Appendix E
Laboratory Testing Results

Phase I
Laboratory Testing Results

Laboratory Test Summary Sheet

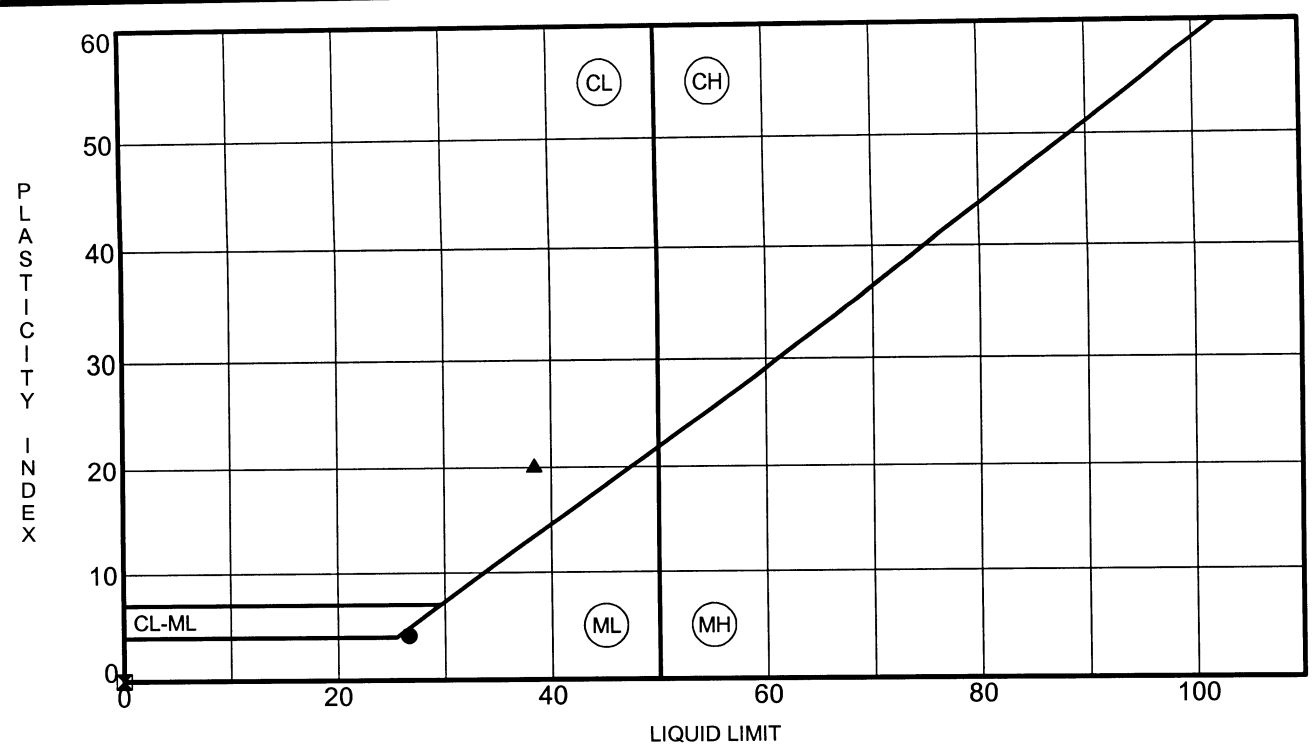
Boring/ Sample No.	Depth	LL	PL	PI	% Natural Moisture	% Gravel	% Sand	% Fines	USCS Class.	AASHTO Class.	Maximum Dry Density	Optimum Moisture Content	CBR Value @ 0.1
FB1	3.3	27	22	5	19.5								
FPS1	6.8					0.0	49.7	50.3					
GCP1	5.0				16.4	0.0	30.6	69.4					
GCP2	6.0				20.6								
GCP2	19.3				21.4	0.9	38.3	60.8					
GCP4	34.3	29	NP	NP									
GPS1	28.6					0.0	68.1	31.9					
GPS2	9.0	38	18	20	21.1								
PS1	10.0												

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

Lab Test Summary — Sheet 1 of 1

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: September 2006



Boring No.		Depth	LL	PL	PI	Fines	Classification
●	FB1	at 3.3	27	22	5		Brown Micaceous Silty Sand
⊠	GCP4	at 34.3	29	NP	NP		Brown Micaceous Silty Sand
▲	GPS2	at 9.0	38	18	20		Light brown/grey Lean Clay with Sand and Mica

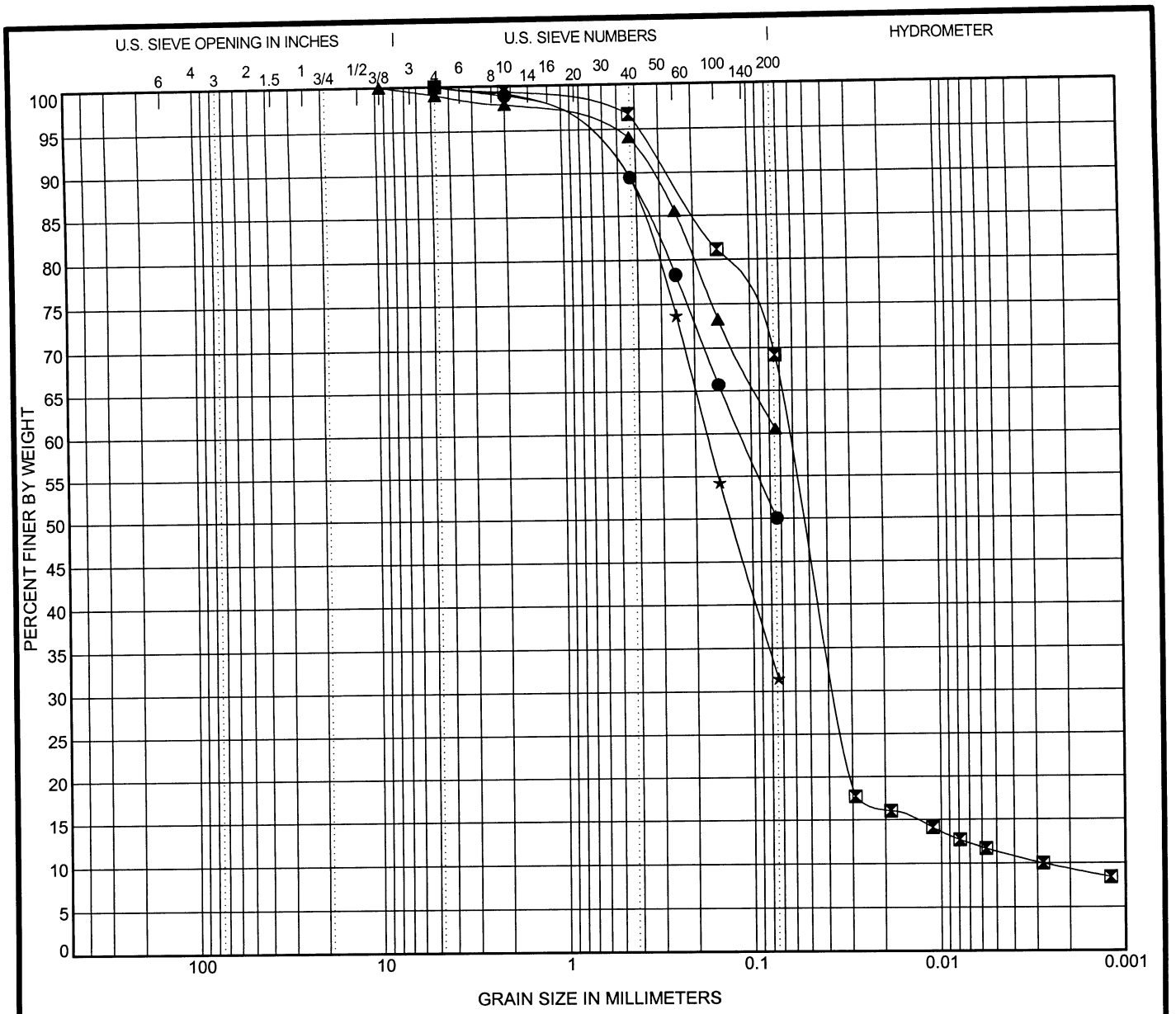
SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

ATTERBERG LIMITS' RESULTS

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: September 2006

US ATTERBERG LIMITS H72-036D.GPJ F&R.GDT 9/12/06



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	FPS1	at	6.8						
⊠	GCP1	at	5.0	Visual:				7.47	22.35
▲	GCP2	at	19.3						
☆	GPS1	at	28.6						

	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	FPS1	at	6.8	4.76	0.115			0.0	49.7	50.3	
⊠	GCP1	at	5.0	4.76	0.063	0.036	0.003	0.0	30.6	58.0	11.4
▲	GCP2	at	19.3	9.52				0.9	38.3	60.8	
★	GPS1	at	28.6	4.76	0.174			0.0	68.1	31.9	

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: September 2006

SINCE 1881

FROEHLING & ROBERTSON, INC.

GEOTECHNICAL • ENVIRONMENTAL • MATERIALS ENGINEERS • LABORATORIES

"OVER ONE HUNDRED TWENTY FIVE YEARS OF SERVICE"

22923 Quicksilver Drive
Suite 111
Sterling, Virginia 20166
Telephone (703) 996-0123 Fax (703) 996-0124

ORGANIC CONTENT TEST RESULTS
ASTM D2974

Project Name: Washington Aqueduct

Date: September 7, 2006

Project No. H72-036D

Lab. Order: 96718

Sample No	Moisture Content %	Organic Content %
PS1 (S5)(9'-11')	19.1	1
FB1(S2)(2.5'-4'	28.8	3.2

Lab ID: 0608544-01 (Soil)
Client ID: GCP3 (4-6)
Sampled Date/Time: 8/11/06 0:00

Analyte	Result	Quant Limit	Units	Prepared	Analyzed	Method	Analyst	Notes
Materials Testing								
Chloride	**9**		ppm	8/22/06 0:00	8/22/06 0:00	AASHTO T291	AT	
pH	**4.64**		su	8/22/06 0:00	8/22/06 0:00	AASHTO T289	AT	
Resistivity	**9700**		ohm-cm	8/22/06 0:00	8/22/06 0:00	In House	AT	
Sulfate	**25**	1	ppm	8/22/06 0:00	8/22/06 0:00	AASHTO T290	AT	

Lab ID: 0608544-02 (Soil)
Client ID: FPS-1 (13.5-15)
Sampled Date/Time: 8/11/06 0:00

Analyte	Result	Quant Limit	Units	Prepared	Analyzed	Method	Analyst	Notes
Materials Testing								
Chloride	**13**		ppm	8/22/06 0:00	8/22/06 0:00	AASHTO T291	AT	
pH	**5.06**		su	8/22/06 0:00	8/22/06 0:00	AASHTO T289	AT	
Resistivity	**20800**		ohm-cm	8/22/06 0:00	8/22/06 0:00	In House	AT	
Sulfate	**8**	1	ppm	8/22/06 0:00	8/22/06 0:00	AASHTO T290	AT	

Lab ID: 0608544-03 (Soil)
Client ID: PS-1 (5-7)
Sampled Date/Time: 8/11/06 0:00

Analyte	Result	Quant Limit	Units	Prepared	Analyzed	Method	Analyst	Notes
Materials Testing								
Chloride	**11**		ppm	8/22/06 0:00	8/22/06 0:00	AASHTO T291	AT	
pH	**7.30**		su	8/22/06 0:00	8/22/06 0:00	AASHTO T289	AT	
Resistivity	**7120**		ohm-cm	8/22/06 0:00	8/22/06 0:00	In House	AT	
Sulfate	**14**	1	ppm	8/22/06 0:00	8/22/06 0:00	AASHTO T290	AT	

Notes and Definitions

mg/L =	milligrams per Liter
µg/L =	micrograms per Liter
mg/kg =	milligrams per kilogram
su =	standard units
BQL =	Below the Quantitation Limit

FROEHLING & ROBERTSON, INC.

GEOTECHNICAL • ENVIRONMENTAL • MATERIALS ENGINEERS • LABORATORIES

"OVER ONE HUNDRED TWENTY FIVE YEARS OF SERVICE"

22923 Quicksilver Drive
Suite 111
Sterling, Virginia 20166
Telephone (703) 996-0123 Fax (703) 996-0124

Unconfined Compressive Strength of Rock Cores

Washington Aqueduct Residuals Project
F&R record number: H72-036D

Core Number	Length After Cutting (in.)	Length After Capping (in.)	Diameter (in.)	Area (in.²)	Ratio L/D	Load (Lbs.)	Unconfined Compressive Strength (PSI)
GPS-1 (R1)(40'-41')	5.000	5.100	2.000	3.142	2.550	31740	10100
GPS-2 (R1)(42.3'-43.3')	5.000	5.100	2.000	3.142	2.550	13980	4450
FB-1 (R1)(30'-31')	5.000	5.100	2.000	3.142	2.550	20730	6600
PS-1 (R2)(39'-40')	5.000	5.100	2.000	3.142	2.550	20820	6630
FPS-1 (R2)(28.3'-29.5')	5.000	5.100	2.000	3.142	2.550	0*	0*

*Rock core broke on an existing discontinuity with minimal stess applied.

geotechnics
INTEGRITY IN TESTING

CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D - 4767 (SOP-S28)

Client	FROEHLING & ROBERTSON		
Client Reference	WASHINGTON AQUADUCT		
Project No.	2006-602-01		
Lab ID	2006-602-01-01	Specific Gravity (assumed)	2.70

Visual Description: GRAY BROWN SANDY CLAY (UNDISTURBED)

SAMPLE CONDITION SUMMARY

Boring No.	GPS-2	GPS-2
Depth (ft)	7.5-8.0	7.0-7.5
Sample No.	GPS-2	GPS-2
Test No.	T1	T2
Deformation Rate (in/min)	0.002	0.002
Back Pressure (psi)	45.5	40.6
Consolidation Time (days)	1	1
Initial State (w%)	19.9	19.2
Total Unit Weight (pcf)	131.5	130.9
Dry Unit Weight (pcf)	109.6	109.8
Final State (w%)	20.9	19.6
Initial State Void Ratio,e	0.537	0.535

Tested By MPS Date 8/29/2006 Input Checked By CEM Date 9-7-06

DCN: CT-S28 DATE 6-25-98 REVISION: 1

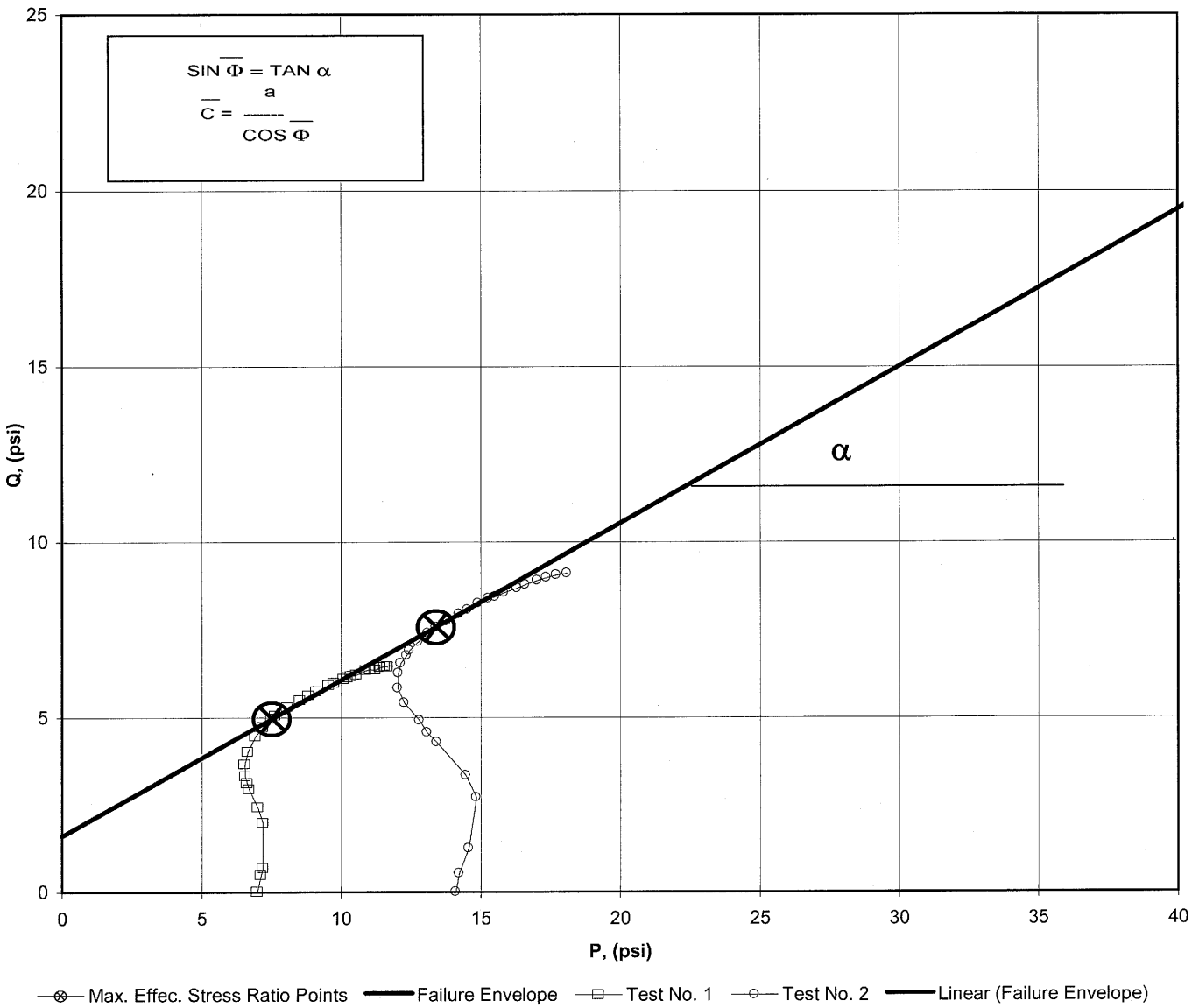
2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

geotechnics
INTEGRITY IN TESTING

CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

Client	FROEHLING & ROBERTSON	Boring No.	GPS-2
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	7.5-8.0
Project No.	2006-602-01	Sample No.	GPS-2
Lab ID	2006-602-01-01		

Consolidated Undrained Triaxial Test with Pore Pressure



a	=	1.60	$\overline{C}$	=	1.79
α	=	24.1	$\overline{\Phi}$	=	26.54

Tested By MPS Date 8/29/2006 Approved By DM Date 9-6-06

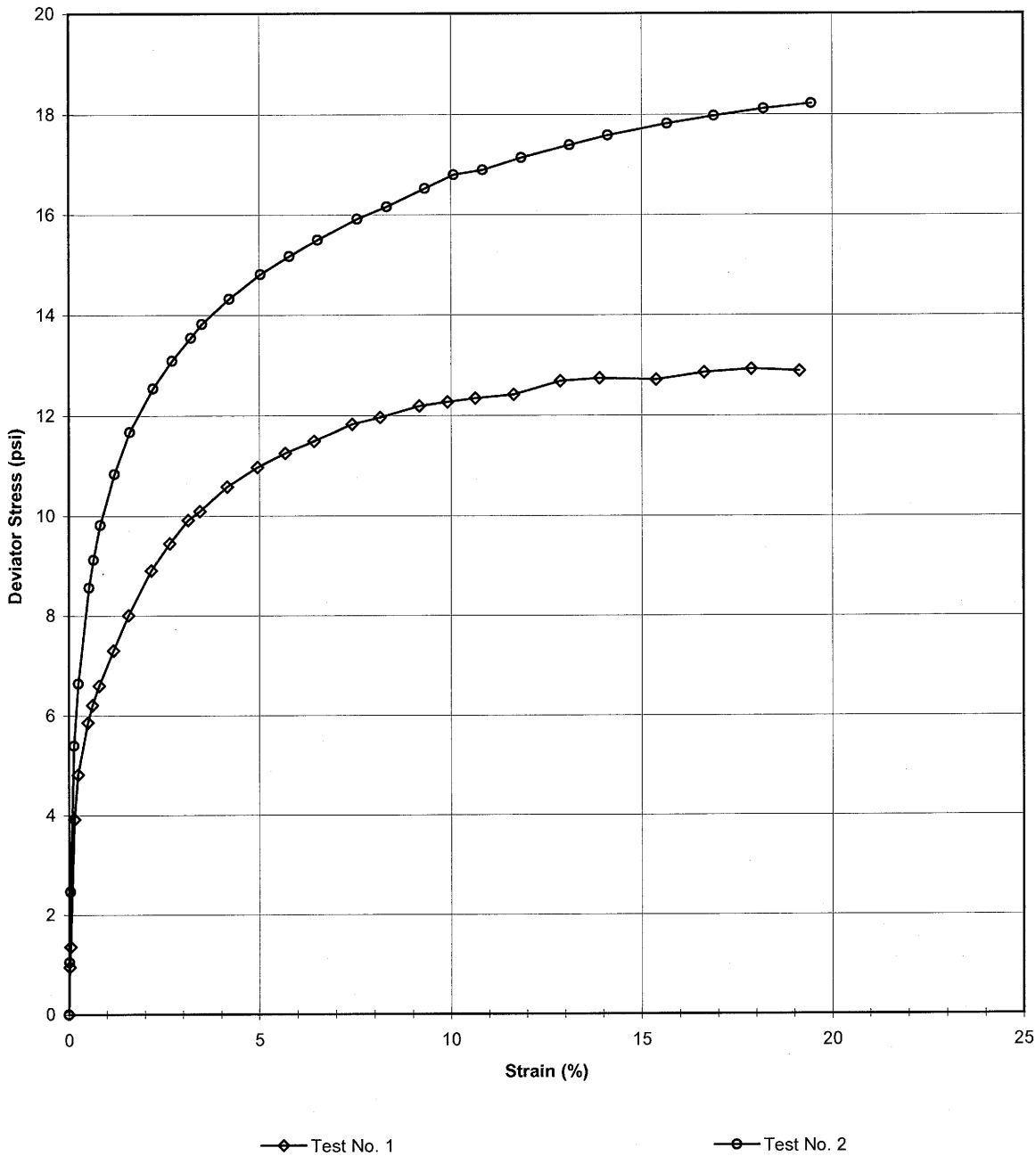
DCN: CT-S28 DATE 6-25-98 REVISION 1

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

geotechnics
INTEGRITY IN TESTING

CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

Client	FROEHLING & ROBERTSON	Boring No.	GPS-2
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	7.5-8.0
Project No.	2006-602-01	Sample No.	GPS-2
Lab ID	2006-602-01-01		
Visual Description:	GRAY BROWN SANDY CLAY (UNDISTURBED)		



Tested By MPS Date 8/29/2006 Approved By JB Date 9-6-06

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics INTEGRITY IN TESTING

Client	FROEHLING & ROBERTSON	Boring No.	GPS-2
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	7.5-8.0
Project No.	2006-602-01	Sample No.	GPS-2
Lab ID	2006-602-01-01		

Visual Description: GRAY BROWN SANDY CLAY (UNDISTURBED)

Stage No.	1
Test No	1

PRESSURES (psi)

Cell Pressure(psi)	52.5
Back Pressure(psi)	45.5
Eff. Cons. Pressure(psi)	7.0
Pore Pressure Response (%)	97

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	7.51
Q	=	4.96

INITIAL SAMPLE DIMENSIONS (in)

Length 1	6.050	Diameter 1	2.840
Length 2	6.051	Diameter 2	2.830
Length 3	6.066	Diameter 3	2.850
Avg Leng.=	6.056	Avg. Diam.=	2.840

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	15.1
Final Change (ml)	8.9

Initial Dial Reading (D.R.), mils	79
D.R. After Saturation, mils	85
D.R. After Consolidation, mils	117

LOAD (LBS)	DEFORMATION (INCHES)	PORE PRESSURE (PSI)
7.5	0.000	45.5
13.5	0.001	45.8
16.0	0.003	46.0
32.1	0.009	47.3
37.8	0.014	47.9
44.4	0.030	48.7
46.7	0.038	49.0
49.2	0.048	49.2
53.8	0.070	49.6
58.5	0.095	49.8
64.6	0.130	50.0
68.3	0.160	50.0
71.7	0.189	49.9
73.0	0.207	49.9
76.7	0.250	49.7
79.9	0.298	49.5
82.2	0.342	49.3
84.5	0.387	49.1
87.6	0.447	48.9
89.1	0.491	48.7
91.6	0.552	48.5
92.9	0.597	48.4
94.1	0.641	48.3
95.6	0.701	48.2
98.8	0.775	48.0
100.3	0.837	47.8
101.7	0.926	47.6
104.1	1.001	47.5
106.1	1.076	47.4
107.4	1.152	47.3

Tested By MPS Date 8/29/2006 Input Checked By JM Date 9-6-06

DCN: CT-S28 DATE 6-25-98 REVISION 1

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	FROEHLING & ROBERTSON	Boring No.	GPS-2
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	7.5-8.0
Project No.	2006-602-01	Sample No.	GPS-2
Lab ID	2006-602-01-01		

Visual Description: GRAY BROWN SANDY CLAY (UNDISTURBED)

Effective Confining Pressure (psi)	7.0	*Stage No.*	1
		Test No	1

INITIAL DIMENSIONS

Initial Sample Length (in.)	6.06
Initial Sample Diameter (in.)	2.84
Initial Sample Area (in^2)	6.33
Initial Sample Volume (in^3)	38.36

VOLUME CHANGE

Volume After Consolidation (in^3)	37.70
Length After Consolidation (in)	6.02
Area After Consolidation (in^2)	6.266

