

Geotechnical Data Report Longview Regional Water Treatment Plant Longview, Washington

June 7, 2010

Prepared for

Kennedy/Jenks Consultants



950 Pacific Avenue, Suite 515
Tacoma, WA 98402
(253) 926-2493

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B	Geotechnical Laboratory Test Results
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1.0 INTRODUCTION

This Geotechnical Data Report (GDR) presents the results of our field geotechnical investigation and laboratory testing program for the Longview Regional Water Treatment Plant and associated waterline in Longview, Washington. The overall project location is shown on the Vicinity Map, Figure 1. The Site and Exploration Plan, Figure 2, shows the approximate location of the explorations completed for this study as well as the locations of historical borings completed by others along the waterline alignment. Figure 3 presents a Site and Exploration Plan for the Water Treatment Plant Site. Appendix A presents summary logs of conditions observed in the explorations completed for this study. The results of the laboratory testing program are included as Appendix B. Logs of previous explorations completed by others are included in Appendix C.

2.0 GEOLOGIC SETTING

Geologic information for the project area was obtained from *Geologic Map of the Mount St. Helens Quadrangle, Washington and Oregon* (Phillips 1987). According to Phillips, subsurface deposits in the vicinity of the proposed improvements consist of alluvium. Deposits defined as alluvium typically consist of younger, unconsolidated, stratified units of silt, sand, and gravel. In some areas alluvium may contain interbeds of peat and organic silt. The alluvium was transported and deposited by the Columbia and Cowlitz Rivers. This unit is typically very soft/loose to stiff/medium dense, has low to moderate shear strength, and depending on its composition, can be moderately compressible.

The general geologic stratigraphy within the project area is relatively complex due to depositional processes. Lateral migration of point bars, channel splays and levees have resulted in interbedded and interfingering layers of sand and silt that vary both horizontally and vertically. The transitions are mostly gradational, but can occur relatively abruptly. Organic material (leaves, sticks, limbs, etc.) is commonly present within the finer-grained sediments. Logs were encountered within the alluvial deposits at the site. Normal deposition has been punctuated by voluminous input of lahar runout and volcanic alluvium from Holocene volcanic eruptions. Fill of variable composition and density is located within the roadway corridors and developed areas.

The methods of field exploration effectively precluded the accurate measurement of the site groundwater level. Based on previous explorations completed in the Mint Farm (see Appendix C), it is anticipated that the site groundwater table is located within 5 to 10 ft of the existing ground surface.

3.0 FIELD EXPLORATION PROGRAM

Subsurface conditions at the location of the proposed Longview Regional Water Treatment Plant (Longview RWTP) and waterline route were explored on May 8, 2009 and between August 12 and 18, 2009. The exploration program consisted of advancing five (5) exploratory borings (B-9, B-10, and B-101 through B-103) and three (3) cone penetrometer test (CPT) soundings (CPT-101 through CPT-103) at the approximate locations illustrated on the Site and Exploration Plan (Figures 2 and 3). The explorations were located in the field with a hand-held GPS unit.

3.1 EXPLORATORY BORINGS

The exploratory borings (B-9, B-10, and B-101 through B-103) were advanced to depths of between 39 and 79 ft BGS with a truck- or track-mounted drill rig and the mud-rotary drilling technique. Borings B-9 and B-10 were advanced on May 8, 2009 while borings B-101 through B-103 were advanced between August 12 and 14, 2009. Holocene Drilling, Inc., of Edgewood, Washington advanced the borings under subcontract to Landau Associates.

The geotechnical exploratory program was coordinated and monitored by a Landau Associates geotechnical engineer who also obtained representative soil samples, maintained a detailed record of the observed subsurface soil and groundwater conditions, and described the soil encountered by visual and textural examination. Each representative soil type observed in our exploratory borings was described using the soil classification system shown on Figure A-1, in general accordance with ASTM D2488, *Standard Recommended Practice for Description of Soils (Visual-Manual Procedure)*. Logs of the exploratory borings are presented on Figures A-2 through A-6. These logs represent our interpretation of subsurface conditions identified during the field exploration program. The stratigraphic contacts shown on the individual logs represent the approximate boundaries between soil types; actual transitions may be more gradual. The soil and groundwater conditions depicted are only for the specific date and locations reported, and therefore, are not necessarily representative of other locations and times.

Disturbed samples of the soil encountered from the borings were obtained at frequent intervals using either a 1.5-inch inside-diameter (ID) Standard Penetration Test (SPT) split-spoon sampler or a 2.375 ID Modified California split-spoon sampler. The samplers were driven up to 18 inches (or a portion thereof) into the undisturbed soil ahead of the auger bit with a 140-lb automatic hammer falling a distance of approximately 30 inches. The number of blows required to drive the sampler for the final 12 inches (or portion thereof) of soil penetration, is noted on the boring logs adjacent to the appropriate sample notation.

Relatively undisturbed samples of fine-grained soil encountered in the borings were obtained by advancing a 3-inch, outside-diameter (OD), thin-walled Shelby tube into the undisturbed soil ahead of the drill bit. The tube was advanced approximately 24 inches using a hydraulic piston sampler. After removal of the tube from the borehole, the ends of the tube were capped and sealed. Samples collected in this manner were submitted to Soil Technology, Inc. of Bainbridge Island, Washington for completion of consolidation tests.

Upon completion of drilling and sampling, the boreholes were abandoned in general accordance with the requirements of Washington Administrative Code (WAC) 173-160.

3.2 CONE PENETROMETER TESTS

The CPT program was completed between August 17 through 18, 2009. The CPT soundings were advanced to depths ranging from between 73 $\frac{1}{3}$ to 120 $\frac{1}{4}$ ft BGS using track-mounted CPT equipment. In Situ Engineering, Inc. of Snohomish, Washington completed the CPT soundings under subcontract to Landau Associates.

At each CPT sound location, a four-channel electronic cone was pushed at a rate of about 1 to 2 cm/sec. The cone was used to simultaneously record tip resistance, sleeve friction, pore pressure, and inclination every 5 cm. Data was transmitted electronically from the cone to a receiver located at the ground surface. Upon completion of testing, the CPT soundings were abandoned in general accordance with the requirements of WAC 173-160.

In Situ Engineering, Inc. reduced the collected CPT data and plotted tip resistance and friction ratio (sleeve friction divided by tip resistance) as a function of sounding depth. They then used published correlations (Robertson and Campanella 1983) to estimate soil behavior types and equivalent Standard Penetration Test (SPT) values at each interval where data was recorded (i.e., every 5 cm). In Situ Engineering's detailed interpretation of soil behavior types and equivalent SPT values are presented on Figures A-7 through A-9. Text files of the CPT test results are also included on a compact disk (CD) on included in Appendix A.

It should be noted that the published correlations used by In Situ Engineering, Inc. to develop their detailed logs are generally regarded as predictions of soil behavior rather than actual soil type. Factors such as changes in stress history, sensitivity, stiffness, and void ratio will influence the soil classifications when using the published correlations. Accordingly, actual soil types at some or all of the CPT locations may vary from the soil types shown on In Situ Engineering's interpreted logs. Furthermore, the soil and groundwater conditions depicted are only for the specific dates and locations reported and, therefore, are not necessarily representative of other locations and times.

4.0 LABORATORY TESTING

Natural moisture content determinations, fines content determinations, Atterberg limit determinations, and one-dimensional consolidation tests were performed on selected samples to aid in soil classification and the determination of engineering properties. Laboratory testing was performed in general accordance with the ASTM standard test procedures, which are described below. The samples were checked against the field log descriptions, which were updated where appropriate in general accordance with ASTM D2487, *Standard Test Method for Classification of Soils for Engineering Purposes*. Corrosion testing was also completed on selected samples obtained from the borings.

4.1 NATURAL MOISTURE CONTENT

Natural moisture content determinations were performed on selected soil samples recovered from the borings in general accordance with ASTM D2216. The natural moisture content of a sample is defined as the ratio of the mass of water lost during drying versus the total mass of the oven-dried (105°C) sample, assuming that the sample received by the lab is representative of the *in situ* moisture condition. The results of these tests are plotted at the respective sample depth on the exploration logs, as indicated in the column labeled “Test Data” on the summary boring logs in Appendix A and the summary test pit logs in Appendix A.

4.2 SIEVE ANALYSIS

A grain size analyses was performed on a single soil sample obtained from borings B-10 in accordance with ASTM D422 to provide an indication of the grain size distribution. The sample selected for grain size analysis is designated with a “GS” entry in the column labeled “Test Data” on Figure A-3 in Appendix A. The result of the grain size analysis is presented on Figure B-1 in the form of grain size distribution curve.

4.3 FINES CONTENT

The fines content (the percentage of material passing the U.S. Standard No. 200 sieve) of selected soil samples obtained from our exploratory borings were determined in general accordance with ASTM D1140 test procedures. The percentages of particles passing the U.S. Standard No. 200 Sieve is shown as -200=xx (percent of dry weight) at the respective sample depth in the column labeled “Test Data” on the summary boring logs in Appendix A.

4.4 ATTERBERG LIMITS

Atterberg limit determinations were performed on representative soil samples obtained from the borings in general accordance with ASTM D4318 to determine the liquid limit (LL), plastic limit (PL), and plasticity index (PI). The results of the Atterberg limit determinations are presented on Figures B-2 and B-3. Samples in which Atterberg limit determinations were completed are designated by “AL” in the column labeled “Test Data” in Appendix A and are also shown graphically on the summary boring logs in Appendix A.

4.5 CONSOLIDATION TESTS

The consolidation characteristics of selected fine-grained soil samples obtained from the exploratory borings were determined at Soil Technology, Inc. laboratory in general accordance with ASTM D2435 test procedures. The consolidation test results are included in the Soil Technology reports, which are included in Appendix B. Samples for which this test was completed are designated by “GT” in the column labeled “Test Data” on the summary logs.

4.6 CORROSION TESTING

Representative soil samples obtained from the borings were subjected to a suite of tests to estimate the corrosive potential of the near-surface soils. The corrosion testing was completed by Analytical Resources, Inc. (ARI) of Tukwila, Washington under subcontract to Landau Associates. The Redox Potential was determined in accordance with Method SM 2580 test procedure. The pH was determined in accordance with the SW9045 test procedure. Sulfides were determined in accordance with the EPA 376.2 test procedure. The Minimum Resistivity was determined in accordance with the ASTM G 57 test procedure. Preserved total solids were determined in accordance with the EPA 160.3 test procedure. Samples in which corrosion testing was completed are designated by “COR” in the column labeled “Test Data” in Appendix A. The results of the testing are summarized in the main portion of this report. The data package prepared by ARI is included as an attachment to this appendix.

5.0 USE OF THIS REPORT

This Geotechnical Data Report summarizes the results of the field exploration and laboratory testing program completed for the proposed Longview RTWP site and associated waterline alignment in Longview, Washington. Within the limitations of scope, schedule, and budget, our services have been provided in accordance with generally accepted geotechnical engineering principles and practices in the area at the time the report was prepared. We make no other warranty, either express or implied.

LANDAU ASSOCIATES, INC.



Brian A. Bennetts, P.E.
Senior Project Engineer

Edward J. Heavey, P.E.
Principal Engineer

BAB/EJH/jas

6.0 REFERENCES

Phillips, W.M. 1987. *Geologic Map of the Mount St. Helens Quadrangle, Washington and Oregon*. Washington Division of Geology and Earth Resources. Open File Report 87-4.

Robertson and Campanella. 1983. *Interpretation of Cone Penetration Tests, Parts I and II*. Canadian Geotechnical Journal. Vol. 20, No. 4, pp 717-745. November 4.



Y:\Projects\133009\Mapdocs\Fig1.mxd 2/22/2010



Data Source: ESRI 2008

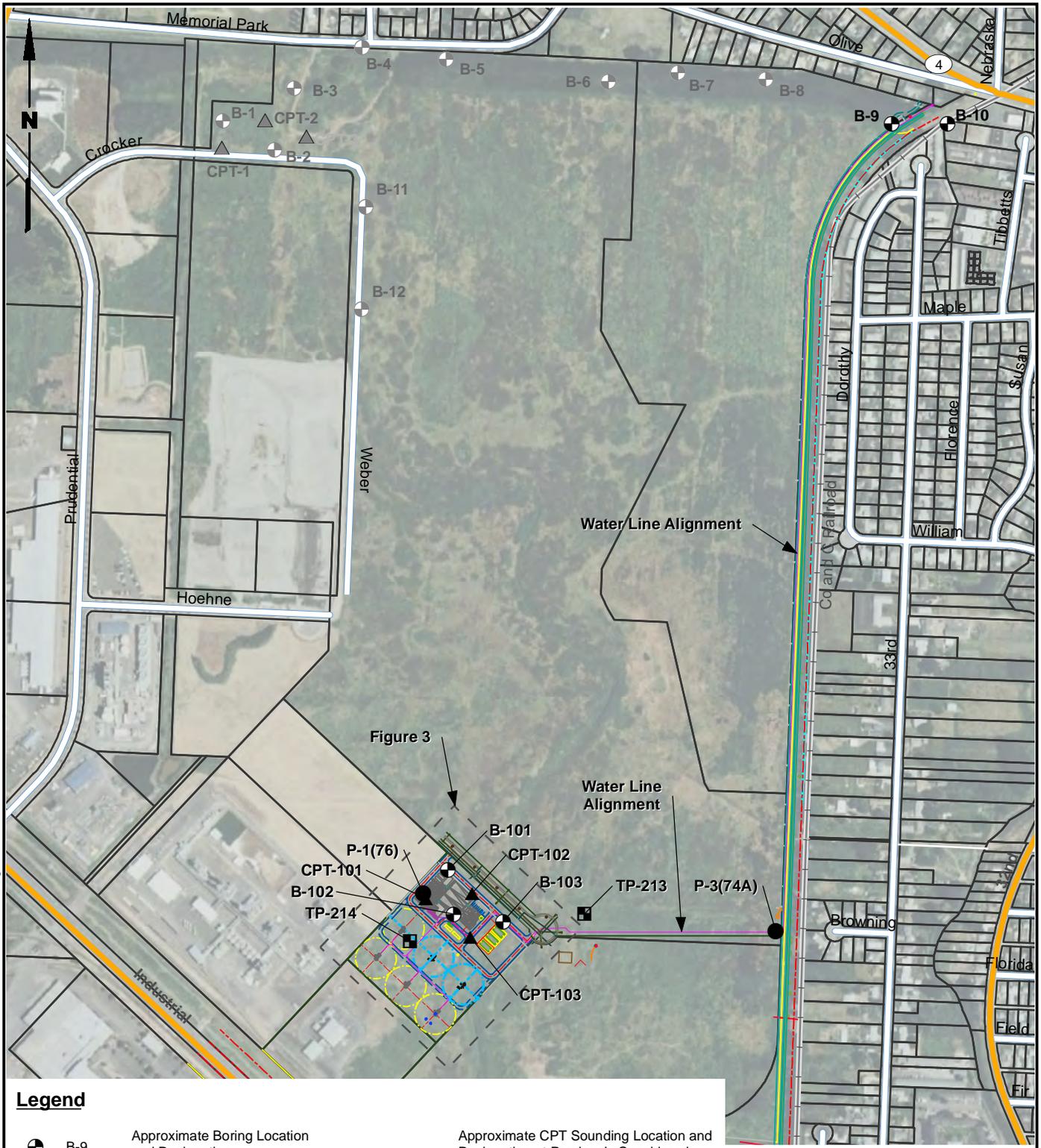


Longview Regional
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Longview, Washington

Vicinity Map

Figure
1

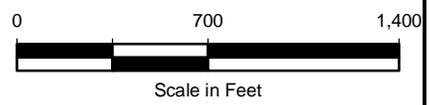
Y:\Projects\133009\Mapdocs\GVT\Fig2-Site Plan.mxd 2/22/2010 NAD 1983 StatePlane Washington South FIPS 4602 Feet



Legend

-
-
-
-

Note
 1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.



