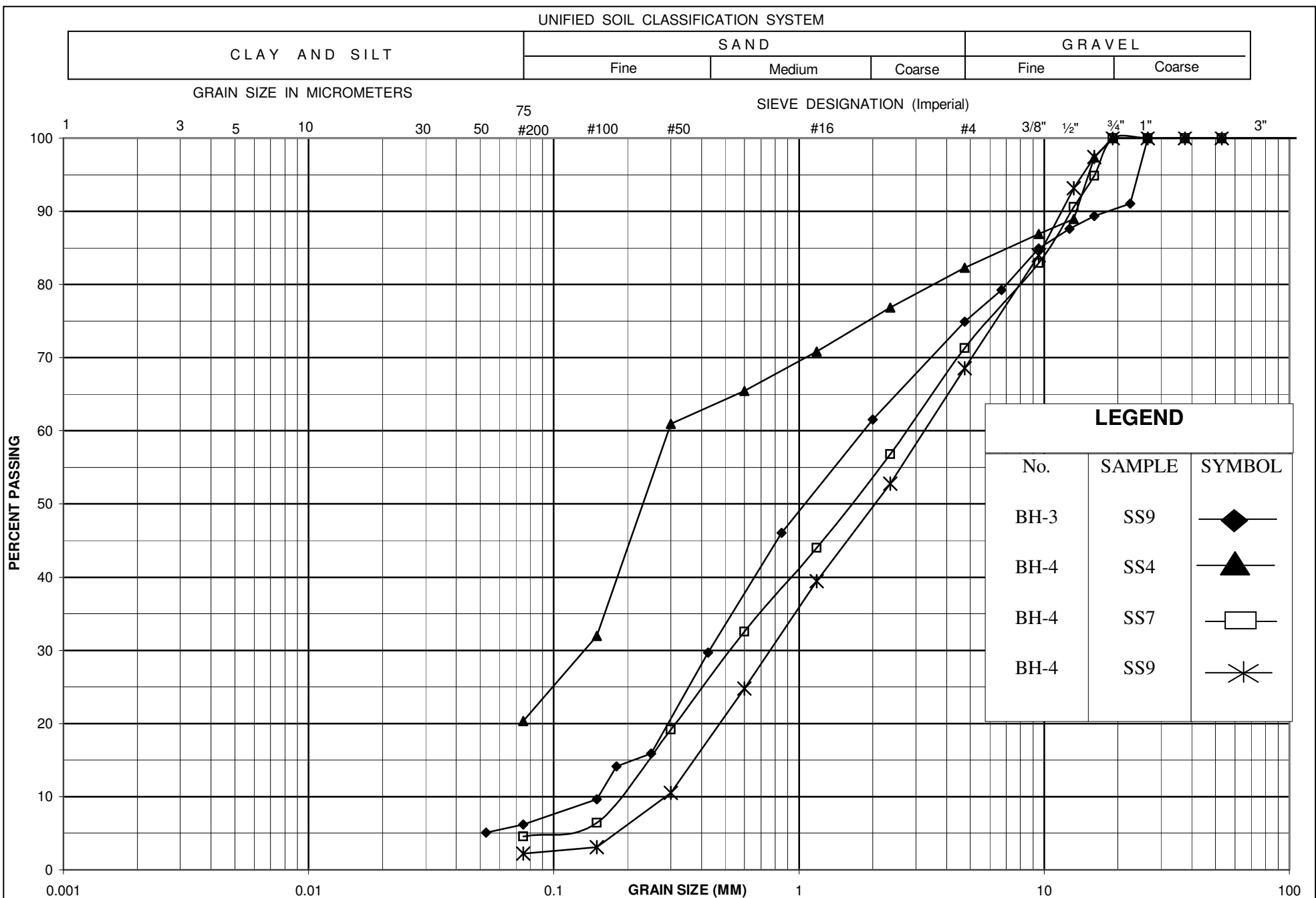
METRIC

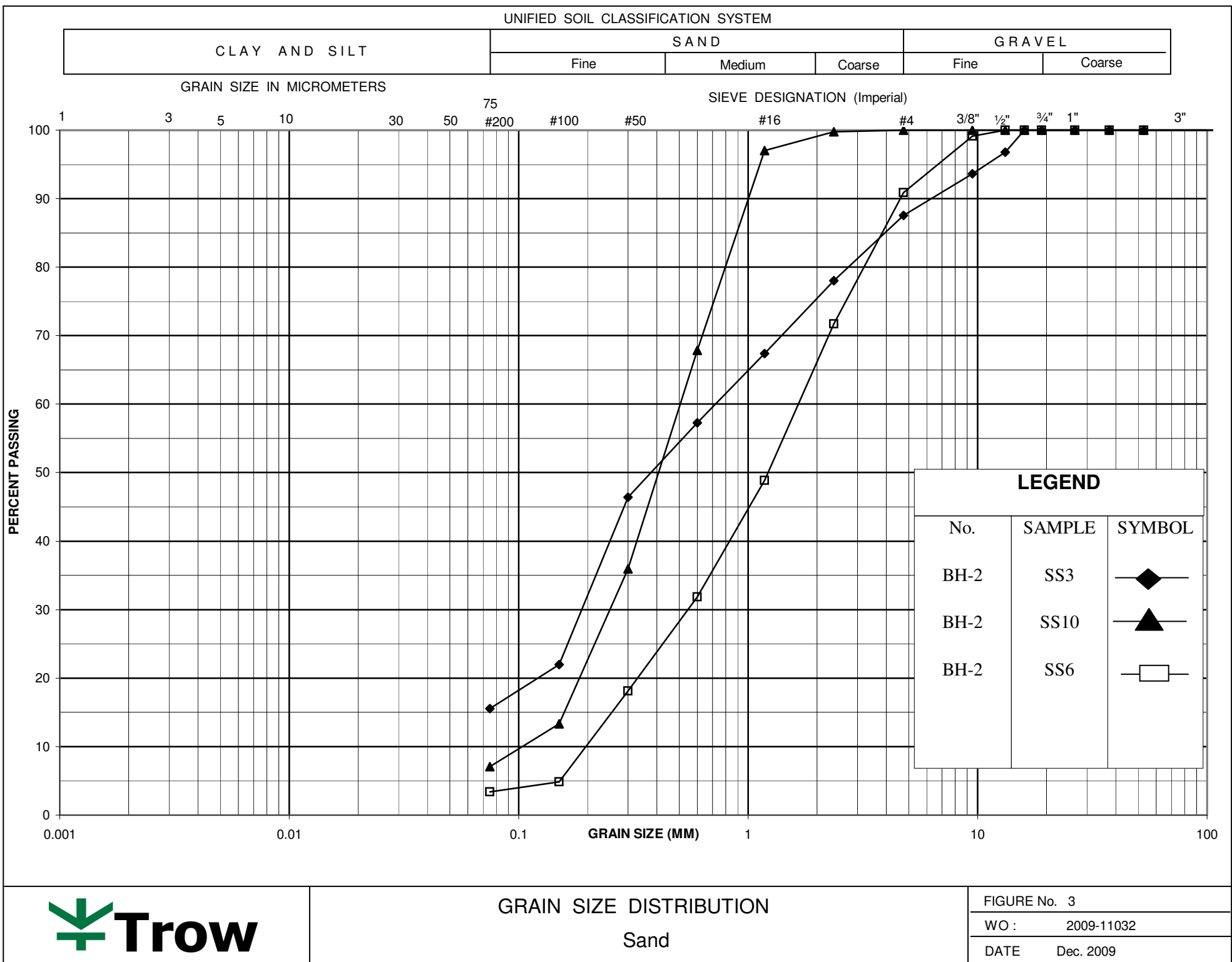
W.P. WO: 2009-11032 GEOCRETS No. 411-241 LOCATION N 5173558.1 E 262146.8 ORIGINATED BY PR
 DIST HWY 144 BOREHOLE TYPE CME Hollow Stem Auger COMPILED BY GQ
 DATUM Geodetic DATE 11.17.09 - 11.17.09 CHECKED BY SM