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	0.95	0.34	7.61	6.7	1.143	0.37	7.13	0.48
0.04	1.35	0.48	7.88	6.5	1.208	0.36	7.20	0.68
0.14	3.92	1.76	9.16	5.2	1.749	0.46	7.20	1.96
0.24	4.82	2.38	9.44	4.6	2.043	0.51	7.03	2.41
0.50	5.86	3.22	9.64	3.8	2.551	0.57	6.71	2.93
0.62	6.21	3.47	9.74	3.5	2.756	0.58	6.64	3.10
0.80	6.60	3.73	9.87	3.3	3.015	0.58	6.57	3.30
1.17	7.30	4.10	10.19	2.9	3.518	0.58	6.55	3.65
1.57	8.01	4.35	10.66	2.7	4.016	0.56	6.66	4.00
2.17	8.90	4.52	11.39	2.5	4.586	0.52	6.94	4.45
2.65	9.44	4.52	11.92	2.5	4.815	0.49	7.20	4.72
3.14	9.92	4.44	12.47	2.6	4.880	0.46	7.51	4.96
3.44	10.09	4.40	12.69	2.6	4.875	0.45	7.65	5.05
4.16	10.58	4.21	13.37	2.8	4.798	0.41	8.08	5.29
4.95	10.97	3.96	14.01	3.0	4.611	0.37	8.52	5.49
5.68	11.25	3.78	14.47	3.2	4.494	0.35	8.84	5.62
6.43	11.49	3.62	14.86	3.4	4.402	0.33	9.12	5.74
7.42	11.83	3.35	15.48	3.6	4.240	0.29	9.56	5.91
8.15	11.96	3.23	15.73	3.8	4.171	0.28	9.75	5.98
9.17	12.19	3.00	16.19	4.0	4.045	0.25	10.10	6.09
9.91	12.27	2.91	16.36	4.1	4.002	0.24	10.22	6.13
10.65	12.34	2.81	16.53	4.2	3.946	0.23	10.36	6.17
11.65	12.42	2.66	16.76	4.3	3.859	0.22	10.55	6.21
12.88	12.69	2.45	17.23	4.5	3.790	0.20	10.89	6.34
13.90	12.74	2.32	17.42	4.7	3.725	0.19	11.05	6.37
15.38	12.71	2.14	17.58	4.9	3.615	0.17	11.22	6.36
16.64	12.85	2.02	17.83	5.0	3.582	0.16	11.41	6.43
17.88	12.92	1.90	18.03	5.1	3.533	0.15	11.56	6.46
19.15	12.88	1.78	18.11	5.2	3.466	0.14	11.67	6.44

Tested By MPS Date 8/29/2006 Input Checked By JM Date 9-6-06

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	FROEHLING & ROBERTSON	Boring No.	GPS-2
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	7.0-7.5
Project No.	2006-602-01	Sample No.	GPS-2
Lab ID	2006-602-01-01		

Visual Description: GRAY BROWN SANDY CLAY (UNDISTURBED)

Stage No.	1
Test No	2

PRESSURES (psi)

Cell Pressure(psi)	54.7
Back Pressure(psi)	40.6
Eff. Cons. Pressure(ps	14.1
Pore Pressure Response (%)	97

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	13.39
Q	=	7.58

INITIAL SAMPLE DIMENSIONS (in)

Length 1	5.976	Diameter 1	2.851
Length 2	5.987	Diameter 2	2.849
Length 3	5.960	Diameter 3	2.850
Avg Leng.=	5.974	Avg. Diam.=	2.850

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	4.9
Final Change (ml)	19.1

Initial Dial Reading (D.R.), mils	86
D.R. After Saturation, mils	86
D.R. After Consolidation, mils	147

LOAD (LBS)	DEFORMATION (INCHES)	PORE PRESSURE (PSI)
8.7	0.000	40.6
15.3	0.001	41.0
24.1	0.002	41.4
42.5	0.008	42.6
50.3	0.015	43.6
62.5	0.031	45.6
66.1	0.039	46.2
70.6	0.049	46.8
77.2	0.071	47.9
82.8	0.095	48.5
88.8	0.131	48.9
92.8	0.161	49.1
96.2	0.190	49.1
98.2	0.207	49.2
102.1	0.250	49.1
106.2	0.298	49.0
109.3	0.342	48.9
112.3	0.386	48.7
116.3	0.447	48.4
118.8	0.492	48.3
122.5	0.551	48.1
125.4	0.596	47.8
127.1	0.641	47.6
130.2	0.701	47.4
133.8	0.776	47.1
136.6	0.835	46.9
140.7	0.926	46.6
143.8	0.999	46.3
147.1	1.076	46.1
150.0	1.151	45.7

Tested By MPS Date 8/29/2006 Input Checked By JM Date 9-6-06

DCN: CT-S28 DATE 6-25-98 REVISION 1

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	FROEHLING & ROBERTSON	Boring No.	GPS-2
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	7.0-7.5
Project No.	2006-602-01	Sample No.	GPS-2
Lab ID	2006-602-01-01		

Visual Description: GRAY BROWN SANDY CLAY (UNDISTURBED)

Effective Confining Pressure (psi)	14.1	*Stage No.*	1
		Test No	2

INITIAL DIMENSIONS

Initial Sample Length (in.)	5.97
Initial Sample Diameter (in.)	2.85
Initial Sample Area (in^2)	6.38
Initial Sample Volume (in^3)	38.11

VOLUME CHANGE

Volume After Consolidation (in^3)	36.95
Length After Consolidation (in)	5.91
Area After Consolidation (in^2)	6.248

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	1.05	0.40	14.75	13.7	1.077	0.39	14.23	0.53
0.04	2.47	0.77	15.80	13.3	1.185	0.32	14.57	1.23
0.14	5.40	1.97	17.53	12.1	1.445	0.38	14.83	2.70
0.25	6.64	2.96	17.78	11.1	1.596	0.46	14.46	3.32
0.53	8.57	4.96	17.71	9.1	1.937	0.60	13.42	4.28
0.65	9.12	5.58	17.64	8.5	2.070	0.63	13.08	4.56
0.83	9.82	6.20	17.72	7.9	2.242	0.65	12.81	4.91
1.21	10.84	7.25	17.68	6.8	2.583	0.69	12.26	5.42
1.61	11.67	7.90	17.87	6.2	2.884	0.70	12.03	5.84
2.22	12.54	8.32	18.32	5.8	3.169	0.68	12.05	6.27
2.72	13.09	8.51	18.68	5.6	3.341	0.67	12.14	6.54
3.21	13.55	8.52	19.12	5.6	3.429	0.65	12.35	6.77
3.51	13.82	8.56	19.36	5.5	3.496	0.64	12.45	6.91
4.22	14.32	8.51	19.92	5.6	3.561	0.61	12.75	7.16
5.04	14.81	8.41	20.50	5.7	3.602	0.59	13.10	7.41
5.79	15.17	8.29	20.98	5.8	3.612	0.56	13.39	7.58
6.53	15.50	8.06	21.53	6.0	3.567	0.54	13.79	7.75
7.56	15.91	7.83	22.18	6.3	3.538	0.51	14.22	7.96
8.33	16.16	7.66	22.60	6.4	3.508	0.49	14.52	8.08
9.32	16.52	7.47	23.15	6.6	3.490	0.47	14.89	8.26
10.08	16.79	7.23	23.66	6.9	3.445	0.44	15.27	8.40
10.85	16.89	7.03	23.96	7.1	3.391	0.43	15.51	8.45
11.86	17.14	6.83	24.40	7.3	3.358	0.41	15.84	8.57
13.12	17.39	6.50	24.99	7.6	3.287	0.39	16.30	8.69
14.13	17.58	6.30	25.39	7.8	3.253	0.37	16.59	8.79
15.67	17.82	5.98	25.94	8.1	3.194	0.35	17.03	8.91
16.89	17.97	5.73	26.34	8.4	3.146	0.33	17.36	8.99
18.20	18.11	5.45	26.76	8.6	3.094	0.31	17.71	9.06
19.46	18.22	5.12	27.20	9.0	3.029	0.29	18.09	9.11

Tested By MPS Date 8/29/2006 Input Checked By JM Date 9-6-06

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

Phase II
Laboratory Testing Results

Laboratory Test Summary Sheet

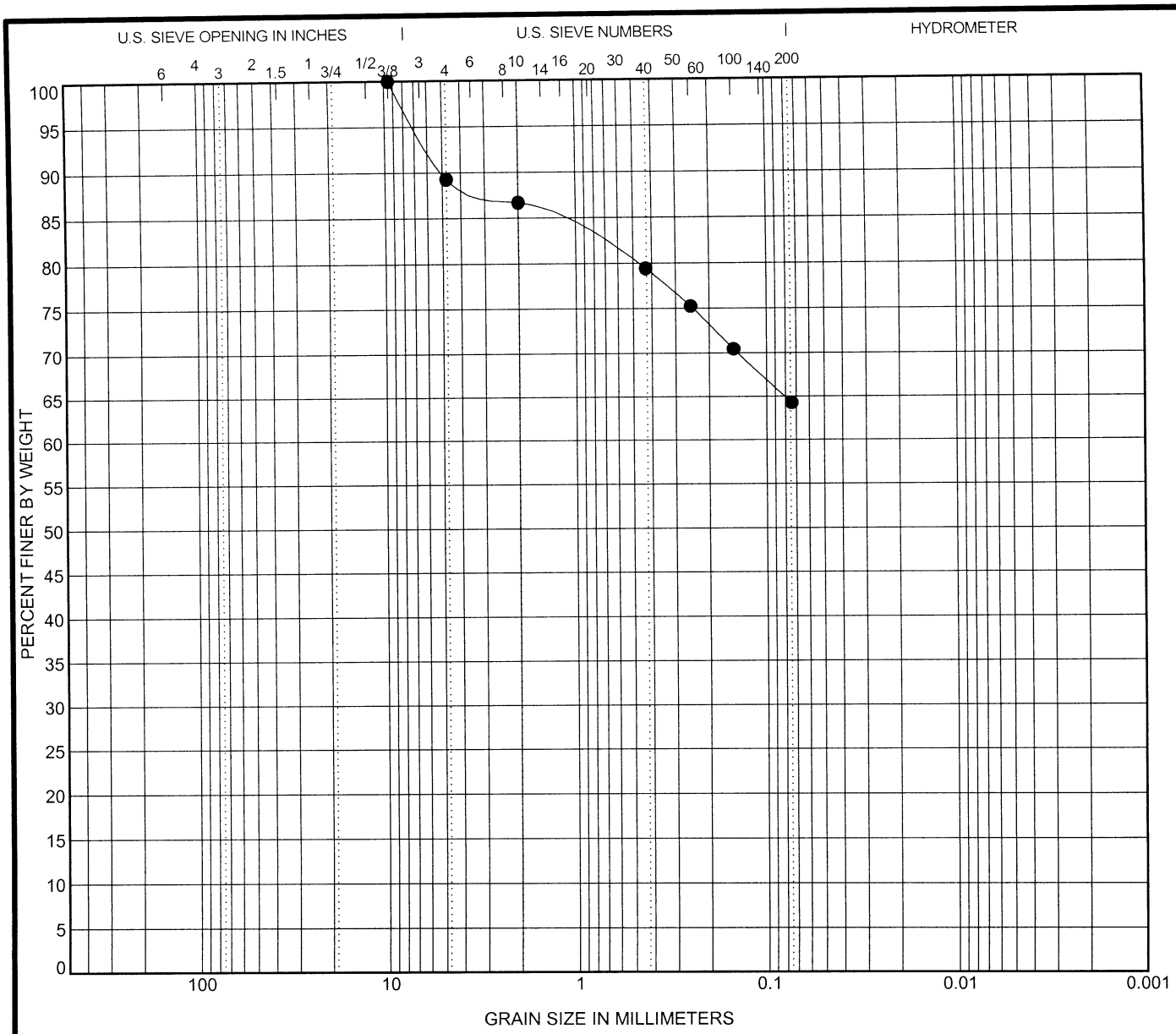
Boring/ Sample No.	Depth	LL	PL	PI	% Natural Moisture	% Gravel	% Sand	% Fines	USCS Class.	AASHTO Class.	Maximum Dry Density	Optimum Moisture Content	CBR Value @ 0.1
BH01/8	7.0					10.7	24.9	64.4					
BH02/11	8.0	42	25	17		0.0	25.8	74.2	CL	A-7-6			
BH04/12	18.5					40.6	46.2	13.2					
BH04/14	28.5	25	15	10	15.8								
BH04/15	33.5				22.8	0.0	28.4	71.6					
BH05/14	28.5	31	16	15	18.2								
BH05/17	43.5					1.0	70.6	28.3					
BH06/14	28.5	29	16	13	21.2								
BH07	33.5				20.0	0.0	17.9	82.1					
BH07/12	18.5					3.1	79.5	17.4					
BH07/14	28.5	27	15	12	19.3								
BH07/16	43.5					0.0	71.8	28.2					
BH08/11	13.5					9.2	49.8	41.0					
BH08/13	23.5					0.0	71.2	28.8					
BH09/11	13.5				16.7	29.0	40.8	30.2					
BH10/13	23.5					4.5	60.3	35.1					
BH10/14	28.5	29	23	6									
BH11/11	18.5	27	18	9	14.8								
BH14/12	18.5					0.0	70.8	29.2					
BH15/7	6.0	30	27	3		0.0	43.4	56.6	ML	A-4			
BH16/10	9.0	31	19	12		0.0	31.4	68.6	CL	A-6			
GCP6/2	2.0					1.6	30.5	67.8					
GCP6/7	12.0					0.0	42.2	57.7					

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

Lab Test Summary

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	BH01/8	at	7.0						

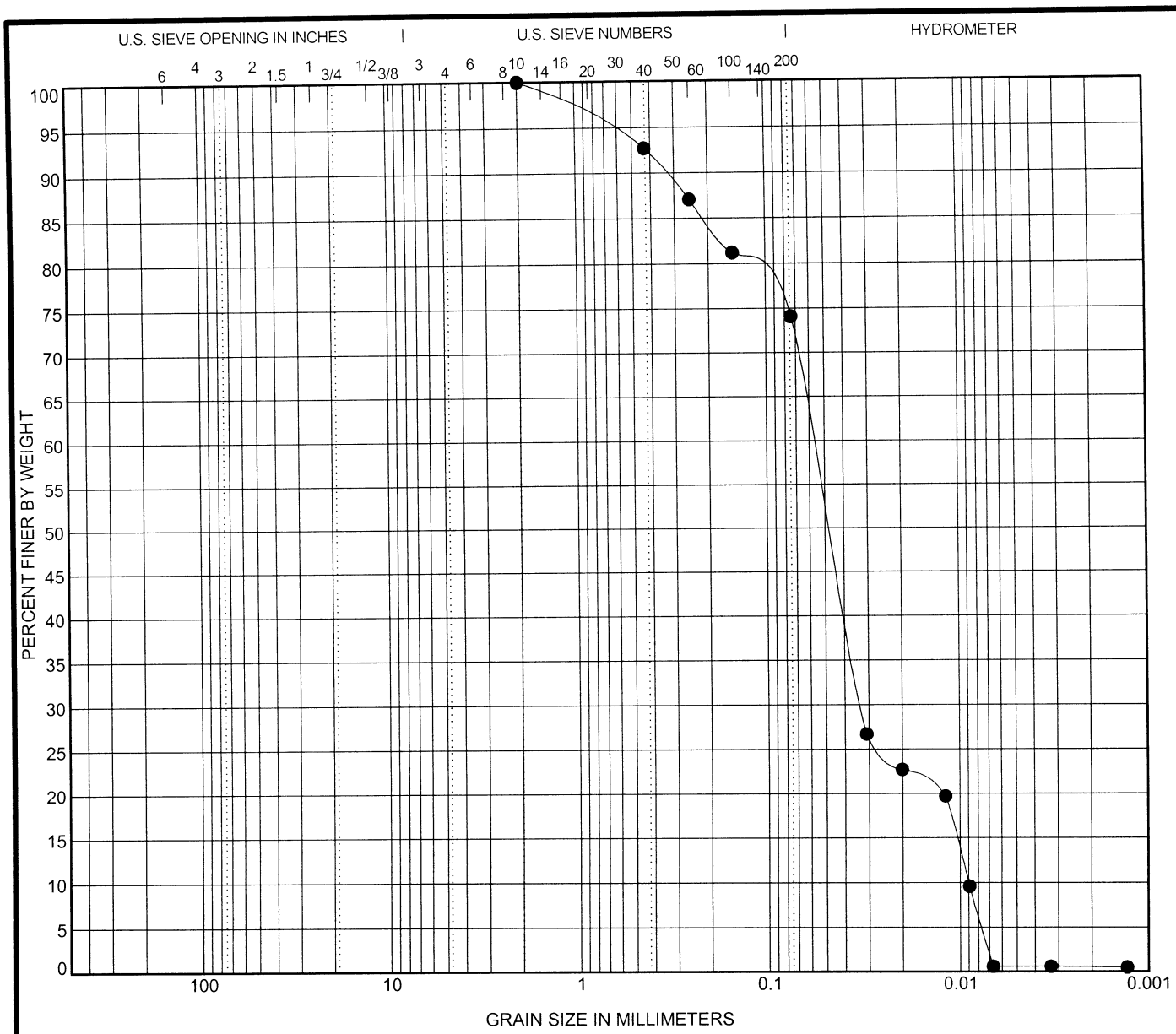
	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH01/8	at	7.0	9.52				10.7	24.9	64.4	

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	BH02/11 at	8.0	LEAN CLAY with SAND(CL)	42	25	17	2.10	6.34

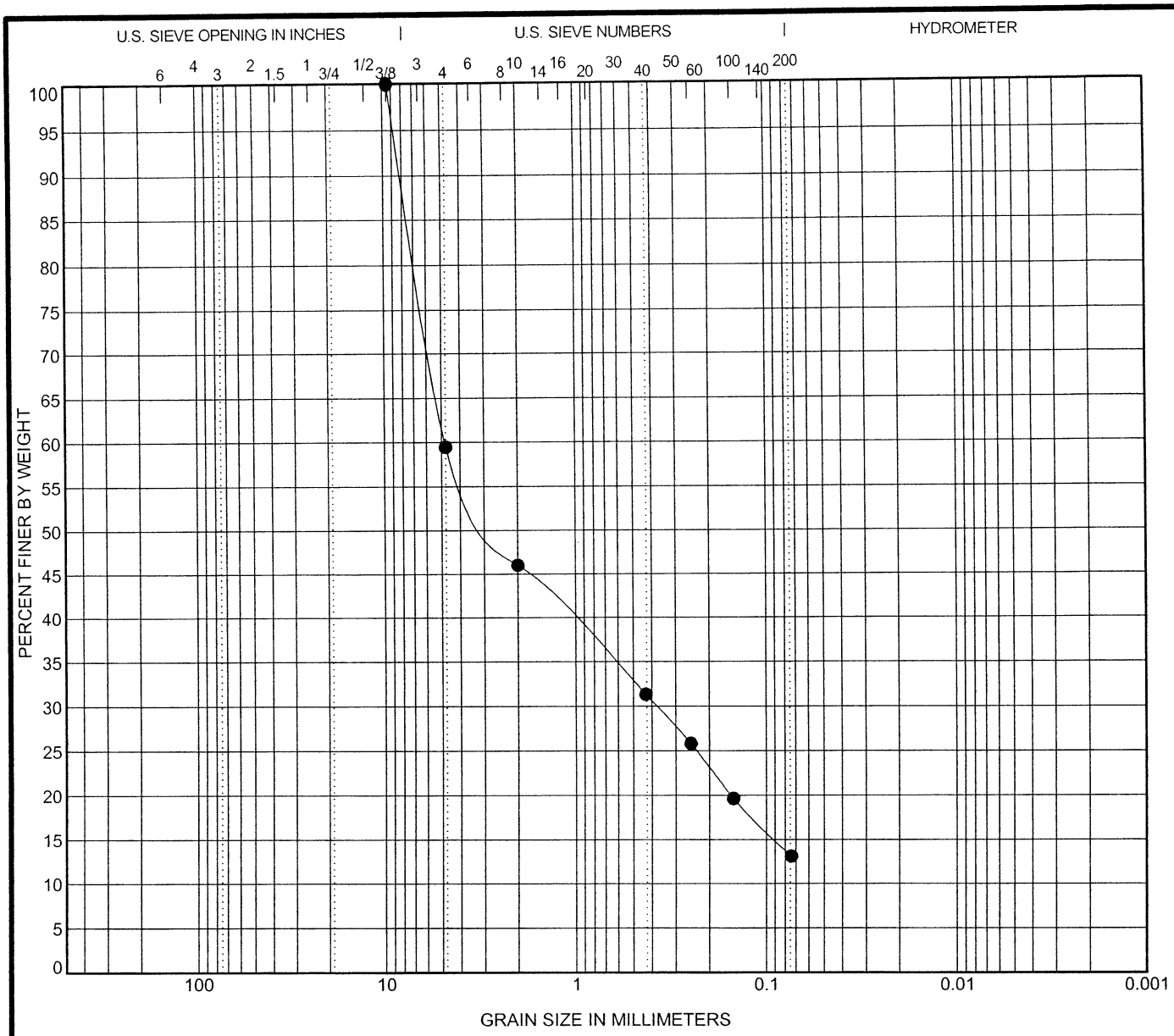
	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH02/11 at	8.0	2	0.057	0.033	0.009	0.0	25.8	73.6	0.6

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	BH04/12 at	18.5						

	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH04/12 at	18.5	9.52	4.804	0.377		40.6	46.2	13.2	

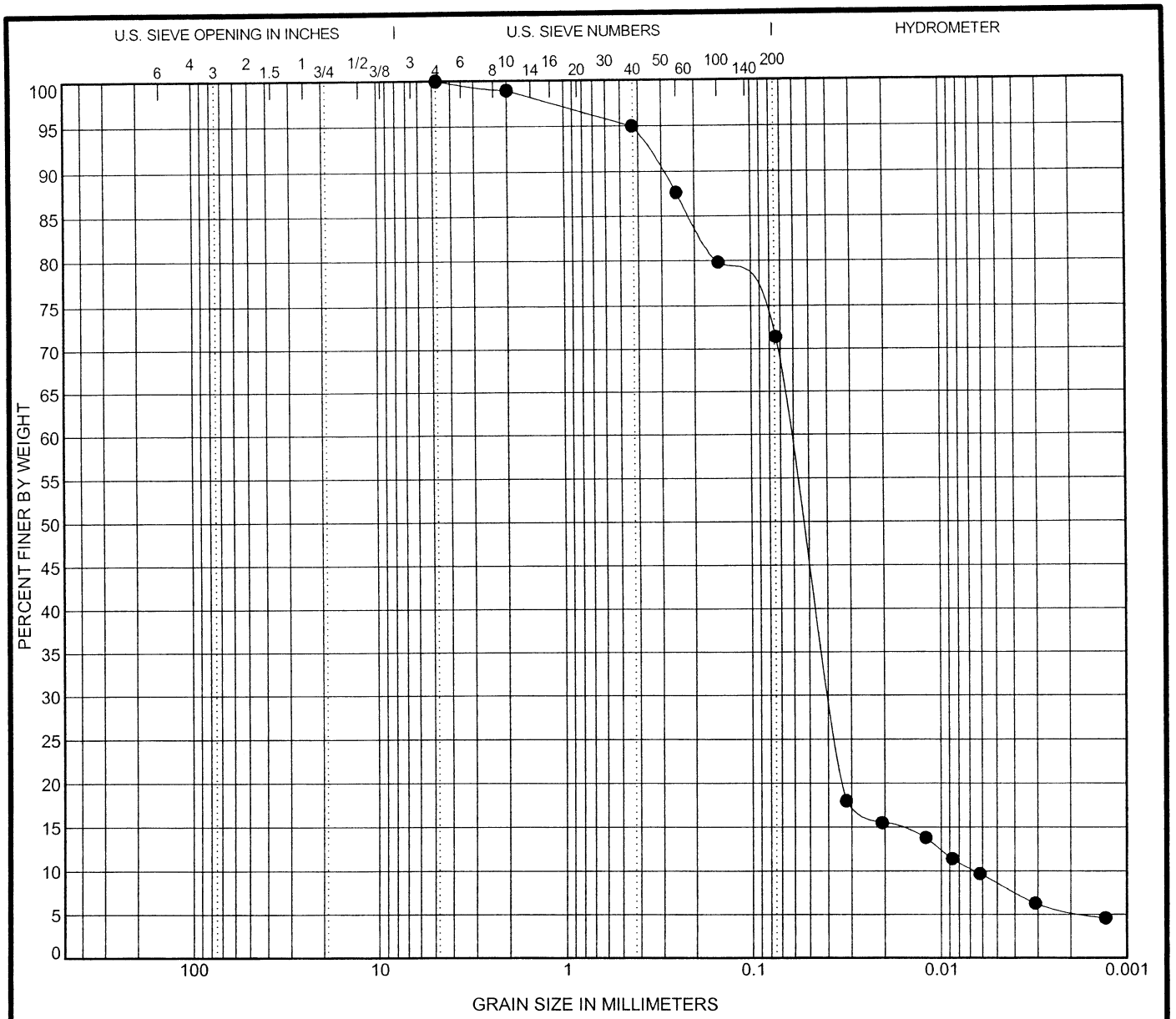
SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007

S GRAIN SIZE LAB TEST RESULTS.GPJ F&R.GDT 4/17/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	BH04/15 at	33.5					3.68	9.40

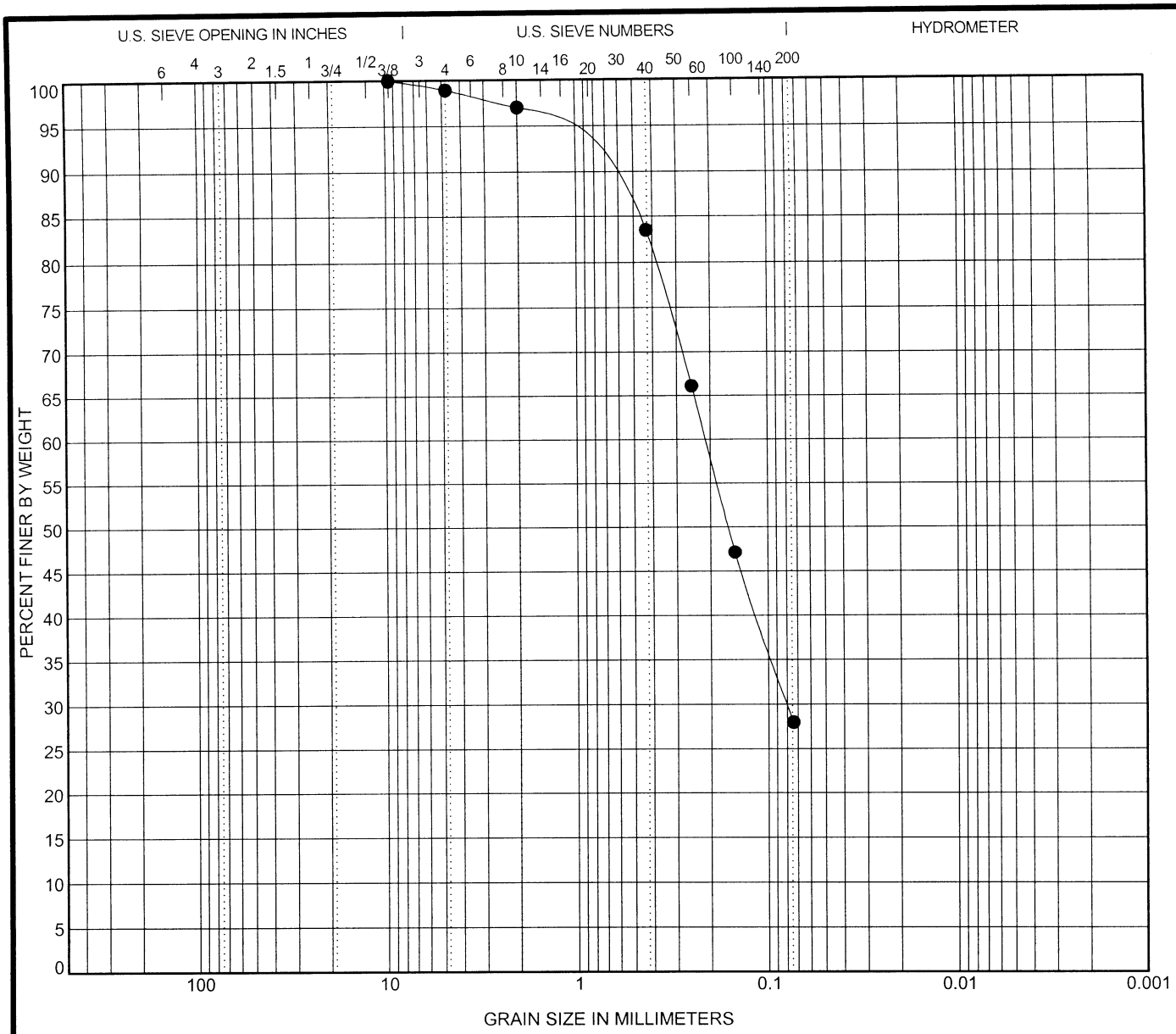
	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH04/15 at	33.5	4.76	0.062	0.039	0.007	0.0	28.4	63.0	8.6