Data Source: Cowlitz County; ESRI Image Server; Kenedy/Jenks 2009

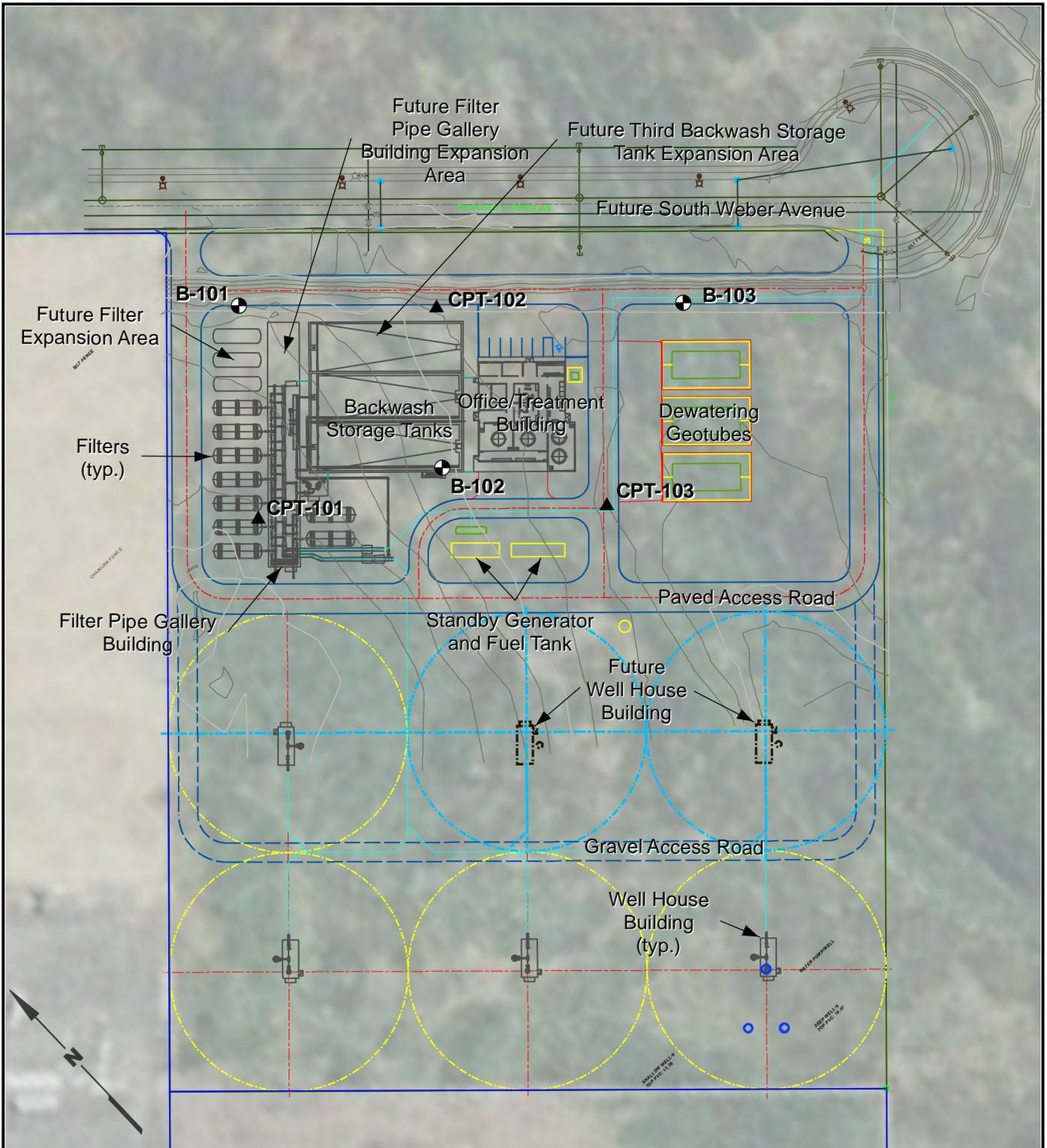


Longview Regional
 Water Treatment Plant
 Longview, Washington

Site and Exploration Plan

Figure
 2

Y:\Projects\133009\Mapdocs\GT\Fig3-Treatmentplant.mxd 2/22/2010 NAD 1983 StatePlane Washington South FIPS 4602 Feet



Legend

- B-101 Approximate Boring Location and Designation
- ▲ CPT-101 Approximate CPT Sounding Location and Designation

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.



Data Source: Cowlitz County; ESRI Image Server; Kenedy/Jenks 2009



Longview Regional
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Longview, Washington

**Site and Exploration Plan -
Water Treatment Plant Site**

Figure
3

Exploration Summary Logs

Soil Classification System

	MAJOR DIVISIONS	USCS GRAPHIC SYMBOL	LETTER SYMBOL ⁽¹⁾	TYPICAL DESCRIPTIONS ⁽²⁾⁽³⁾		
COARSE-GRAINED SOIL (More than 50% of material is larger than No. 200 sieve size)	GRAVEL AND GRAVELLY SOIL	CLEAN GRAVEL (Little or no fines)		GW	Well-graded gravel; gravel/sand mixture(s); little or no fines	
		GRAVEL WITH FINES (Appreciable amount of fines)		GP	Poorly graded gravel; gravel/sand mixture(s); little or no fines	
	(More than 50% of coarse fraction retained on No. 4 sieve)	SAND AND SANDY SOIL	CLEAN SAND (Little or no fines)		GM	Silty gravel; gravel/sand/silt mixture(s)
			SAND WITH FINES (Appreciable amount of fines)		GC	Clayey gravel; gravel/sand/clay mixture(s)
		(More than 50% of coarse fraction passed through No. 4 sieve)	CLEAN SAND (Little or no fines)		SW	Well-graded sand; gravelly sand; little or no fines
			SAND WITH FINES (Appreciable amount of fines)		SP	Poorly graded sand; gravelly sand; little or no fines
FINE-GRAINED SOIL (More than 50% of material is smaller than No. 200 sieve size)	SILT AND CLAY (Liquid limit less than 50)		ML	Inorganic silt and very fine sand; rock flour; silty or clayey fine sand or clayey silt with slight plasticity		
			CL	Inorganic clay of low to medium plasticity; gravelly clay; sandy clay; silty clay; lean clay		
			OL	Organic silt; organic, silty clay of low plasticity		
	SILT AND CLAY (Liquid limit greater than 50)		MH	Inorganic silt; micaceous or diatomaceous fine sand		
			CH	Inorganic clay of high plasticity; fat clay		
			OH	Organic clay of medium to high plasticity; organic silt		
	HIGHLY ORGANIC SOIL			PT	Peat; humus; swamp soil with high organic content	

OTHER MATERIALS	GRAPHIC SYMBOL	LETTER SYMBOL	TYPICAL DESCRIPTIONS
PAVEMENT		AC or PC	Asphalt concrete pavement or Portland cement pavement
ROCK		RK	Rock (See Rock Classification)
WOOD		WD	Wood, lumber, wood chips
DEBRIS		DB	Construction debris, garbage

- Notes:
- USCS letter symbols correspond to symbols used by the Unified Soil Classification System and ASTM classification methods. Dual letter symbols (e.g., SP-SM for sand or gravel) indicate soil with an estimated 5-15% fines. Multiple letter symbols (e.g., ML/CL) indicate borderline or multiple soil classifications.
 - Soil descriptions are based on the general approach presented in the Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), outlined in ASTM D 2488. Where laboratory index testing has been conducted, soil classifications are based on the Standard Test Method for Classification of Soils for Engineering Purposes, as outlined in ASTM D 2487.
 - Soil description terminology is based on visual estimates (in the absence of laboratory test data) of the percentages of each soil type and is defined as follows:

Primary Constituent: > 50% - "GRAVEL," "SAND," "SILT," "CLAY," etc.
 Secondary Constituents: > 30% and ≤ 50% - "very gravelly," "very sandy," "very silty," etc.
 > 15% and ≤ 30% - "gravelly," "sandy," "silty," etc.
 Additional Constituents: > 5% and ≤ 15% - "with gravel," "with sand," "with silt," etc.
 ≤ 5% - "with trace gravel," "with trace sand," "with trace silt," etc., or not noted.

- Soil density or consistency descriptions are based on judgement using a combination of sampler penetration blow counts, drilling or excavating conditions, field tests, and laboratory tests, as appropriate.

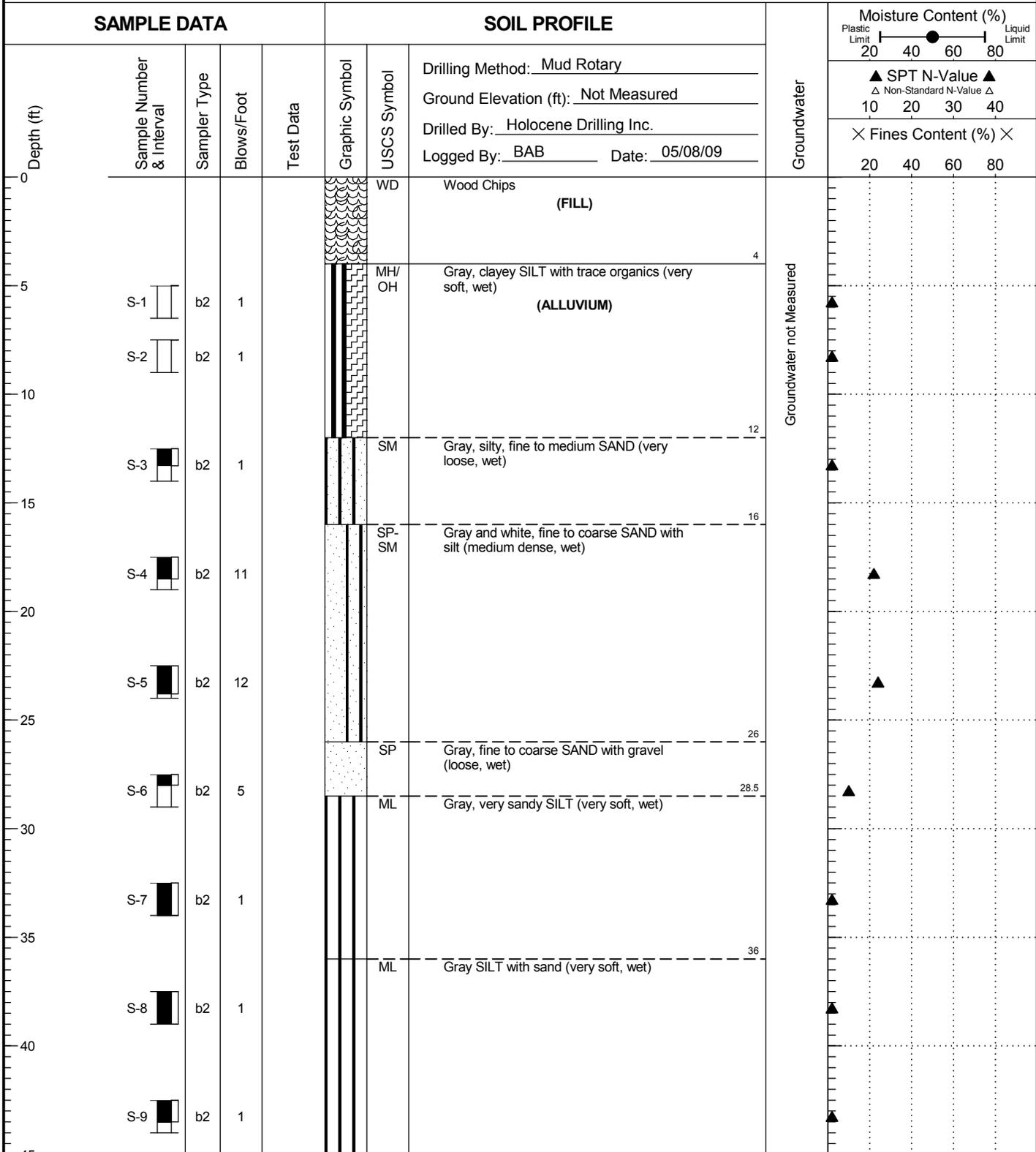
Drilling and Sampling Key		Field and Lab Test Data	
SAMPLER TYPE	SAMPLE NUMBER & INTERVAL	Code	Description
Code	Description	Code	Description
a	3.25-inch O.D., 2.42-inch I.D. Split Spoon	PP = 1.0	Pocket Penetrometer, tsf
b	2.00-inch O.D., 1.50-inch I.D. Split Spoon	TV = 0.5	Torvane, tsf
c	Shelby Tube	PID = 100	Photoionization Detector VOC screening, ppm
d	Grab Sample	W = 10	Moisture Content, %
e	Single-Tube Core Barrel	D = 120	Dry Density, pcf
f	Double-Tube Core Barrel	-200 = 60	Material smaller than No. 200 sieve, %
g	2.50-inch O.D., 2.00-inch I.D. WSDOT	GS	Grain Size - See separate figure for data
h	3.00-inch O.D., 2.375-inch I.D. Mod. California	AL	Atterberg Limits - See separate figure for data
i	Other - See text if applicable	GT	Other Geotechnical Testing
1	300-lb Hammer, 30-inch Drop	CA	Chemical Analysis
2	140-lb Hammer, 30-inch Drop		
3	Pushed		
4	Vibrocore (Rotosonic/Geoprobe)		
5	Other - See text if applicable		

