

November 1, 2005

Environmental Engineering Company
Suite 1, 2345-6 Street, N.W.
Calgary, AB
T7T 8Z8

Attention: John Smith

EEC Project #: 12345678

Geotechnical Laboratory Testing Report

SOLUM Job #: 100010501024
Received: October 24, 2005
of Samples Received: One-5 gal pail, 1 Shelby Tube

Test	Quantity	ASTM Designation
Water Content	1	D2216
Atterberg Limits	1	D4318
Full Gradation	1	D422
Standard Proctor	1	D698
Fall Cone Shear Test	1	N/A
Vane Shear Test	1	D4648
Hydraulic Conductivity; Remolded at 95% of Maximum Dry Density	1	D5084

Saad A.M. Farag
Laboratory Manager
Solum Consultants Ltd.

Total Cover Pages: 1

Laboratory Analysis Summary



GEOTECHNICAL & MATERIAL
TESTING LABORATORY

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Calgary, Alberta T1Y 5Z8
Ph: (403)250-3035
Fax: (403)250-3021
Email: solum@mts.net
www.solumconsultantsltd.com

Project Number:
Client:
Project Name:
Location:
Tested By:
Date Reviewed:

12345678

Geotechnical Engineering Company

Site X Geotechnical Investigation

KC/SF

Reviewed By:

25-Oct-09

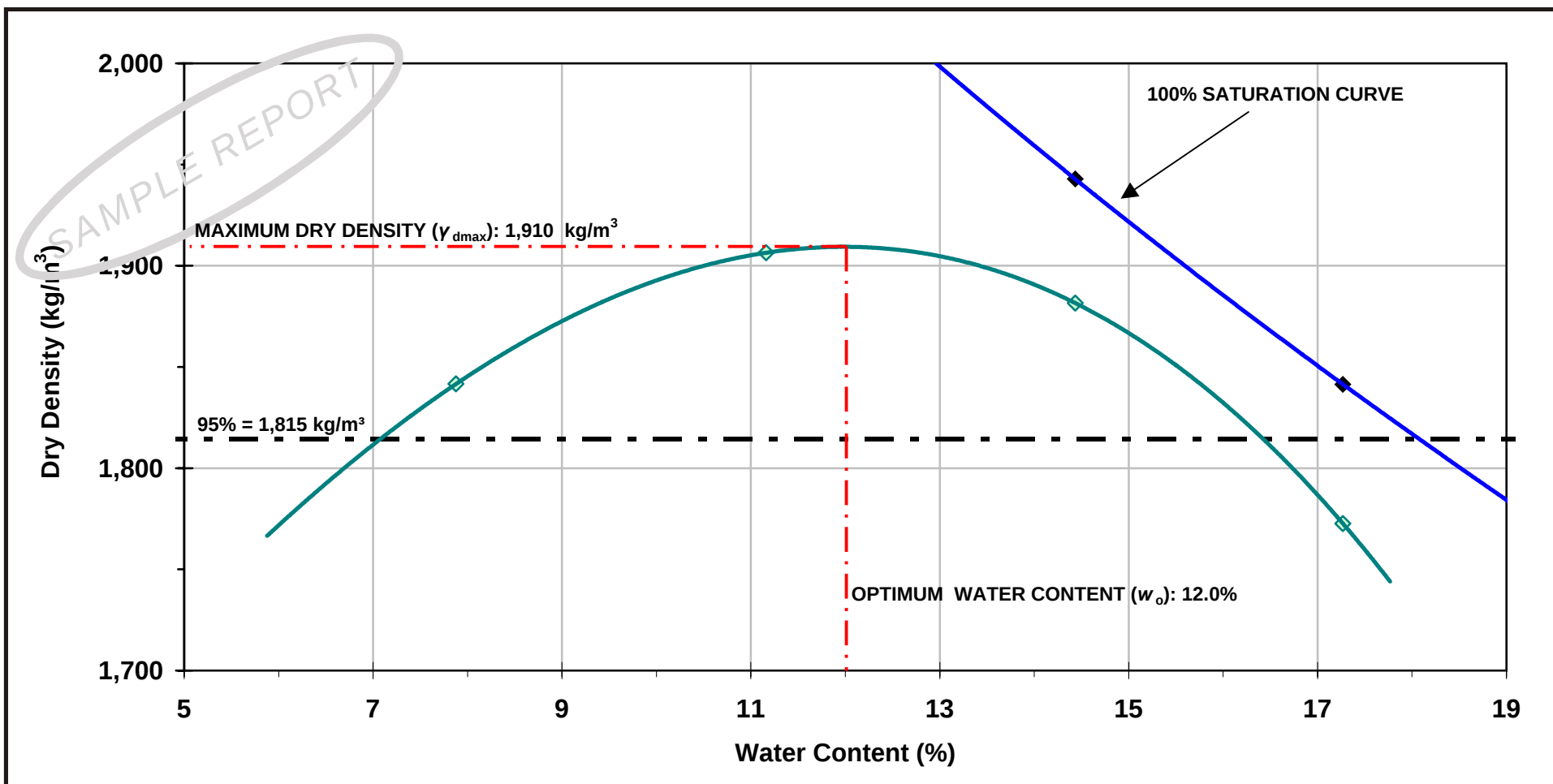
(dd-mm-yy)

Results

Sample ID	Depth (m)	Moisture Content(%)	Atterberg Limits				Particle Size Analysis					Soil Classification** Group Symbols	Standard Proctor				Constant Head Permeability k_{20} (cm/sec)
			Liquid Limit(%)	Plastic Limit(%)	Plastic Index(%)	Classification* (USCS)	Cobble Size (%) (75-300mm)	Gravel Size (%) (4.75-75mm)	Sand Size (%) (0.075-4.5mm)	Silt Size (%) (0.005-0.075 mm)	Clay Size (%) (<0.005mm)		Maximum Dry Density (kg/m ³)	Optimum Water Content (%)	Over Size Density Correction (kg/m ³)	Over Size Optimum Water Content Correction(%)	
CCL-68680200-05	GR	40.7	83	45	38	MH	0.0	0.8	32.6	35.9	30.7	MH	1068	46.0	N/A	N/A	3.6E-08

* Note: Soil classification is for material less than 0.425 mm (material used for Atterberg Limits), this includes the fine sand, silt and clay fraction of the sample. The USCS does not recognize the group symbol CI.

** Note: Soil classification is for the whole sample. Soil classification uses the Atterberg Limits results and the percent fines, percent sand and percent gravel as described in ASTM D2487.



Laboratory Compaction Characteristics of Soil - Standard Proctor (ASTM D698)

SOLUMTM
CONSULTANTS LTD.
GEOTECHNICAL & MATERIAL
TESTING LABORATORY

Site X Remediation

Client: Environmental Engineering Company
Project No.: 12345678
Sample ID: TP01
Depth: 0.5 - 1.5 m

OVERSIZE CORRECTION
ASTM D4718
Particles Retained on the No. 4
(4.75 mm) Sieve (P_c): **2.3 %**
 G_M : **2.55** (Assumed)
Corrected Max. Dry Density:
N/A
Corrected Opt. Water Content:
N/A

Tested by:

RA

Date Tested:

26-Oct-05

Approved by:

PREPARED SOLELY FOR THE USE OF OUR CLIENT AS SPECIFIED IN THE ACCOMPANYING REPORT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH SOLUM CONSULTANTS LTD. HAS NOT ENTERED INTO A CONTRACT.

Atterberg Limits (ASTM D4318) - Method A



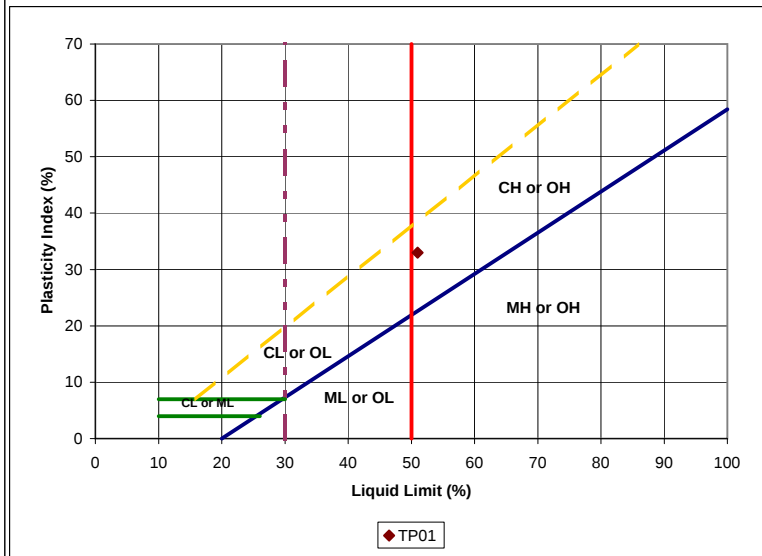
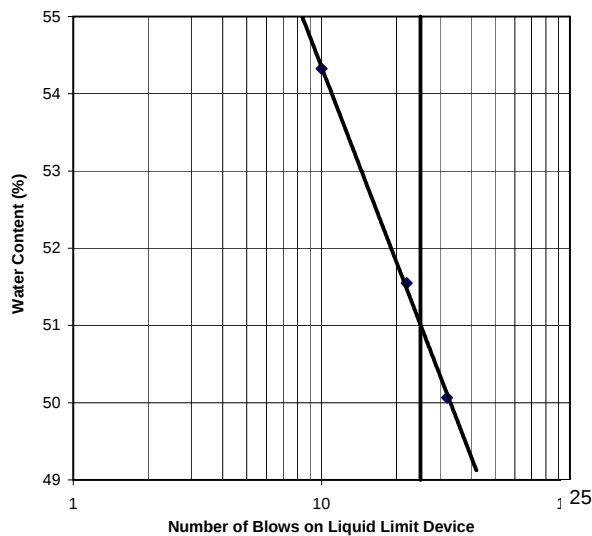
GEOTECHNICAL & MATERIAL
TESTING LABORATORY