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	BH05/17 at	43.5						

	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH05/17 at	43.5	9.52	0.212	0.08		1.0	70.6	28.3	

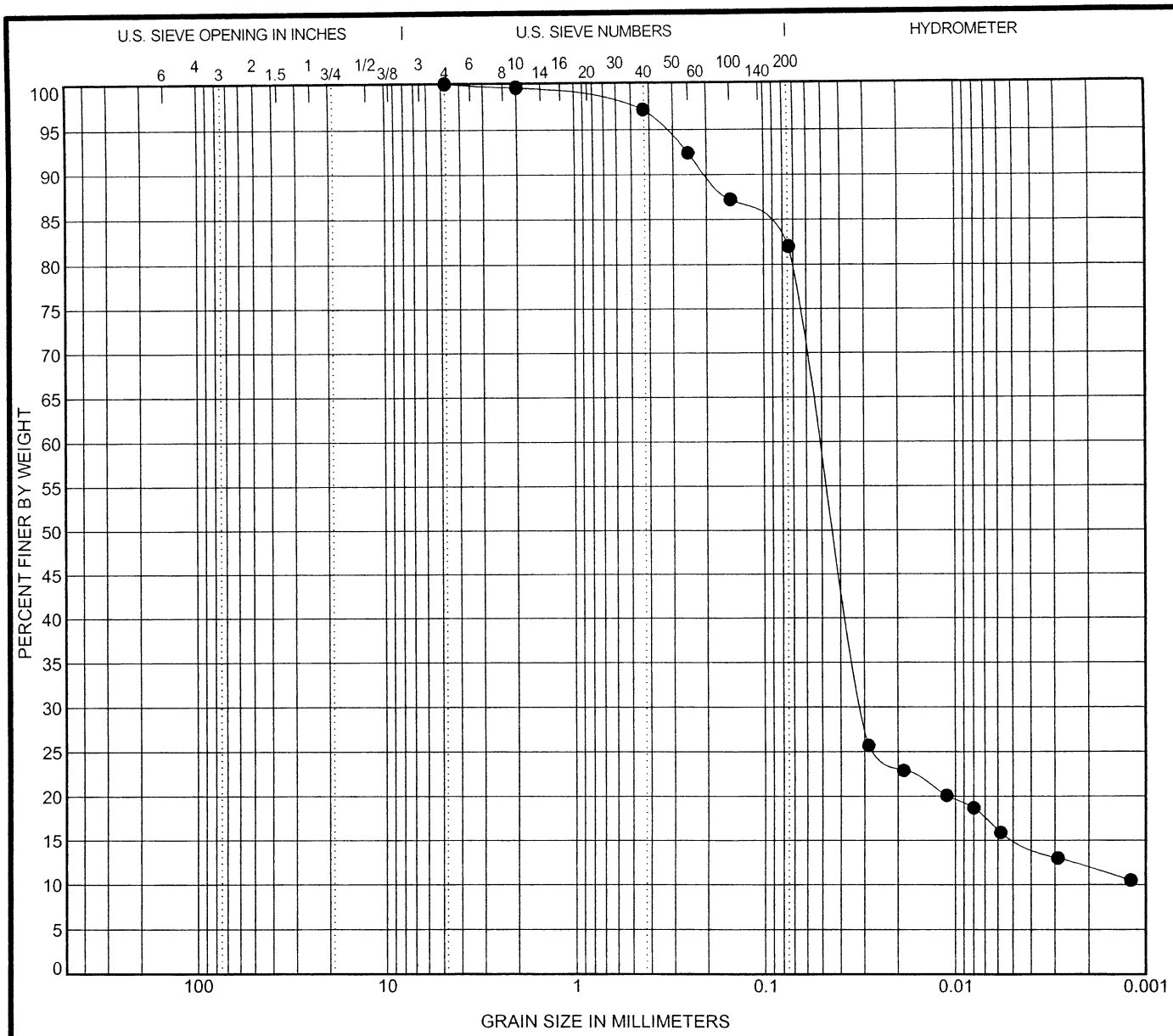
SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007

US GRAIN SIZE LAB TEST RESULTS.GPJ F&R.GDT 4/17/07



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.		Depth	Classification	LL	PL	PI	Cc	Cu
●	BH07	at	33.5						

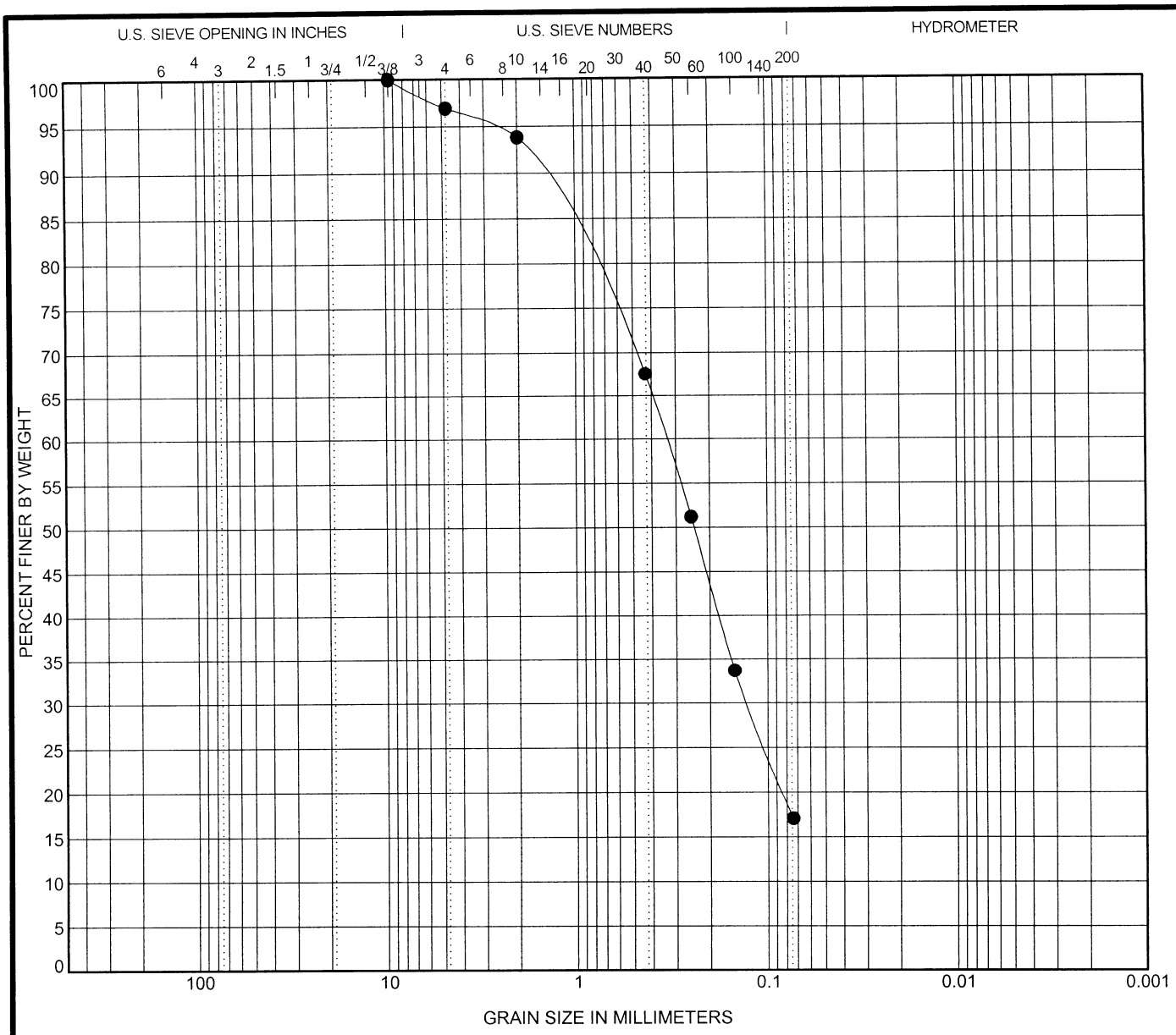
	Boring No.		Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH07	at	33.5	4.76	0.051	0.031		0.0	17.9	66.8	15.3

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	BH07/12 at	18.5						

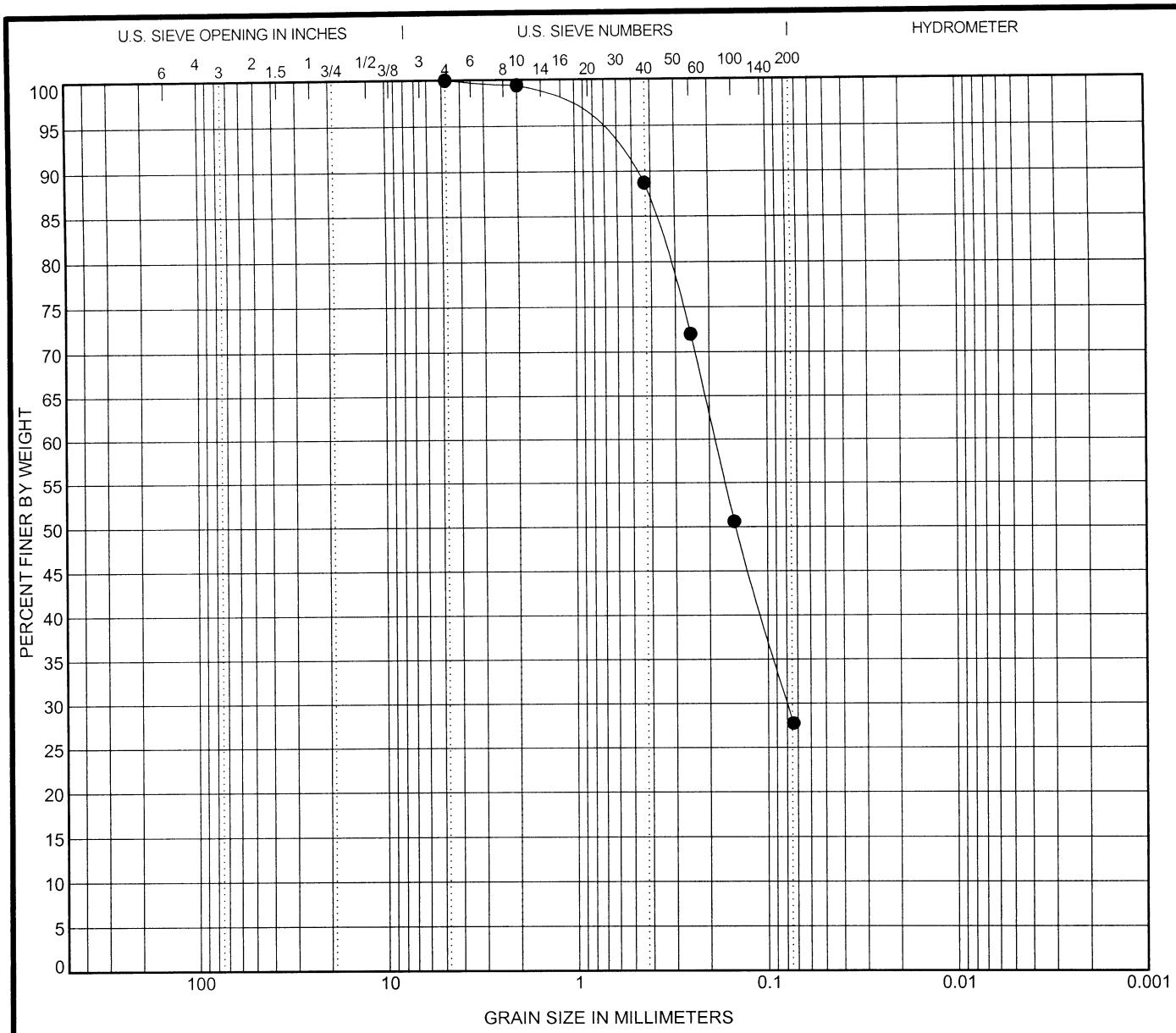
	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH07/12 at	18.5	9.52	0.335	0.127		3.1	79.5	17.4	

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	BH07/16 at	43.5						

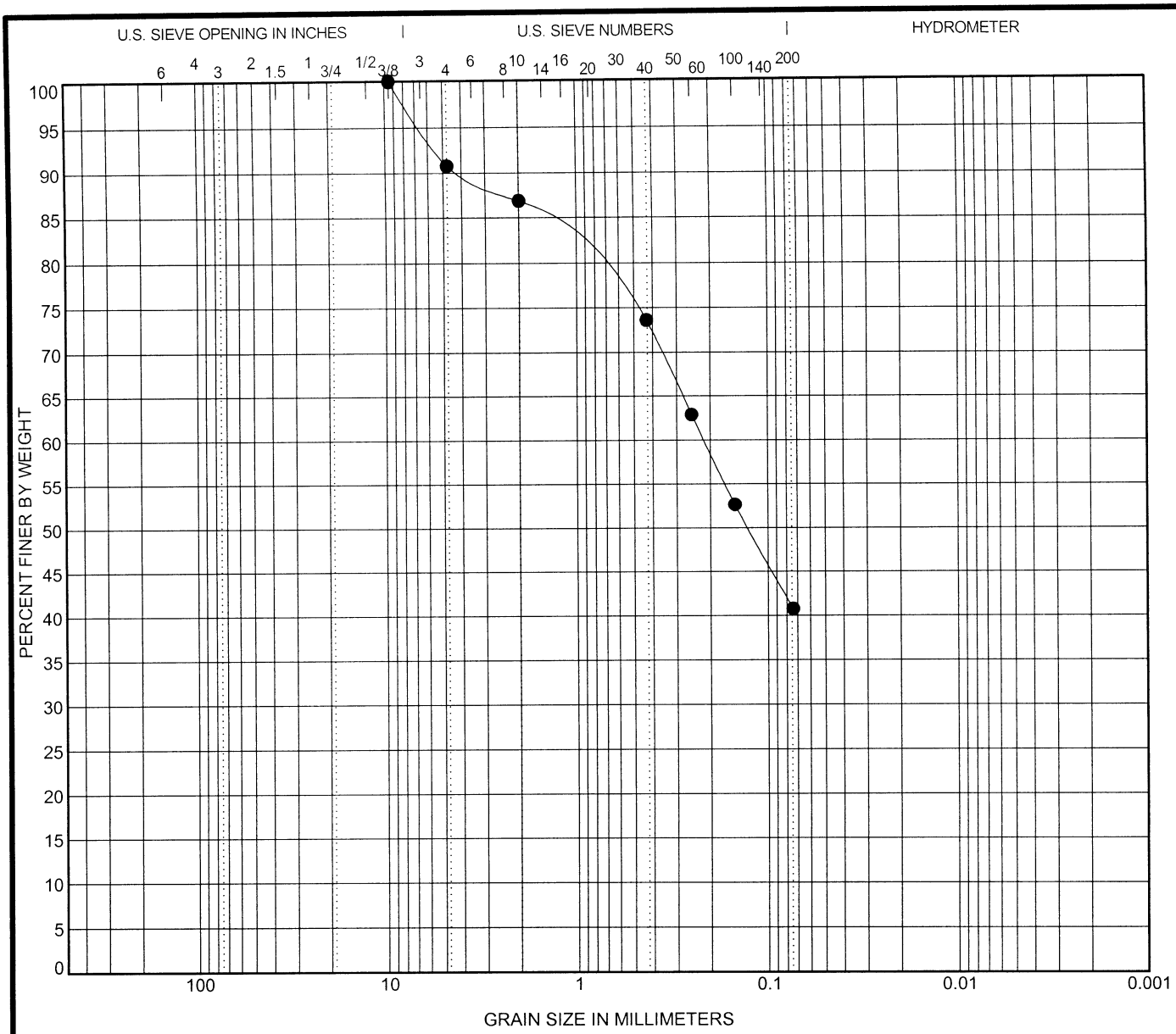
	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH07/16 at	43.5	4.76	0.187	0.079		0.0	71.8	28.2	

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	BH08/11 at	13.5						

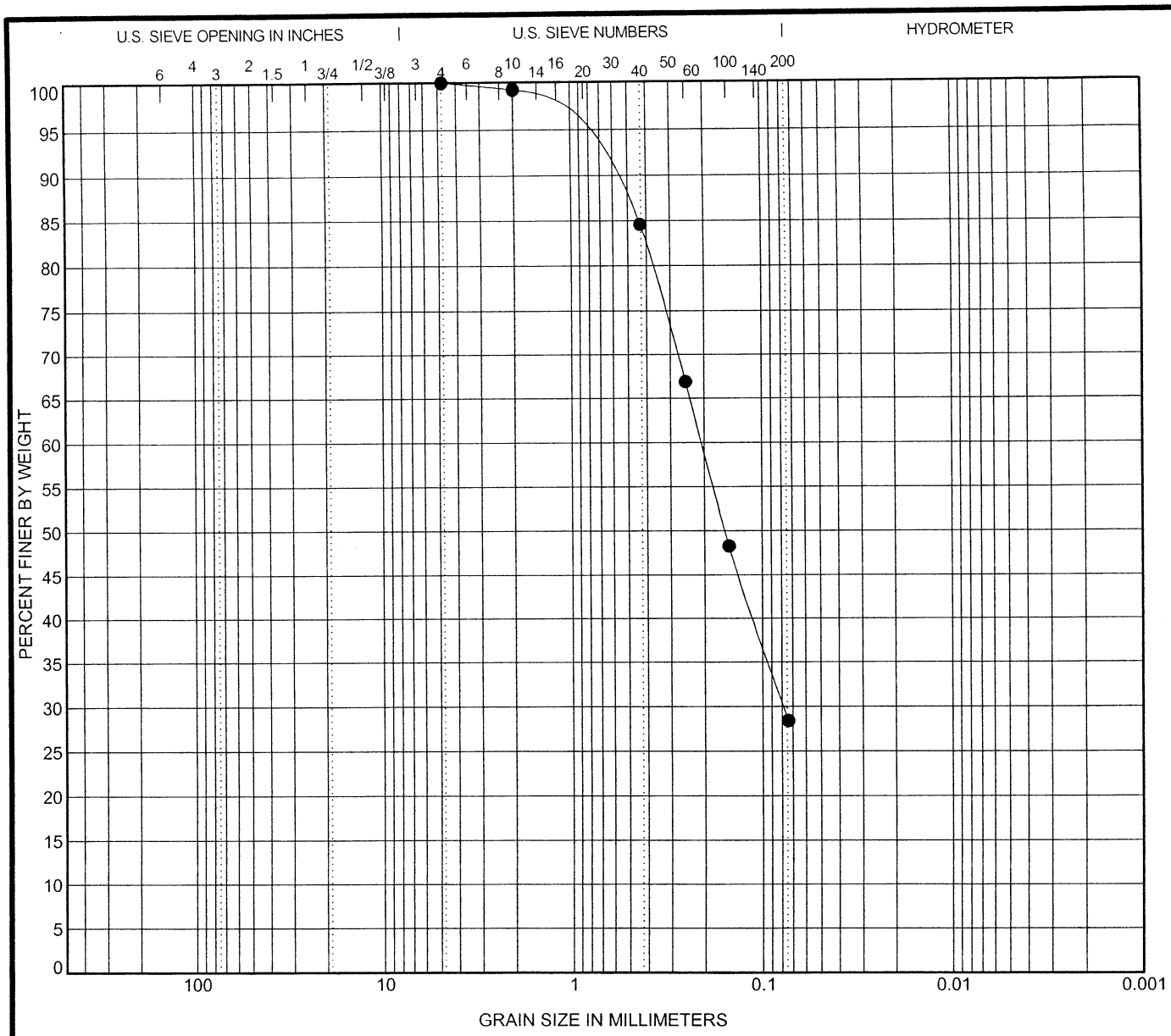
	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH08/11 at	13.5	9.52	0.216			9.2	49.8	41.0	

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	BH08/13 at	23.5						

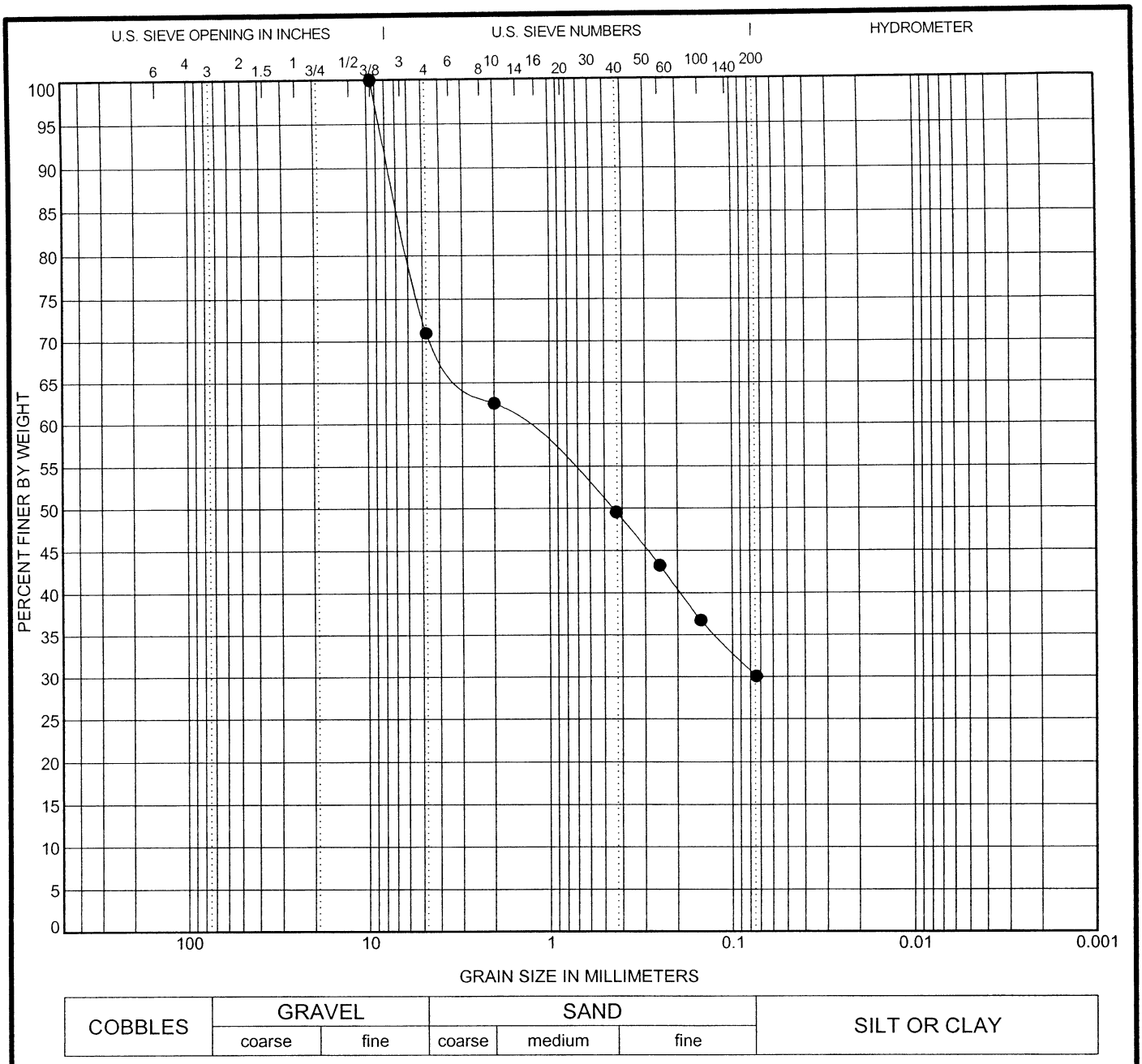
	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH08/13 at	23.5	4.76	0.206	0.078		0.0	71.2	28.8	