Groundwater	
	Approximate water level at time of drilling (ATD)
	Approximate water level at time other than ATD

12/21/09 Y:\1333009.000\1333009.010.GPJ SOIL CLASS SHEET

B-9

LAI Project No: 133009.010



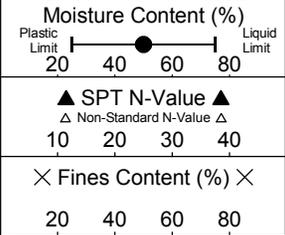
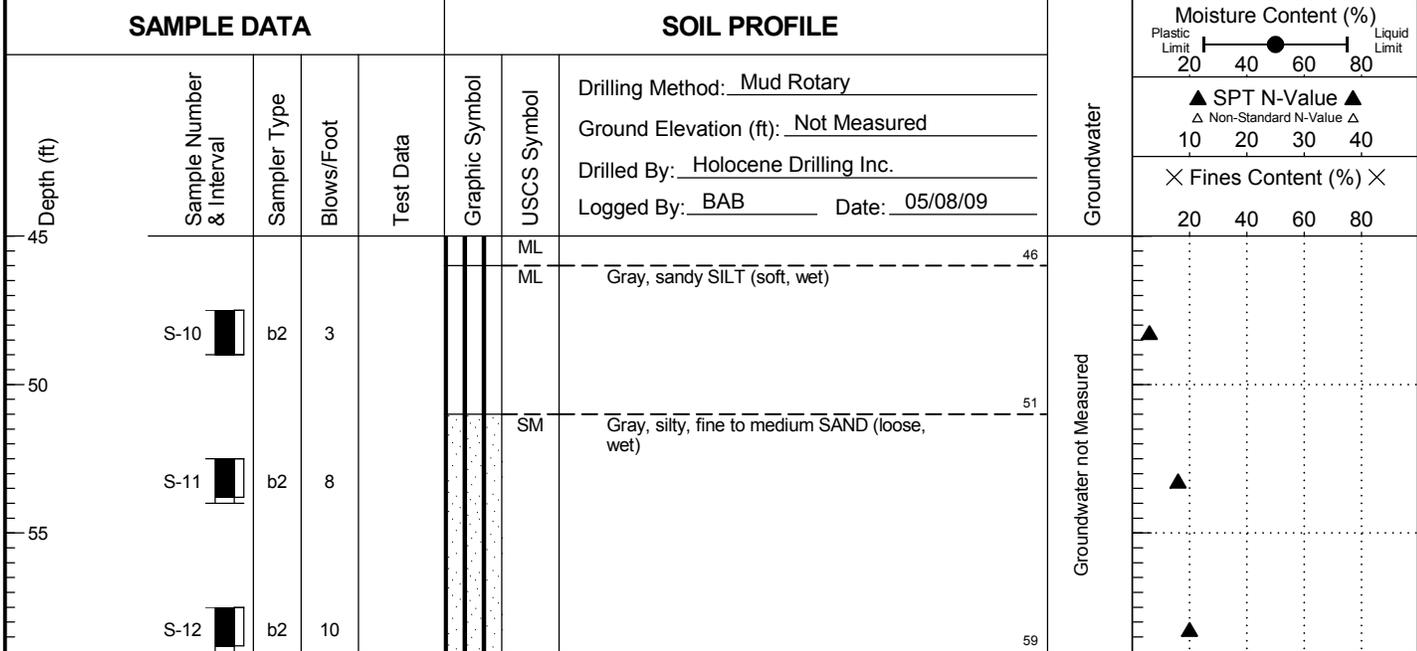
133009.01 12/21/09 Y:\133009.000\T1\133009.010.GPJ SOIL BORING LOG WITH GRAPH

- Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
 2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
 3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.



B-9

LAI Project No: 133009.010



Depth (ft)

Boring Completed 05/08/09. Total Depth of Boring = 59.0 ft.

133009.01 12/21/09 Y:\133009.000\T1\133009.010.GPJ SOIL BORING LOG WITH GRAPH

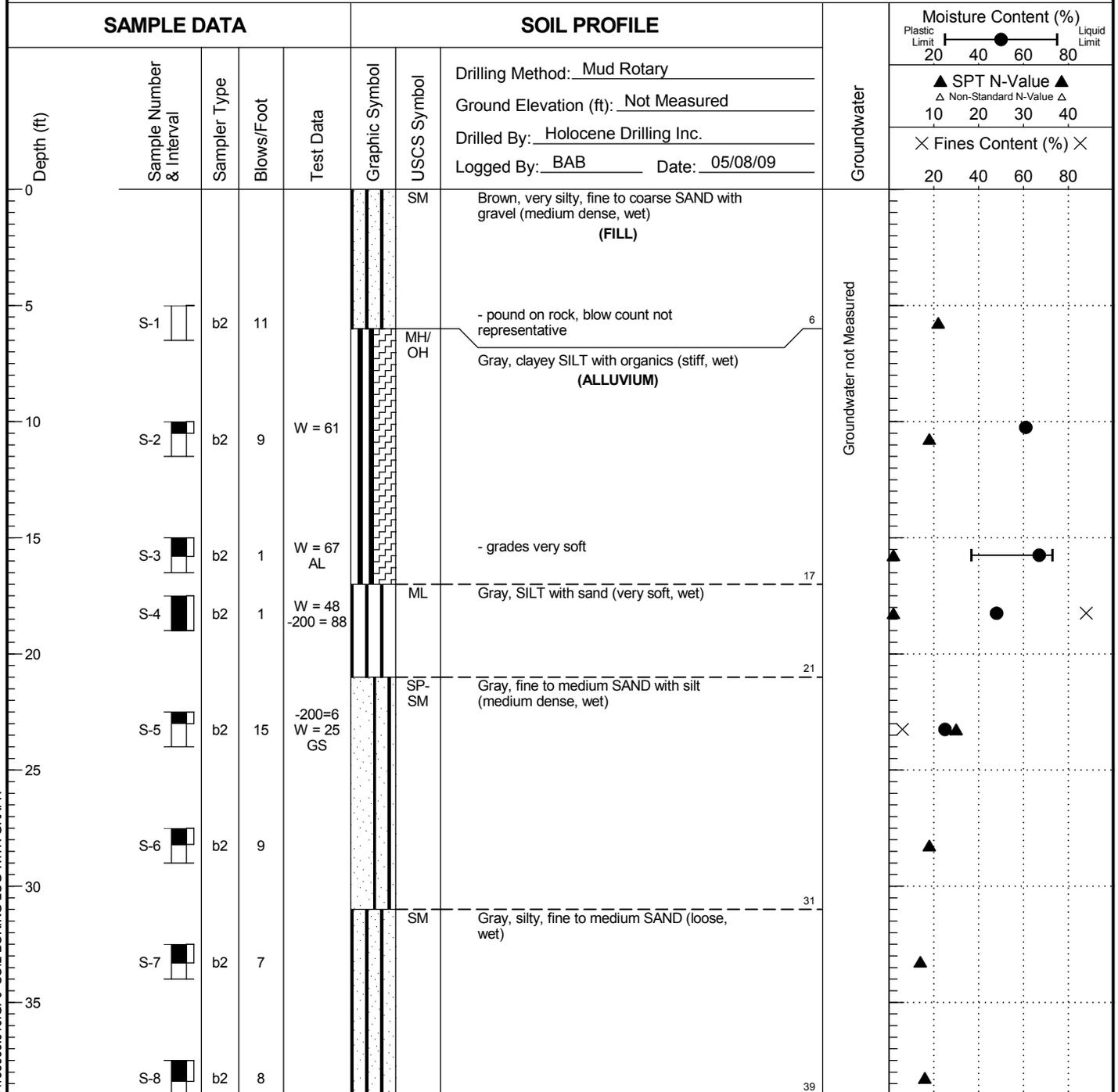
- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
 2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
 3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.



Longview Regional Water Treatment Plant Longview, Washington	Log of Boring B-9	Figure A-2 (2 of 2)
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B-10

LAI Project No: 133009.010



Boring Completed 05/08/09. Total Depth of Boring = 39.0 ft.

- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
 2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
 3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

133009.01 12/21/09 Y:\133009.000\T1\133009.010.GPJ SOIL BORING LOG WITH GRAPH



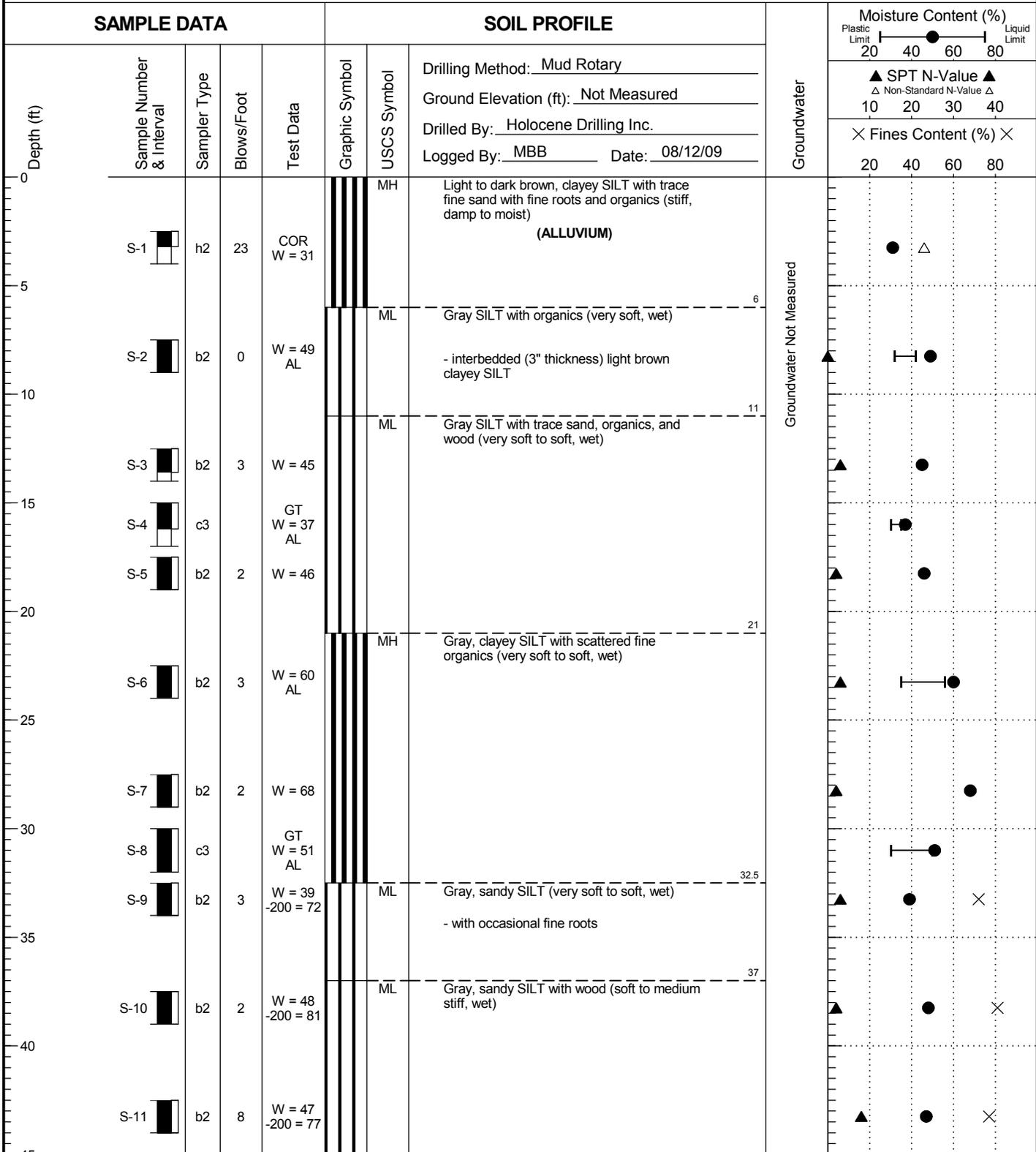
Longview Regional
Water Treatment Plant
Longview, Washington

Log of Boring B-10

Figure
A-3

B-101

LAI Project No: 133009.010



- Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
 2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
 3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