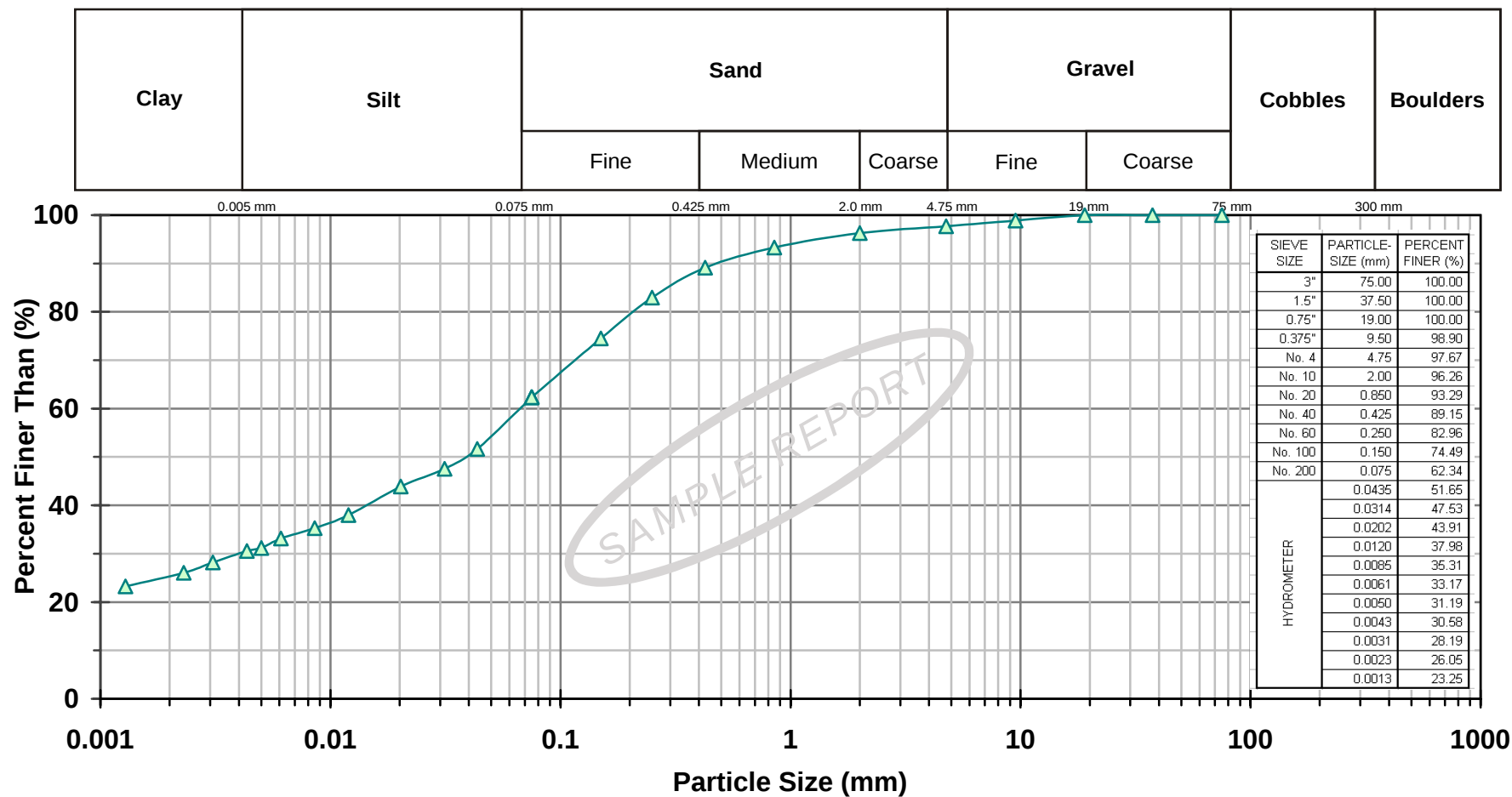
Project Number: 12345678
Client: Geotechnical Engineering Company
Project Name: Site X Geotechnical Investigation
Location: Calgary, AB
Sample ID: TP01 Depth: 2.37-2.67 m
Tested By: KC Reviewed By: SF
Date Tested: 29-Nov-11 (dd-mmm-yy)

Sample Information

	Liquid Limit (Air Dried) - Multipoint Method			Liquid Limit (Oven Dried)	
Container ID	1	2	3		
Number of Blows	10	22	32		
Wet Sample Weight +Tare (g)	20.70	22.21	22.78		
Dry Sample Weight +Tare (g)	17.37	18.55	18.97		
Weight of Water (g)	3.33	3.66	3.81		
Tare (g)	11.24	11.45	11.36		
Weight of Dry Soil (g)	6.13	7.10	7.61		
Water Content (%)	54.3	51.5	50.1		

Flow Curve





Particle Size Analysis (ASTM C136/D422)



Site X Remediation

Client: Environmental Engineering Company
Project No.: 12345678.00
Sample ID: TP01
Depth: 0.5 - 1.5 m

Particle Size (%)

Cobbles: 0.0
Gravel: 2.3
Sand: 35.3
Silt: 31.2
Clay: 31.2

Tested by:

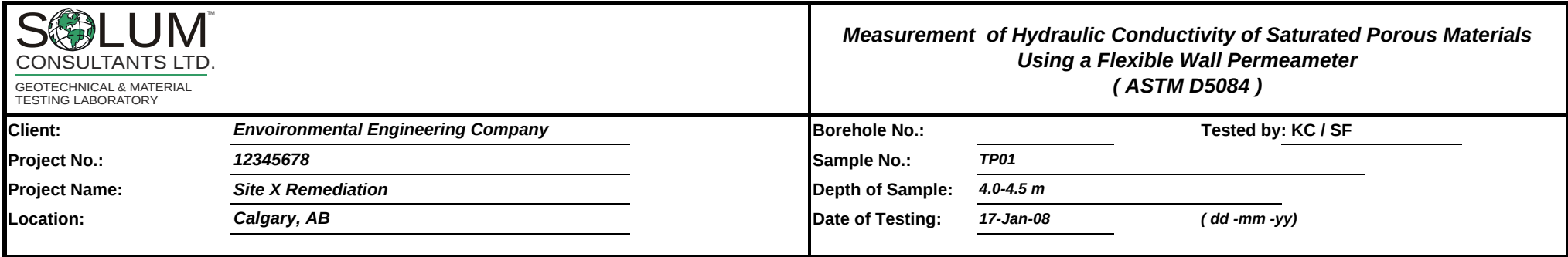
KC

Date Tested:

25-Oct-05

Approved by:

RA

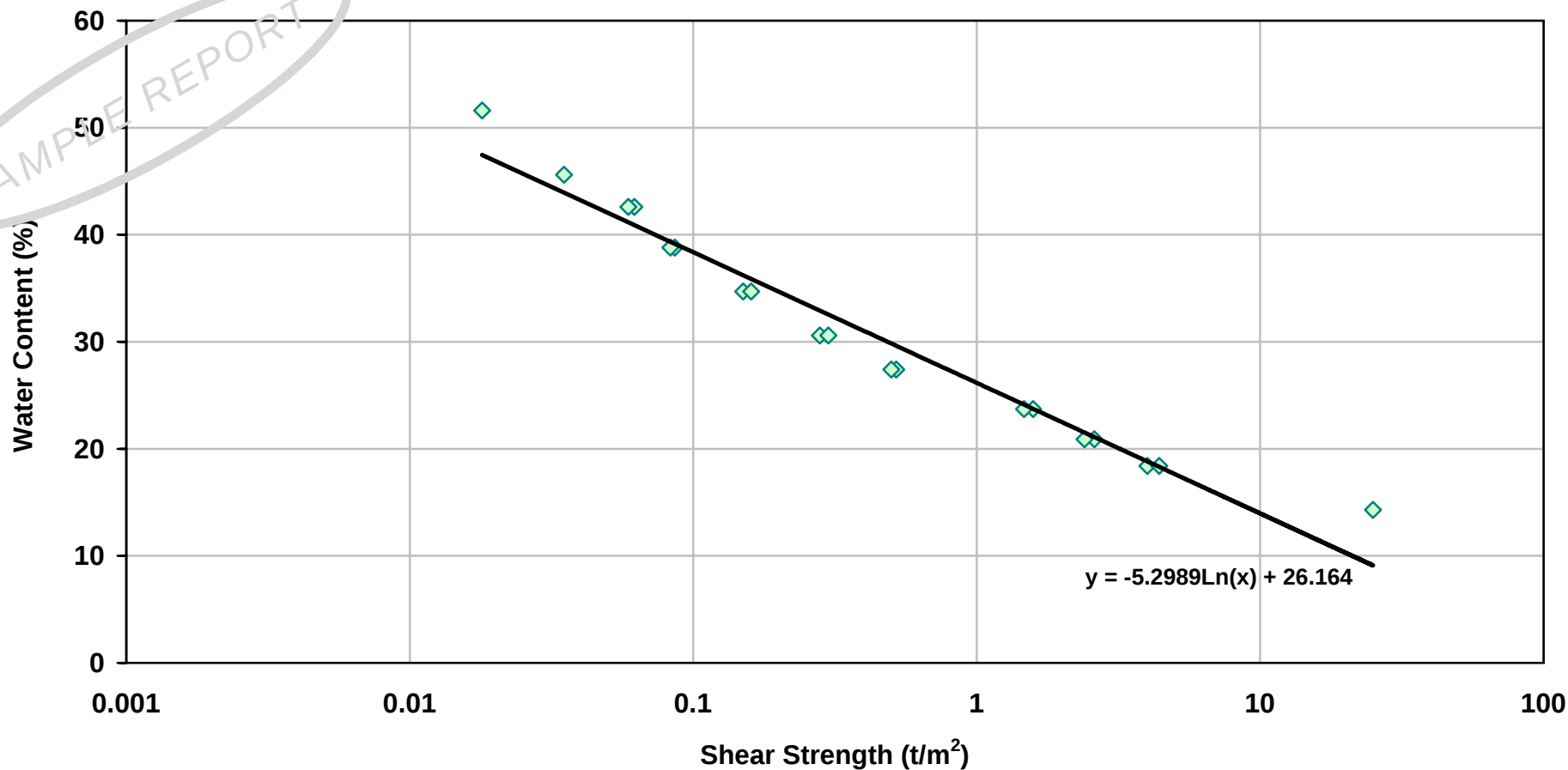


DATE	TIME	ELAPSED TIME (MIN)	INCREMENTAL TIME		TEMP. (deg. C)	Rt	IN BURETS				OUT BURETS				Hydraulic Conductivity K ₂₀ (cm/sec)
			(MIN)	(SEC)			READING	VOLUME (cm ³)	CHANGE (cm ³)	TOTAL (cm ³)	READING	VOLUME (cm ³)	CHANGE (cm ³)	TOTAL (cm ³)	
27-Jan-08	0:01				17	1.079	20	41.28			20	41.28			
	2:30	149.00	149	8940	17	1.079	19.7	40.66	0.62	0.62	21.2	43.76	2.48	2.48	3.95E-08
	5:00	299.00	150	9000	17	1.079	19.4	40.04	0.62	0.62	21.4	44.17	0.41	2.89	3.94E-08
Reported 3.9E-08 cm/sec															