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	BH09/11 at	13.5						

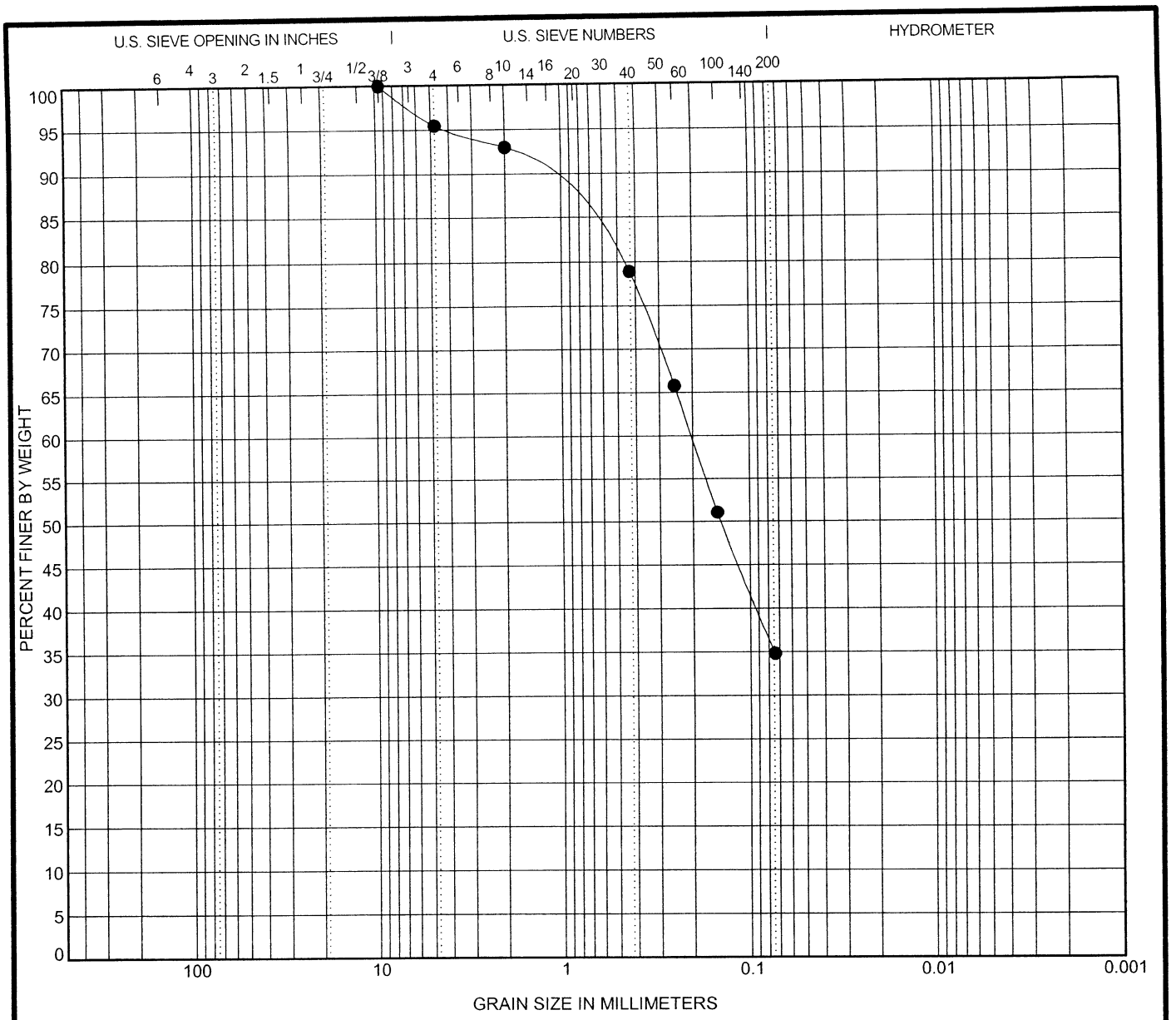
	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH09/11 at	13.5	9.52	1.483			29.0	40.8	30.2	

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	BH10/13 at	23.5						

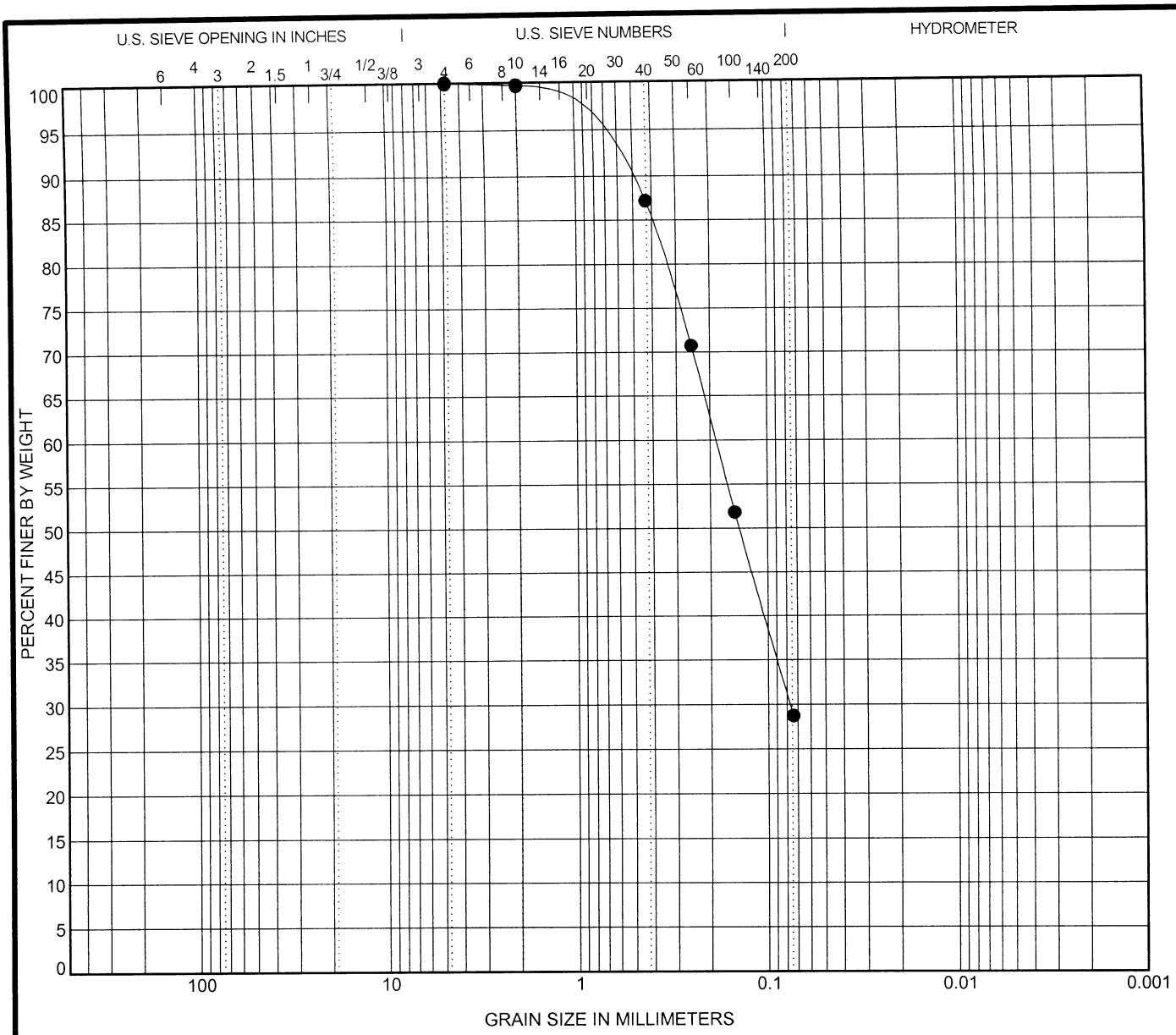
	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH10/13 at	23.5	9.52	0.204			4.5	60.3	35.1	

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	BH14/12 at	18.5						

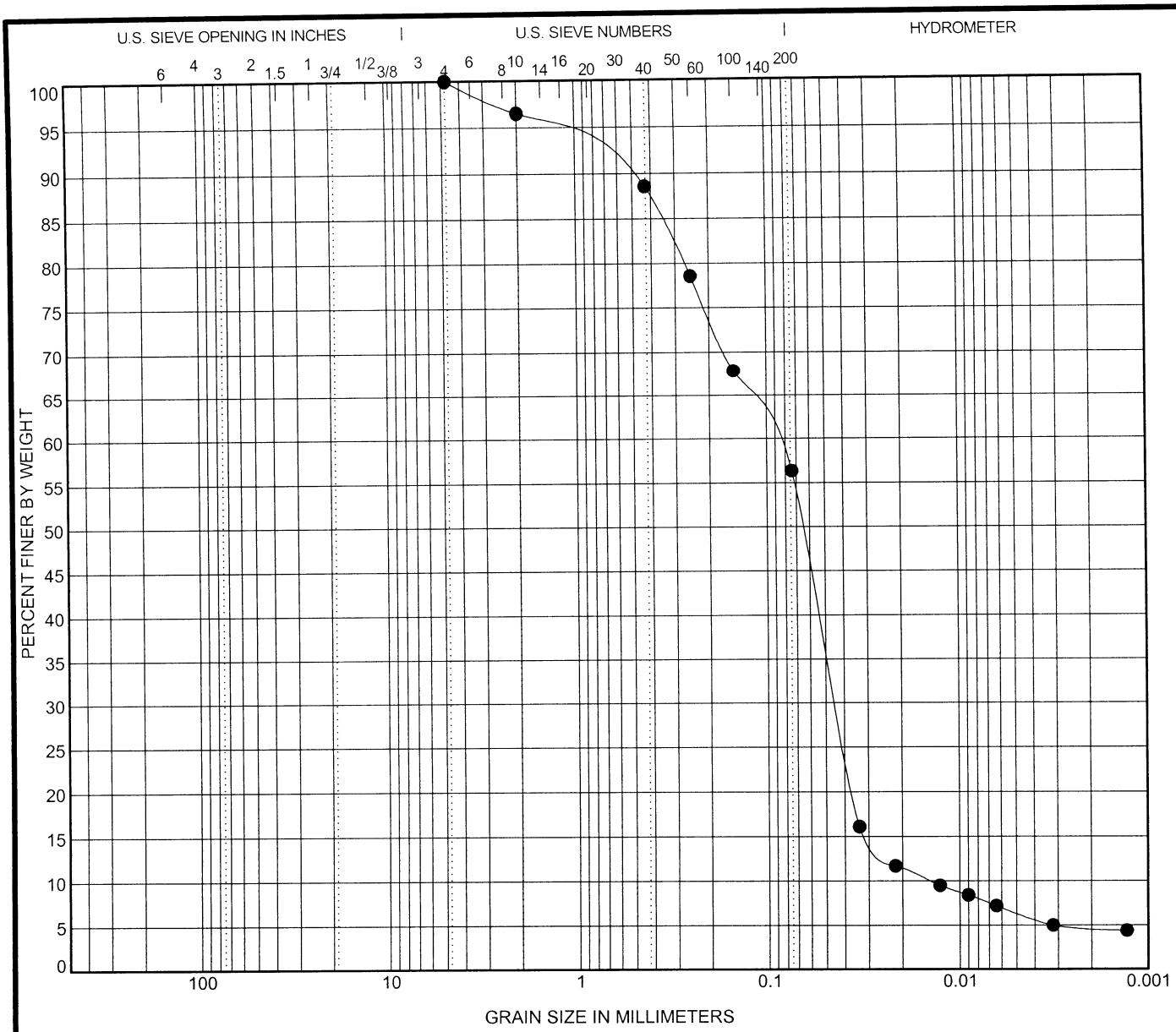
	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH14/12 at	18.5	4.76	0.186	0.077		0.0	70.8	29.2	

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	BH15/7 at	6.0	SANDY SILT(ML)	30	27	3	1.47	6.43

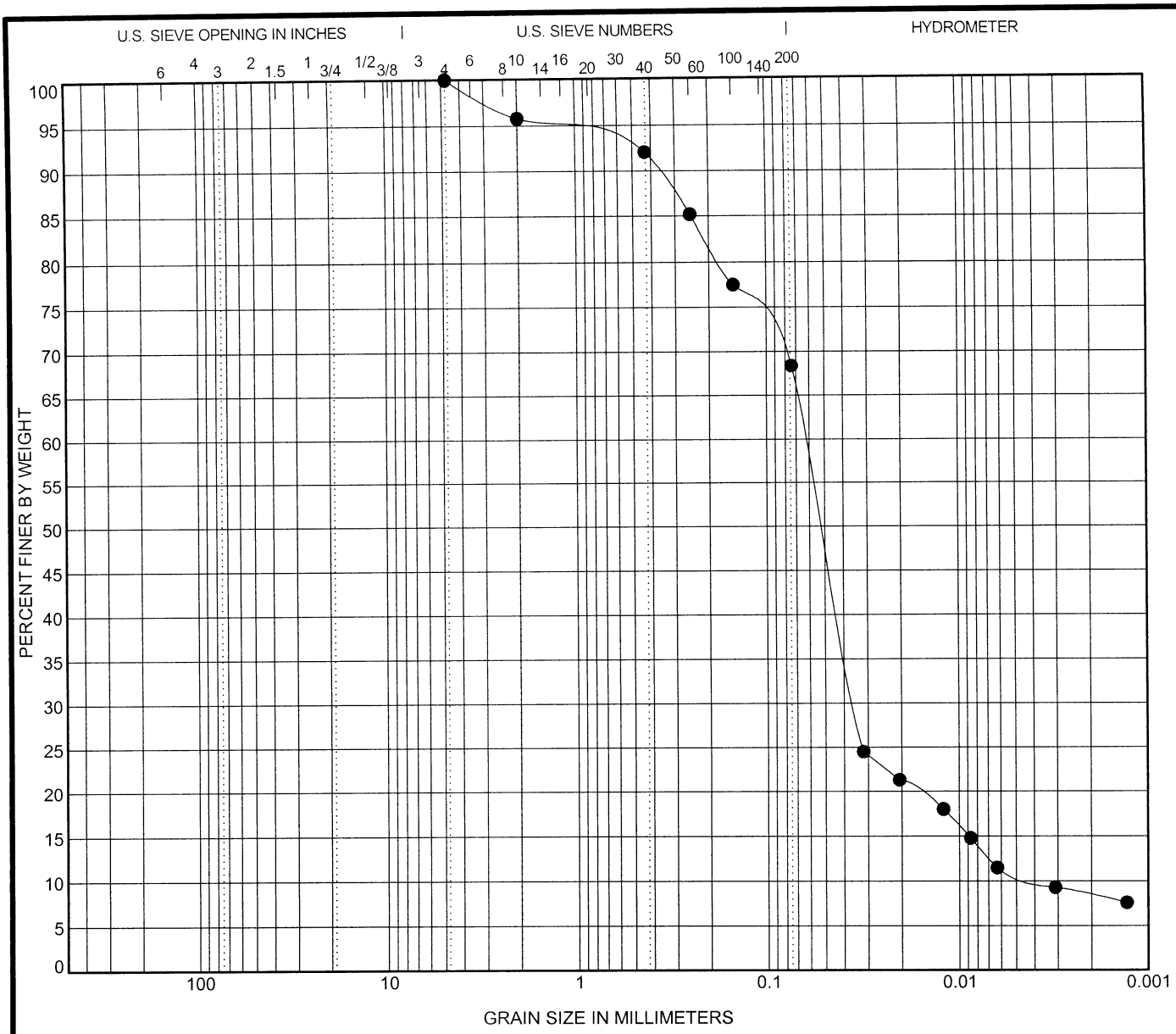
	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH15/7 at	6.0	4.76	0.092	0.044	0.014	0.0	43.4	50.2	6.4

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	BH16/10 at	9.0	SANDY LEAN CLAY(CL)	31	19	12	5.11	16.21

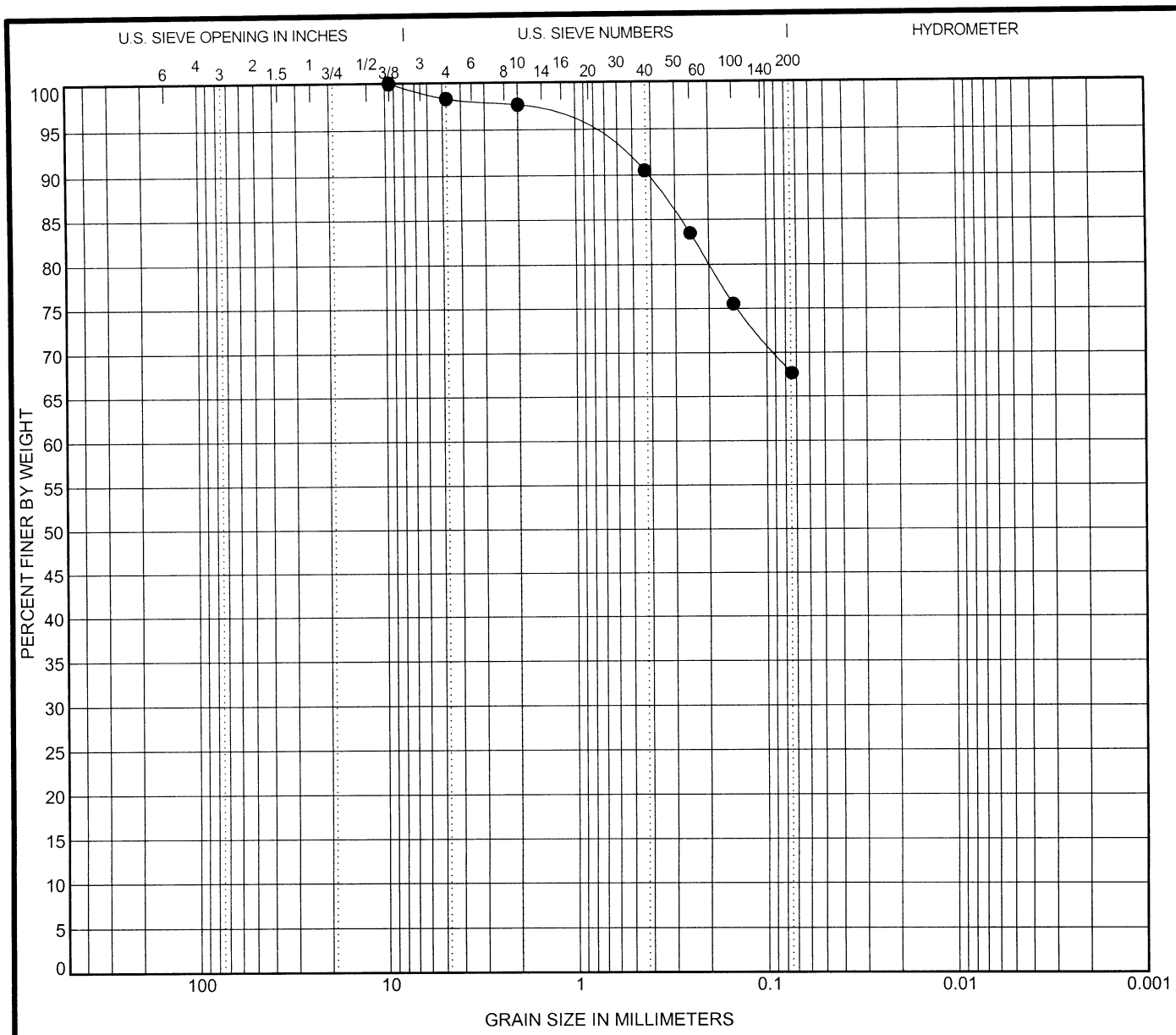
	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BH16/10 at	9.0	4.76	0.063	0.035	0.004	0.0	31.4	57.8	10.8

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	GCP6/2 at	2.0						

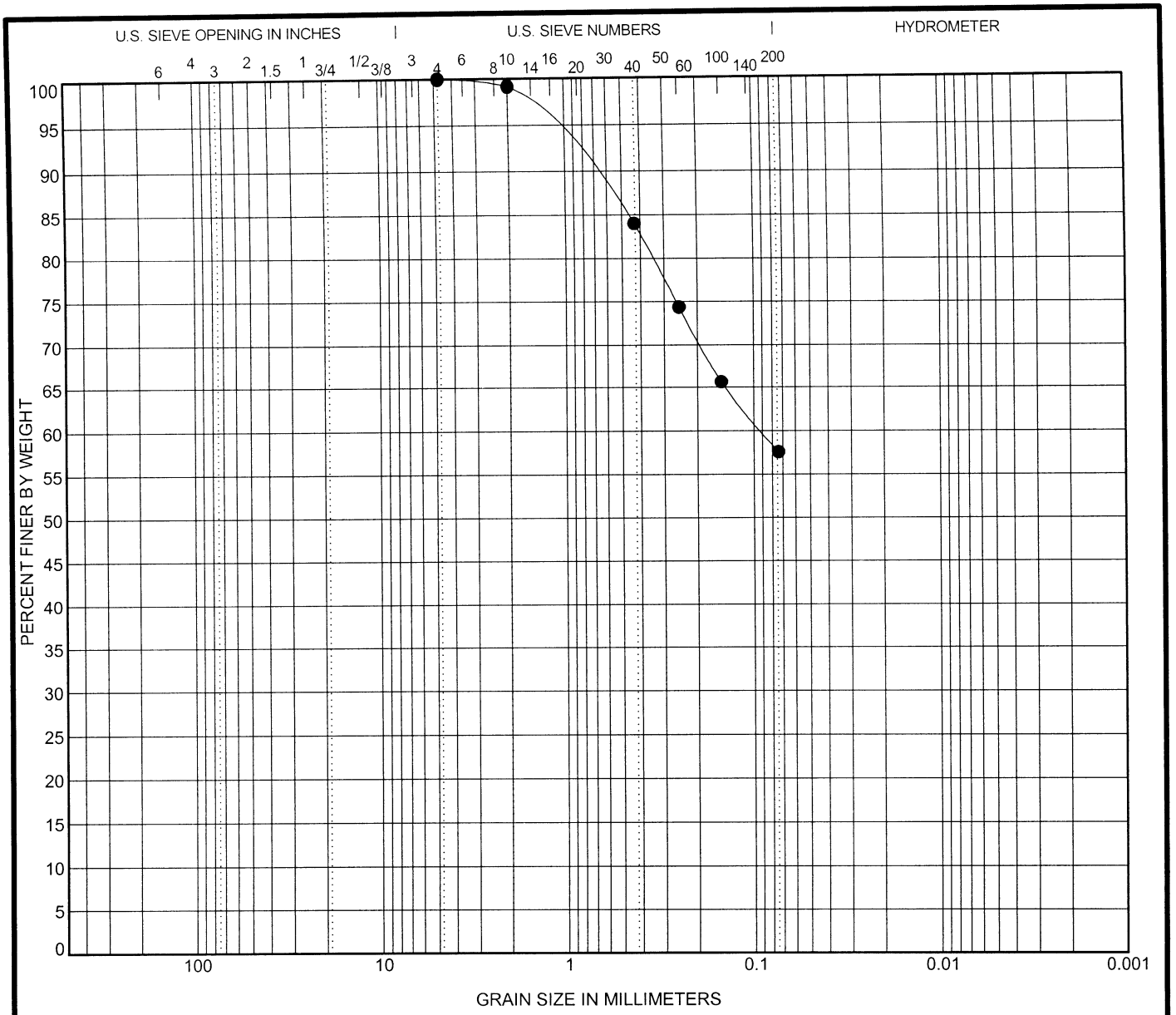
	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCP6/2 at	2.0	9.52				1.6	30.5	67.8	

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring No.	Depth	Classification	LL	PL	PI	Cc	Cu
●	GCP6/7 at	12.0						

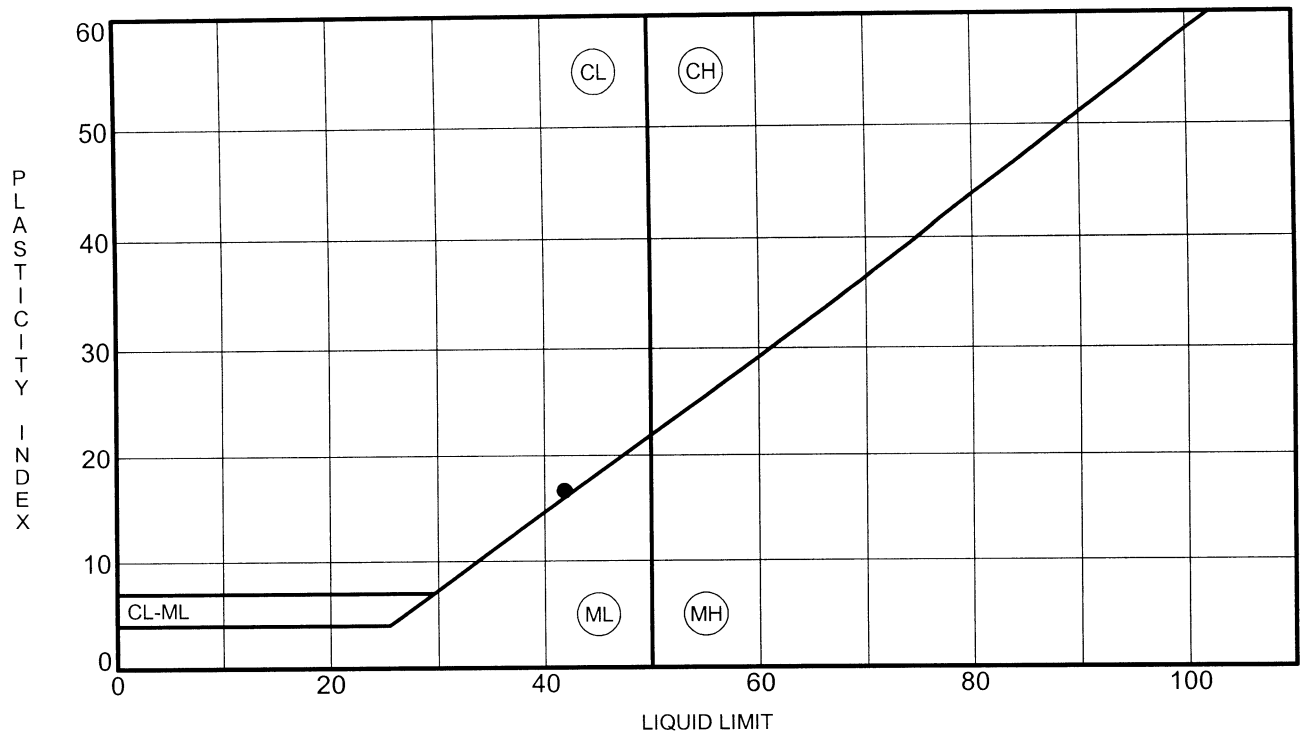
	Boring No.	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	GCP6/7 at	12.0	4.76	0.091			0.0	42.2	57.7	

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

GRAIN SIZE DISTRIBUTION

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



Boring No.	Depth	LL	PL	PI	Fines	Classification
● BH02/11 at	8.0	42	25	17	74	LEAN CLAY with SAND(CL),{A-7-6}