133009.01 12/21/09 Y:\133009.000\T1\133009.010.GPJ SOIL BORING LOG WITH GRAPH



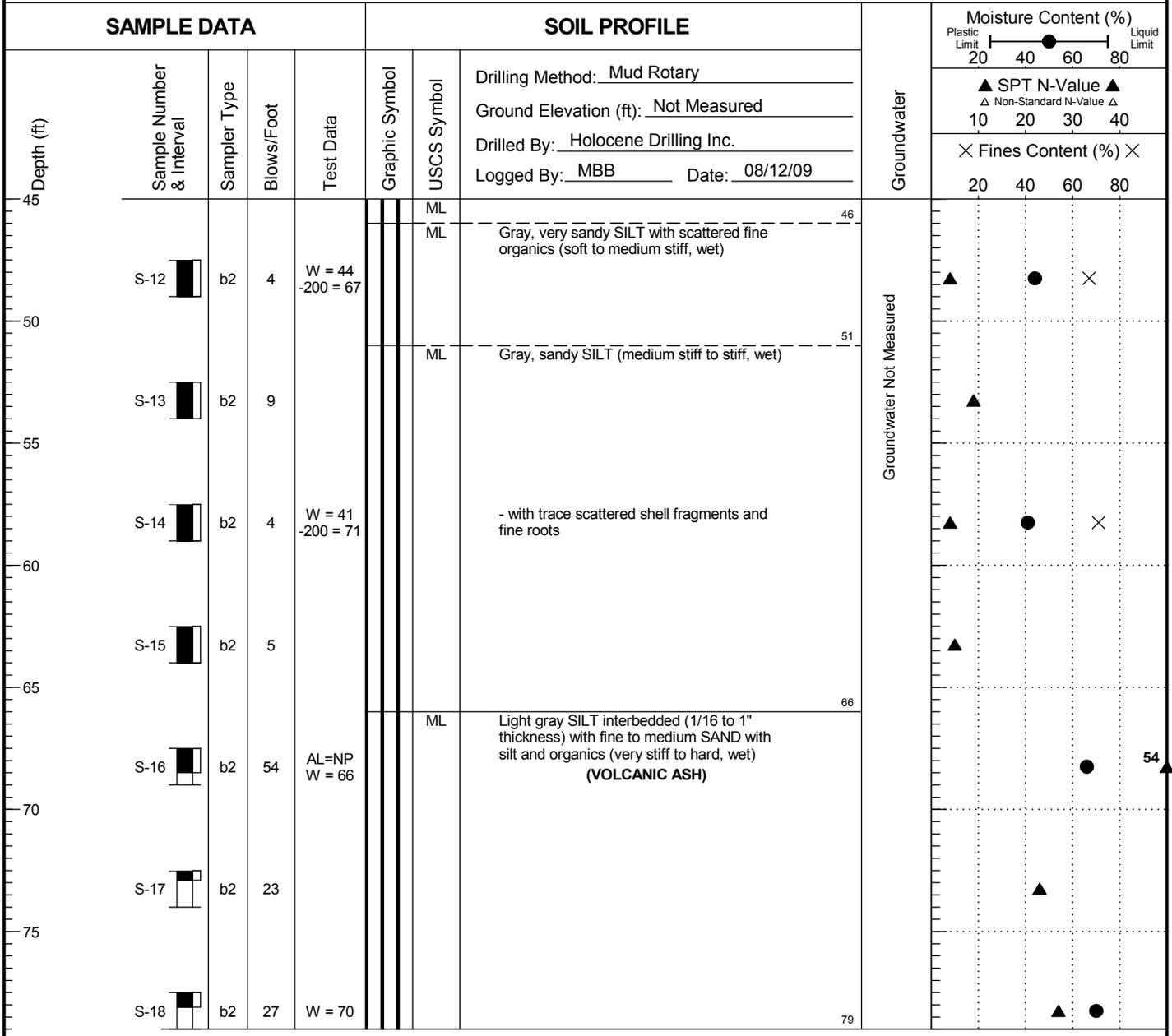
Longview Regional
Water Treatment Plant
Longview, Washington

Log of Boring B-101

Figure
A-4
(1 of 2)

B-101

LAI Project No: 133009.010



Boring Completed 08/12/09. Total Depth of Boring = 79.0 ft.

- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
 2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
 3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

133009.01 12/21/09 Y:\133009.000\T1\133009.010.GPJ SOIL BORING LOG WITH GRAPH

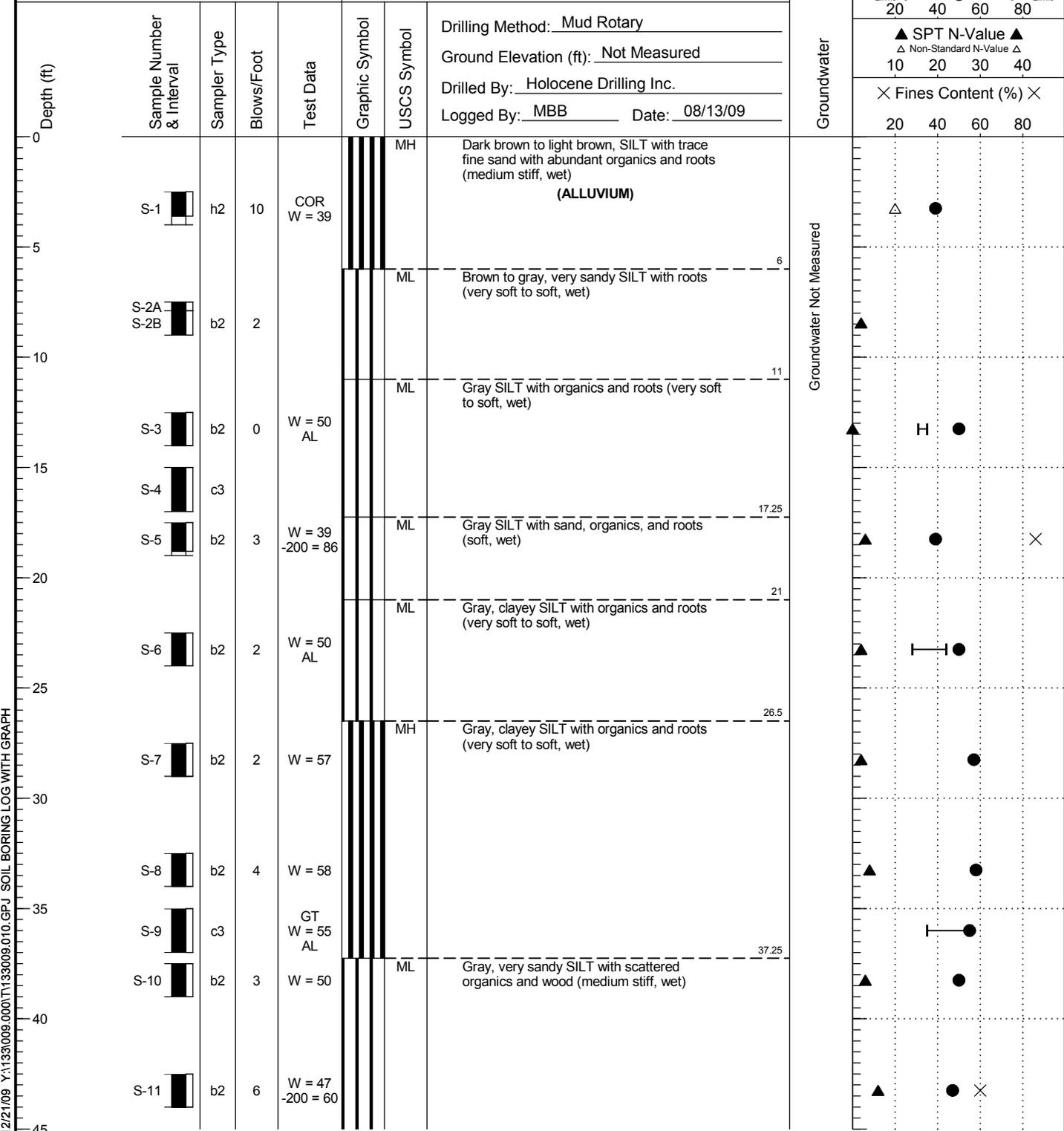


B-102

LAI Project No: 133009.010

SAMPLE DATA

SOIL PROFILE



- Notes:
- Stratigraphic contacts are based on field interpretations and are approximate.
 - Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
 - Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

133009.01 12/21/09 Y:\133009.000\T1\133009.010.GPJ SOIL BORING LOG WITH GRAPH



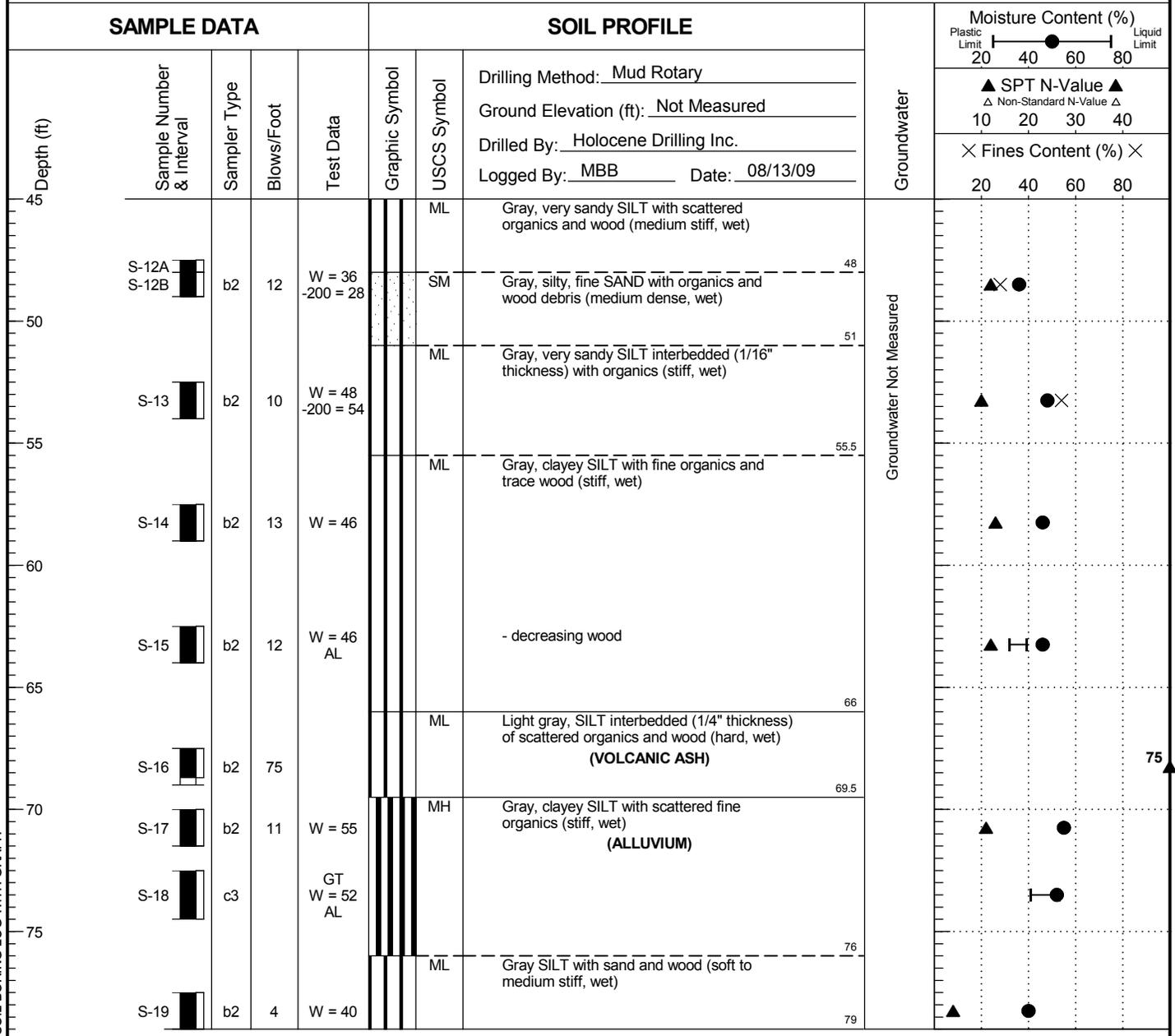
Longview Regional
Water Treatment Plant
Longview, Washington

Log of Boring B-102

Figure
A-5
(1 of 2)

B-102

LAI Project No: 133009.010



Boring Completed 08/13/09. Total Depth of Boring = 79.0 ft.

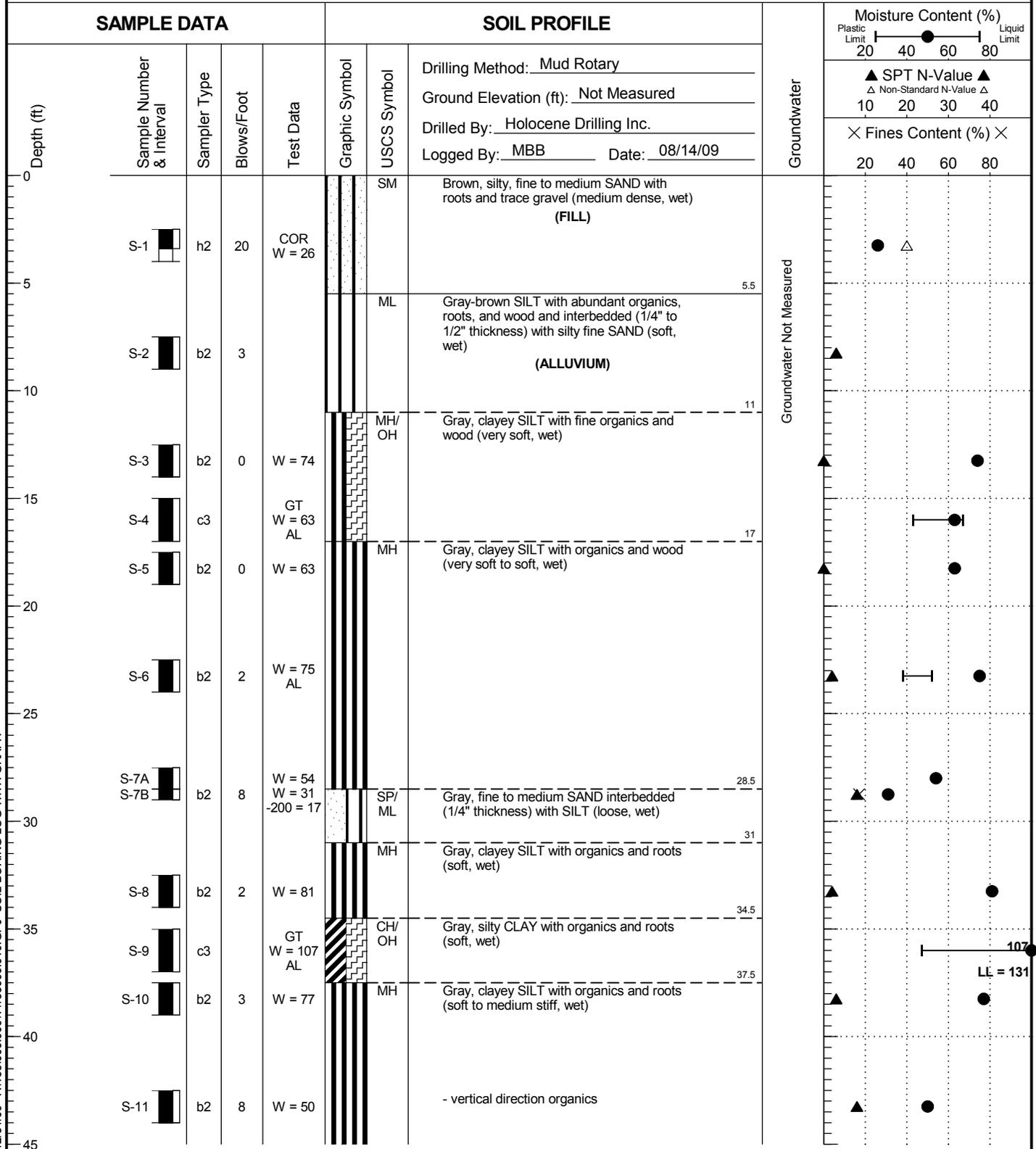
- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
 2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
 3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

133009.01 12/21/09 Y:\133009.000\T1\133009.010.GPJ SOIL BORING LOG WITH GRAPH



B-103

LAI Project No: 133009.010



- Notes: 1. Stratigraphic contacts are based on field interpretations and are approximate.
 2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
 3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.