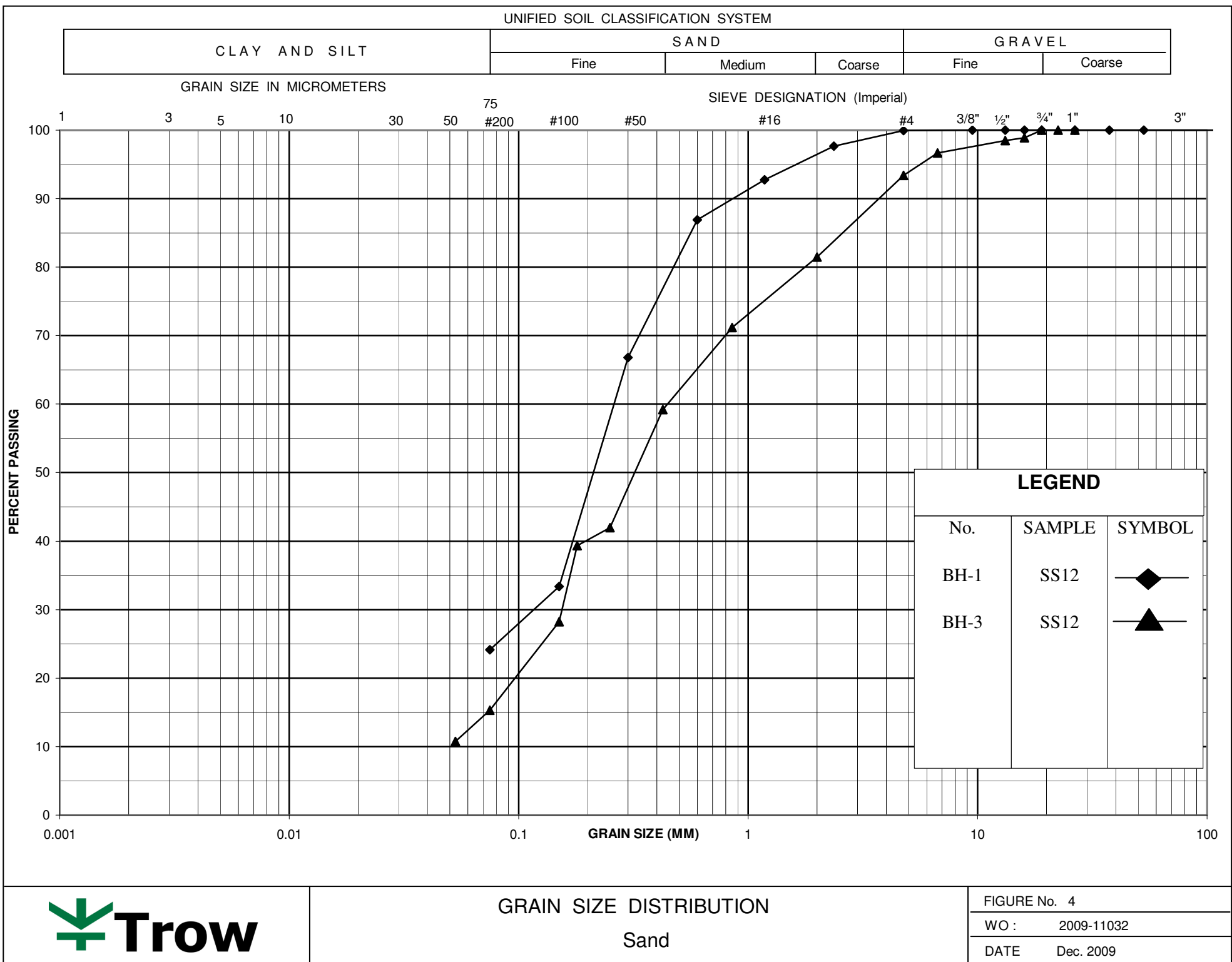
SOIL PROFILE			SAMPLES			GROUND WATER CONDITIONS	ELEVATION SCALE	DYNAMIC CONE PENETRATION RESISTANCE PLOT					PLASTIC LIMIT w _p	NATURAL MOISTURE CONTENT w	LIQUID LIMIT w _L	UNIT WEIGHT γ kN/m ³	REMARKS & GRAIN SIZE DISTRIBUTION (%) GR SA SI CL			
ELEV DEPTH	DESCRIPTION	STRAT PLOT	NUMBER	TYPE	"N" VALUES			SHEAR STRENGTH kPa										WATER CONTENT (%)		
								○ UNCONFINED	+ FIELD VANE	● QUICK TRIAXIAL	× LAB VANE									
417.4								20	40	60	80	100								
410.0	ASPHALT, (~ 40 mm) SAND and GRAVEL (SW-SM), trace to some silt, brown, moist to wet, compact to dense.		1	AS		▽	416													
			2	SS	26															
			3	SS	20															
			4	SS	33															
			5	SS	18			414												
			6	SS	20															
			7	SS	32															
								412												
			9	SS	43															
								410												
			10	SS	35															
408.2								408												
9.1	SAND, coarse sand, trace to some gravel, trace to some silt, brown, wet, very loose to very dense. - Heaving sand occurred below a depth of 9.14 m.		11	SS	27															
							406													
			12	SS	3															
			13	SS	11		404													
403.0			14	SS	104															
14.3	BOREHOLE TERMINATED AT ~ 14.33 m DEPTH NOTES: 1. This drawing is to be read with the subject report and project number as presented above. 2. Interpretation assistance by Trow is required before use by others. 3. A local benchmark was employed (PBM748076, Elev=417.367m, Location: Tablet SE Comer 73.4 LT 21+942.7).																			