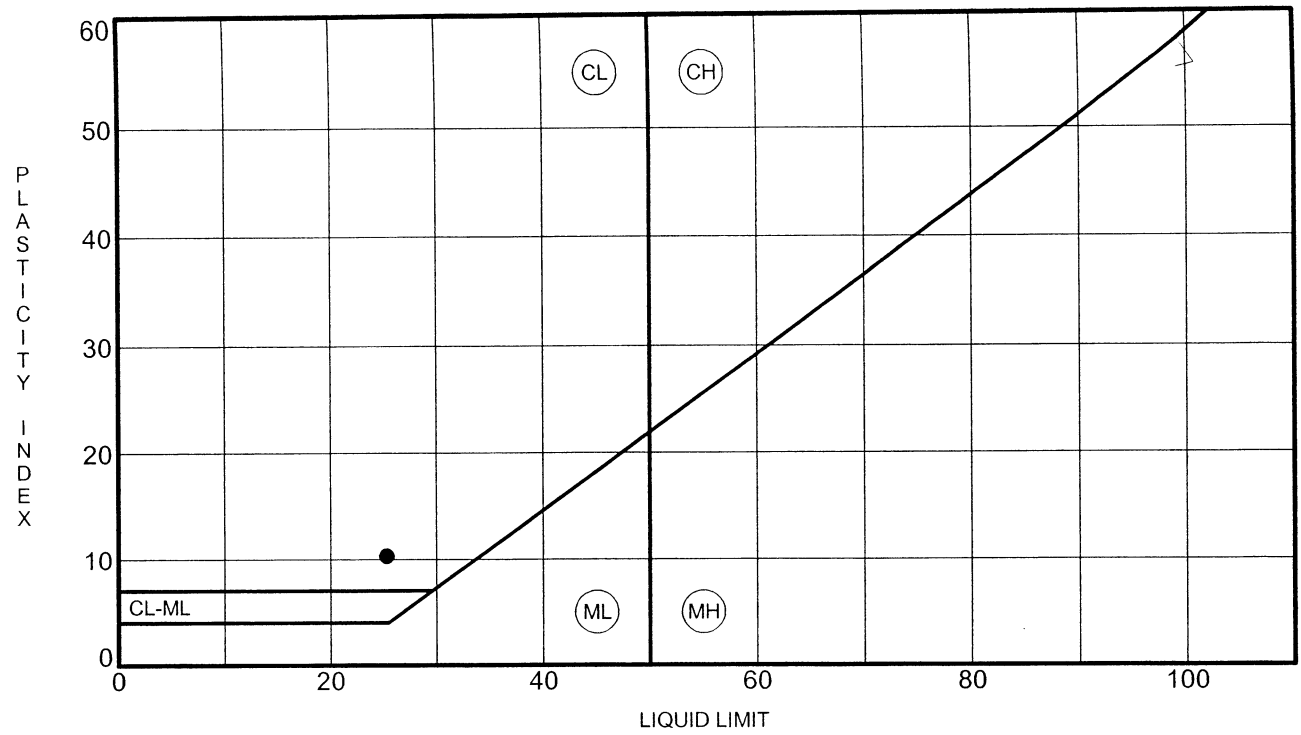
SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

ATTERBERG LIMITS' RESULTS

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007

US ATTERBERG LIMITS LAB TEST RESULTS.GPJ F&R.GDT 4/17/07



Boring No.	Depth	LL	PL	PI	Fines	Classification
● BH04/14 at	28.5	25	15	10		

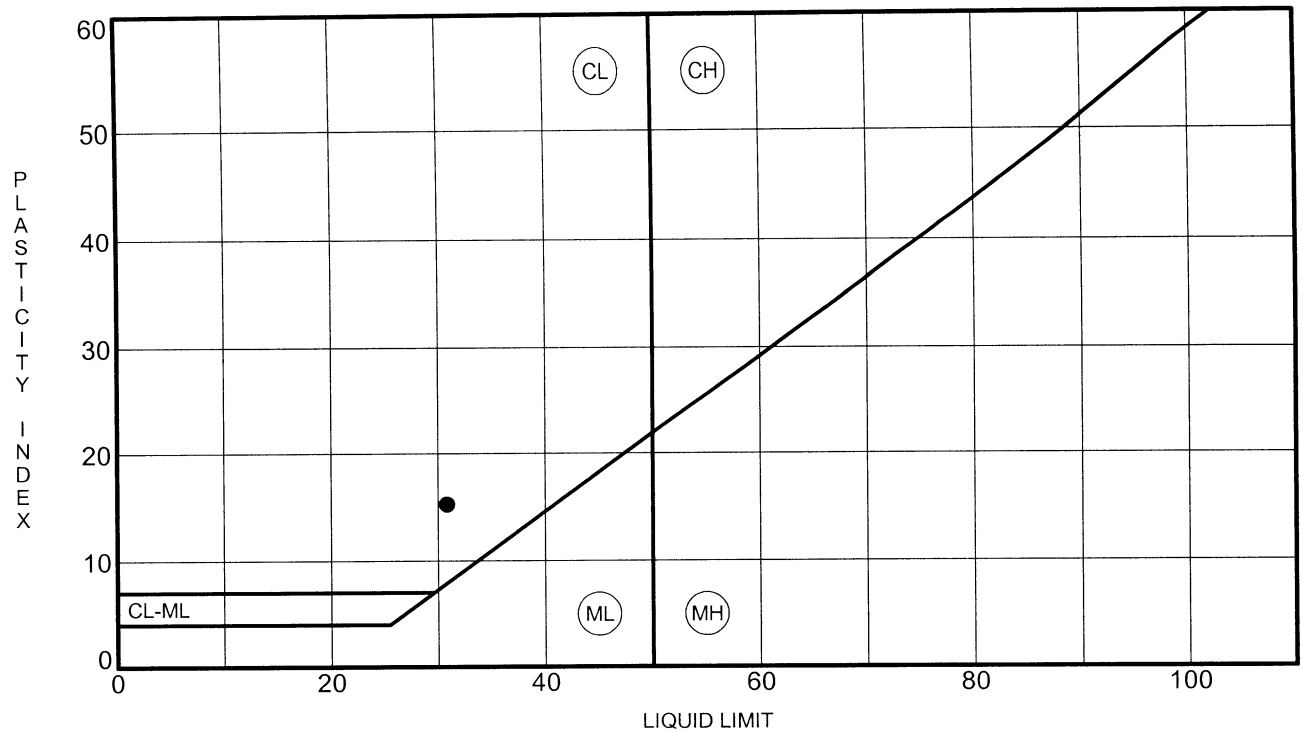
SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

ATTERBERG LIMITS' RESULTS

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007

S ATTERBERG LIMITS LAB TEST RESULTS.GPJ F&R.GDT 4/17/07



	Boring No.	Depth	LL	PL	PI	Fines	Classification
●	BH05/14 at	28.5	31	16	15		

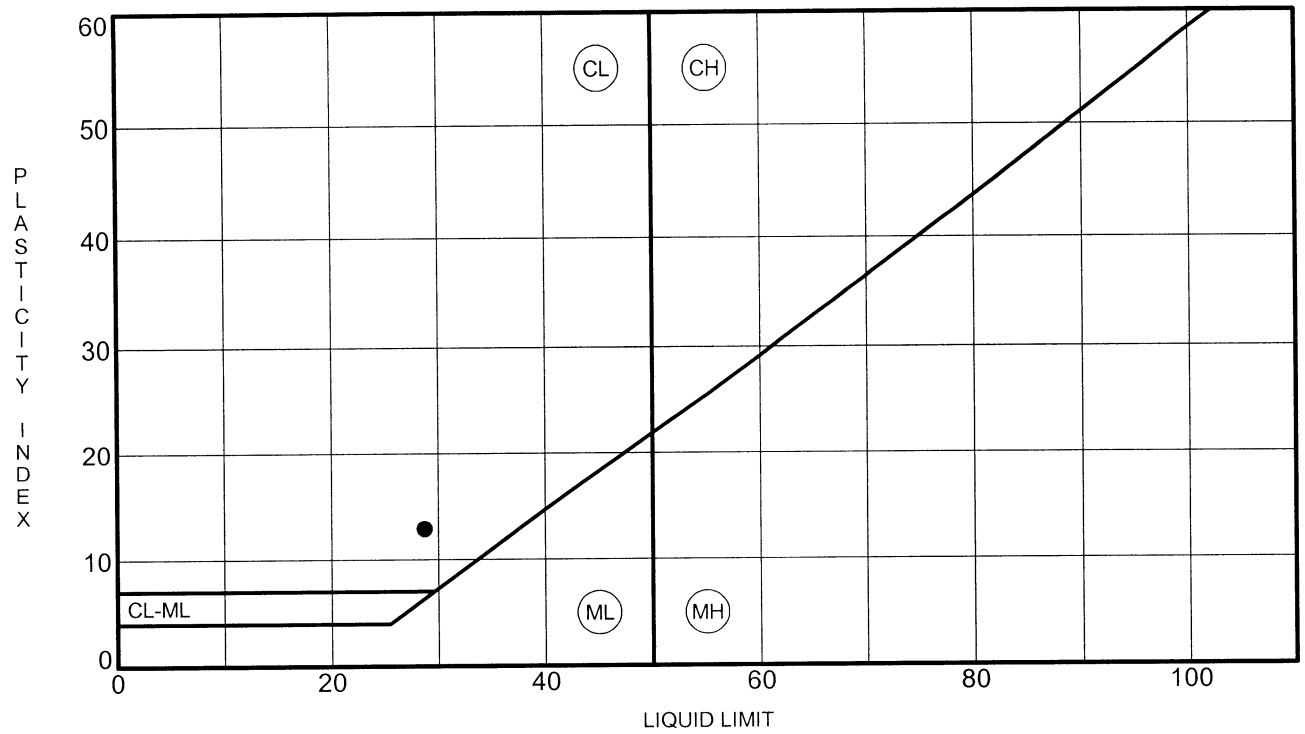
SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

ATTERBERG LIMITS' RESULTS

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007

US ATTERBERG LIMITS LAB TEST RESULTS.GPJ F&R.GDT 4/17/07



	Boring No.	Depth	LL	PL	PI	Fines	Classification
●	BH06/14 at	28.5	29	16	13		

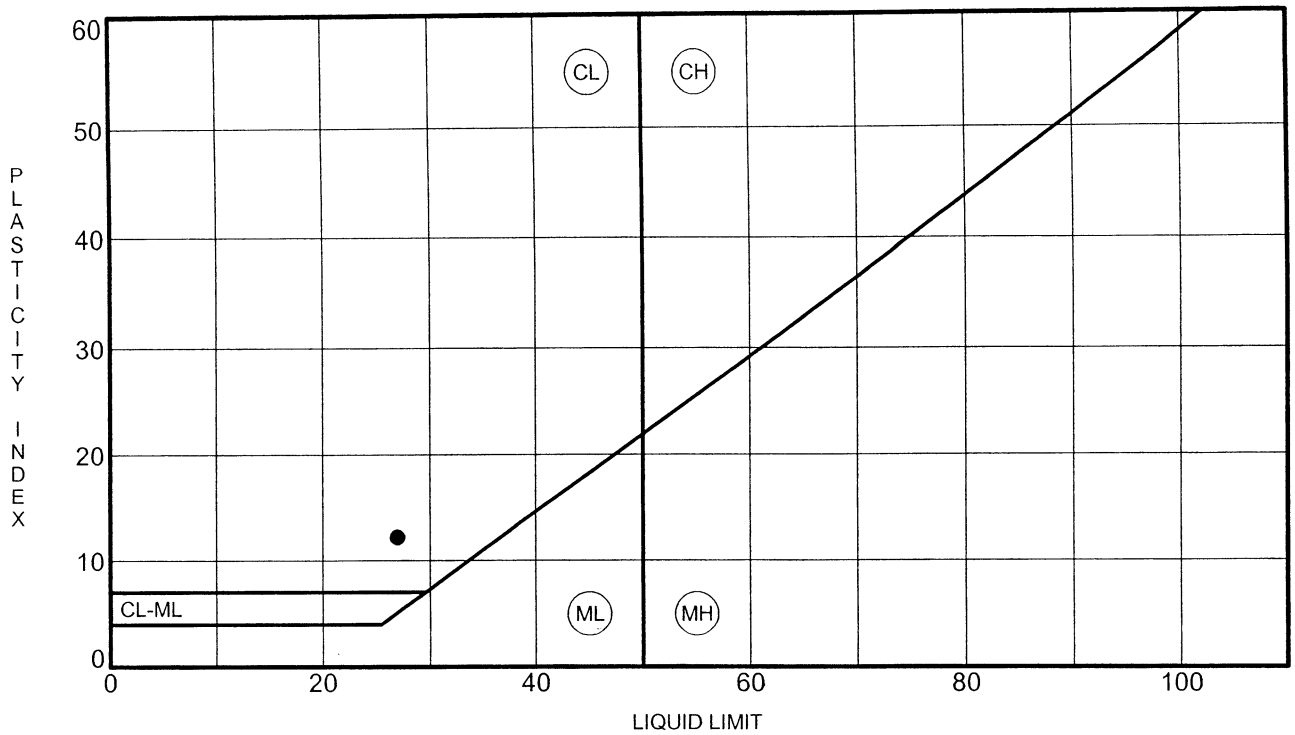
SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

ATTERBERG LIMITS' RESULTS

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007

US ATTERBERG LIMITS LAB TEST RESULTS.GPJ F&R.GDT 4/17/07



Boring No.	Depth	LL	PL	PI	Fines	Classification
● BH07/14 at	28.5	27	15	12		

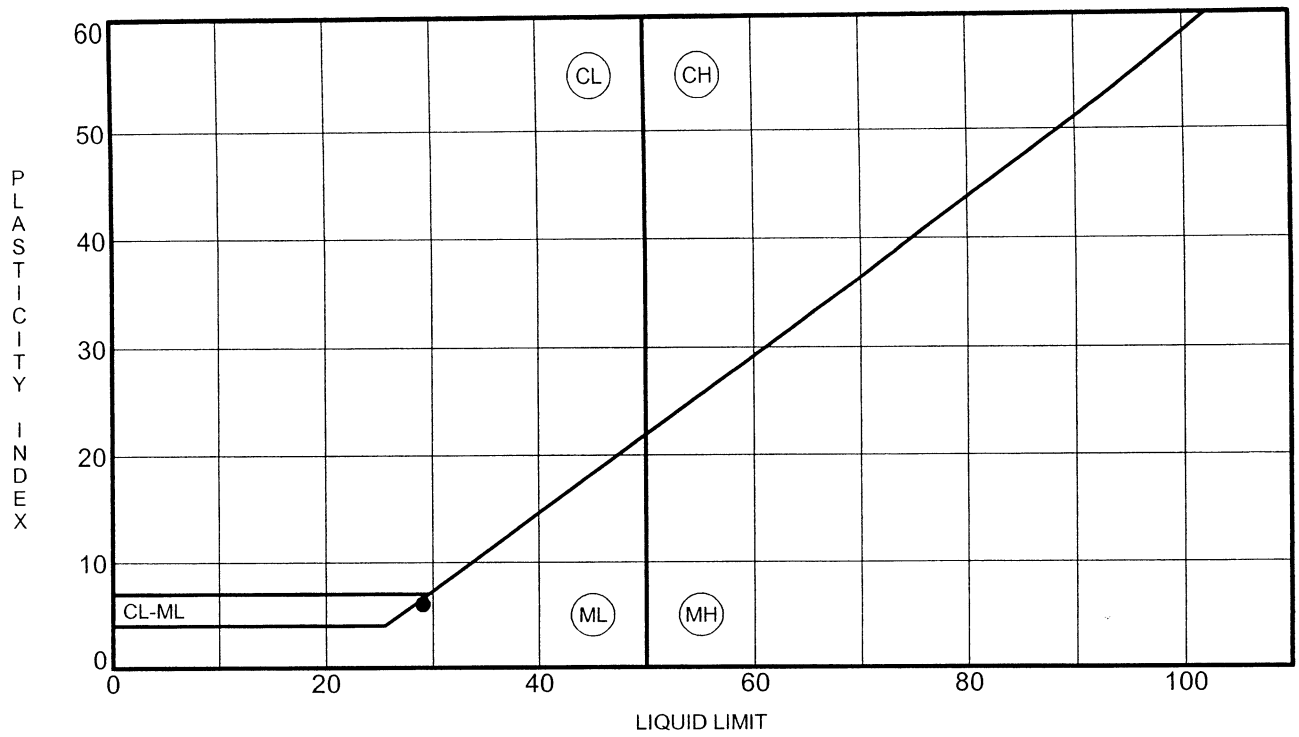
SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

ATTERBERG LIMITS' RESULTS

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007

US ATTERBERG LIMITS LAB TEST RESULTS.GPJ F&R.GDT 4/17/07



Boring No.	Depth	LL	PL	PI	Fines	Classification
● BH10/14	at 28.5	29	23	6		

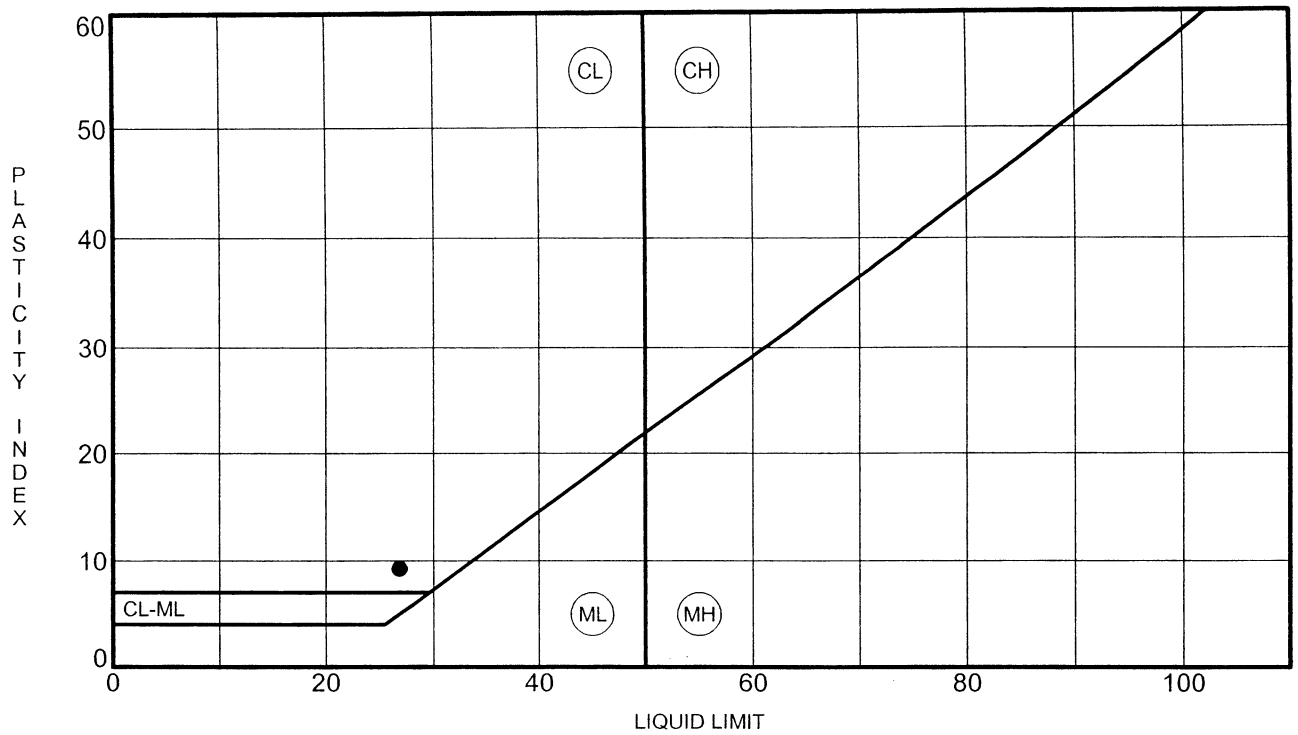
SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

ATTERBERG LIMITS' RESULTS

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007

JS ATTERBERG LIMITS LAB TEST RESULTS.GPJ F&R.GDT 4/17/07



Boring No.	Depth	LL	PL	PI	Fines	Classification
● BH11/11 at	18.5	27	18	9		

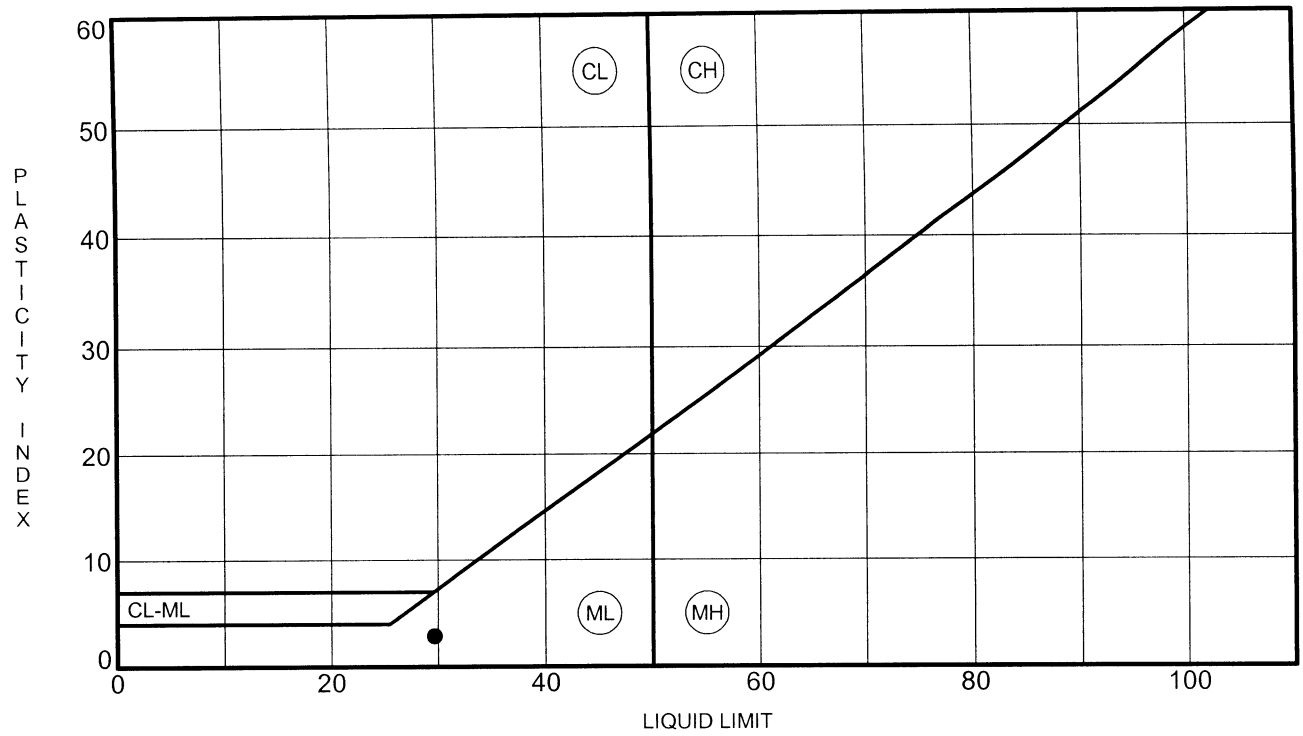
SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

ATTERBERG LIMITS' RESULTS

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007

US ATTERBERG LIMITS LAB TEST RESULTS.GPJ F&R.GDT 4/17/07



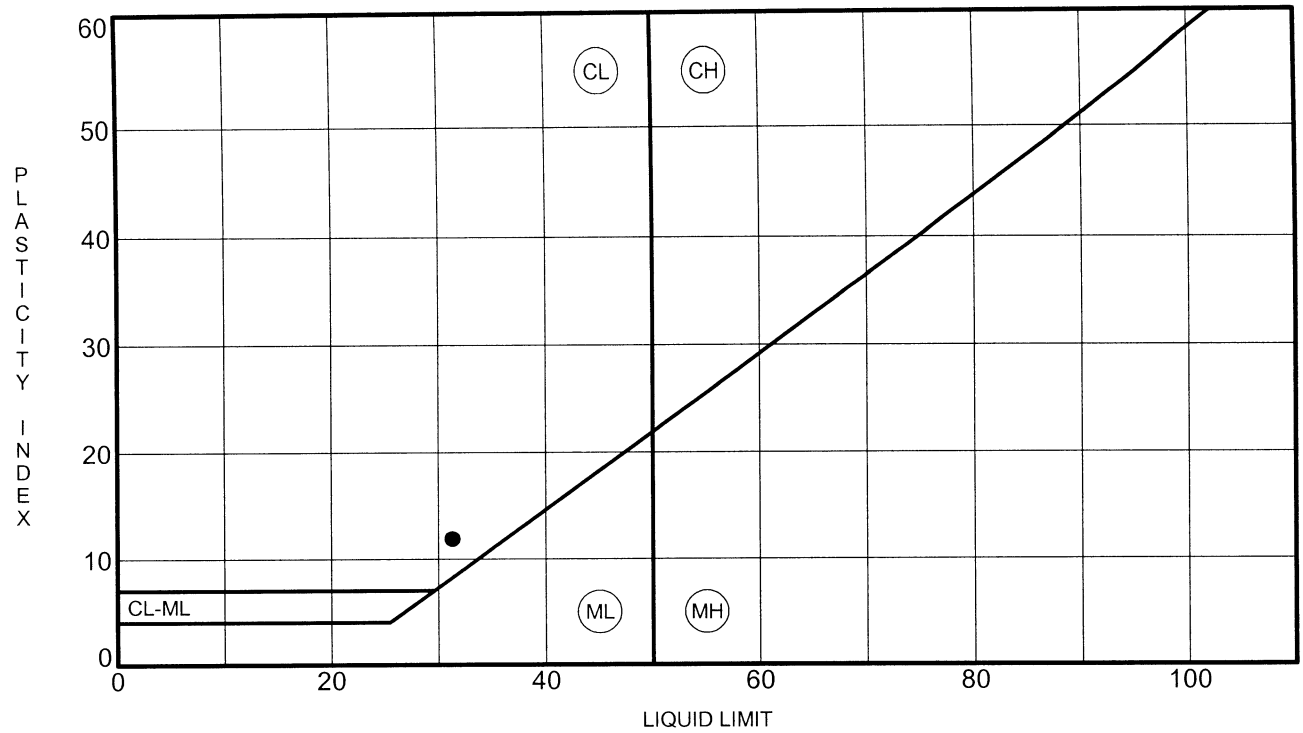
Boring No.	Depth	LL	PL	PI	Fines	Classification
● BH15/7	at 6.0	30	27	3	57	SANDY SILT(ML),{A-4}

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

ATTERBERG LIMITS' RESULTS

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007



Boring No.	Depth	LL	PL	PI	Fines	Classification
● BH16/10 at	9.0	31	19	12	69	SANDY LEAN CLAY(CL),{A-6}

SINCE 1881

FROEHLING & ROBERTSON, INC.
GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER ONE HUNDRED YEARS OF SERVICE"

ATTERBERG LIMITS' RESULTS

Report No.: H72-036D
Client: CH2MHill
Project: Washington Aqueduct
Location: Washington, D.C.
Date: April 2007