Wet Mass:	257.37 gr	Top Pore Pressure:	385 kPa	Sample Height :	3.33 cm
Water Content:	27.3%	Bottom Pore Pressure:	400 kPa	Sample Diameter :	7.24 cm
Wet Density:	1880.7 kg/m ³	Cell Pressure:	415 kPa	Sample Area :	41.13 cm ²
Dry Density:	1477.3 kg/m ³	Hydraulic Gradient:	46.0	Sample Volume :	136.85 cm ³

Remarks: _____

SAMPLE REPORT



Shear Strength vs. Water Content (Fall Cone Test)

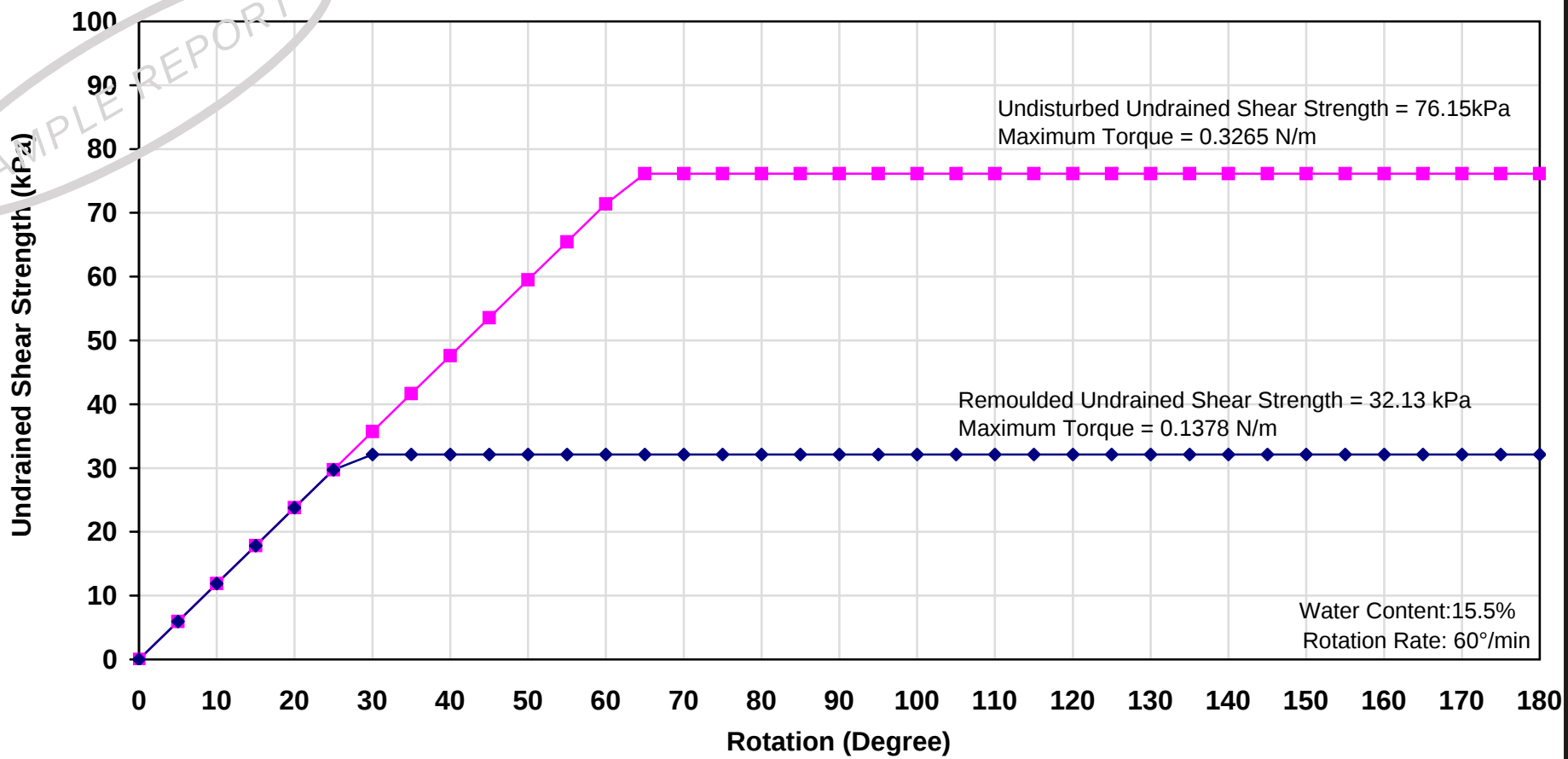
SOLUMTM
CONSULTANTS LTD.
GEOTECHNICAL & MATERIAL
TESTING LABORATORY

Client: Environmental Engineering Company
Project No.: 12345678
Sample ID: TP01
Depth: 0.5 - 1.5 m

Site X Remediation

Tested by:
RA
Date Tested:
26-Oct-05
Approved by:

SAMPLE REPORT



Laboratory Miniature Vane Shear Test for Saturated Fine-Grained Clayey Soil - ASTM D4648

 GEOTECHNICAL & MATERIAL TESTING LABORATORY	Site X Remediation		Tested by:
	Client:	Environmental Engineering Company	RA
	Project No.:	12345678	Date Tested:
	Sample ID:	TP01	26-Oct-05
Depth:		0.5-1.5 m	Approved by:

PREPARED SOLELY FOR THE USE OF OUR CLIENT. NO REPRESENTATION OF ANY KIND IS MADE TO OTHER PARTIES WITH WHICH SOLUM CONSULTANTS LTD. HAS NOT ENTERED INTO A CONTRACT.

Boring No. N/A
Sample No. B1
Depth (ft) 5.0 m
Date 11/5/2010
Sheet No. _____

SOLUM
CONSULTANTS LTD.
UNCONFINED
COMPRESSION TEST (ASTM D2166)

Job No. N/A
Job Name N/A
Tested By SF/KC
Calculated By KC
Checked By SF

SPECIMEN DIAMETER	<u>7.34</u> (cm)	MOISTURE CONTENT	<u>21.0</u> (%)
SPECIMEN HEIGHT	<u>15.48</u> (cm)	MASS OF WET SAMPLE	<u>1273.1</u> (g)
SPECIMEN AREA	<u>42.27</u> (cm ²)	HEIGHT/DIAMETER RATIO	<u>2.11</u>
SPECIMEN VOLUME	<u>654.41</u> (cm ³)	WET BULK DENSITY	<u>1945.4</u> (kg/m ³)
ASSUMED G _s	<u>2.75</u>	INITIAL SATURATION	<u>81.3</u> (%)
INITIAL VOID RATIO	<u>0.71</u>		

Shear Strength	<u>76.36</u> (kPa)	Unconfined Compressive Strength	<u>152.72</u> (kPa)
Axial Failure Strain	<u>9.47</u> (%)		

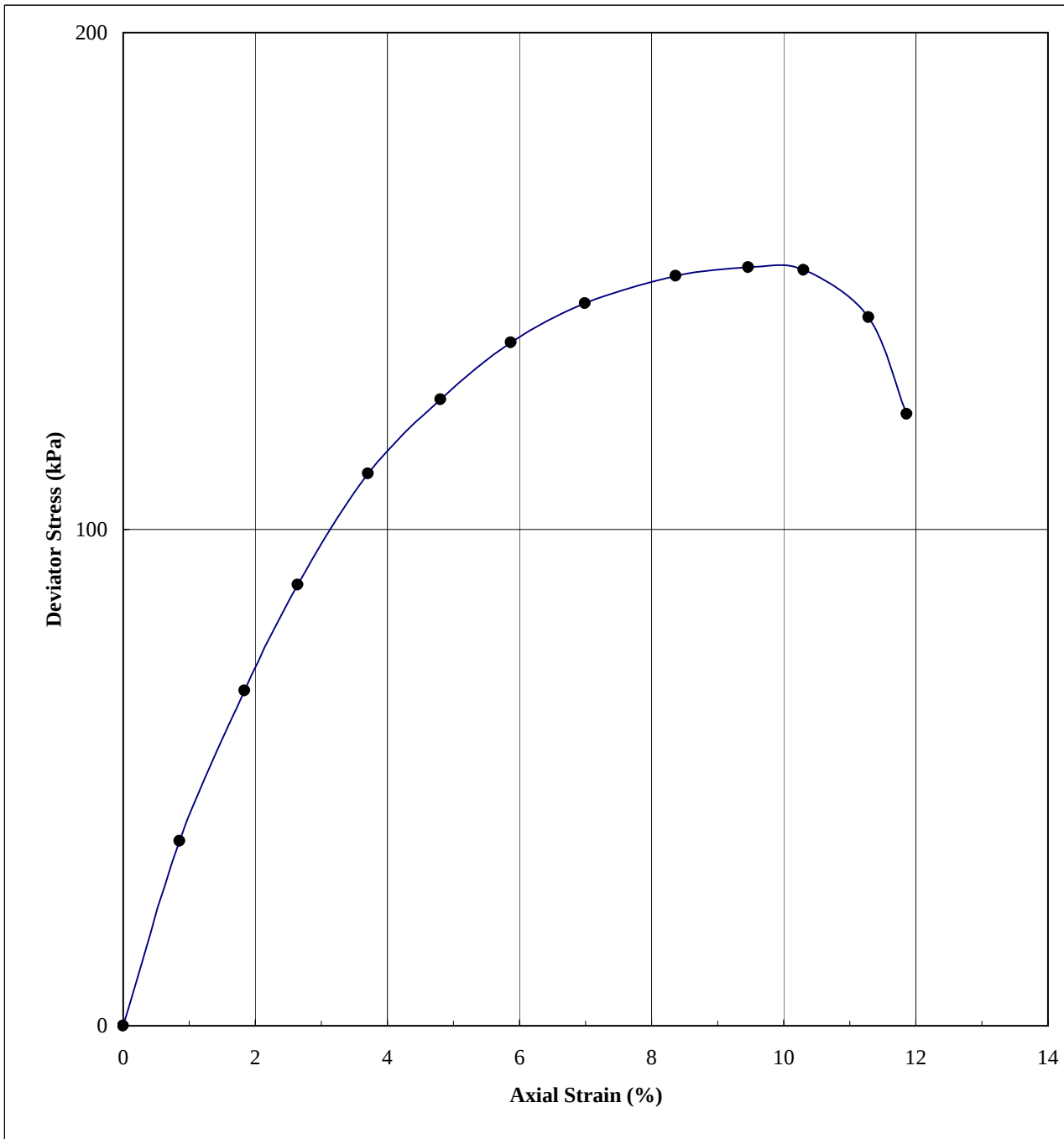
VERT. DISPL. (cm)	LOAD CELL (kN)	ε ₁ (%)	σ ₁ -σ ₃ (σ ₁ -σ ₃)/2 (kPa)	(kPa)
0.00	0.00	0.00	0.00	0.00
0.13	0.16	0.85	37.25	18.62
0.28	0.29	1.84	67.46	33.73
0.41	0.39	2.64	88.83	44.41
0.57	0.49	3.71	111.16	55.58
0.74	0.56	4.81	126.12	63.06
0.91	0.62	5.87	137.59	68.79
1.08	0.66	6.99	145.45	72.73
1.30	0.70	8.37	151.01	75.50
1.47	0.71	9.47	152.72	76.36
1.60	0.72	10.30	152.16	76.08
1.75	0.68	11.29	142.71	71.36
1.84	0.59	11.86	123.18	61.59