133009.01 12/31/09 Y:\133009.000\T1\133009.010.GPJ SOIL BORING LOG WITH GRAPH



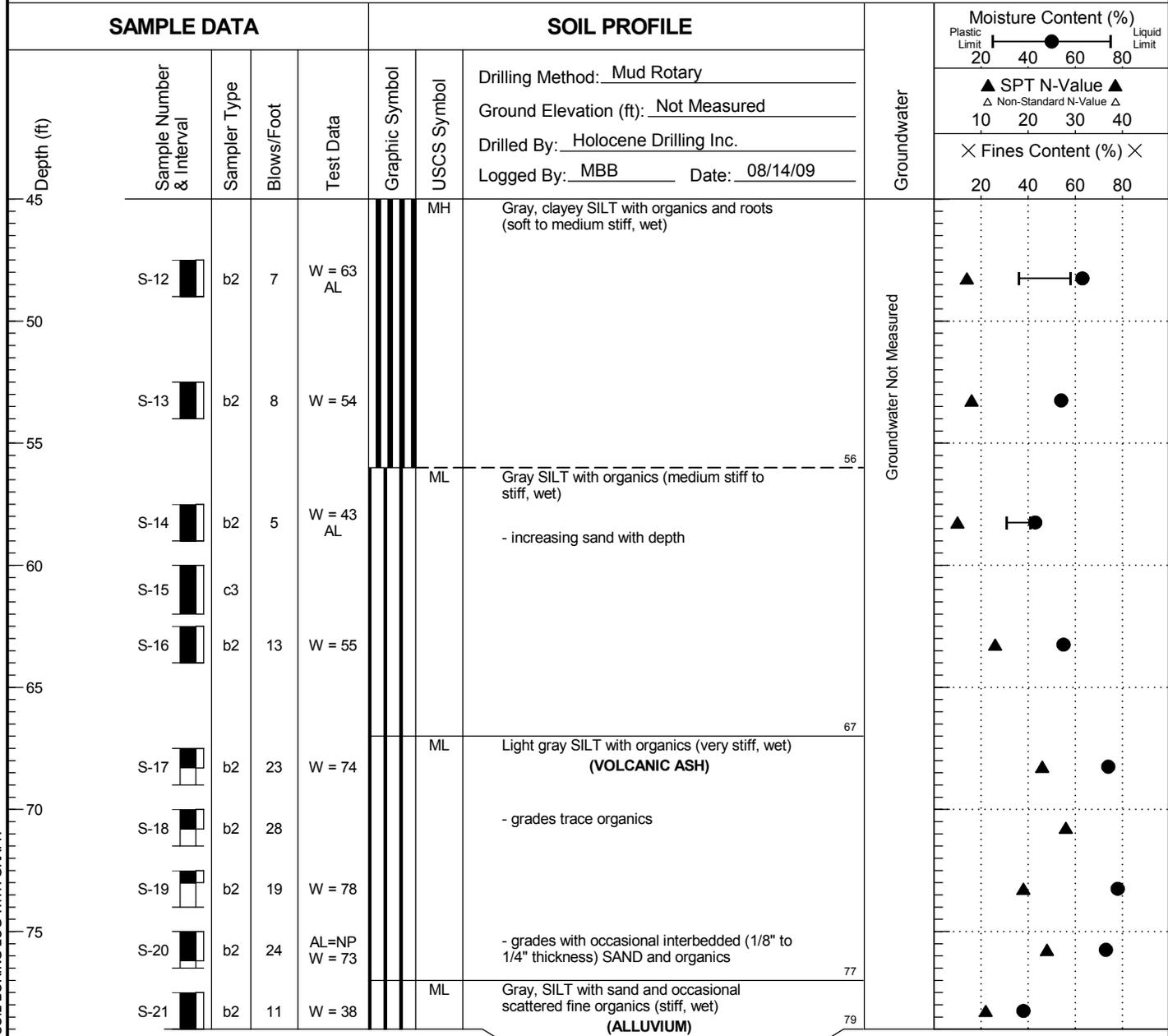
Longview Regional
Water Treatment Plant
Longview, Washington

Log of Boring B-103

Figure
A-6
(1 of 2)

B-103

LAI Project No: 133009.010



Boring Completed 08/14/09. Total Depth of Boring = 79.0 ft.

133009.01 12/31/09 Y:\133009.000\T1\133009.010.GPJ SOIL BORING LOG WITH GRAPH

- Notes:
1. Stratigraphic contacts are based on field interpretations and are approximate.
 2. Reference to the text of this report is necessary for a proper understanding of subsurface conditions.
 3. Refer to "Soil Classification System and Key" figure for explanation of graphics and symbols.



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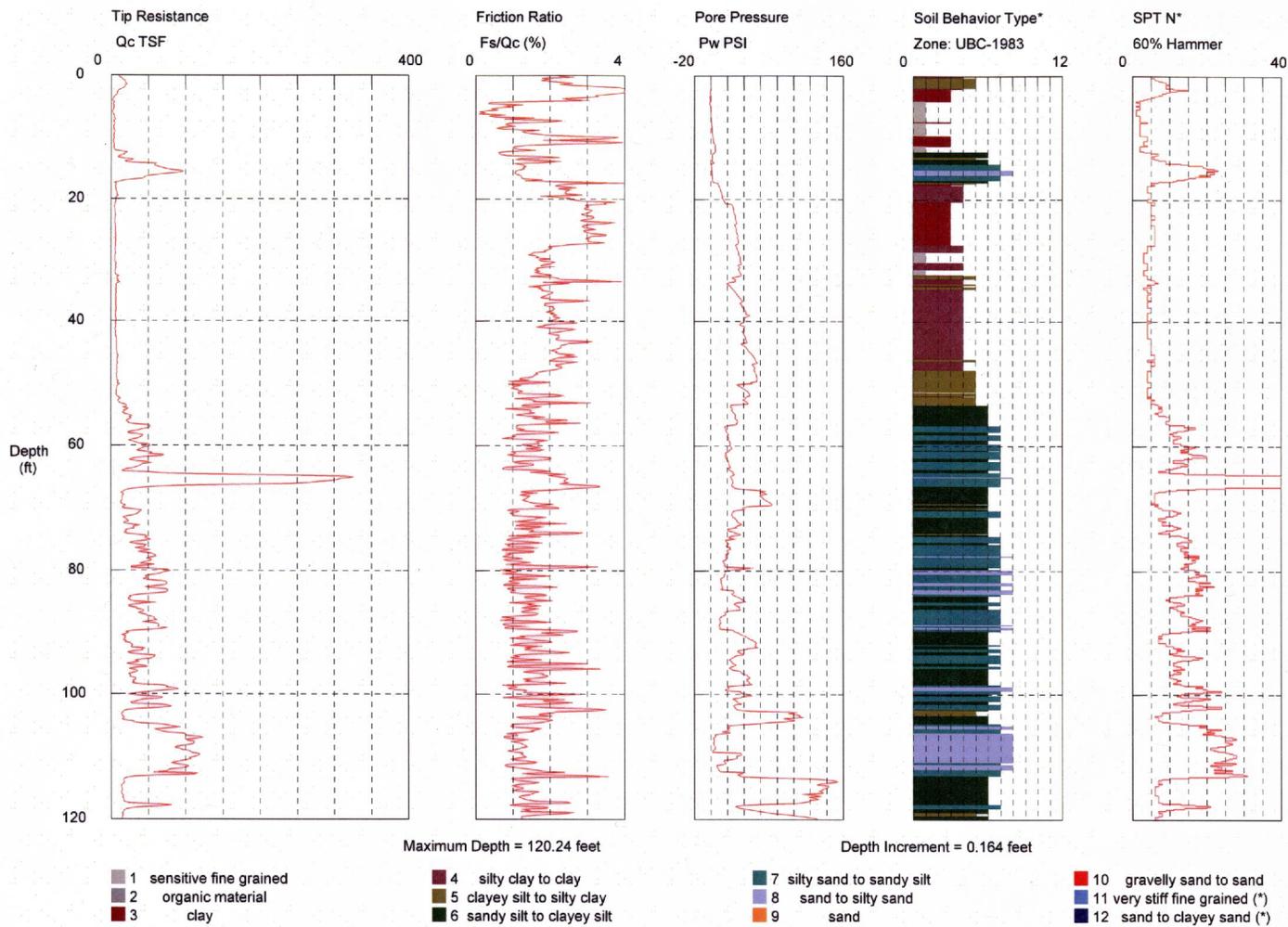
Log of Boring B-103

Figure
A-6
(2 of 2)

Landau Associates

Operator: Dafni
Sounding: CPT-101
Cone Used: DSG1079

CPT Date/Time: 8/18/2009 1:40:18 PM
Location: Longview Water Treatment Plant
Job Number: 133009.010.011



*Soil behavior type and SPT based on data from UBC-1983

In Situ Engineering

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

Longview Regional
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Log of CPT Sounding CPT-101

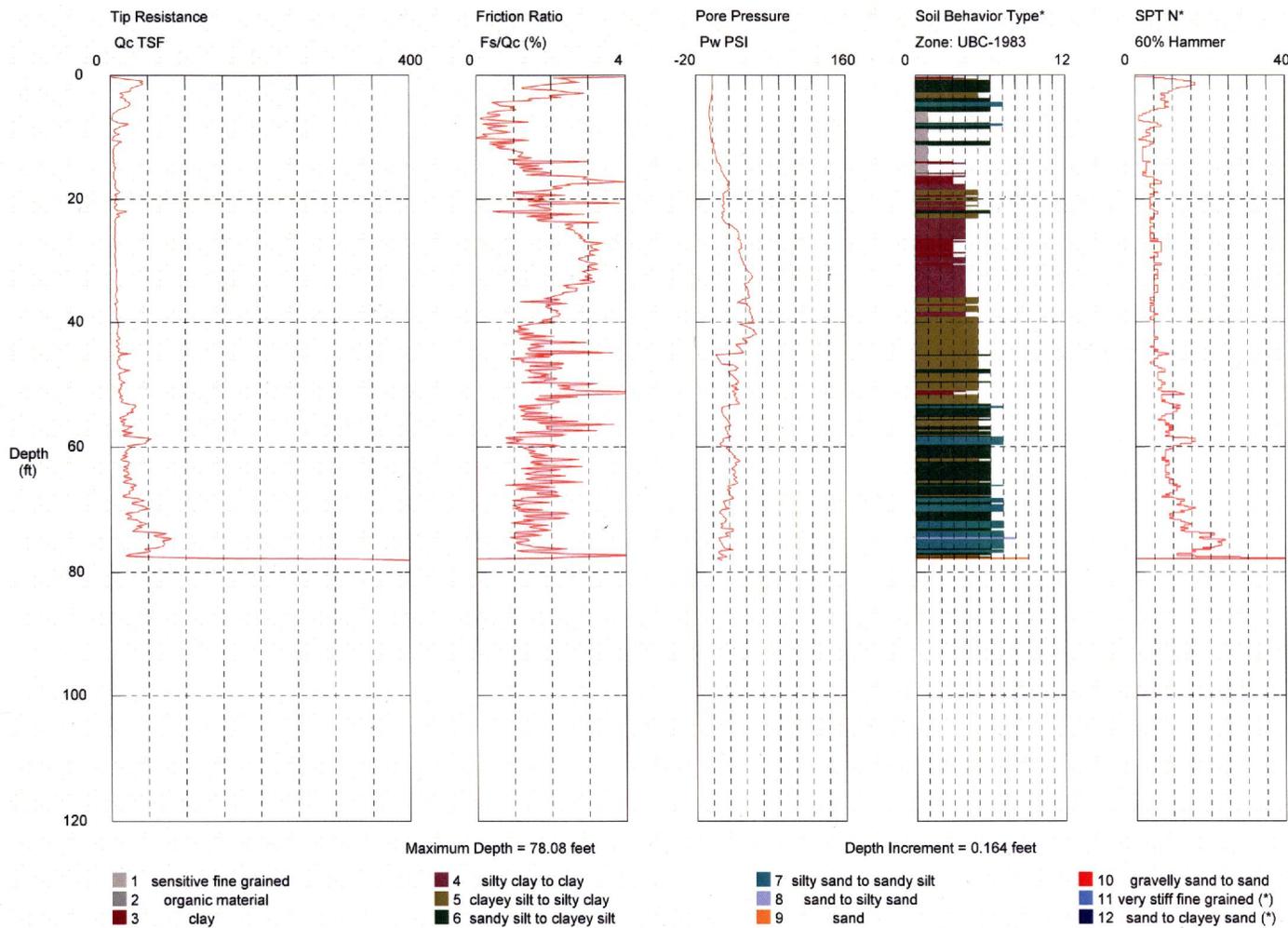
Figure
A-7



Landau Associates

Operator: Dafni
Sounding: CPT-102
Cone Used: DSG1079

CPT Date/Time: 8/18/2009 11:30:03 AM
Location: Longview Water Treatment Plant
Job Number: 133009.010.011