US ATTERBERG LIMITS LAB TEST RESULTS.GPJ F&R.GDT 4/17/07

Organic and Moisture Content of Soil
ASTM D2974

	Moisture Content			
Sample ID	BH3/S6	BH12/SS11	BH13/S7	
Mass of dish and foil, g	118.54	120.14	118.54	
Mass of dish, foil and sample; Wet, g	197.58	187.73	171.81	
Mass of dish, foil and sample; Dry, g	189.07	178.22	164.43	
Mass of soil; Wet, g	79.04	67.59	53.27	
Mass of soil; Dry, g	70.53	58.08	45.89	
Moisture content, %	12	16	16	

	Organic Matter			
Sample ID	BH3/S6	BH12/SS11	BH13/S7	
Mass of dish and foil, g	118.54	120.14	118.54	
Mass of dish, foil and dry specimen, before, g	189.07	178.22	164.43	
Mass of dish, foil and dry specimen, after, g	187.89	177.09	163.58	
Mass of sample before burn-off, g	70.53	58.08	54.89	
Mass of sample after burn-off, g	69.35	56.95	45.04	
Ash content, %	98.3	98.1	98.1	
Organic Matter, %	1.7	1.9	1.9	

SINCE 1881

FROEHLING & ROBERTSON, INC

GEOTECHNICAL ● ENVIRONMENTAL ● MATERIALS
ENGINEERS ● LABORATORIES
"OVER 125 YEARS OF SERVICE"
22923 Quicksilver Drive, Suite 111
Sterling, Virginia 20166
Phone: 703.996.0123 Fax: 703.996.0124

Corrosivity Test Results

Washington Aqueduct Residuals Project
H72-036D

Sample ID	Sample Depth (ft)	Chloride Content (ppm)	pH	Resistivity (ohm-cm)	Sulfate (ppm)
GCP-5	6.0-10.0	13	5.27	7610	89
BH-5	6.0-8.0	15	6.8	4590	96
BH-5	13.5-15.0	9	7.06	3090	107
BH-8	33.5-45.0	12	4.90	437	63
BH-12	18.5-25.0	14	8.09	9150	58
BH-13	23.5-30.0	18	6.02	8780	51
BH-16	13.5-20.0	13	4.1	13700	45

SINCE 1881

FROEHLING & ROBERTSON, INC

GEOTECHNICAL • ENVIRONMENTAL • MATERIALS
ENGINEERS • LABORATORIES
"OVER 125 YEARS OF SERVICE"
22923 Quicksilver Drive, Suite 111
Sterling, Virginia 20166
Phone: 703.996.0123 Fax: 703.996.0124

Rock Core Test Report

Washington Aqueduct Residuals Project
H72-036D

Sample ID	Sample Depth (ft.)	Length After Sawing (in.)	Length After Cap (in.)	Diameter (in.)	Area (in.^{2})	L/D	Lbs.	Compressive Strength (psi)
BH-1 (R-1)	41'-41.7'	4.55	4.58	1.97	3.048052	2.324873	15860	5203
BH-3_5 (R-1)	17'-18'	4.80	4.85	1.97	3.048052	2.461929	39560	12979
BH-4 (R-1)	66.3'-67'	4.41	4.46	1.97	3.048052	2.263959	39370	12916
BH-5 (R-1)	71'-72'	3.69	3.72	1.97	3.048052	1.888325	24270	7962
BH-5 (R-1)	75'-76'	4.55	4.58	1.97	3.048052	2.324873	18780	6161
BH-6 (R-1)	67'-67.5'	4.14	4.18	1.97	3.048052	2.121827	21750	7136
BH-7	70'3"-75'3"	3.89	3.91	1.98	3.079075	1.974747	20870	6779
BH-8	75'4"-80'4"	3.94	3.97	1.98	3.079075	2.005051	23320	7575
BH-9 (R-2)	66.3'-67.3'	4.79	4.83	1.97	3.048052	2.451777	32500	10663
BH-10 (R-2)	63'-64'	4.76	4.81	1.97	3.048052	2.441624	10730	3520
BH-11	75'10"-80'10"	3.95	3.98	1.98	3.079075	2.010101	23240	7548
BH-13 (R-1)	58'-59'	4.53	4.57	1.97	3.048052	2.319797	22770	7470
BH-14 (R-1)	64'-65'	4.77	4.82	1.97	3.048052	2.446701	14900	4888
BH-15 (R-1)	49'-50'	5.08	5.11	1.97	3.048052	2.593909	19880	6522
BH-16 (R-1)	52'-53'	4.70	4.74	1.97	3.048052	2.406091	12340	4048
BH-16 (R-2)	56.5'-57'	4.76	4.79	1.97	3.048052	2.431472	27030	8868

CALIFORNIA BEARING RATIO TEST AT (90%)

CLIENT: CH2MHILL

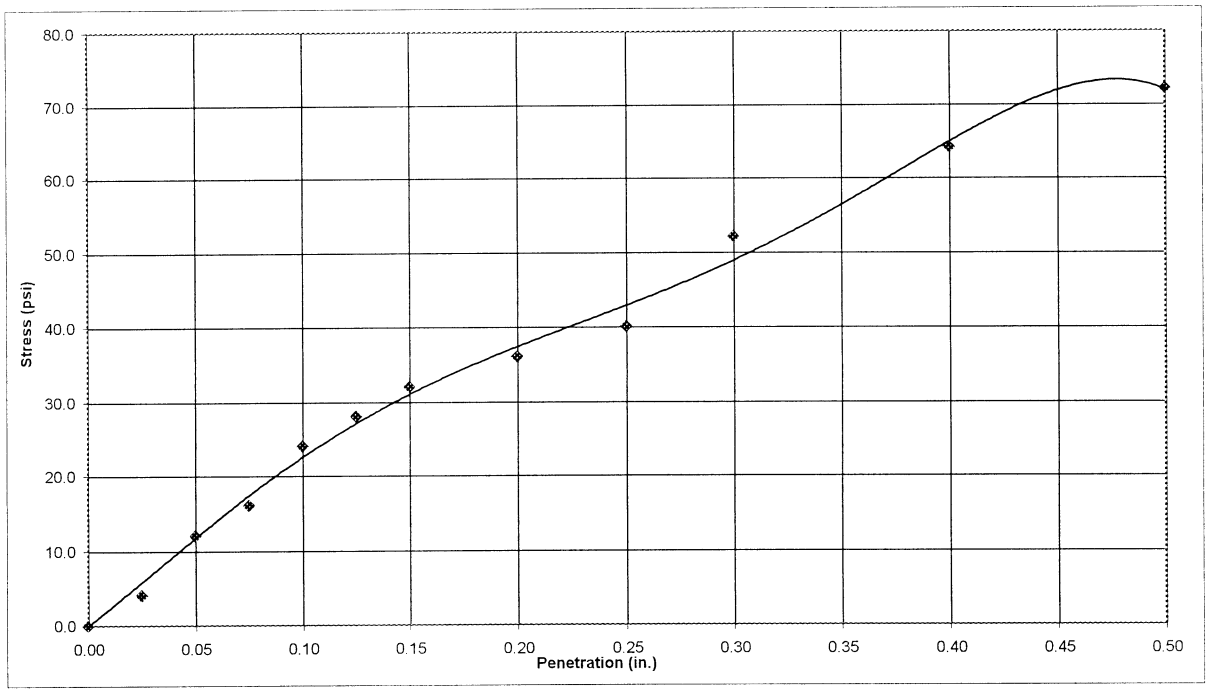
PROJECT NO.: H72-036D

PROJECT: Washington Aqueduct

DATE TESTED: J. Boyd

LOCATION: Bag 2 , BH-01, 7 to 15 ft bgs

TEST METHOD: ASTM D1883



Soaked CBR =	2.4	**Swell :**	1.6%
Surcharge Load :	9.98 lbs	**Liquid Limit :**	
USCS Classification:		**Plasticity Index :**	
Max Dry Density (pcf):	128.6	**CBR % Compaction:**	97.8%
Optimum Moisture (%):	12.0%	**CBR Sample Moisture: (before soaking)**	7.6%
		CBR Sample Moisture: (after soaking)	

CALIFORNIA BEARING RATIO TEST AT (95%)

CLIENT: CH2MHILL

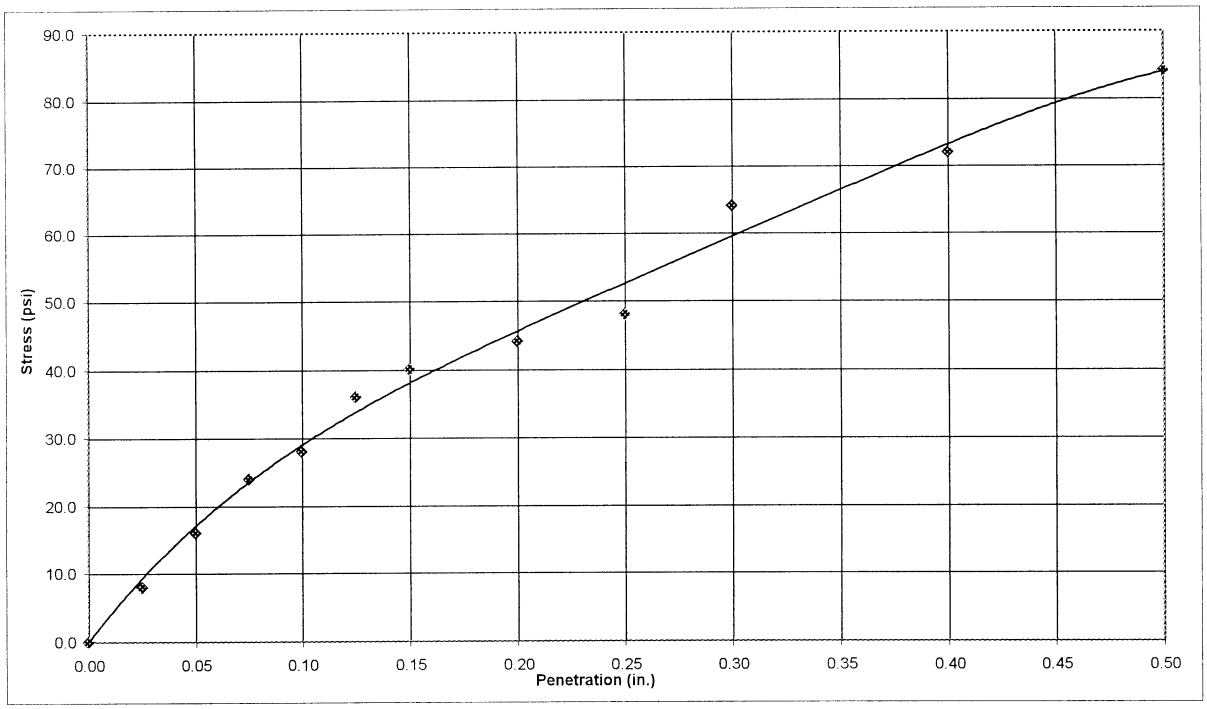
PROJECT: Washington Aqueduct

LOCATION: Bag 2 , BH-01, 7 to 15 ft bgs

PROJECT NO.: H72-036D

DATE TESTED: J. Boyd

TEST METHOD: ASTM D1883



Soaked CBR =	2.8	**Swell :**	3.3%
Surcharge Load :	9.98 lbs	**Liquid Limit :**	
USCS Classification:		**Plasticity Index :**	
Max Dry Density (pcf):	128.6	**CBR % Compaction:**	97.4%
Optimum Moisture (%):	12.0%	**CBR Sample Moisture: (before soaking)**	9.3%
		CBR Sample Moisture: (after soaking)	

CALIFORNIA BEARING RATIO TEST AT (100%)

CLIENT: CH2MHILL

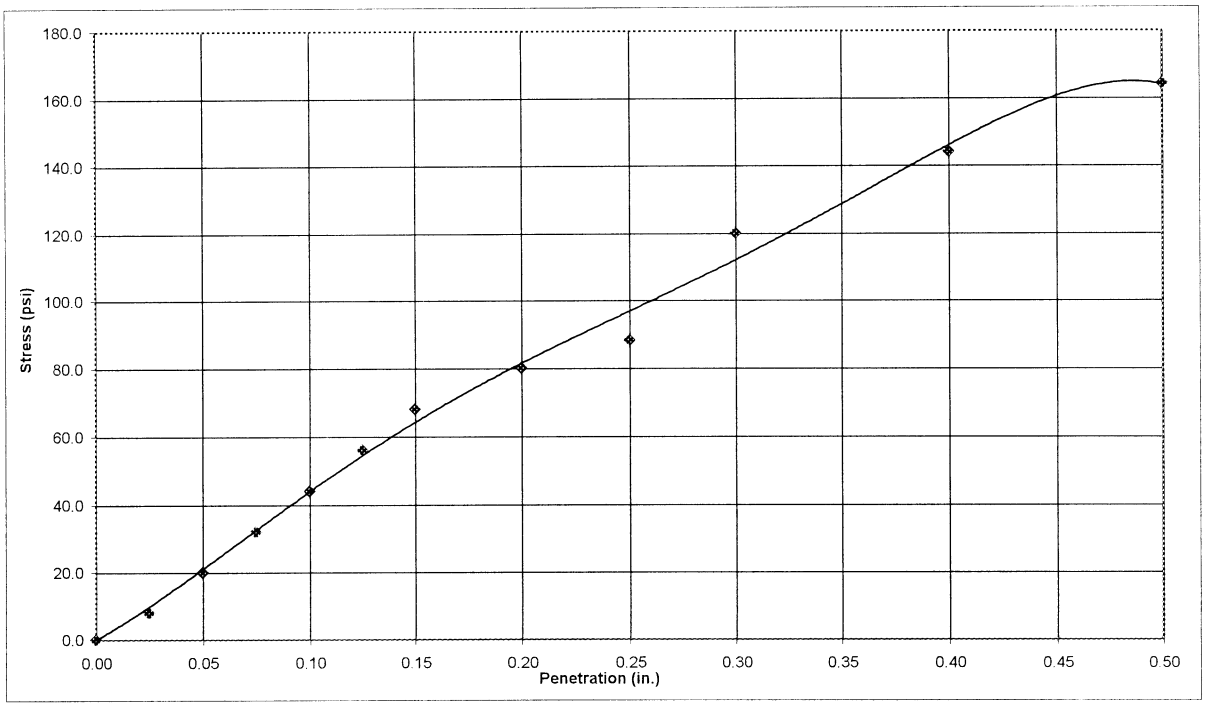
PROJECT: Washington Aqueduct

LOCATION: Bag 2 , BH-01, 7 to 15 ft bgs

PROJECT NO.: H72-036D

DATE TESTED: J. Boyd

TEST METHOD: ASTM D1883



Soaked CBR =	4.4	**Swell :**	2.7%
Surcharge Load :	9.98 lbs	**Liquid Limit :**	
USCS Classification:		**Plasticity Index :**	
Max Dry Density (pcf):	128.6	**CBR % Compaction:**	98.1%
Optimum Moisture (%):	12.0%	**CBR Sample Moisture: (before soaking)**	11.9%
		CBR Sample Moisture: (after soaking)	

CALIFORNIA BEARING RATIO TEST AT (90%)

CLIENT: CH2MHILL

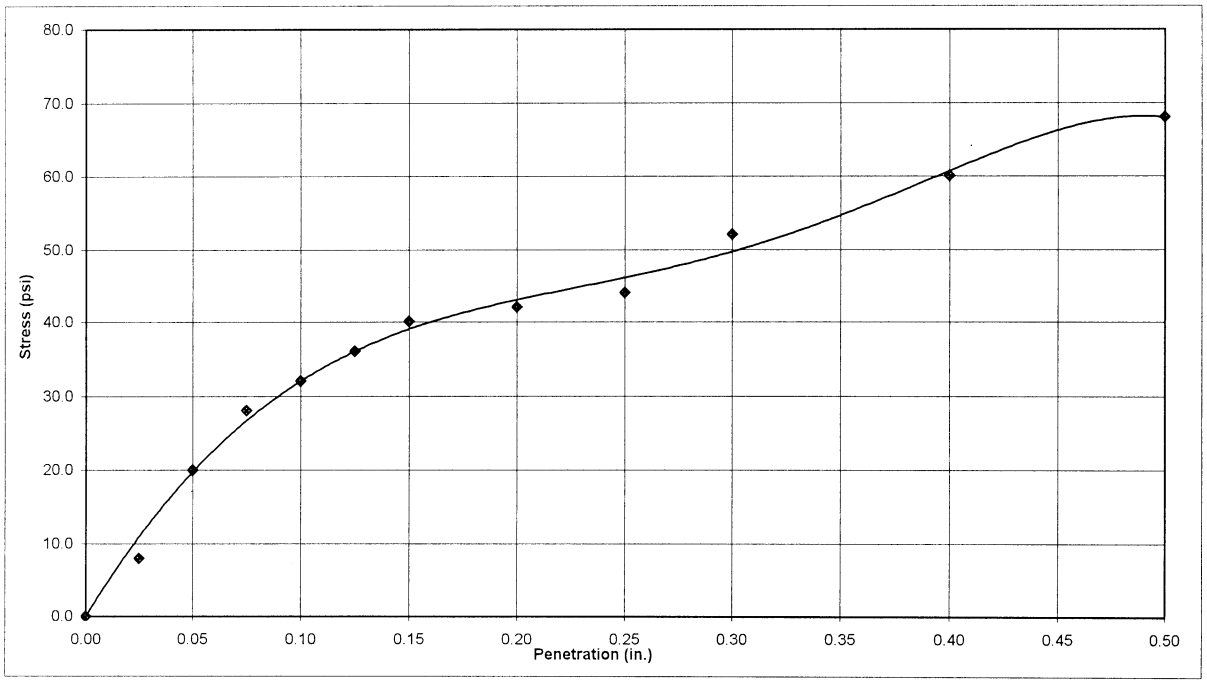
PROJECT NO.: H72-036D

PROJECT: Washington Aqueduct

DATE TESTED: J. Boyd

LOCATION: Bag 1, BH-06, 5-15 ft bgs

TEST METHOD: ASTM D1883



Soaked CBR =	3.2	**Swell :**	1.8%
Surcharge Load :	9.98 lbs	**Liquid Limit :**	
USCS Classification:		**Plasticity Index :**	
Max Dry Density (pcf):	113.8	**CBR % Compaction:**	98.1%
Optimum Moisture (%):	14.9%	**CBR Sample Moisture: (before soaking)**	9.2%
		CBR Sample Moisture: (after soaking)	24.6%

CALIFORNIA BEARING RATIO TEST AT (95%)

CLIENT: CH2MHILL

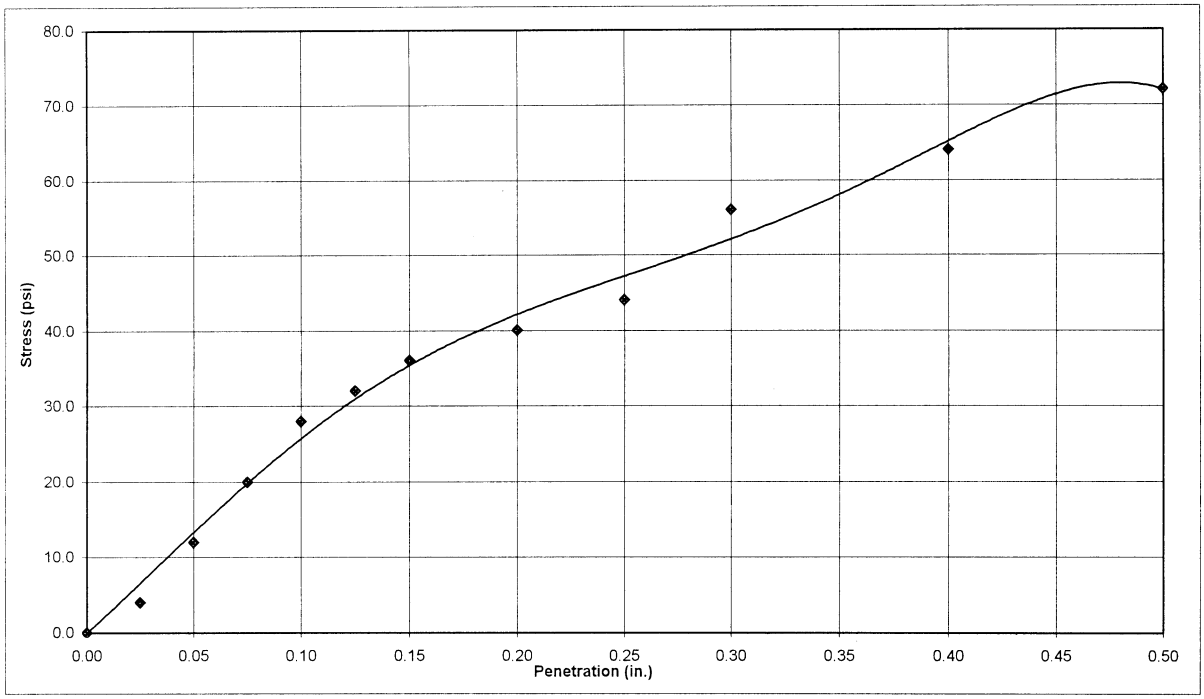
PROJECT: Washington Aqueduct

LOCATION: Bag 1 , BH-06, 5-15 ft bgs

PROJECT NO.: H72-036D

DATE TESTED: J. Boyd

TEST METHOD: ASTM D1883



Soaked CBR =	2.8	**Swell :**	2.0%
Surcharge Load :	9.98 lbs	**Liquid Limit :**	
USCS Classification:		**Plasticity Index :**	
Max Dry Density (pcf):	113.8	**CBR % Compaction:**	97.9%
Optimum Moisture (%):	14.9%	**CBR Sample Moisture: (before soaking)**	10.4%
		CBR Sample Moisture: (after soaking)	25.9%

CALIFORNIA BEARING RATIO TEST AT (100%)

CLIENT: CH2MHILL

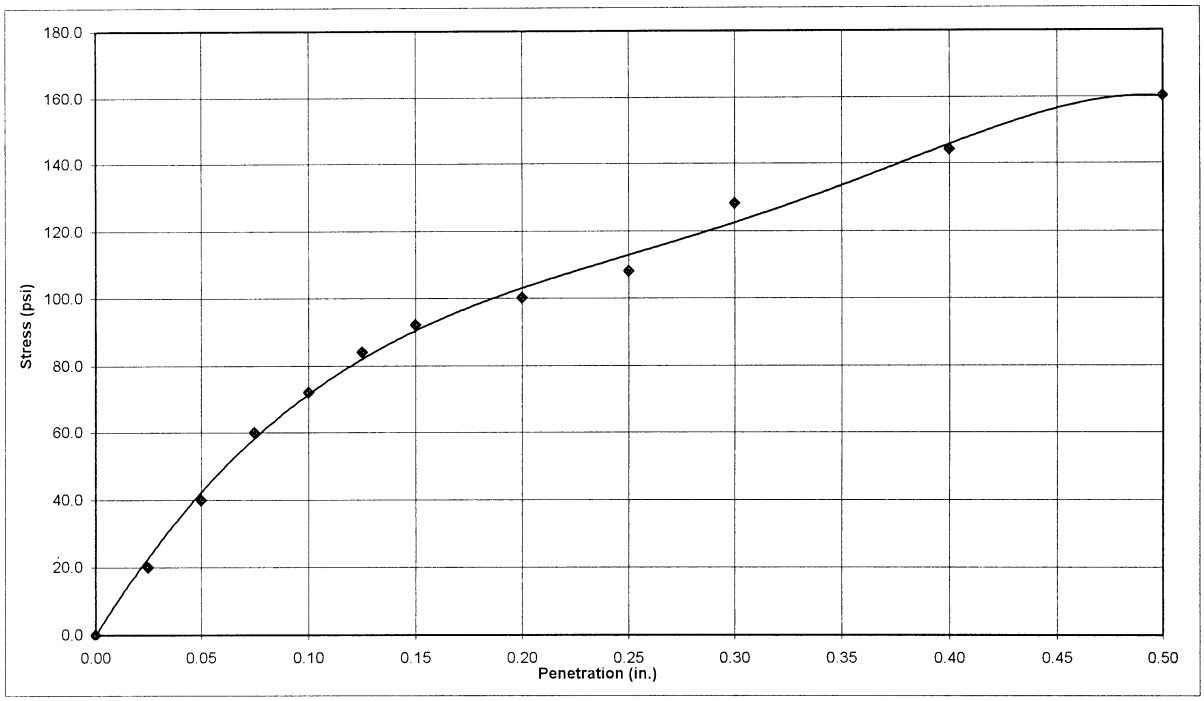
PROJECT: Washington Aqueduct

LOCATION: Bag 1 , BH-06, 5-15 ft bgs

PROJECT NO.: H72-036D

DATE TESTED: J. Boyd

TEST METHOD: ASTM D1883



Soaked CBR =	7.2	**Swell :**	2.8%
Surcharge Load :	9.98 lbs	**Liquid Limit :**	
USCS Classification:		**Plasticity Index :**	
Max Dry Density (pcf):	113.8	**CBR % Compaction:**	97.5%
Optimum Moisture (%):	14.9%	**CBR Sample Moisture: (before soaking)**	15.4%
		CBR Sample Moisture: (after soaking)	22.4%

CALIFORNIA BEARING RATIO TEST AT (90%)