Appendix D: LABORATORY DATA









APPENDIX E: BOULDER CORE PHOTOGRAPHS

Photograph 1 **BH-1**

(a) Overall



(b) Top



Photograph 1 **BH-1**

(c) Middle portion

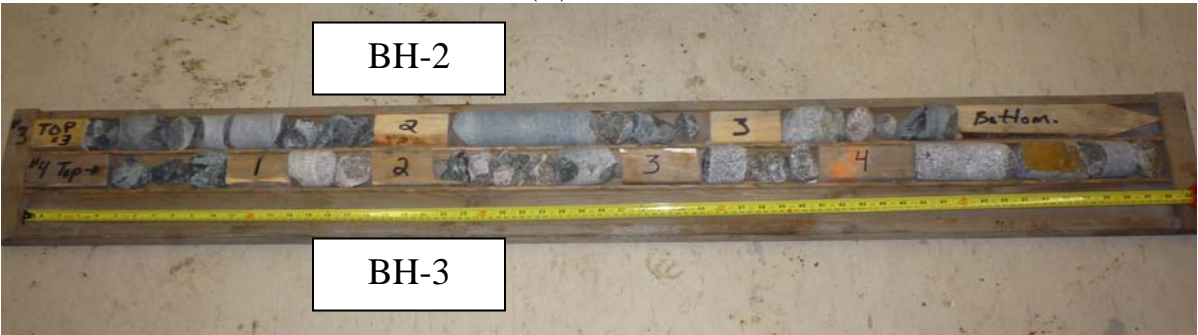


(d) Bottom



Photograph 2 **BH-2 and BH-3**

(a) Overall

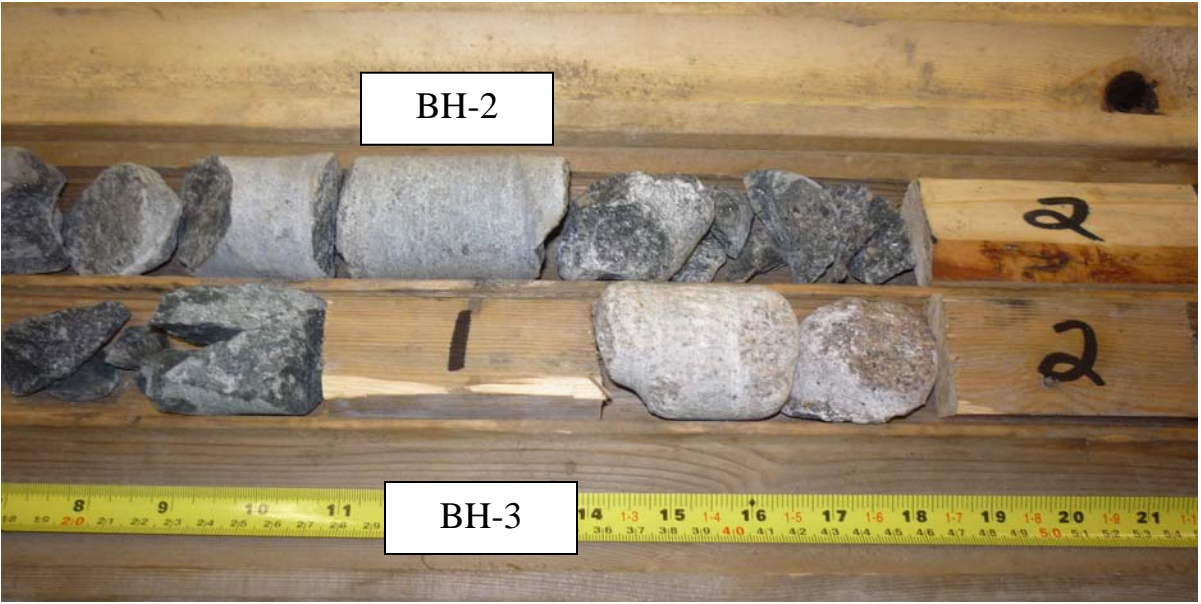


(b) Top



Photograph 2 **BH-2 and BH-3**

(c) Mid -1



(d) Mid -2



Photograph 2 **BH-2 and BH-3**

(e) Mid -3



(f) Bottom