*Soil behavior type and SPT based on data from UBC-1983

In Situ Engineering

Note

- Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

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Longview, Washington

Log of CPT Sounding CPT-102

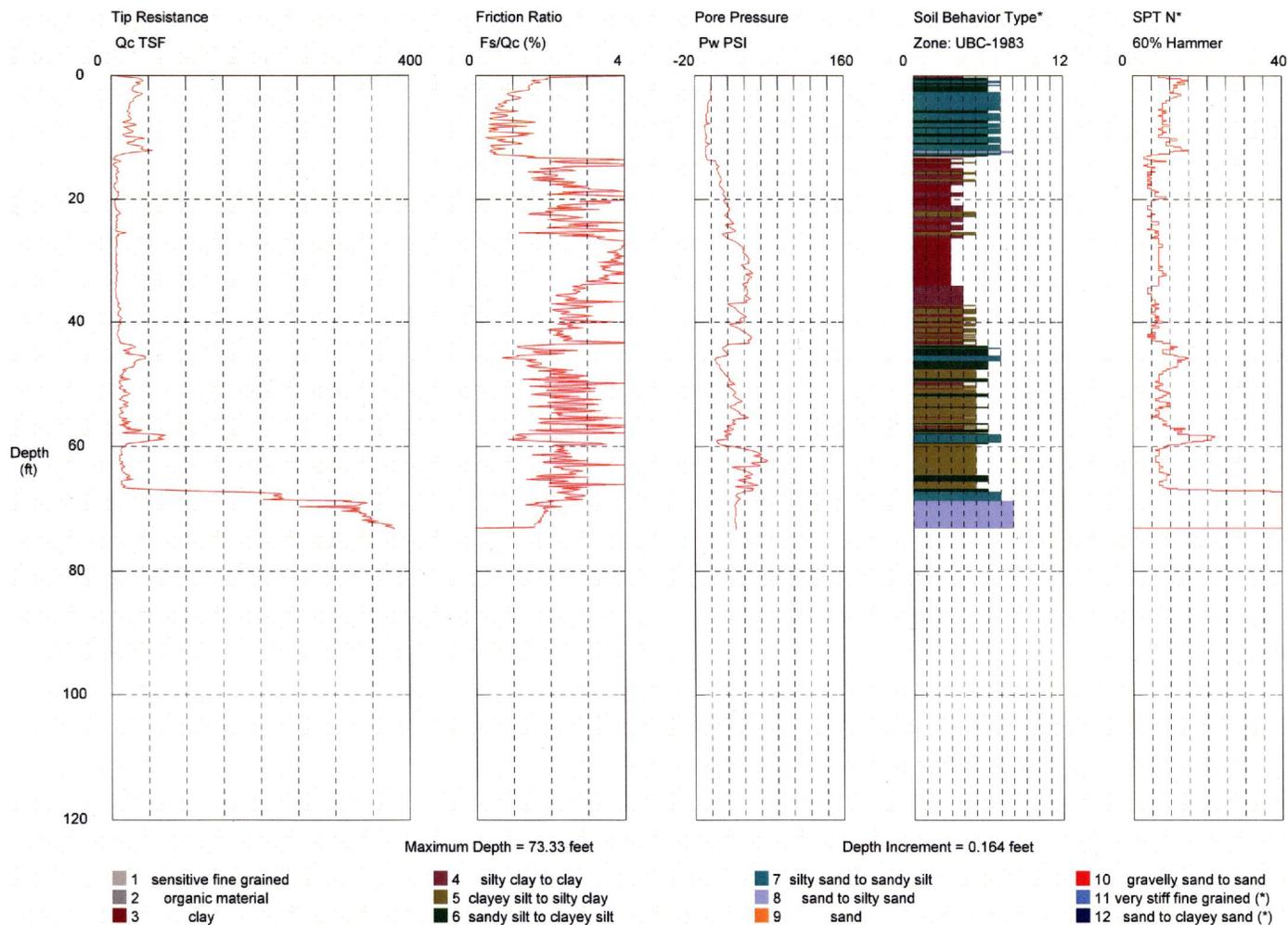
Figure
A-8



Landau Associates

Operator: Dafni
Sounding: CPT-103
Cone Used: DSG1079

CPT Date/Time: 8/17/2009 1:54:39 PM
Location: Longview Water Treatment Plant
Job Number: 133009.010.011



*Soil behavior type and SPT based on data from UBC-1983

In Situ Engineering

Note

1. Black and white reproduction of this color original may reduce its effectiveness and lead to incorrect interpretation.

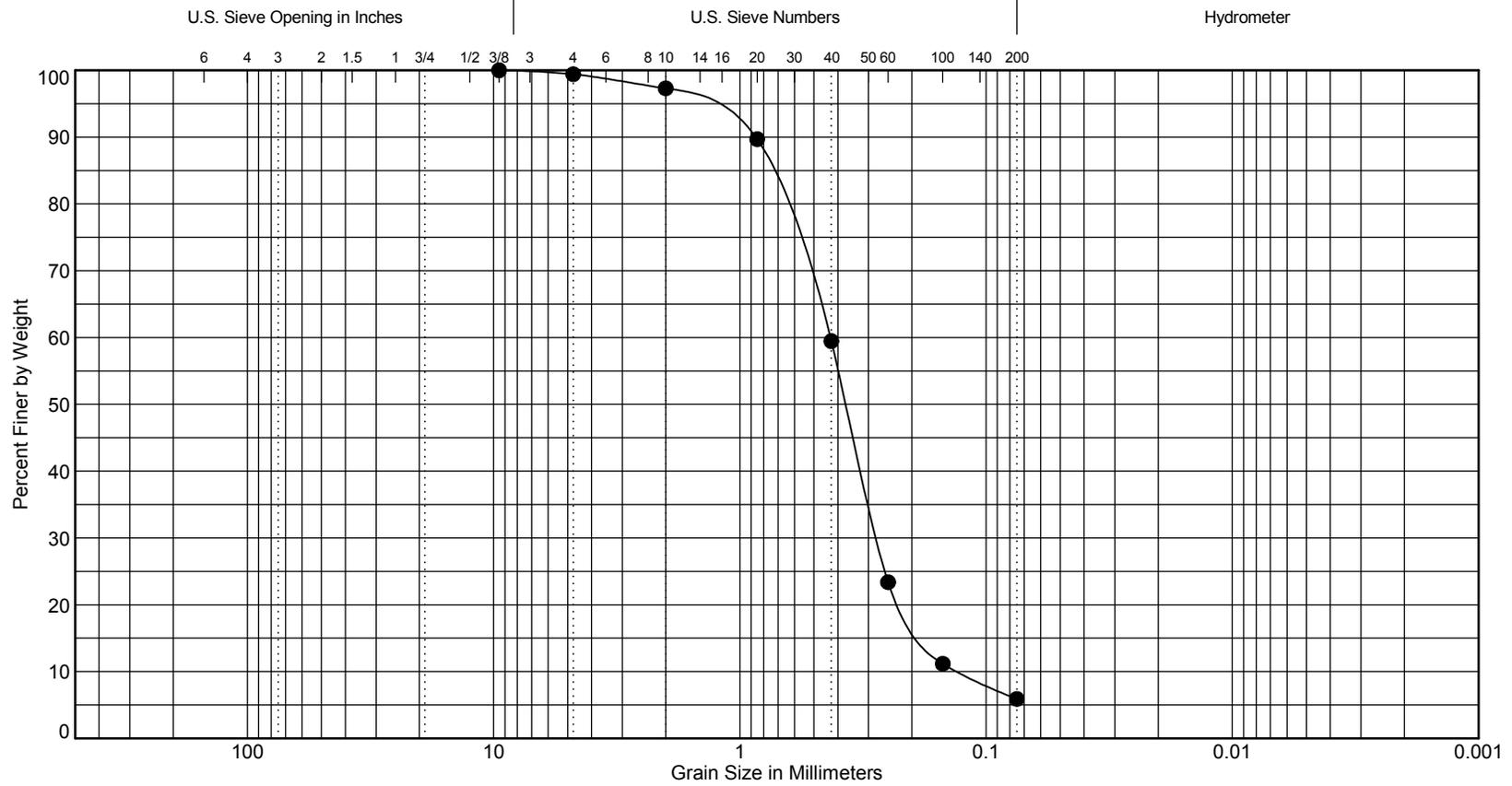
Longview Regional
Water Treatment Plant
Longview, Washington

Log of CPT Sounding CPT-103

Figure
A-9

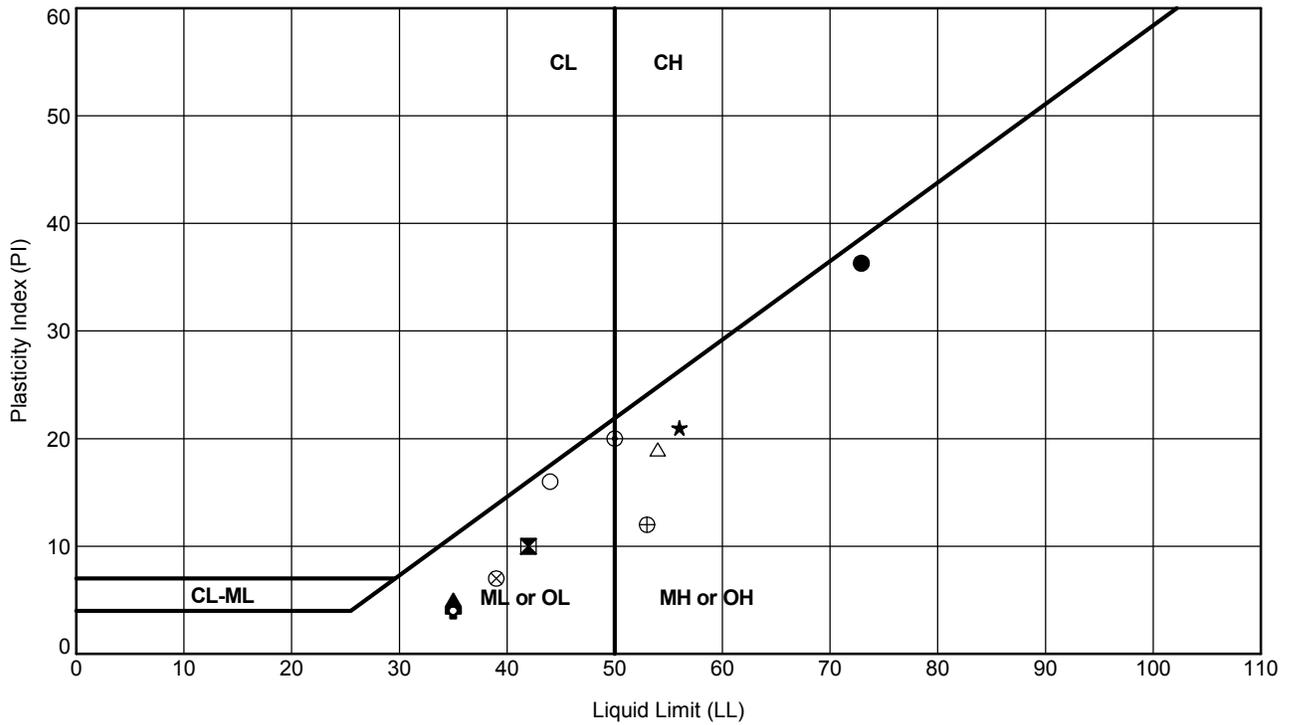


Geotechnical Laboratory Test Results



Cobbles	Gravel		Sand			Silt or Clay
	Coarse	Fine	Coarse	Medium	Fine	

Symbol	Exploration Number	Sample Number	Depth (ft)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-10	S-5	22.5	25	Fine to medium SAND with silt	SP-SM



ATTERBERG LIMIT TEST RESULTS

Symbol	Exploration Number	Sample Number	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-10	S-3	15.0	73	37	36	67	Clayey SILT with organics	OH
⊠	B-101	S-2	7.5	42	32	10	49	SILT with organics	ML
▲	B-101	S-4	15.0	35	30	5	37	SILT with trace sand, organics, and wood	ML
★	B-101	S-6	22.5	56	35	21	60	Clayey SILT with scattered fine organics	MH
⊙	B-101	S-8	30.0	50	30	20	51	Clayey SILT with scattered fine organics	MH
⊕	B-102	S-3	12.5	35	31	4	50	SILT with organics and roots	ML
○	B-102	S-6	22.5	44	28	16	50	Clayey SILT with organics and roots	ML
△	B-102	S-9	35.0	54	35	19	55	Clayey SILT with organics and roots	MH
⊗	B-102	S-15	62.5	39	32	7	46	Clayey SILT with fine organics	ML
⊕	B-102	S-18	72.5	53	41	12	52	Clayey SILT with scattered fine organics	MH