CLIENT: CH2MHILL

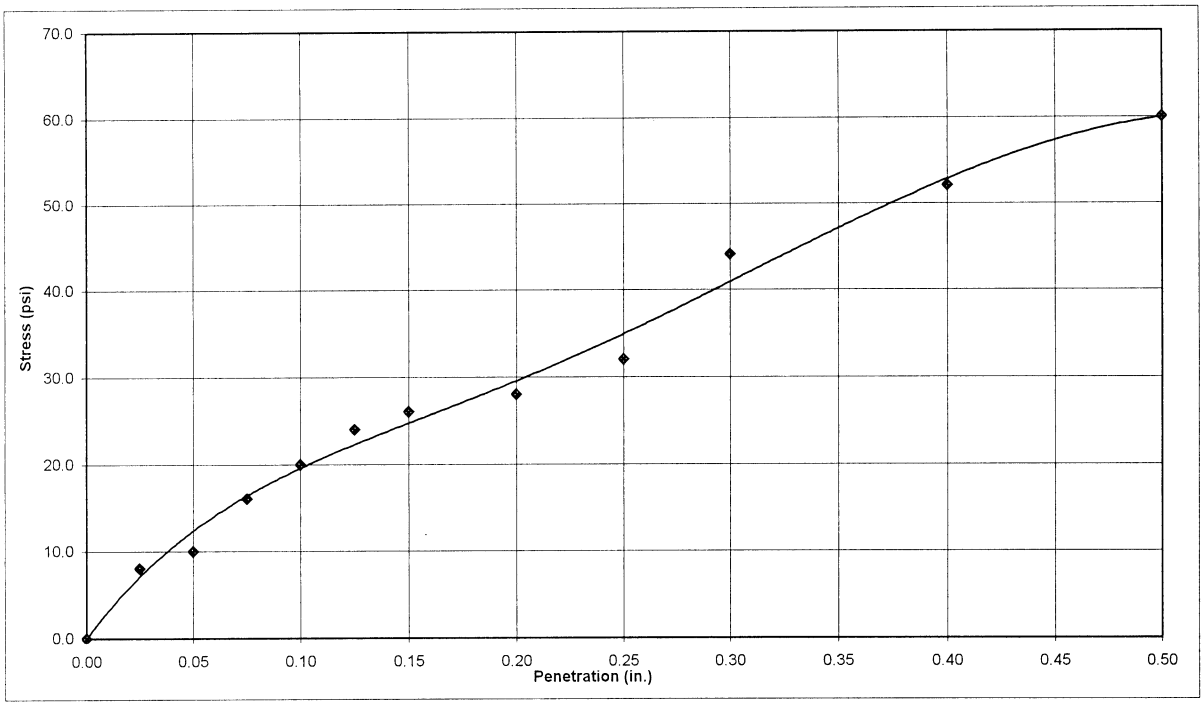
PROJECT: Washington Aqueduct

LOCATION: Bag 3 , BH-14

PROJECT NO.: H72-036D

DATE TESTED: J. Boyd

TEST METHOD: ASTM D1883



Soaked CBR =	2.0	**Swell :**	0.4%
Surcharge Load :	9.98 lbs	**Liquid Limit :**	
USCS Classification:		**Plasticity Index :**	
Max Dry Density (pcf):	113	**CBR % Compaction:**	97.1%
Optimum Moisture (%):	13.3%	**CBR Sample Moisture: (before soaking)**	5.0%
		CBR Sample Moisture: (after soaking)	24.1%

CALIFORNIA BEARING RATIO TEST AT (95%)

CLIENT: CH2MHILL

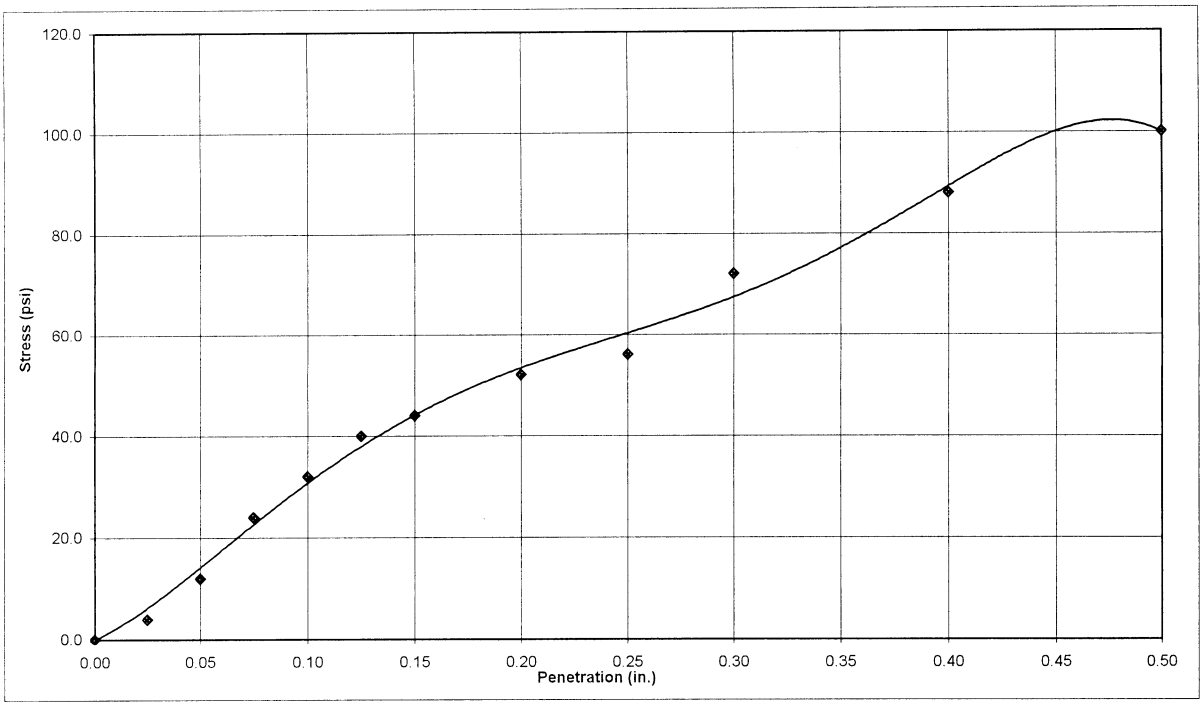
PROJECT: Washington Aqueduct

LOCATION: Bag 3 , BH-14

PROJECT NO.: H72-036D

DATE TESTED: J. Boyd

TEST METHOD: ASTM D1883



Soaked CBR =	3.2	**Swell :**	0.5%
Surcharge Load :	9.98 lbs	**Liquid Limit :**	
USCS Classification:		**Plasticity Index :**	
Max Dry Density (pcf):	113	**CBR % Compaction:**	97.2%
Optimum Moisture (%):	13.3%	**CBR Sample Moisture: (before soaking)**	6.7%
		CBR Sample Moisture: (after soaking)	24.2%

CALIFORNIA BEARING RATIO TEST AT (100%)

CLIENT: CH2MHILL

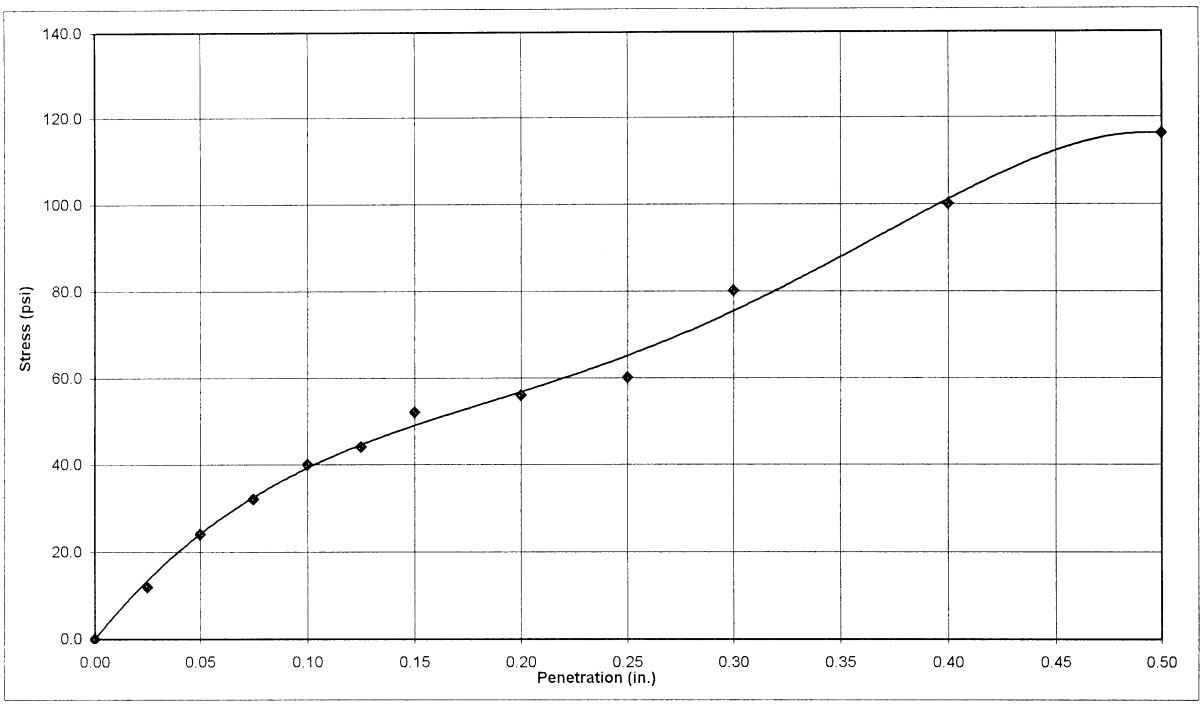
PROJECT: Washington Aqueduct

LOCATION: Bag 3 , BH-14

PROJECT NO.: H72-036D

DATE TESTED: J. Boyd

TEST METHOD: ASTM D1883



Soaked CBR =	4.0	**Swell :**	0.7%
Surcharge Load :	9.98 lbs	**Liquid Limit :**	
USCS Classification:		**Plasticity Index :**	
Max Dry Density (pcf):	113	**CBR % Compaction:**	97.0%
Optimum Moisture (%):	13.3%	**CBR Sample Moisture: (before soaking)**	12.0%
		CBR Sample Moisture: (after soaking)	21.6%

geotechnics
INTEGRITY IN TESTING

CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D - 4767 (SOP-S28)

Client	FROEHLING & ROBERTSON		
Client Reference	WASHINGTON AQUADUCT		
Project No.	2007-557-01		
Lab ID	2007-557-01-01	Specific Gravity (assumed)	2.70

Visual Description: TAN GRAY CLAYEY SAND (UNDISTURBED)

SAMPLE CONDITION SUMMARY

Boring No.	GCP-6	GCP-6	GCP-6
Depth (ft)	10.4-10.9	10.9-11.4	11.4-11.9
Sample No.	SB-2	SB-2	SB-2
Test No.	T1	T2	T3
Deformation Rate (in/min)	0.00034	0.00034	0.00034
Back Pressure (psi)	50.1	50.4	50.7
Consolidation Time (days)	1	1	1
Initial State (w%)	21.9	21.9	23.5
Total Unit Weight (pcf)	134.1	123.9	133.8
Dry Unit Weight (pcf)	110.0	101.7	108.3
Final State (w%)	20.2	22.3	21.0
Initial State Void Ratio,e	0.532	0.658	0.557

Tested By TMS Date 04/02/07 Input Checked By MDS Date 4-13-07

DCN: CT-S28 DATE 6-25-98 REVISION: 1

C:\Data Sheets\[Triax Summary.XLS]Sheet1

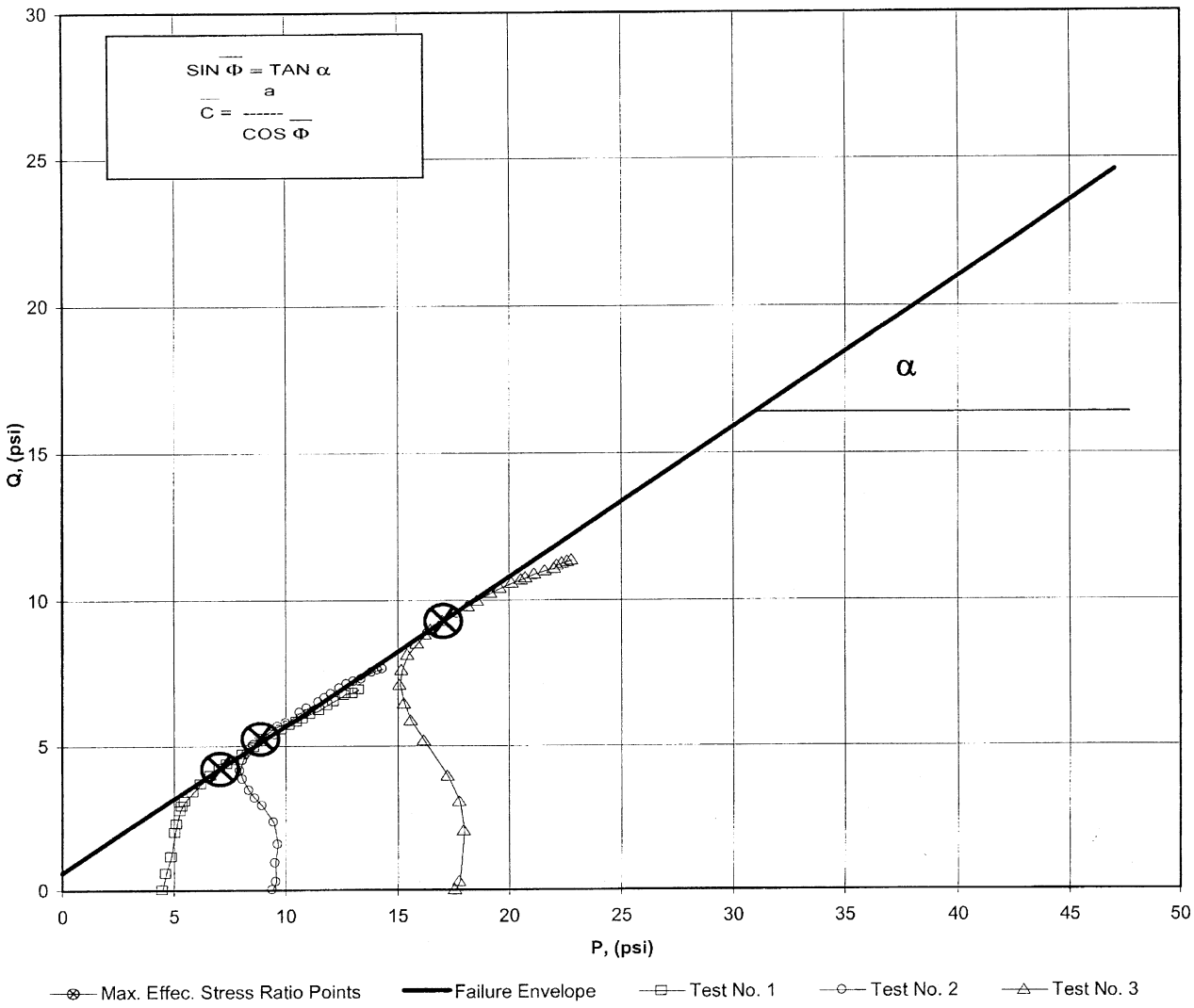
2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

geotechnics
INTEGRITY IN TESTING

CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

Client	FROEHLING & ROBERTSON	Boring No.	GCP-6
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	10-12
Project No.	2007-557-01	Sample No.	SB-2
Lab ID	2007-557-01-01		

Consolidated Undrained Triaxial Test with Pore Pressure



a	=	0.61	$\overline{C}$	=	0.71
α	=	27.0	$\overline{\Phi}$	=	30.62

Tested By TMS Date 4/2/07 Approved By DB Date 4-12-07

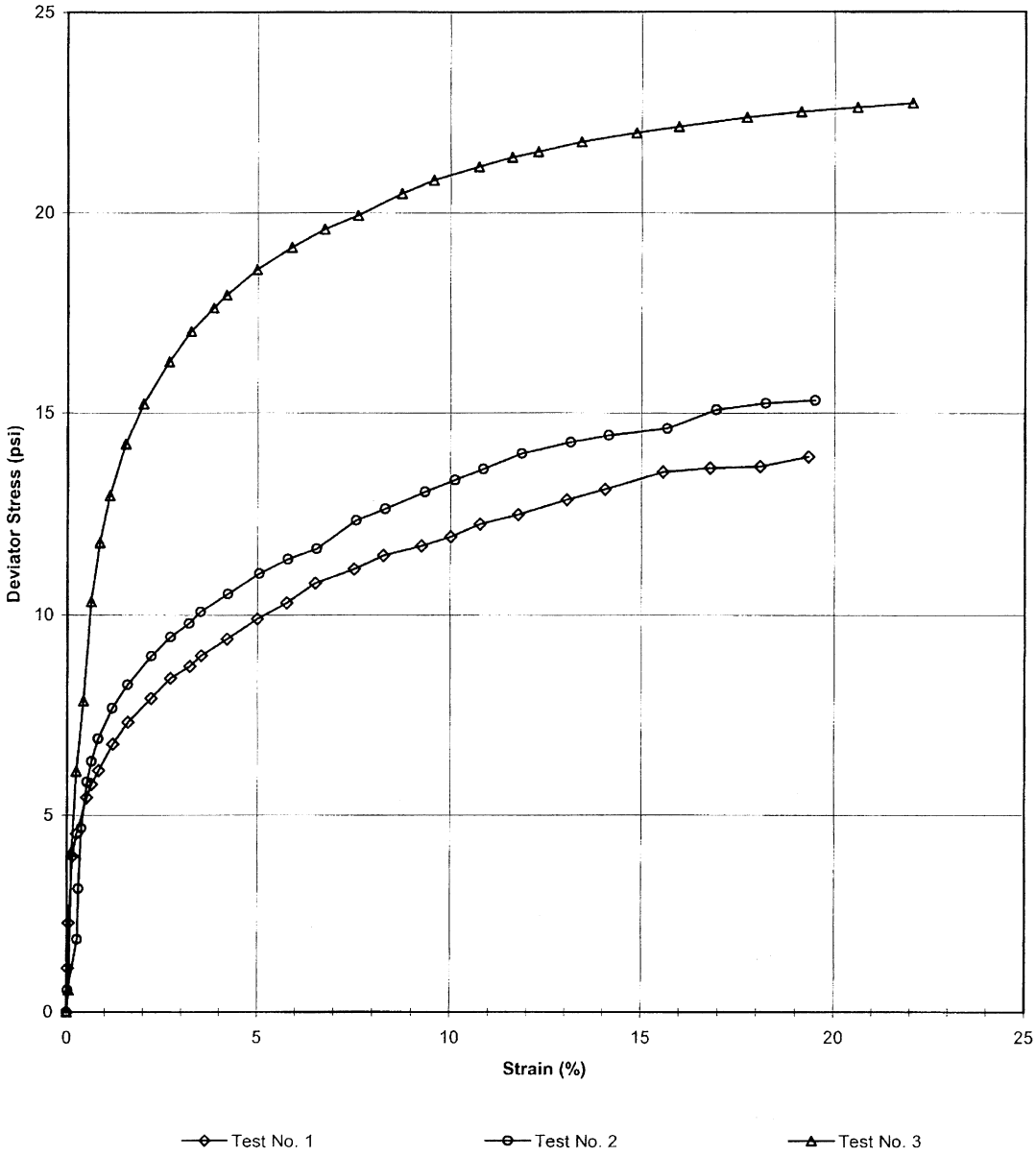
DCN: CT-S28 DATE 6-25-98 REVISION 1

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

geotechnics
INTEGRITY IN TESTING

CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

Client	FROEHLING & ROBERTSON	Boring No.	GCP-6
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	10-12
Project No.	2007-557-01	Sample No.	SB-2
Lab ID	2007-557-01-01		
Visual Description:	TAN GRAY CLAYEY SAND (UNDISTURBED)		



Tested By TMS Date 4/2/07 Approved By DB Date 4-12-07

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	FROEHLING & ROBERTSON	Boring No.	GCP-6
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	10.4-10.9
Project No.	2007-557-01	Sample No.	SB-2
Lab ID	2007-557-01-01		

Visual Description: TAN GRAY CLAYEY SAND (UNDISTURBED)

Stage No.	1
Test No	1

PRESSURES (psi)

Cell Pressure(psi)	54.6
Back Pressure(psi)	50.1
Eff. Cons. Pressure(psi)	4.5
Pore Pressure Response (%)	97

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	7.06
Q	=	4.20

INITIAL SAMPLE DIMENSIONS (in)

Length 1	5.991	Diameter 1	2.793
Length 2	6.014	Diameter 2	2.872
Length 3	5.985	Diameter 3	2.844
Avg Leng.=	5.997	Avg. Diam.=	2.836

VOLUME CHANGE

Initial Burette Reading (ml)	24.0
Final Burette Reading (ml)	17.4
Final Change (ml)	6.6

Initial Dial Reading (D.R.), mils	155
D.R. After Saturation, mils	161
D.R. After Consolidation, mils	184

LOAD (LBS)	DEFORMATION (INCHES)	PORE PRESSURE (PSI)
1.2	0.000	50.1
8.2	0.001	50.5
15.5	0.003	50.9
26.0	0.008	51.5
29.7	0.015	51.7
35.5	0.031	52.0
37.5	0.039	52.1
39.8	0.049	52.2
44.1	0.072	52.1
47.8	0.095	52.0
51.8	0.131	51.9
55.3	0.162	51.7
57.6	0.192	51.6
59.5	0.210	51.4
62.6	0.250	51.2
66.5	0.298	51.0
69.7	0.344	50.8
73.5	0.388	50.6
76.6	0.448	50.3
79.5	0.494	50.2
82.0	0.552	50.0
84.3	0.598	49.8
87.2	0.643	49.6
89.9	0.703	49.4
93.8	0.778	49.2
96.7	0.838	49.0
101.6	0.929	48.8
103.9	1.002	48.7
105.8	1.079	48.5
109.3	1.154	48.3

Tested By TMS Date 4/2/07 Input Checked By [illegible] Date 4-13-07

DCN: CT-S28 DATE 6-25-98 REVISION 1

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	FROEHLING & ROBERTSON	Boring No.	GCP-6
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	10.4-10.9
Project No.	2007-557-01	Sample No.	SB-2
Lab ID	2007-557-01-01		

Visual Description: TAN GRAY CLAYEY SAND (UNDISTURBED)

Effective Confining Pressure (psi)	4.5	*Stage No.*	1
		Test No	1

INITIAL DIMENSIONS

Initial Sample Length (in.)	6.00
Initial Sample Diameter (in.)	2.84
Initial Sample Area (in^2)	6.32
Initial Sample Volume (in^3)	37.89

VOLUME CHANGE

Volume After Consolidation (in^3)	37.37
Length After Consolidation (in)	5.97
Area After Consolidation (in^2)	6.263

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	1.12	0.42	5.21	4.1	1.275	0.38	4.64	0.56
0.04	2.27	0.75	6.02	3.7	1.607	0.34	4.88	1.14
0.14	3.95	1.41	7.04	3.1	2.277	0.37	5.07	1.97
0.24	4.53	1.63	7.40	2.9	2.578	0.37	5.14	2.27
0.51	5.44	1.94	8.00	2.6	3.120	0.37	5.28	2.72
0.65	5.76	2.01	8.25	2.5	3.309	0.36	5.37	2.88
0.83	6.11	2.05	8.55	2.4	3.499	0.35	5.50	3.05
1.20	6.76	2.02	9.24	2.5	3.730	0.31	5.86	3.38
1.59	7.31	1.94	9.88	2.6	3.854	0.27	6.22	3.66
2.19	7.90	1.79	10.61	2.7	3.913	0.23	6.66	3.95
2.71	8.41	1.64	11.26	2.9	3.943	0.20	7.06	4.20
3.22	8.71	1.47	11.74	3.0	3.870	0.17	7.39	4.35
3.51	8.98	1.31	12.17	3.2	3.814	0.15	7.68	4.49
4.20	9.40	1.10	12.80	3.4	3.764	0.12	8.10	4.70
5.00	9.90	0.86	13.53	3.6	3.722	0.09	8.58	4.95
5.77	10.30	0.67	14.13	3.8	3.692	0.07	8.98	5.15
6.51	10.79	0.49	14.80	4.0	3.691	0.05	9.40	5.39
7.51	11.14	0.23	15.41	4.3	3.609	0.02	9.84	5.57
8.27	11.47	0.07	15.90	4.4	3.588	0.01	10.17	5.74
9.26	11.71	-0.14	16.35	4.6	3.523	-0.01	10.50	5.86
10.02	11.94	-0.28	16.72	4.8	3.495	-0.02	10.75	5.97
10.78	12.25	-0.46	17.21	5.0	3.473	-0.04	11.08	6.13
11.77	12.49	-0.74	17.73	5.2	3.383	-0.06	11.48	6.24
13.04	12.85	-0.92	18.27	5.4	3.371	-0.07	11.85	6.43
14.05	13.11	-1.09	18.70	5.6	3.345	-0.09	12.15	6.56
15.57	13.54	-1.34	19.38	5.8	3.319	-0.10	12.61	6.77
16.79	13.64	-1.35	19.49	5.9	3.329	-0.10	12.67	6.82
18.09	13.67	-1.65	19.82	6.1	3.225	-0.12	12.98	6.84
19.34	13.92	-1.81	20.23	6.3	3.205	-0.13	13.27	6.96

Tested By TMS Date 4/2/07 Input Checked By MWS Date 4-13-07

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	FROEHLING & ROBERTSON	Boring No.	GCP-6
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	10.9-11.4
Project No.	2007-557-01	Sample No.	SB-2
Lab ID	2007-557-01-01		

Visual Description: TAN GRAY CLAYEY SAND (UNDISTURBED)

Stage No.	1
Test No	2

PRESSURES (psi)

Cell Pressure(psi)	59.8
Back Pressure(psi)	50.4
Eff. Cons. Pressure(ps	9.4
Pore Pressure Response (%)	97

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	8.87
Q	=	5.26

INITIAL SAMPLE DIMENSIONS (in)

Length 1	5.968	Diameter 1	2.875
Length 2	5.971	Diameter 2	2.836
Length 3	5.975	Diameter 3	2.824
Avg Leng.=	5.971	Avg. Diam.=	2.845

VOLUME CHANGE

Initial Burette Reading (ml)	18.4
Final Burette Reading (ml)	0.0
Final Change (ml)	18.4

Initial Dial Reading (D.R.), mils	117
D.R. After Saturation, mils	129
D.R. After Consolidation, mils	181

LOAD (LBS)	DEFORMATION (INCHES)	PORE PRESSURE (PSI)
8.0	0.000	50.4
11.5	0.001	50.5
19.5	0.016	51.2
27.5	0.018	51.7
37.1	0.022	52.7
44.3	0.031	53.8
47.6	0.038	54.3
51.1	0.048	54.9
56.1	0.070	55.6
60.0	0.094	56.0
64.9	0.130	56.2
68.2	0.160	56.3
70.7	0.189	56.3
72.7	0.207	56.3
76.1	0.249	56.2
80.0	0.298	56.0
82.9	0.342	55.8
85.2	0.387	55.6
90.8	0.447	55.3
93.4	0.491	55.2
97.3	0.552	54.9
100.0	0.598	54.7
102.7	0.642	54.6
106.5	0.701	54.4
109.9	0.777	54.2
112.3	0.836	54.0
115.5	0.926	53.7
120.6	1.001	53.5
123.5	1.077	53.3
125.9	1.152	53.1

Tested By TMS Date 4/2/07 Input Checked By MM Date 4-13-07

DCN: CT-S28 DATE 6-25-98 REVISION 1

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	FROEHLING & ROBERTSON	Boring No.	GCP-6
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	10.9-11.4
Project No.	2007-557-01	Sample No.	SB-2
Lab ID	2007-557-01-01		

Visual Description: TAN GRAY CLAYEY SAND (UNDISTURBED)

Effective Confining Pressure (psi)	9.4	*Stage No.*	1
		Test No	2

INITIAL DIMENSIONS

Initial Sample Length (in.)	5.97
Initial Sample Diameter (in.)	2.85
Initial Sample Area (in^2)	6.36
Initial Sample Volume (in^3)	37.96