Boring No. N/A
Sample No. B1
Depth (ft) 5.0 m
Date 11/5/2010
Sheet No. _____



**UNCONFINED
COMPRESSION TEST (ASTM D2166)
Stress-Strain Plot**

Job No. N/A
Job Name N/A
Tested By SF/KC
Calculated By KC
Checked By SF



Direct Shear Test of Soils Under Consolidated Drained Conditions (ASM D3080)



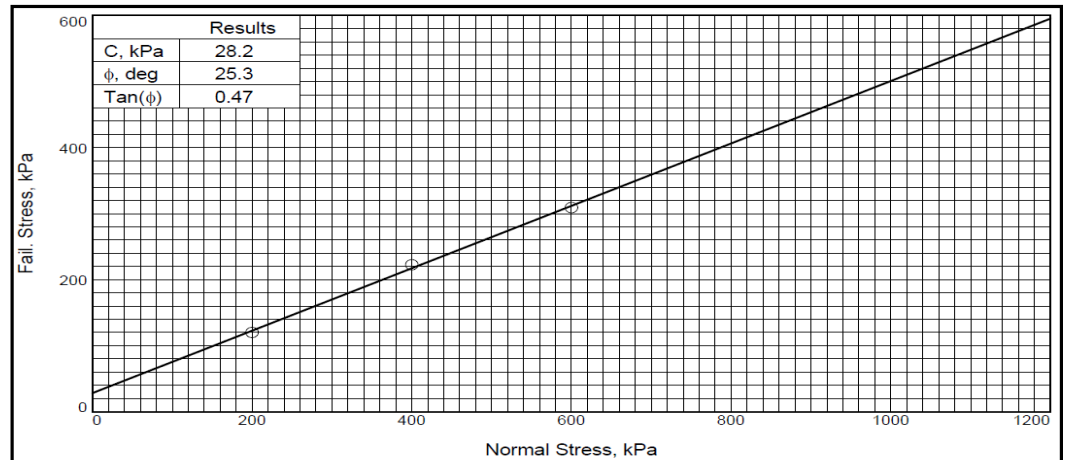
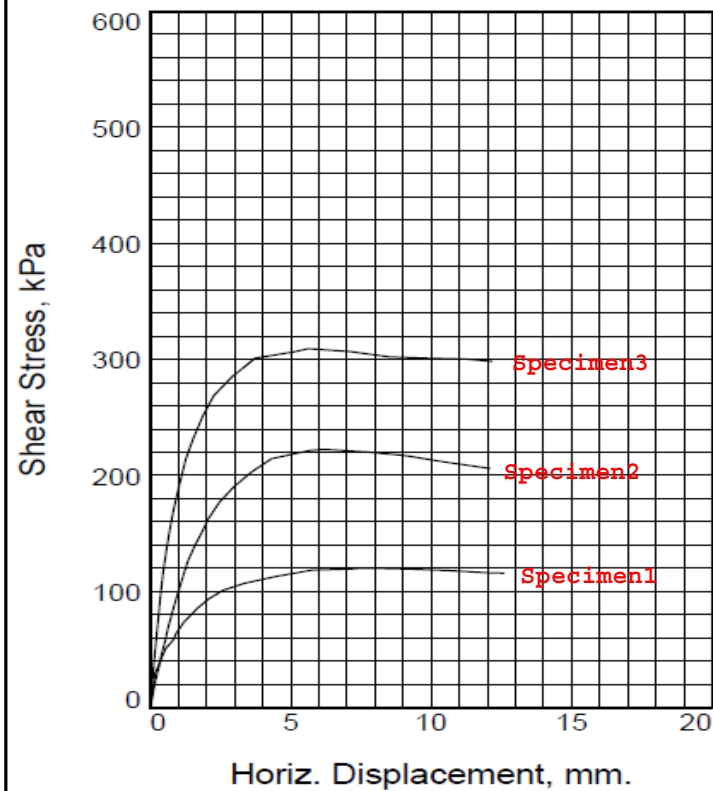
GEOTECHNICAL & MATERIAL
TESTING LABORATORY

Project Number: 12345678
Client: Geotechnical Engineering Company
Project Name: Site X Geotechnical Investigation
Location: ---
Sample ID: BH-01 Depth: N/A
Tested By: SF/KC Reviewed By: SF
Date of Testing: 20-Nov-09 (dd-mmm-yy)

Sample Information

Sample Preparation Method: ☒ Remoulded

Specimen No.	Normal Stress (kPa)	Peak Stress(kPa)	Residual Stress(kPa)	Horizontal Disp. (mm)	Shearing Rate (mm/min)	Add Water
1	200	120.1	---	7.5	0.1270	Yes
2	400	222.5	---	6.2	0.1270	
3	600	309.1	---	5.6	0.1270	



SWELL/CONSOLIDATION TEST DATA

Client:
Project:
Project Number:

Sample Data

Source:
Sample No.: B1
Elev. or Depth: Sample Length(in./cm.):
Location:
Description:
Liquid Limit: Plasticity Index:
USCS: AASHTO: Figure No.:
Testing Remarks:

Test Specimen Data

TOTAL SAMPLE	BEFORE TEST	AFTER TEST
Wet w+t = 57.83 g.	Consolidometer # = 1	Wet w+t = 169.47 g.
Dry w+t = 50.24 g.		Dry w+t = 145.83 g.
Tare Wt. = 14.05 g.	Spec. Gravity = 2.8	Tare Wt. = 43.00 g.
Height = 2.00 cm.	Height = 2.00 cm.	
Diameter = 6.18 cm.	Diameter = 6.18 cm.	
Weight = 124.43 g.	Defl. Table = reference Set (mm/kPa)	
Moisture = 21.0 %	Ht. Solids = 1.2247 cm.	Moisture = 23.0 %
Wet Den. = 2074 kg/m ³	Dry Wt. = 102.86 g.*	Dry Wt. = 102.83 g.
Dry Den. = 1715 kg/m ³	Void Ratio = 0.633	Void Ratio = 0.618
	Saturation = 92.8 %	

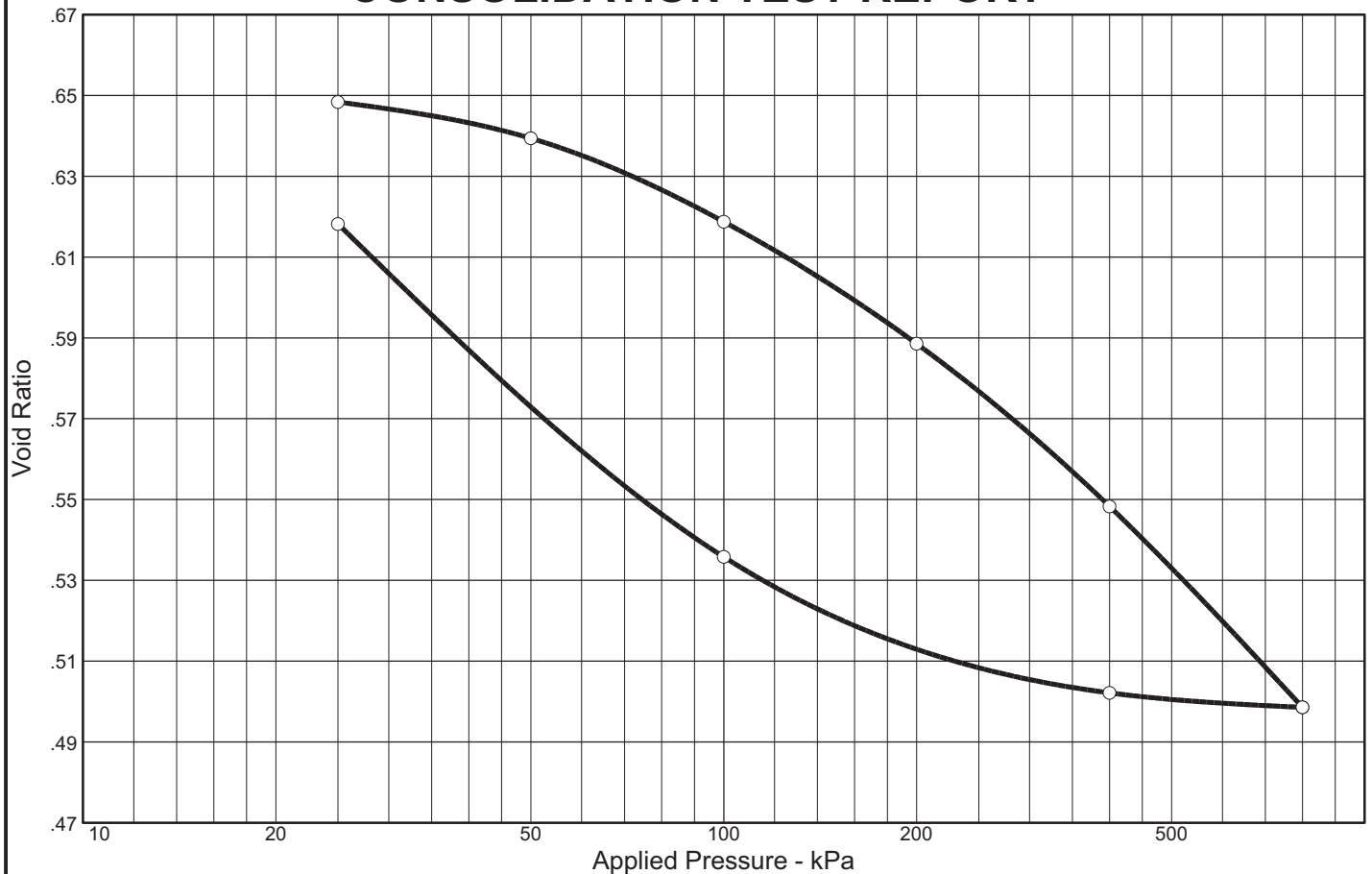
* Initial dry weight used in calculations