ASTM D 4318 Test Method

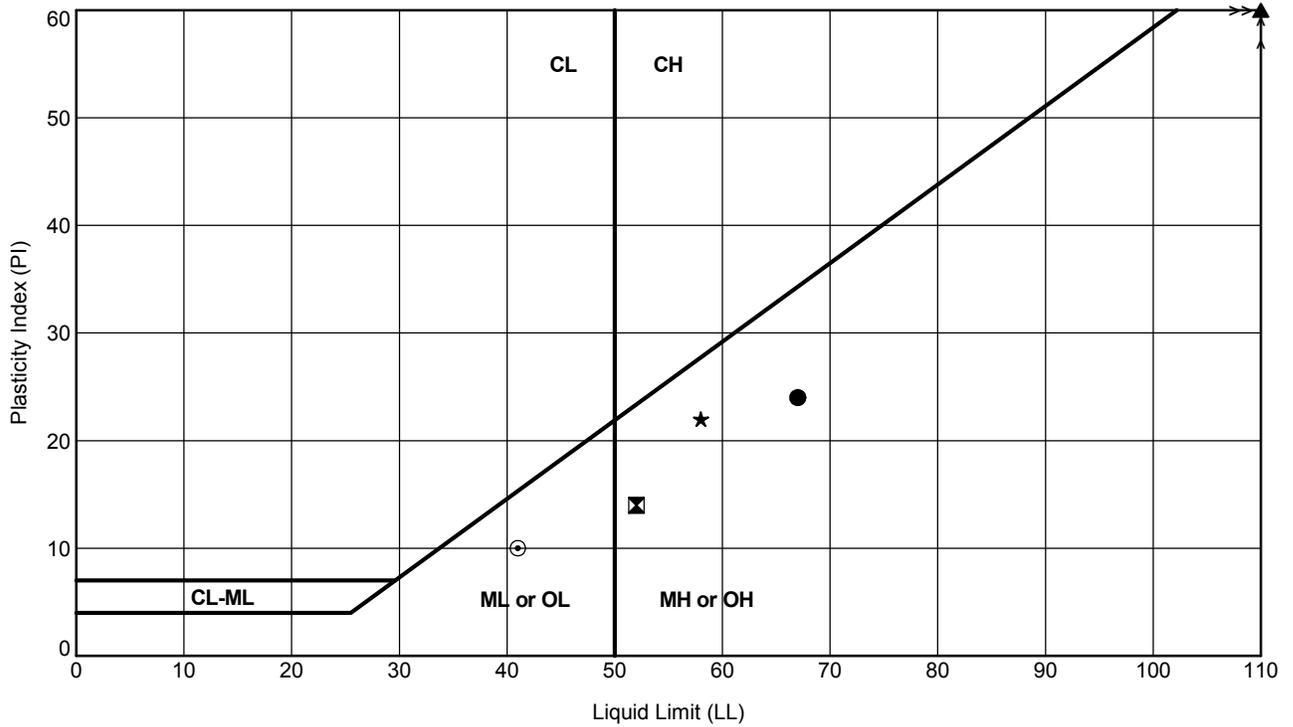
133009.01 12/21/09 Y:\133009.000\T1133009.010.GPJ ATTERBERG LIMITS FIGURE



Longview Regional
Water Treatment Plant
Longview, Washington

Plasticity Chart

Figure
B-2



ATTERBERG LIMIT TEST RESULTS

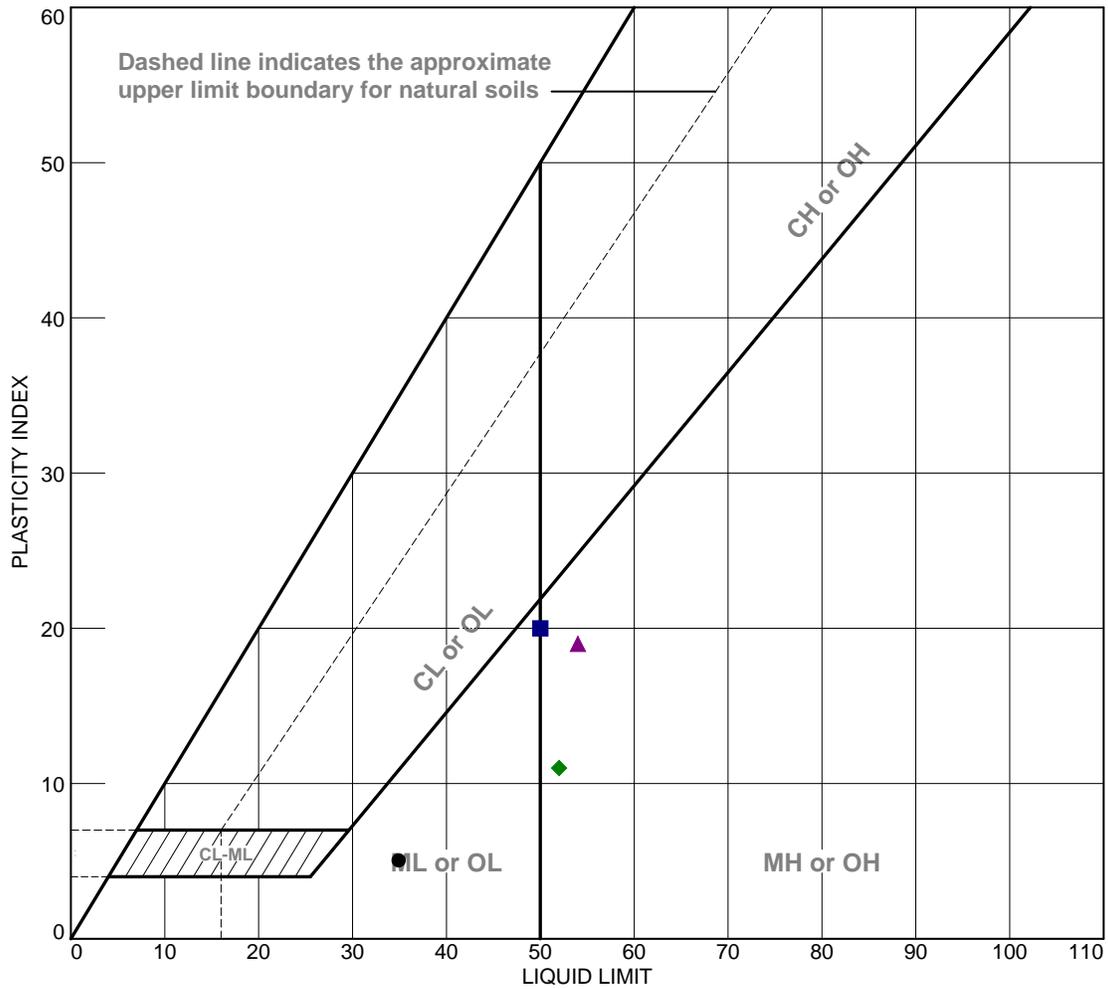
Symbol	Exploration Number	Sample Number	Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Natural Moisture (%)	Soil Description	Unified Soil Classification
●	B-103	S-4	15.0	67	43	24	63	Clayey SILT with fine organics and wood	MH/OH
☒	B-103	S-6	22.5	52	38	14	75	Clayey SILT with organics and wood	MH
▲	B-103	S-9	35.0	131	47	84	107	Silty CLAY with organics and roots	CH/OH
★	B-103	S-12	47.5	58	36	22	63	Clayey SILT with organics and roots	MH
⊙	B-103	S-14	57.5	41	31	10	43	SILT with organics	ML

ASTM D 4318 Test Method

133009.01 12/21/09 Y:\133\009\000\T1\133009.010.GPJ ATTERBERG LIMITS FIGURE



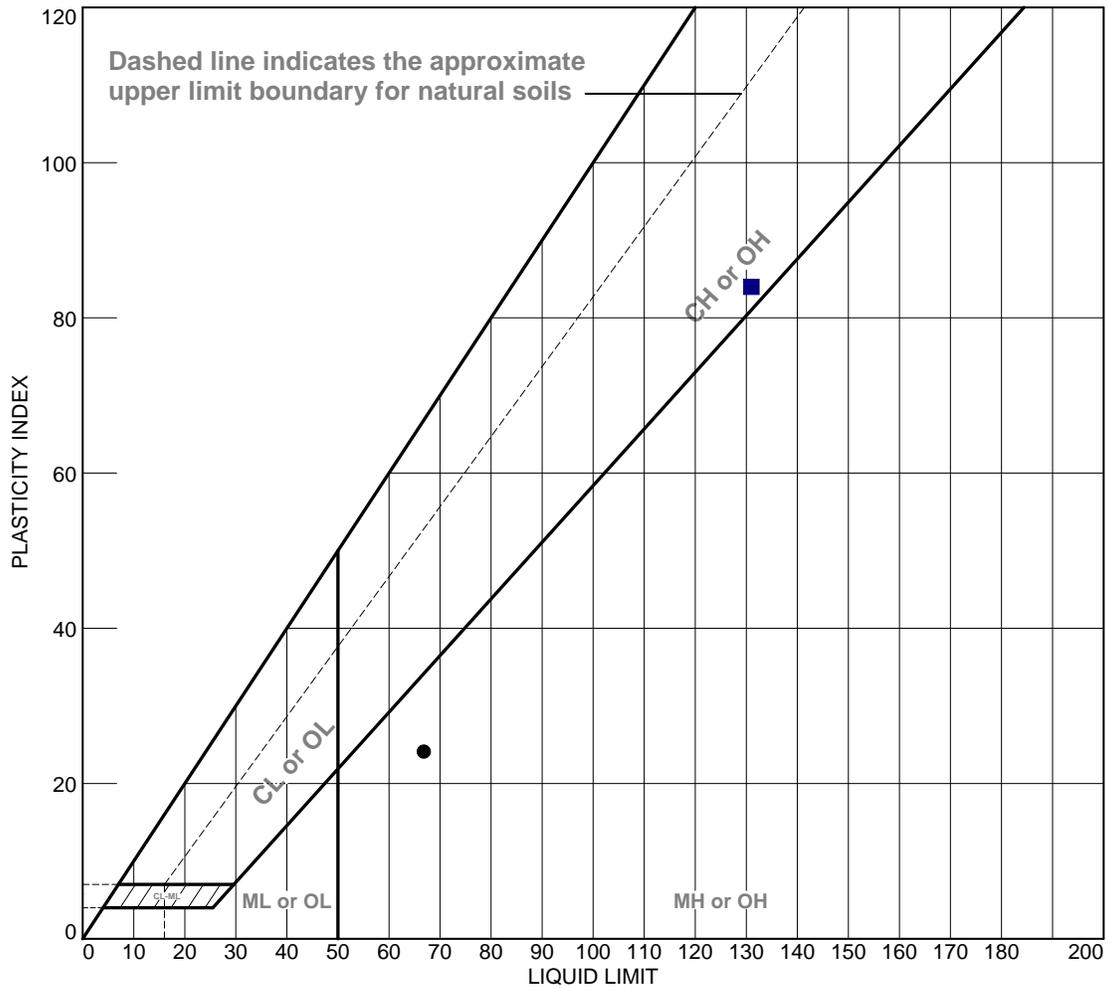
Atterberg Limits Test Report ASTM D-4318



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-101	S-4	16.1-16.2 ft.	37	30	35	5	ML
■	B-101	S-8	31.5-31.6 ft.	51	30	50	20	MH
▲	B-102	S-9	36.2-36.3 ft.	55	35	54	19	MH
◆	B-102	S-18	72.7-72.8 ft.	52	41	52	11	MH

<p style="text-align: center;">SOIL TECHNOLOGY</p> <p style="text-align: center;">Bainbridge Island, WA</p>	<p>Client: Landau Associates</p> <p>Project: Longview Water Treatment Plant Project No. 133009.010.011</p> <p>Project No.: J-09-2326</p>	<p>Figure 1</p>
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Atterberg Limits Test Report ASTM D-4318



SOIL DATA								
SYMBOL	SOURCE	SAMPLE NO.	DEPTH	NATURAL WATER CONTENT (%)	PLASTIC LIMIT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	USCS
●	B-103	S-4	16.5-16.6 ft.	63	43	67	24	OH
■	B-103	S-9	36.1-36.2 ft.	107	47	131	84	OH

SOIL TECHNOLOGY

Bainbridge Island, WA

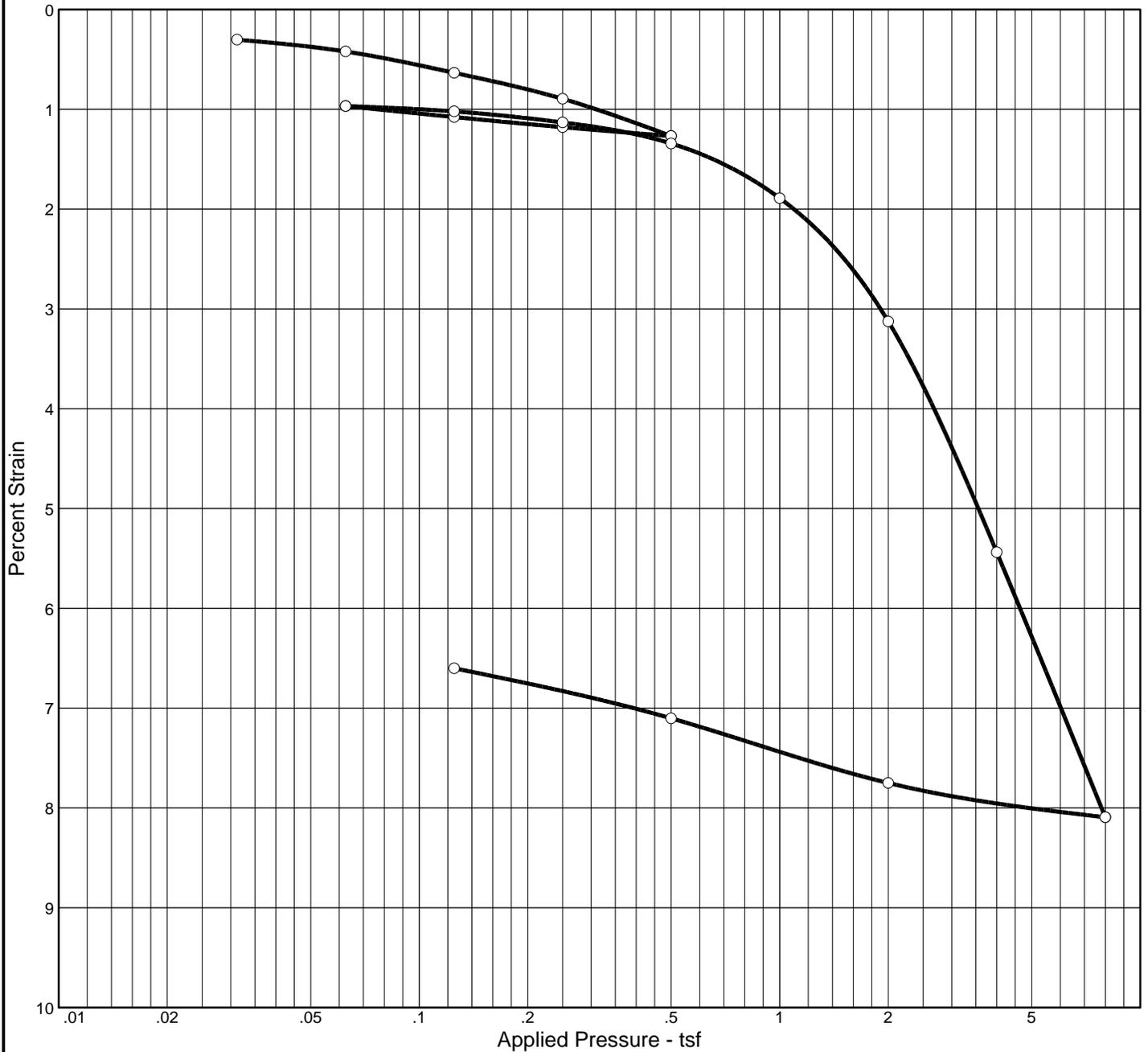
Client: Landau Associates

Project: Longview Water Treatment Plant
Project No. 133009.010.011

Project No.: J-09-2326

Figure 2

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P _c (tsf)	C _c	C _r	Swell Press. (tsf)	Swell %	e ₀
Sat.	Moist.											
99.1 %	37.4 %	82.0	35	5	2.60		1.75	0.18	0.01			0.982