VOLUME CHANGE

Volume After Consolidation (in^3)	36.61
Length After Consolidation (in)	5.91
Area After Consolidation (in^2)	6.197

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.02	0.56	0.12	9.84	9.3	1.061	0.22	9.56	0.28
0.27	1.85	0.80	10.45	8.6	1.215	0.44	9.53	0.92
0.30	3.14	1.31	11.22	8.1	1.388	0.43	9.66	1.57
0.37	4.67	2.26	11.81	7.1	1.655	0.50	9.47	2.34
0.52	5.82	3.36	11.86	6.0	1.964	0.59	8.95	2.91
0.64	6.34	3.94	11.80	5.5	2.161	0.64	8.63	3.17
0.82	6.90	4.49	11.81	4.9	2.405	0.67	8.36	3.45
1.18	7.66	5.16	11.90	4.2	2.808	0.69	8.07	3.83
1.58	8.25	5.56	12.09	3.8	3.147	0.69	7.96	4.12
2.20	8.97	5.79	12.57	3.6	3.488	0.67	8.09	4.48
2.71	9.44	5.87	12.98	3.5	3.671	0.64	8.26	4.72
3.20	9.78	5.88	13.30	3.5	3.778	0.62	8.41	4.89
3.50	10.07	5.86	13.62	3.5	3.845	0.60	8.58	5.04
4.22	10.52	5.79	14.13	3.6	3.918	0.57	8.87	5.26
5.05	11.02	5.59	14.83	3.8	3.897	0.52	9.32	5.51
5.79	11.38	5.43	15.35	4.0	3.868	0.49	9.66	5.69
6.54	11.64	5.20	15.84	4.2	3.771	0.46	10.02	5.82
7.56	12.34	4.94	16.80	4.5	3.769	0.41	10.63	6.17
8.32	12.63	4.76	17.27	4.6	3.722	0.39	10.95	6.31
9.34	13.05	4.45	18.00	4.9	3.638	0.35	11.47	6.53
10.12	13.34	4.31	18.43	5.1	3.622	0.33	11.76	6.67
10.86	13.61	4.17	18.84	5.2	3.602	0.32	12.04	6.81
11.87	14.00	3.98	19.41	5.4	3.585	0.29	12.41	7.00
13.15	14.27	3.80	19.87	5.6	3.548	0.27	12.74	7.14
14.15	14.44	3.58	20.26	5.8	3.482	0.26	13.04	7.22
15.68	14.62	3.31	20.71	6.1	3.400	0.23	13.40	7.31
16.95	15.08	3.07	21.41	6.3	3.384	0.21	13.87	7.54
18.23	15.24	2.90	21.74	6.5	3.343	0.20	14.12	7.62
19.50	15.31	2.71	22.00	6.7	3.290	0.18	14.34	7.66

Tested By TMS Date 4/2/07 Input Checked By MPS Date 4-13-07

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

geotechnics
INTEGRITY IN TESTING

CONSOLIDATED UNDRAINED TRIAXIAL TEST WITH PORE PRESSURE READINGS

ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

Client	FROEHLING & ROBERTSON	Boring No.	GCP-6
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	11.4-11.9
Project No.	2007-557-01	Sample No.	SB-2
Lab ID	2007-557-01-01		

Visual Description: TAN GRAY CLAYEY SAND (UNDISTURBED)

Stage No.	1
Test No	3

PRESSURES (psi)

Cell Pressure(psi)	68.3
Back Pressure(psi)	50.7
Eff. Cons. Pressure(ps	17.6
Pore Pressure Response (%)	97

MAXIMUM OBLIQUITY POINTS

$\overline{P}$	=	17.05
Q	=	9.29

INITIAL SAMPLE DIMENSIONS (in)

Length 1	5.982	Diameter 1	2.798
Length 2	5.975	Diameter 2	2.807
Length 3	5.981	Diameter 3	2.750
Avg Leng.=	5.979	Avg. Diam.=	2.785

VOLUME CHANGE

Initial Burette Reading (ml)	24.8
Final Burette Reading (ml)	0.0
Final Change (ml)	24.8

Initial Dial Reading (D.R.), mils	131
D.R. After Saturation, mils	139
D.R. After Consolidation, mils	217

LOAD (LBS)	DEFORMATION (INCHES)	PORE PRESSURE (PSI)
8.9	0.000	50.7
12.2	0.003	50.8
32.9	0.007	52.3
44.9	0.014	53.5
55.4	0.025	54.9
70.2	0.037	57.3
79.0	0.050	58.6
86.2	0.065	59.5
94.1	0.090	60.3
100.5	0.117	60.7
107.4	0.157	61.0
112.7	0.191	60.9
117.0	0.226	60.9
119.3	0.246	60.8
124.2	0.293	60.5
128.8	0.347	60.2
132.8	0.397	59.9
136.1	0.448	59.7
141.2	0.515	59.3
144.6	0.564	59.1
148.6	0.633	58.7
151.5	0.684	58.4
153.5	0.724	58.3
157.2	0.791	58.0
161.2	0.876	57.7
164.3	0.941	57.3
169.3	1.045	57.3
173.1	1.128	57.2
176.9	1.214	57.0
180.8	1.299	56.9

Tested By TMS Date 4/2/07 Input Checked By MAS Date 4-13-07

DCN: CT-S28 DATE 6-25-98 REVISION 1

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

CONSOLIDATED UNDRAINED TRIAXIAL TEST
WITH PORE PRESSURE READINGS
ASTM D4767-95 / AASHTO T297-94 (SOP-S28)

geotechnics
INTEGRITY IN TESTING

Client	FROEHLING & ROBERTSON	Boring No.	GCP-6
Client Reference	WASHINGTON AQUADUCT	Depth(ft.)	11.4-11.9
Project No.	2007-557-01	Sample No.	SB-2
Lab ID	2007-557-01-01		

Visual Description: TAN GRAY CLAYEY SAND (UNDISTURBED)

Effective Confining Pressure (psi)	17.6	*Stage No.*	1
		Test No	3

INITIAL DIMENSIONS

Initial Sample Length (in.)	5.98
Initial Sample Diameter (in.)	2.79
Initial Sample Area (in^2)	6.09
Initial Sample Volume (in^3)	36.42

VOLUME CHANGE

Volume After Consolidation (in^3)	34.76
Length After Consolidation (in)	5.89
Area After Consolidation (in^2)	5.899

Strain (%)	Deviation Stress	ΔU	$\overline{\sigma}_1$	$\overline{\sigma}_3$	Effective Principle Stress Ratio	$\overline{A}$	$\overline{P}$	Q
0.05	0.56	0.09	18.07	17.5	1.032	0.17	17.79	0.28
0.12	4.06	1.62	20.04	16.0	1.254	0.41	18.01	2.03
0.24	6.09	2.84	20.85	14.8	1.413	0.48	17.80	3.05
0.42	7.85	4.24	21.21	13.4	1.587	0.56	17.28	3.92
0.63	10.33	6.56	21.37	11.0	1.935	0.65	16.21	5.16
0.85	11.80	7.88	21.52	9.7	2.213	0.69	15.62	5.90
1.10	12.96	8.76	21.80	8.8	2.466	0.70	15.32	6.48
1.53	14.23	9.60	22.23	8.0	2.779	0.70	15.11	7.11
1.99	15.23	10.00	22.82	7.6	3.004	0.68	15.21	7.61
2.66	16.26	10.26	23.60	7.3	3.217	0.65	15.47	8.13
3.24	17.03	10.22	24.41	7.4	3.309	0.62	15.89	8.52
3.83	17.62	10.16	25.06	7.4	3.370	0.59	16.25	8.81
4.17	17.95	10.06	25.49	7.5	3.380	0.58	16.51	8.97
4.97	18.58	9.84	26.34	7.8	3.396	0.55	17.05	9.29
5.89	19.14	9.53	27.20	8.1	3.373	0.51	17.63	9.57
6.74	19.59	9.21	27.97	8.4	3.336	0.48	18.18	9.79
7.60	19.94	8.97	28.56	8.6	3.311	0.46	18.60	9.97
8.74	20.48	8.64	29.44	9.0	3.285	0.43	19.20	10.24
9.57	20.81	8.38	30.02	9.2	3.258	0.42	19.62	10.40
10.74	21.14	8.02	30.72	9.6	3.208	0.39	20.15	10.57
11.61	21.38	7.72	31.26	9.9	3.165	0.37	20.57	10.69
12.29	21.51	7.59	31.52	10.0	3.149	0.36	20.77	10.76
13.42	21.76	7.32	32.05	10.3	3.117	0.35	21.16	10.88
14.86	21.98	6.96	32.63	10.6	3.065	0.33	21.63	10.99
15.97	22.14	6.64	33.10	11.0	3.020	0.31	22.03	11.07
17.73	22.37	6.62	33.35	11.0	3.037	0.31	22.17	11.18
19.14	22.51	6.47	33.64	11.1	3.023	0.30	22.38	11.26
20.60	22.62	6.28	33.94	11.3	2.999	0.29	22.63	11.31
22.04	22.72	6.15	34.17	11.4	2.985	0.28	22.81	11.36

Tested By TMS Date 4/2/07 Input Checked By MMS Date 4-13-07

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

geotechnics
INTEGRITY IN TESTING

ATTERBERG LIMITS

ASTM D 4318-98 / AASHTO T89 (SOP - S4A)

Client	FROEHLING & ROBERTSON	Boring No.	GCP-6
Client Reference	WASHINGTON AQUADUCT	Depth (ft)	10-12
Project No.	2007-557-01	Sample No.	SB-2
Lab ID	2007-557-01-01	Soil Description	**TAN LEAN CLAY**

Note: The USCS symbol used with this test refers only to the minus No. 40 sieve material. See the "Sieve and Hydrometer Analysis" graph page for the complete material description. (Minus No. 40 sieve material, Airdried)

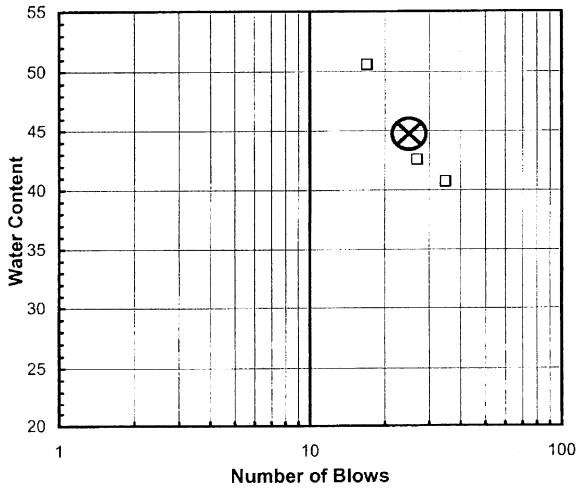
Liquid Limit Test	**1**	**2**	**3**	
Tare Number	G	D	V	M U L T I P O I N T
Wt. of Tare & WS (gm)	39.40	38.43	37.35	
Wt. of Tare & DS (gm)	31.23	31.49	30.97	
Wt. of Tare (gm)	15.07	15.18	15.29	
Wt. of Water (gm)	8.2	6.9	6.4	
Wt. of DS (gm)	16.2	16.3	15.7	
Moisture Content (%)	**50.6**	**42.6**	**40.7**	
Number of Blows	**17**	**27**	**35**	

Plastic Limit Test	**1**	**2**	**Range**
Tare Number	A-P	A-B	
Wt. of Tare & WS (gm)	21.75	21.90	
Wt. of Tare & DS (gm)	20.84	20.99	
Wt. of Tare (gm)	15.58	15.56	
Wt. of Water (gm)	0.9	0.9	
Wt. of DS (gm)	5.3	5.4	
Moisture Content (%)	**17.3**	**16.8**	**0.5**

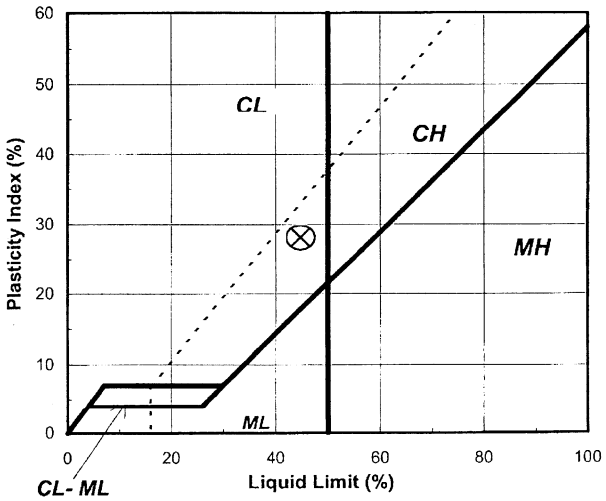
Note: The acceptable range of the two Moisture contents is ± 2.6

Test Results	
Liquid Limit (%)	**45**
Plastic Limit (%)	**17**
Plasticity Index (%)	**28**
USCS Symbol	**CL**

Flow Curve



Plasticity Chart



Tested By KMR *Date* 04/11/07 *Checked By* MM *Date* 4-13-07

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

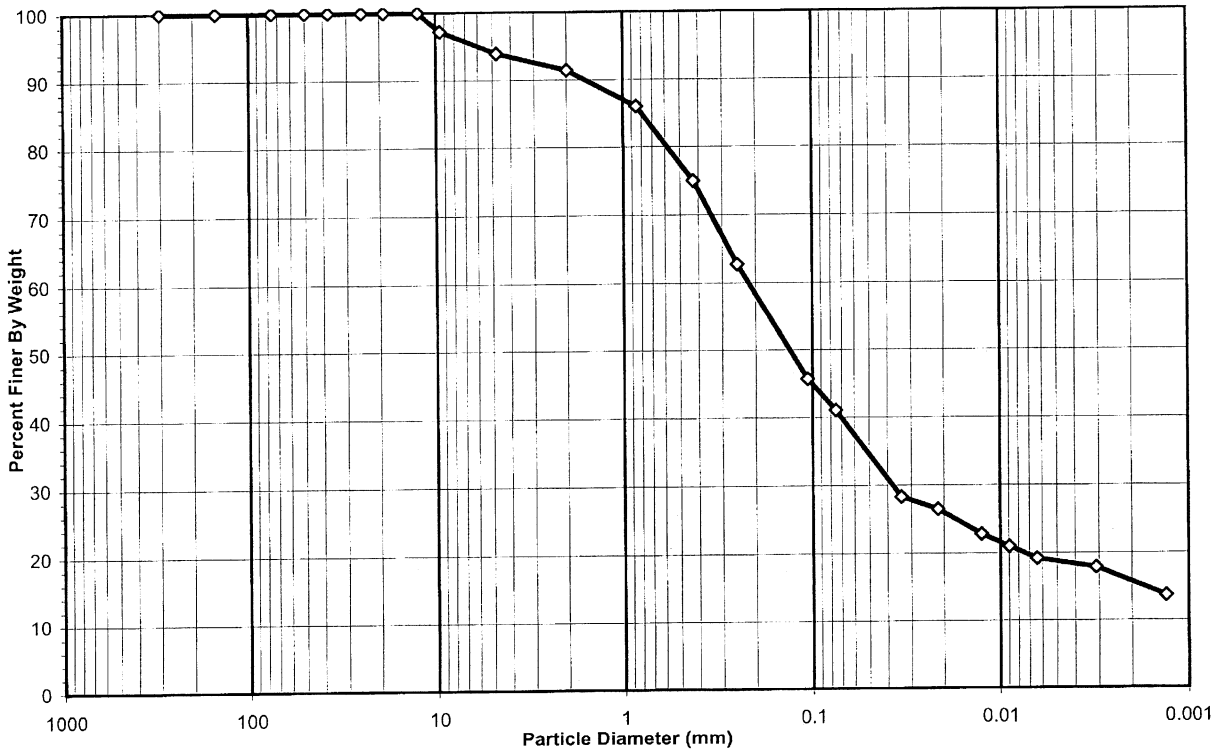
geotechnics
INTEGRITY IN TESTING

SIEVE AND HYDROMETER ANALYSIS
ASTM D 422-63 (SOP-S3)

Client	FROEHLING & ROBERTSON	Boring No.	GCP-6
Client Reference	WASHINGTON AQUADUCT	Depth (ft)	10-12
Project No.	2007-557-01	Sample No.	SB-2
Lab ID	2007-557-01-01	Soil Color	**TAN**

	SIEVE ANALYSIS					HYDROMETER	
USCS	cobbles	gravel		sand		silt and clay fraction	
USDA	cobbles	gravel		sand		silt	clay

12" 6" 3" 3/4" 3/8" #4 #10 #20 #40 #140 #200



Sieve Sizes (mm)	USCS Summary	Percentage
Greater Than #4	*Gravel*	6.09
#4 To #200	*Sand*	52.85
Finer Than #200	*Silt & Clay*	41.06

USCS Symbol ***SC, TESTED***

USCS Classification *CLAYEY SAND*

DCN: CT-S3P DATE:02/15/05 REVISION:8

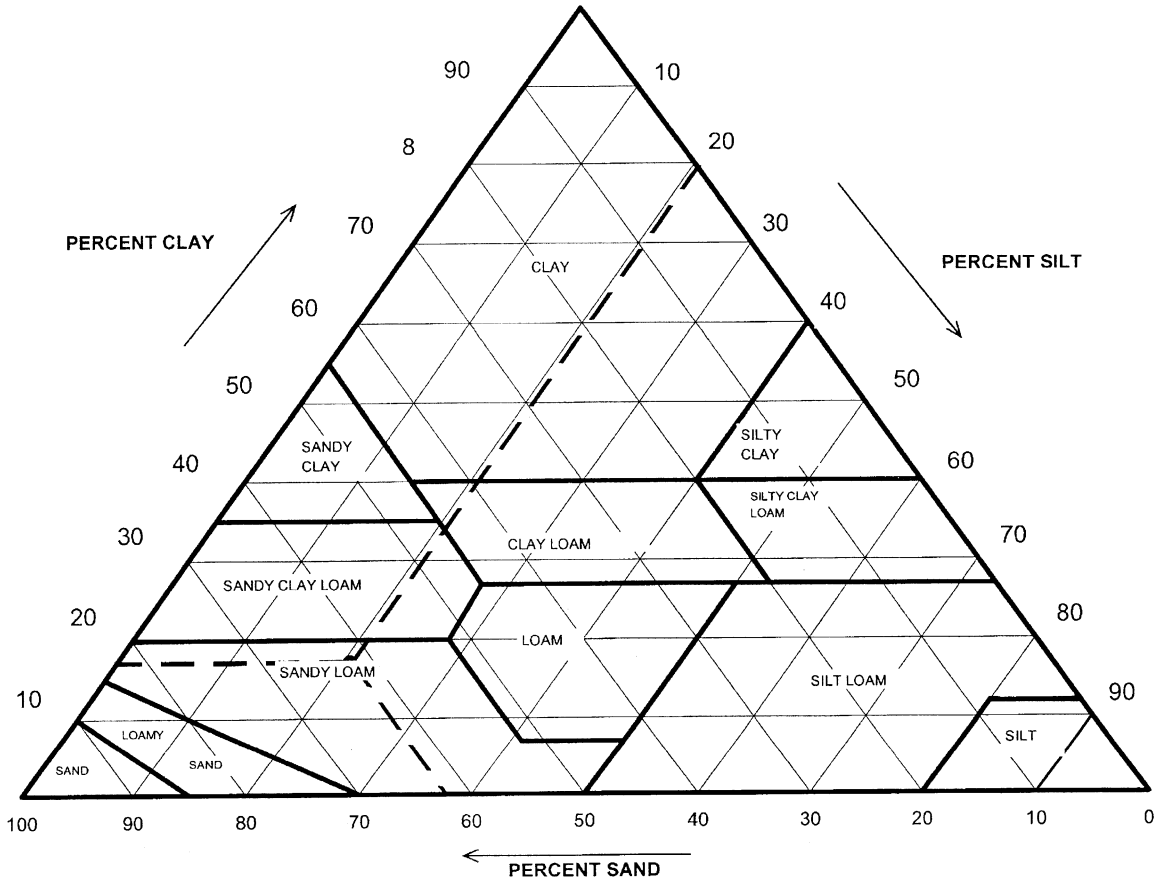
C:\2007 PROJECTS\2007-557 F&R\[2007-557-01-01 #10 Split Hydro rev 8.xls]Sheet1

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

geotechnics
INTEGRITY IN TESTING

USDA CLASSIFICATION CHART

Client	FROEHLING & ROBERTSON	Boring No.	GCP-6
Client Reference	WASHINGTON AQUADUCT	Depth (ft)	10-12
Project No.	2007-557-01	Sample No.	SB-2
Lab ID	2007-557-01-01	Soil Color	TAN



Particle Size (mm)	Percent Finer	USDA SUMMARY	Actual Percentage	Corrected % of Minus 2.0 mm material for USDA Classificat.
		Gravel	8.62	**0.00**
2	91.38	*Sand*	56.79	**62.15**
0.05	34.58	*Silt*	18.89	**20.67**
0.002	15.69	*Clay*	15.69	**17.18**

USDA Classification: ***SANDY LOAM***

DCN: CT-S3P DATE:02/15/05 REVISION:8 C:\2007 PROJECTS\2007-557 F&R\[2007-557-01-01 #10 Split Hydro rev 8.xls]Sheet1

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

geotechnics
INTEGRITY IN TESTING

WASH SIEVE ANALYSIS #10 SPLIT

ASTM D 422-63 (SOP-S3)

Client	FROEHLING & ROBERTSON	Boring No.	GCP-6
Client Reference	WASHINGTON AQUADUCT	Depth (ft)	10-12
Project No.	2007-557-01	Sample No.	SB-2
Lab ID	2007-557-01-01	Soil Color	**TAN**

Moisture Content/sieve +10 Material		Moisture Content for Hydrometer Portion	
Tare No.	319	Tare No.	V-1
Wgt.Tare + Wet Soil (gm)	582.50	Wgt.Tare + Wet Soil (gm)	58.55
Wgt.Tare + Dry Soil (gm)	518.26	Wgt.Tare + Dry Soil (gm)	58.11
Weight of Tare (gm)	208.94	Weight of Tare (gm)	21.93
Weight of Water (gm)	64.24	Weight of Water (gm)	0.44
Weight of Dry Soil (gm)	309.32	Weight of Dry Soil (gm)	36.18
Moisture Content (%)	**20.8**	**Moisture Content (%)**	**1.2**

Soil Specimen Data			
Wet Weight +#10 Material (gm)	373.56	Weight of the Dry Sample (gm)	358.72
Dry Weight +#10 Material(gm)	309.3	Weight of minus #200 material (gm)	22.20
Wet Weight Hydro. Material.(gm)	50.00	Weight of plus #200 material (gm)	336.52
Dry Weight Hydro. Material (gm)	49.40		
Total Dry Weight Sample (gm)	358.72	**J-FACTOR (%FINER THAN #10)**	**0.9138**

Sieve Size	Sieve Opening (mm)	Wgt.of Soil Retained (gm)	Percent Retained (%)	Accumulated Percent Retained (%)	Percent Finer (%)	**Accumulated Percent Finer (%)**
12"	300	0.00	0.00	0.00	100.00	**100.00**
6"	150	0.00	0.00	0.00	100.00	**100.00**
3"	75	0.00	0.00	0.00	100.00	**100.00**
2"	50	0.00	0.00	0.00	100.00	**100.00**
1 1/2"	37.5	0.00	0.00	0.00	100.00	**100.00**
1"	25.0	0.00	0.00	0.00	100.00	**100.00**
3/4"	19.0	0.00	0.00	0.00	100.00	**100.00**
1/2"	12.5	0.00	0.00	0.00	100.00	**100.00**
3/8"	9.50	8.69	2.81	2.81	97.19	**97.19**
#4	4.75	10.15	3.28	6.09	93.91	**93.91**
#10	2.00	7.83	2.53	8.62	91.38	**91.38**
#20	0.85	2.91	5.89	5.89	94.11	**85.99**
#40	0.425	5.93	12.00	17.90	82.10	**75.03**
#60	0.250	6.65	13.46	31.36	68.64	**62.72**
#140	0.106	9.22	18.66	50.02	49.98	**45.67**
#200	0.075	2.49	5.04	55.06	44.94	**41.06**
Pan	-	22.20	44.94	100.00	-	-

Notes :

Tested By TMS Date 04/11/07 Checked By MMS Date 4-13-07

DCN: CT-S3P DATE:02/15/05 REVISION:8

C:\2007 PROJECTS\2007-557 F&R\[2007-557-01-01 #10 Split Hydro rev 8.xls]Sheet1

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460

geotechnics
INTEGRITY IN TESTING

HYDROMETER ANALYSIS

ASTM D 422-63 (SOP-S3)

Client	FROEHLING & ROBERTSON	Boring No.	GCP-6
Client Reference	WASHINGTON AQUADUCT	Depth (ft)	10-12
Project No.	2007-557-01	Sample No.	SB-2
Lab ID	2007-557-01-01	Soil Color	**TAN**

Elapsed Time (min)		R Measured	Temp. (°C)	Composite Correction	R Corrected	N (%)	K Factor	Diameter (mm)	N' (%)
0	NA	NA	NA	NA	NA	NA	NA	NA	NA
2	20.0	20.0	21.4	4.55	15.5	31.0	0.01322	0.0337	**28.3**
5		19.0	21.4	4.55	14.5	29.0	0.01322	0.0215	**26.5**
15		17.0	21.4	4.55	12.5	25.0	0.01322	0.0125	**22.8**
30		16.0	21.4	4.55	11.5	22.9	0.01322	0.0089	**21.0**
60		15.0	21.4	4.55	10.5	20.9	0.01322	0.0063	**19.1**
250		14.0	22.4	4.26	9.7	19.5	0.01307	0.0031	**17.8**
1440		12.0	21.4	4.55	7.5	14.9	0.01322	0.0013	**13.6**

Soil Specimen Data		**Other Corrections**	
Tare + Dry Material (gm)	49.40	a - Factor	0.99
Weight of Tare (gm)	0		
Weight of Deflocculant (gm)	5.0	Percent Finer than # 10	91.38
Weight of Dry Material (gm)	49.40		
		Specific Gravity	2.7 Assumed

Note:

Tested By KMR Date 04/12/07 Checked By KMR Date 4-13-07

DCN: CT-S3P DATE:02/15/05 REVISION:8 *C:\2007 PROJECTS\2007-557 F&R\[2007-557-01-01 #10 Split Hydro rev 8.xls]Sheet1*

2200 Westinghouse Boulevard • Suite 105 • Raleigh, NC 27604 • Phone (919) 876-0405 • Fax (919) 876-0460