End-of-Load Summary

Pressure (kPa)	Final Dial (cm.)	Machine Defl. (cm.)	Corrected (cm.)	Void Ratio	% Compression /Swell
start	-0.01200			0.633	
25.00	0.00660	0.00010	0.00670	0.648	0.9 Swell
50.00	-0.00480	0.00050	-0.00430	0.639	0.4 Swell
100.00	-0.03040	0.00080	-0.02960	0.619	0.9 Compr.
200.00	-0.06840	0.00180	-0.06660	0.589	2.7 Compr.
400.00	-0.11860	0.00270	-0.11590	0.548	5.2 Compr.
800.00	-0.18020	0.00340	-0.17680	0.499	8.2 Compr.
400.00	-0.17540	0.00300	-0.17240	0.502	8.0 Compr.
100.00	-0.13320	0.00200	-0.13120	0.536	6.0 Compr.
25.00	-0.03040	0.00010	-0.03030	0.618	0.9 Compr.

$C_c = 0.17$ $P_c = 132.17$ kPa $C_r = 0.07$

CONSOLIDATION TEST REPORT



Coefficients of Consolidation and Secondary Consolidation

No.	Load (kPa)	C_v (cm.2/sec.)	C_α	No.	Load (kPa)	C_v (cm.2/sec.)	C_α	No.	Load (kPa)	C_v (cm.2/sec.)	C_α
2	50.00	0.0050									
3	100.00	0.0017									
4	200.00	0.0001									
5	400.00	0.0000									
6	800.00	0.0000									
7	400.00	0.0002									
8	100.00	0.0000									
9	25.00	0.0000									

Natural		Dry Dens. (kg/m ³)	LL	PI	Sp. Gr.	Overburden (kPa)	P_c (kPa)	C_c	C_r	Initial Void Ratio
Saturation	Moisture									
92.8 %	21.0 %	1715			2.8		132.17	0.17	0.07	0.633

MATERIAL DESCRIPTION

USCS

AASHTO

Project No.

Client:

Remarks:

Project:

Source:

Sample No.: B1

Elev./Depth:

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GEOTECHNICAL & MATERIAL
TESTING LABORATORY

Figure

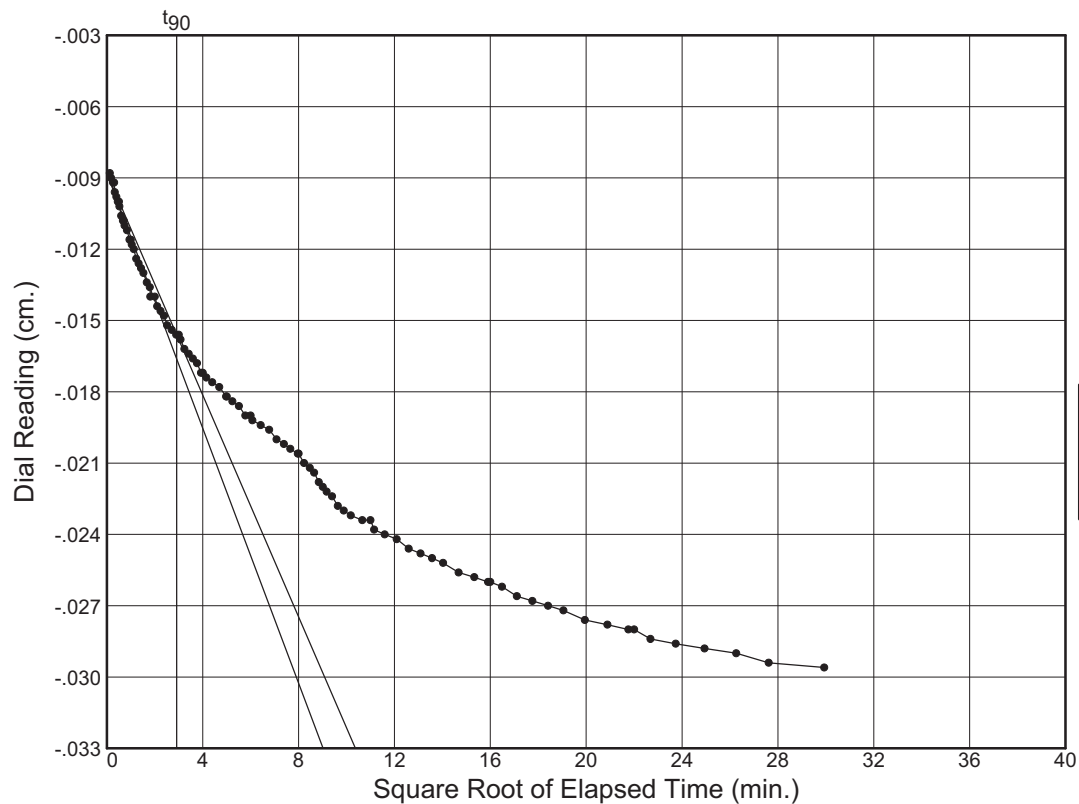
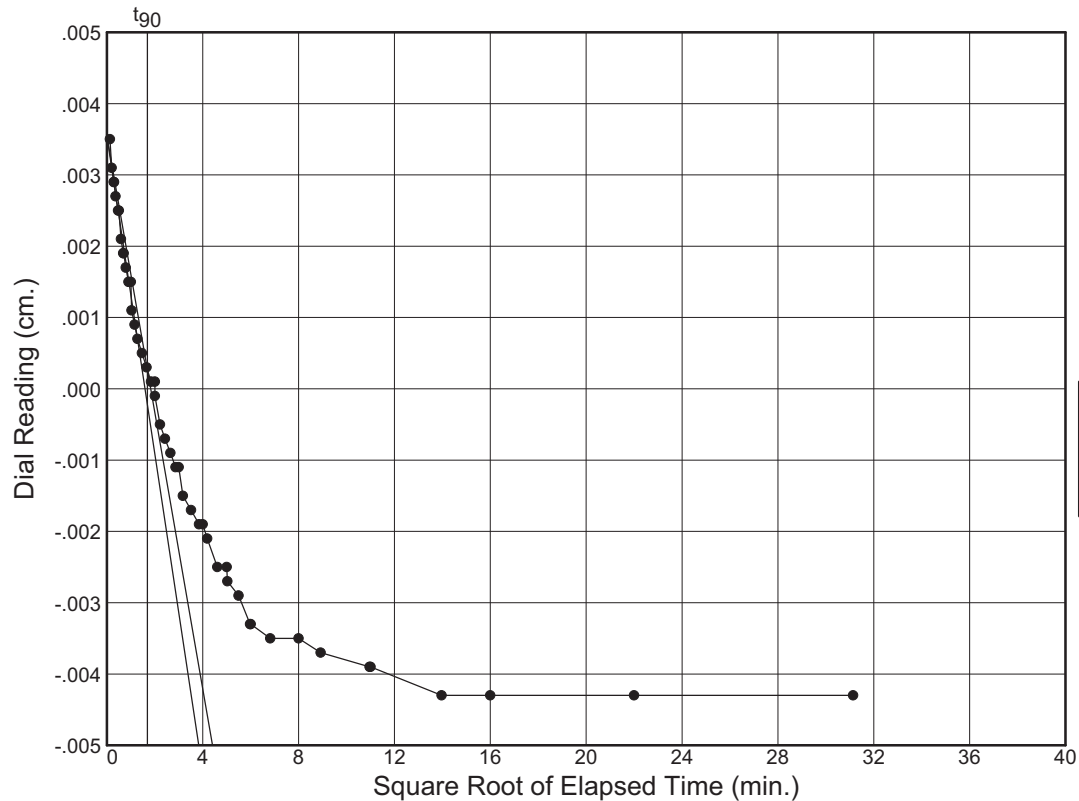
Dial Reading vs. Time

Project No.:
Project:

Source:

Sample No.: B1

Elev./Depth:



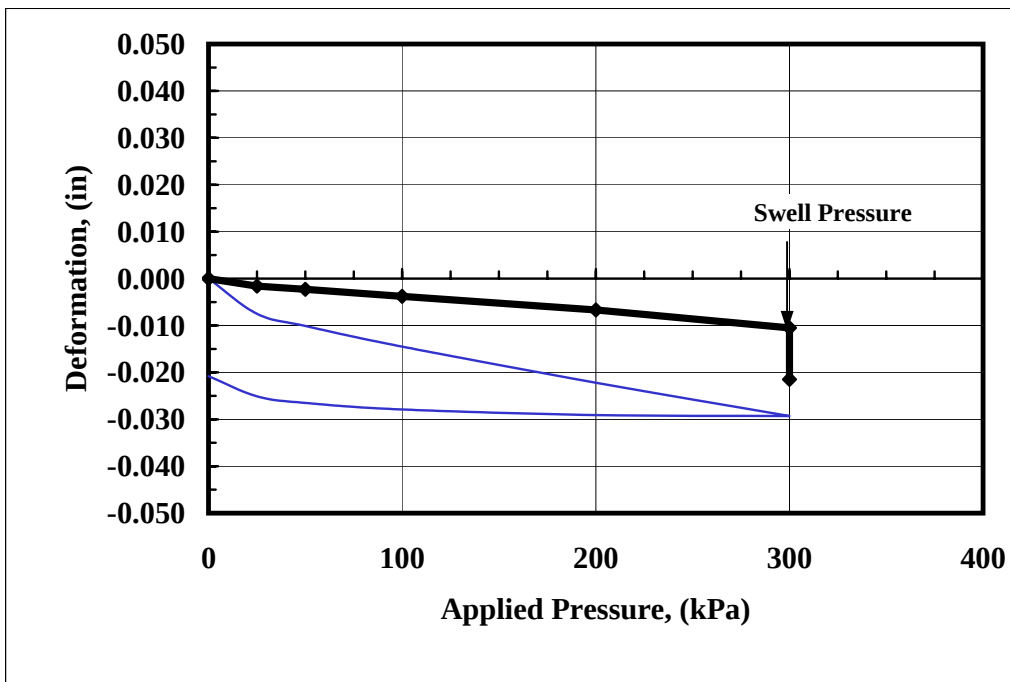
Figure

SOLUM CONSULTANTS LTD.
One-Dimensional Swell Test (ASTM D 4546)

JOB NAME N/A JOB NO. N/A
BORING NO. SAMPLE NO. BH10-01 DEPTH 1.50-2.50 m TEST DATE 12/6/2009
SAMPLE DESCRIPTION Silty clay w/ trace of gravels

Loading (I)		Un-Loading		Loading (II)	
Applied	Dial	Applied	Dial	Applied	Dial
Pressure	Reading	Pressure	Reading	Pressure	Reading
(kPa)	(in)	(kPa)	(in)	(kPa)	(in)
0	0.0000	300	-0.0293	0	0.0000
25	-0.0075	200	-0.0291	25	-0.0016
50	-0.0101	100	-0.0279	50	-0.0023
100	-0.0145	50	-0.0265	100	-0.0038
200	-0.0222	25	-0.0251	200	-0.0067
300	-0.0293	0	-0.0208	300	-0.0105
				300	-0.0215

Dial Reading Before Inundate -0.0105 in Swell Pressure 300 (kPa)
Dial Reading After Inundate -0.0215 in
Swell or Collapse Strain -1.1 (%)



Boring No. N/A
 Sample No. _____
 Depth (m) _____
 Date _____
 Sheet No. _____



**CONSOLIDATED-UNDRAINED
 TRIAXIAL COMPRESSION TEST
 ASTM D4767**

Job No. _____
 Job Name _____
 Tested By SF & KC
 Calculated By SF
 Checked By SF

STAGE1

SPECIMEN DIAMETER	<u>7.199</u> (cm)	CELL PRESSURE (CP)	<u>565.0</u> (kPa)
SPECIMEN HEIGHT	<u>13.376</u> (cm)	BACK PRESSURE (BP)	<u>165.0</u> (kPa)
SPECIMEN AREA	<u>40.678</u> (sq.cm)	EFFECTIVE PRESSURE (EP)	<u>400.0</u> (kPa)
SPECIMEN VOLUME	<u>544.092</u> (cu.cm)		

Failure Criteria: Max. Deviator Stress

Axial Failure Strain 1.52 (%)

($\sigma_1 - \sigma_3$)f	<u>144.74</u> (kPa)	(σ_3)f	<u>400.00</u> (kPa)	(σ_1)f	<u>544.74</u> (kPa)
(Δu)f	<u>165.47</u> (kPa)	(σ_3')f	<u>234.53</u> (kPa)	(σ_1')f	<u>379.27</u> (kPa)

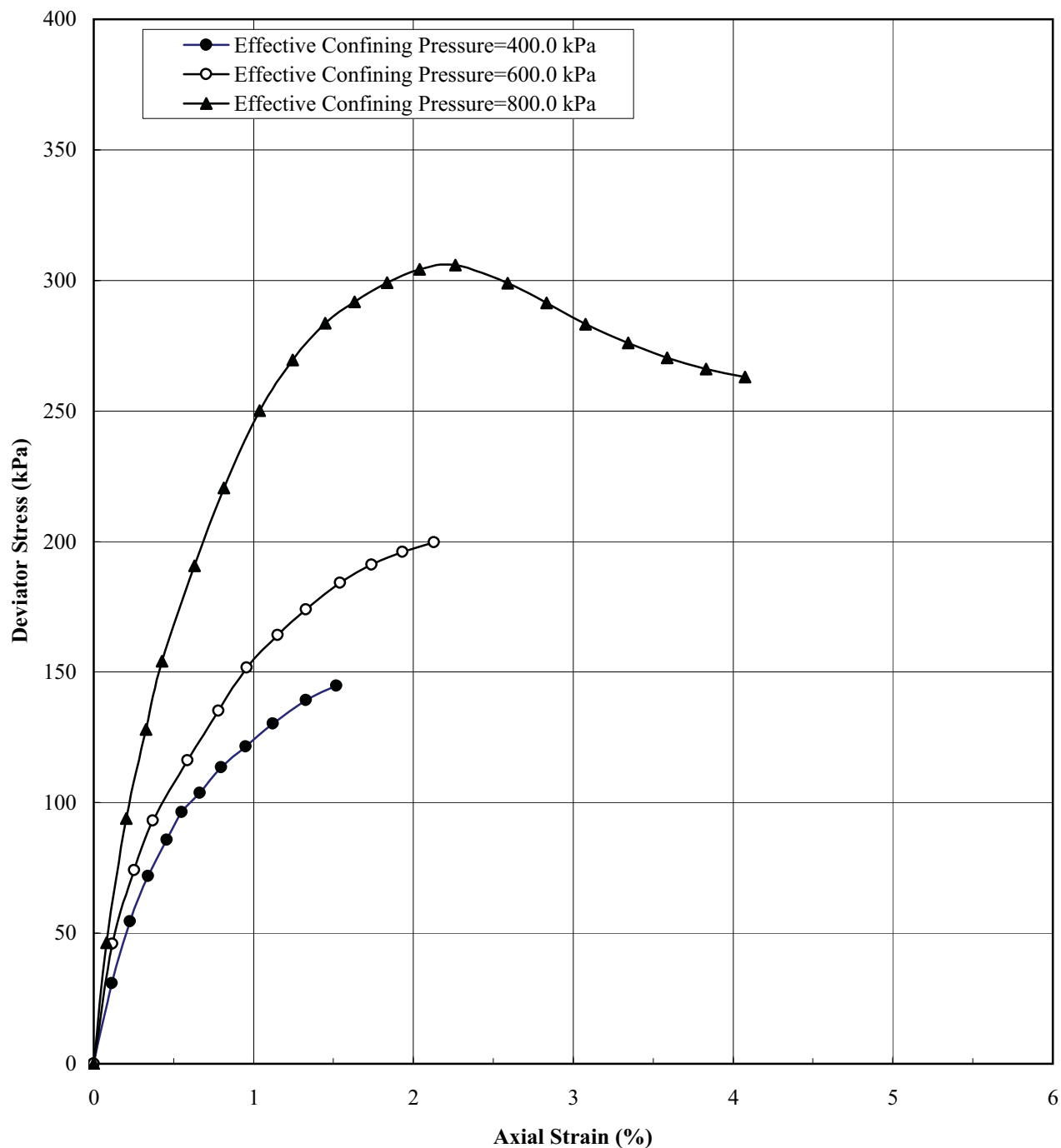
VERT. DISPL. (cm)	LOAD CELL (KN)	Δu (kPa)	ϵ_1 (%)	$\sigma_1 - \sigma_3$ (kPa)	σ_1' (kPa)	σ_3' (kPa)	p (kPa)	p' (kPa)	q (kPa)	σ_1' / σ_3'
0.00	0.00	0.00	0.00	0.00	400.00	400.00	400.00	400.00	0.00	1
0.02	0.13	15.86	0.11	30.80	414.94	384.14	415.40	399.54	15.40	1.08
0.03	0.22	35.85	0.23	54.55	418.70	364.15	427.28	391.42	27.28	1.15
0.05	0.29	55.16	0.34	71.93	416.77	344.84	435.96	380.80	35.96	1.21
0.06	0.35	72.39	0.46	85.67	413.27	327.61	442.83	370.44	42.83	1.26
0.07	0.39	86.87	0.55	96.35	409.48	313.13	448.18	361.30	48.18	1.31
0.09	0.42	102.04	0.66	103.63	401.59	297.96	451.81	349.77	51.81	1.35
0.11	0.47	117.21	0.80	113.58	396.37	282.79	456.79	339.58	56.79	1.40
0.13	0.50	128.24	0.95	121.42	393.18	271.76	460.71	332.47	60.71	1.45
0.15	0.54	144.10	1.12	130.29	386.19	255.90	465.15	321.05	65.15	1.51
0.18	0.57	155.82	1.33	139.19	383.37	244.18	469.59	313.77	69.59	1.57
0.20	0.60	165.47	1.52	144.74	379.26	234.53	472.37	306.89	72.37	1.62

Boring No. N/A
Sample No. _____
Depth (m) _____
Date _____
Sheet No. _____



**CONSOLIDATED-UNDRAINED
TRIAXIAL COMPRESSION TEST
ASTM D4767**

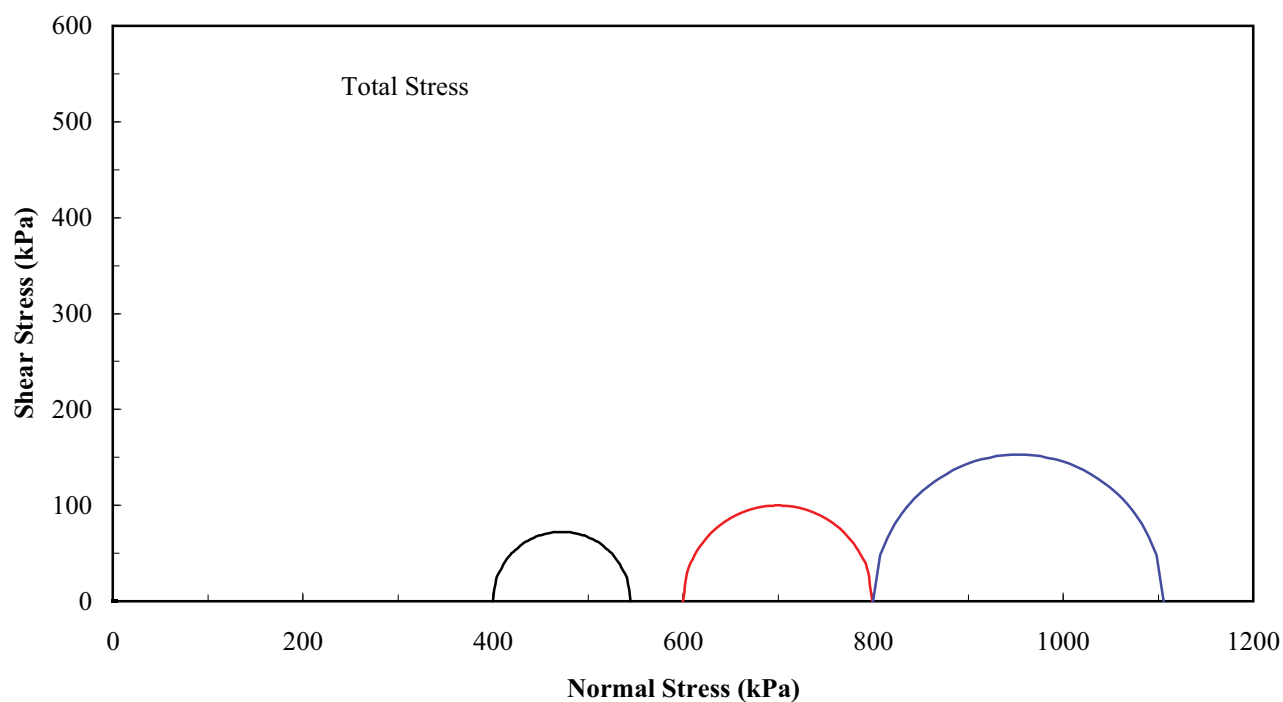
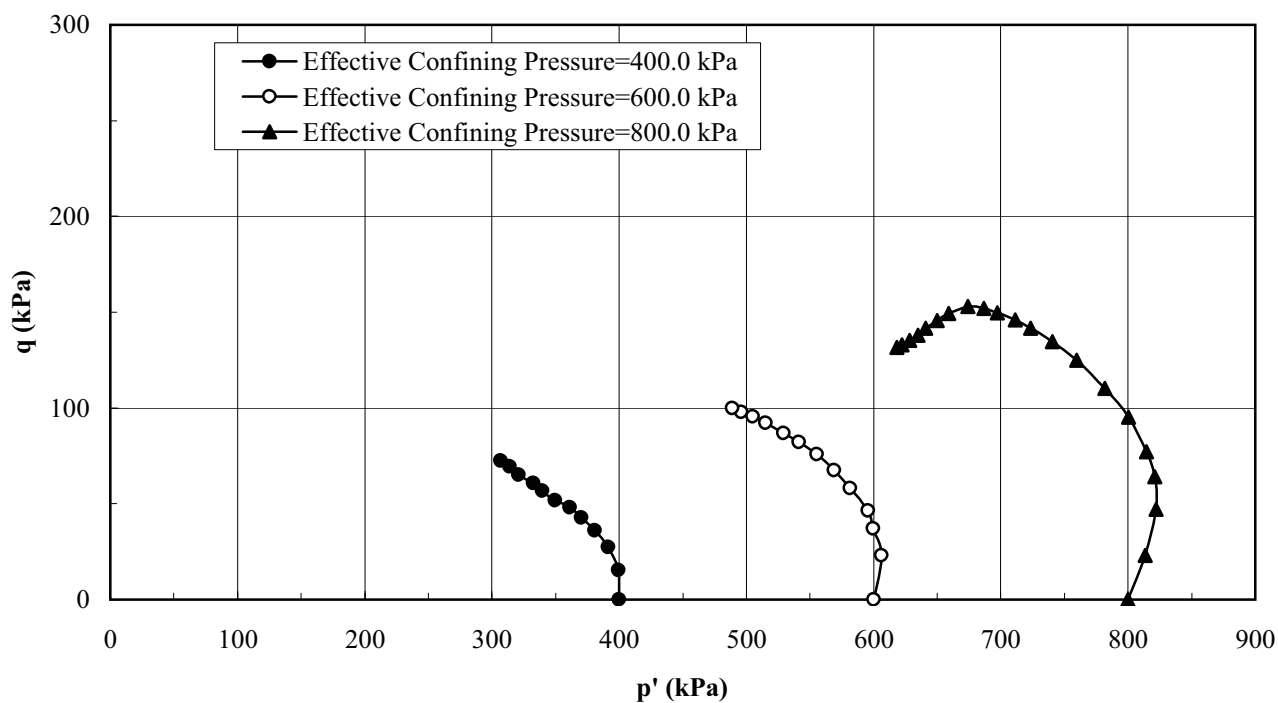
Job No. _____
Job Name _____
Tested By SF & KC
Calculated By SF
Checked By SF



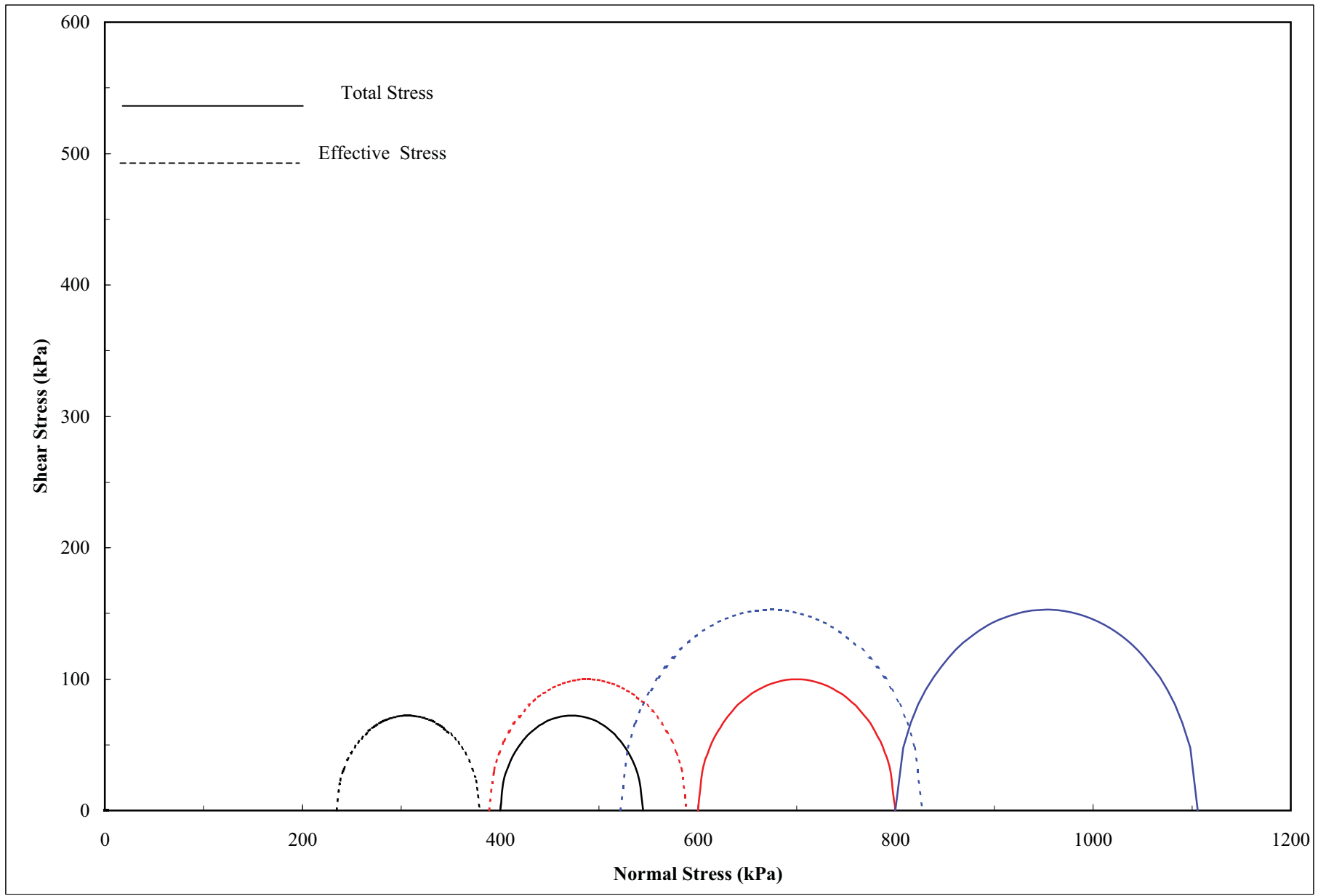
Boring No. N/A
Sample No. _____
Depth (m) _____
Date _____
Sheet No. _____

SOLUM
CONSULTANTS LTD.
**CONSOLIDATED-UNDRAINED
TRIAXIAL COMPRESSION TEST**
ASTM D4767

Job No. _____
Job Name _____
Tested By SF & KC
Calculated By SF
Checked By SF



p-q&Mohr Chart 2



CALIFORNIA BEARING RATIO

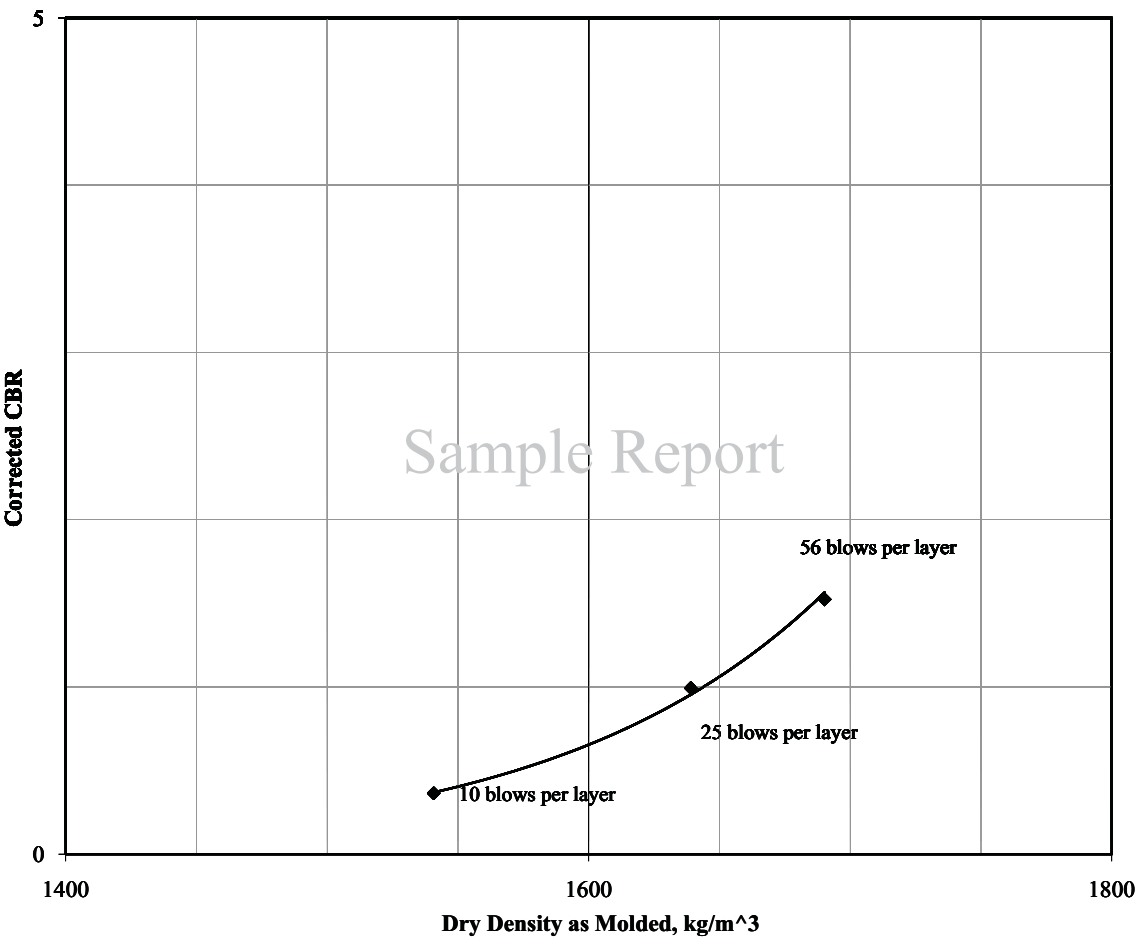
ASTM D 1883-05 (One Water Content only)

TP-1
Brown Lean Clay (CL)
Surcharge Amount: 4.54 Kg.

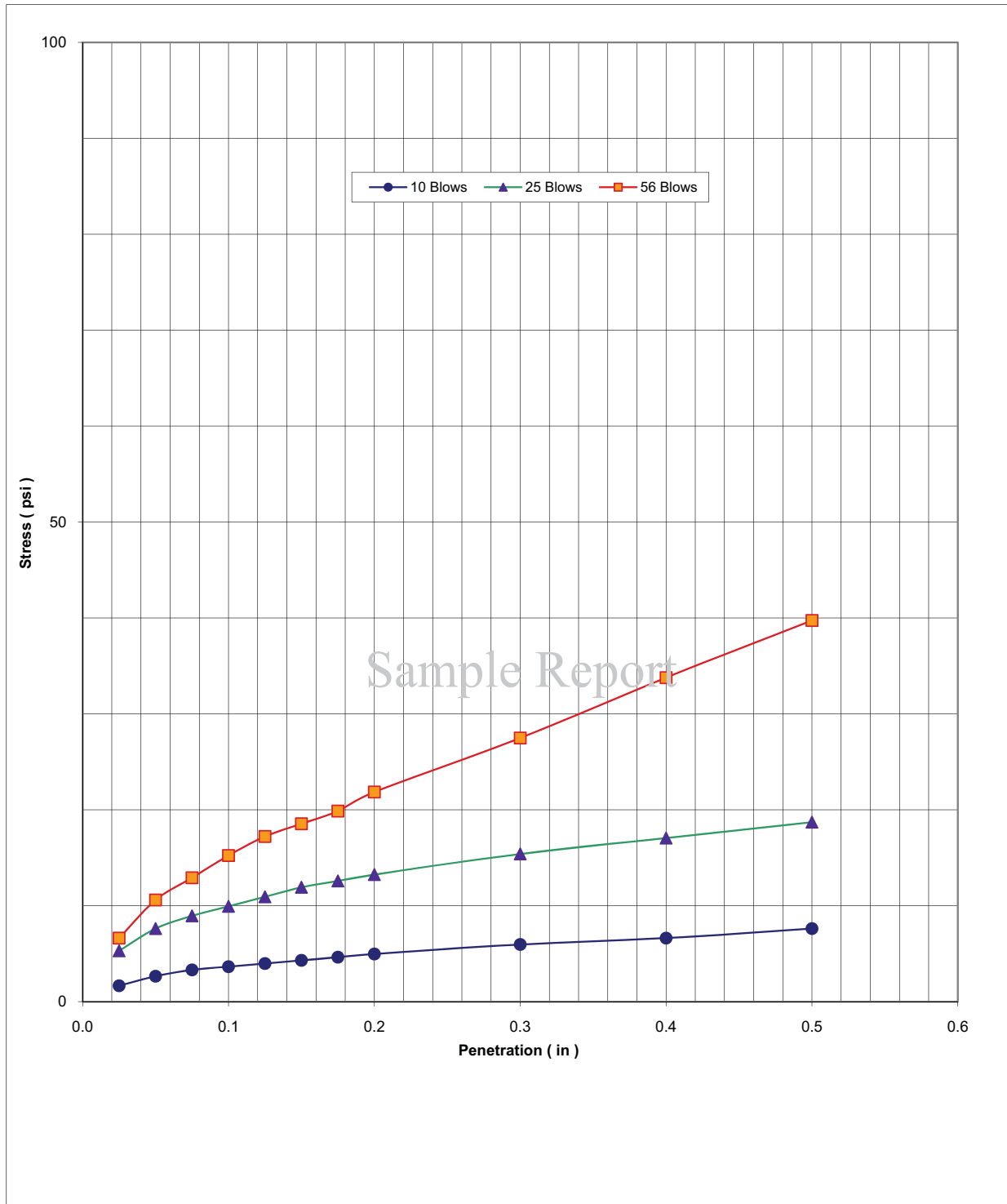
95% Optimum Moisture Content

	10 Blows	25 Blows	56 Blows
Dry density before soak, kg/m^3	1,541	1,639	1,690
Dry density after soak, kg/m^3	1,554	1,649	1,698
Moisture content before soak, %	19.5	19.8	19.8
Moisture content after soak, avg., %	27.4	25.3	23.7
Moisture content after soak, top 1", %	29.5	27.1	25.1
% Swell after 96 hour soak	-0.83	-0.61	-0.48
Bearing Ratio, 0.100" penetration	0.4	1.0	1.5

Dry Density vs CBR



Stress vs. Penetration @ 95% Optimum Moisture Content

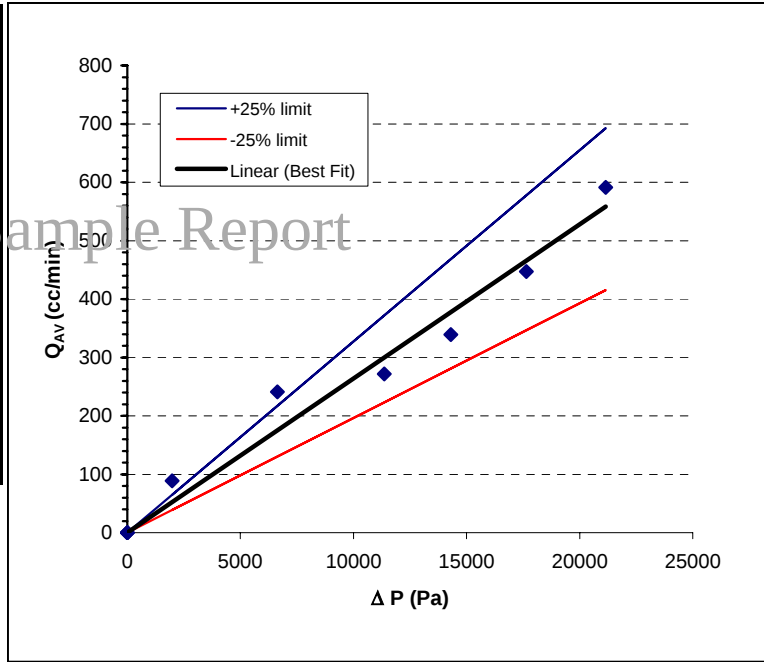


SOLUM CONSULTANTS LTD. GEOTECHNICAL & MATERIAL TESTING LABORATORY		Measurement of Pneumatic Permeability of Partially Saturated Porous Material (ASTM D6539)	
Client: XYZ Environmental Ltd.		Borehole No.: N/A Tested by: KC / SF	
Project No.: 12345678		Sample No.: BH09-01	
Project Name: X Site Assessment		Depth: 4.5-5.0 m	
Location: X Site		Date : 15-Oct-09 (dd -mm -yy)	

Experiment No.	TEMP. (deg. C)	Inlet Pressure (Pa)	Outlet Pressure (Pa)	Pressure Drop (Pa)	Bubble Meter Reading (cc/min)	Qav (cc/min)	Pneumatic Conductivity Kp (Darcy)	O-Outlier V-Valid
1	21.0	2250	270	1980	90	8.89E+01	1.89E-01	O
2	21.0	7200	570	6630	250	2.41E+02	1.53E-01	O
3	21.0	12560	1200	11360	290	2.72E+02	1.01E-01	V
4	21.0	16450	2150	14300	370	3.39E+02	9.98E-02	V
5	21.0	21000	3360	17640	500	4.47E+02	1.07E-01	V
6	21.0	26000	4850	21150	680	5.91E+02	1.18E-01	V
Average:							1.1E-01	

Test Method:	☒ Flexible Wall ☐ Rigid Wall	Test Gas:	☒ N ₂ ☐ Air
Barometric Pressure (kPa):	102.4	Specimen Type:	Undisturbed
Wet Mass:	420.36 g	Sample Height :	4.78 cm
Water Content:	18.6%	Sample Diameter :	7.17 cm
Wet Density:	2178.0 kg/m ³	Sample Area :	40.38 cm ²
Dry Density:	1836.5 kg/m ³	Sample Volume :	193.00 cm ³

Remarks: _____



Standard Test Method for Determine the Thermal Conductivity/Resistivity of Soils (ASTM D5334)



GEOTECHNICAL & MATERIAL
TESTING LABORATORY

Project Number: N/A
Client: N/A
Project Name: N/A
Location: ---
Sample ID: TP-1 Depth: Bulk
Tested By: KC/SF Reviewed By: SF
Date of Testing: 9-Mar-10 (dd-mmm-yy)

Results

Specimen No.	1	2	3	4	5	6				
Moisture Content (%)	0.7	1.7	3.4	5.0	9.2	13.5				
Dry Density (kg/m ³)	1725.0	1737.0	1750.0	1760.0	1758.0	1765.0				
Thermal Resistivity (k-cm/watt)	427	266	164	129	86	78				
Temperature (°C)	24.3	21.8	21.8	20.1	20.4	19.1				

Proctor Information:

Max. Dry Density (kg/m ³):	1855.0
Opt. Moisture Content (%):	14.2
Target % Compaction:	95%
Target Dry Density(kg/m ³):	1762.3

Thermal Resistivity Dry-Out Curve