MATERIAL DESCRIPTION	USCS	AASHTO
M-stiff, moist, grey SILT	ML	---

Project No. J-09-2326 Client: Landau Associates Project: Longview Water Treatment Plant Project No. 133009.010.011 Source: B-101 Sample No.: S-4 Elev./Depth: 16.1-16.2 ft.	Remarks: Sample contained fine roots Specific gravity estimated
SOIL TECHNOLOGY Bainbridge Island, WA	

Figure 1

Dial Reading vs. Time

Project No.: J-09-2326

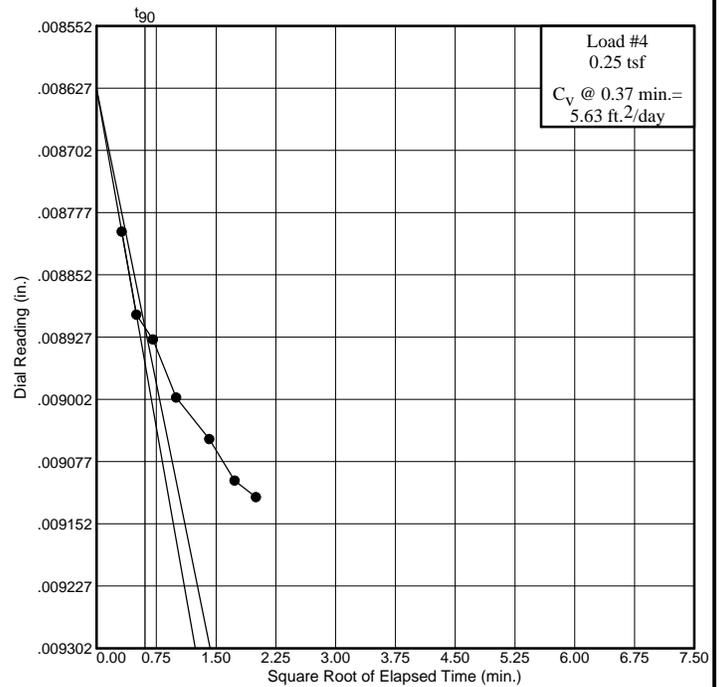
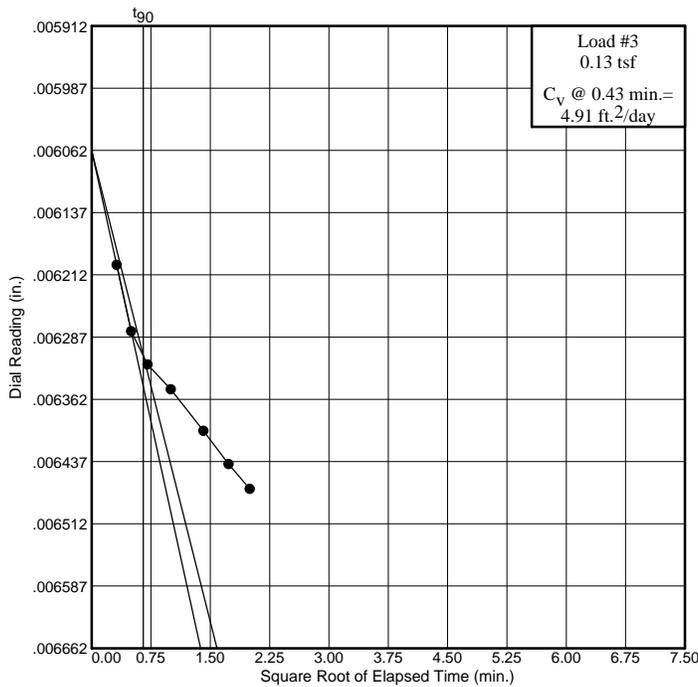
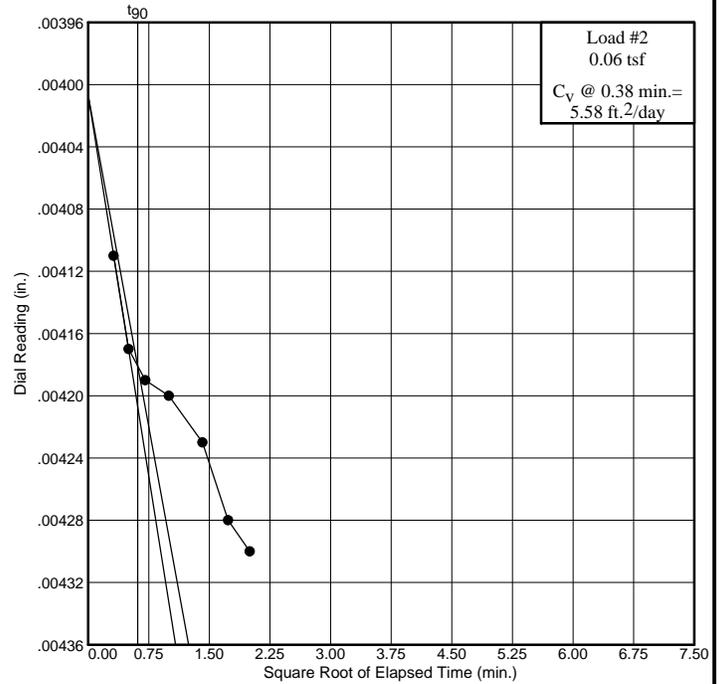
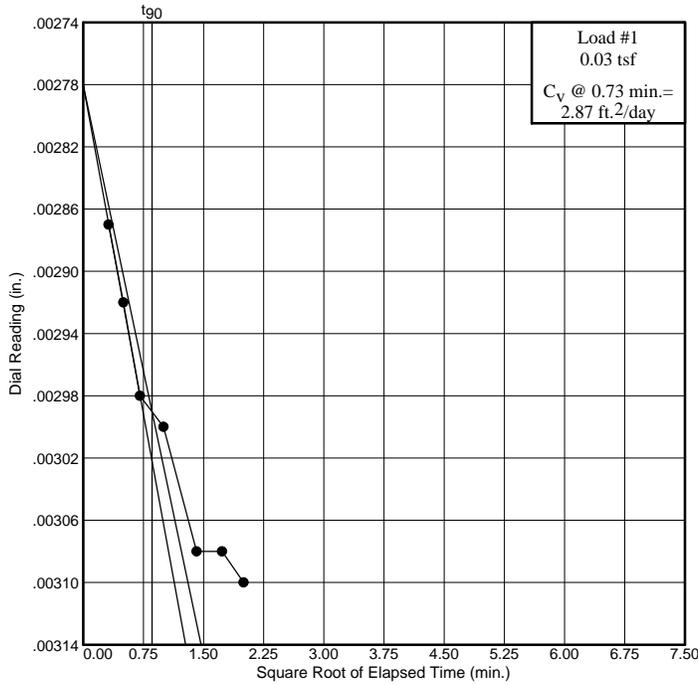
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-101

Sample No.: S-4

Elev./Depth: 16.1-16.2 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 2

Dial Reading vs. Time

Project No.: J-09-2326

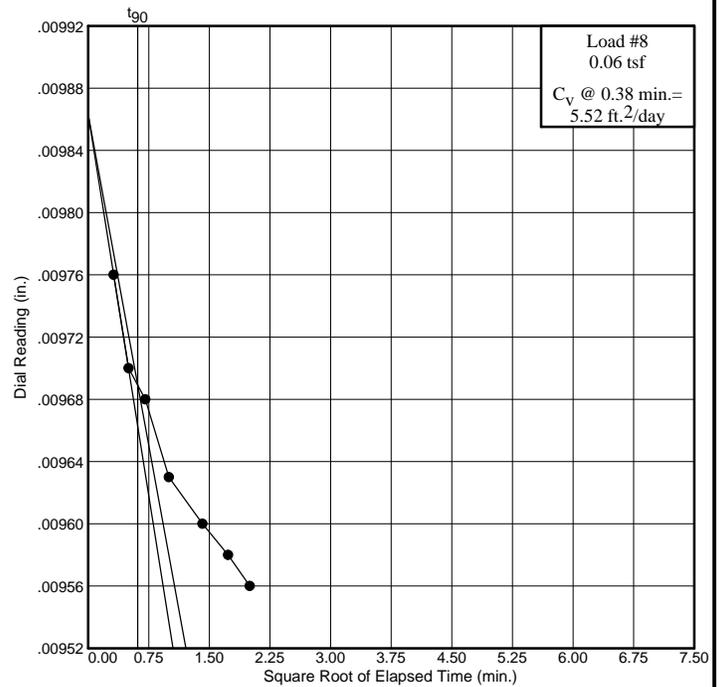
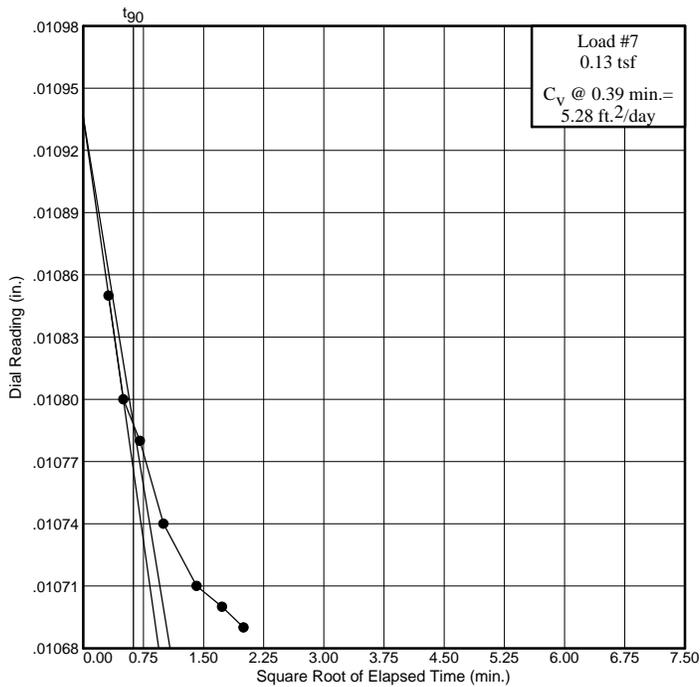
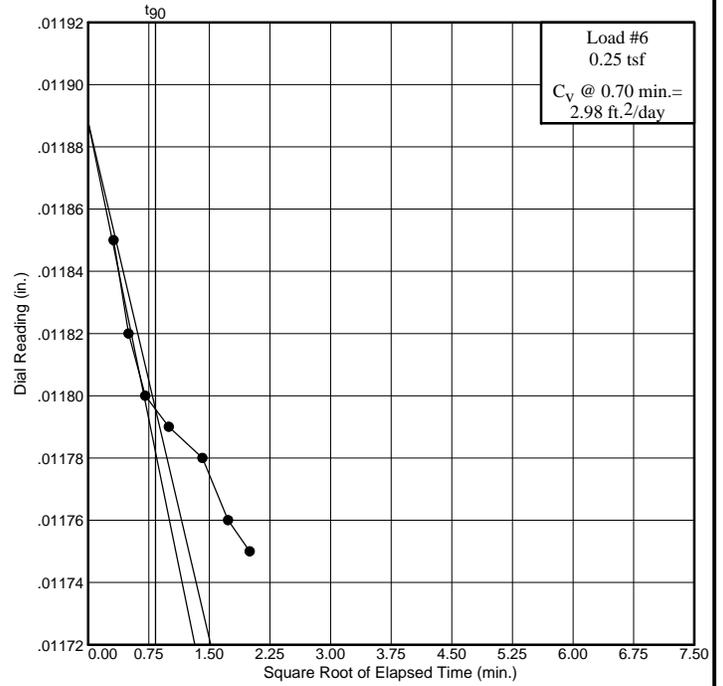
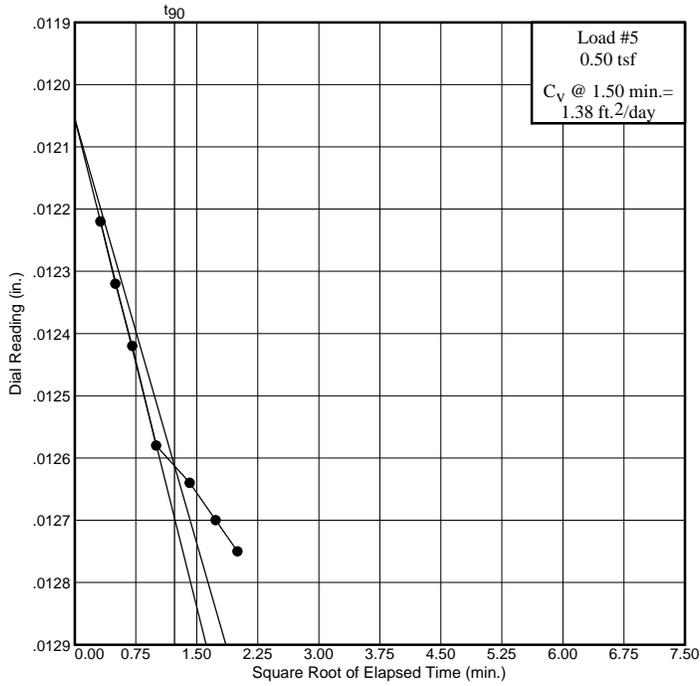
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-101

Sample No.: S-4

Elev./Depth: 16.1-16.2 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 3

Dial Reading vs. Time

Project No.: J-09-2326

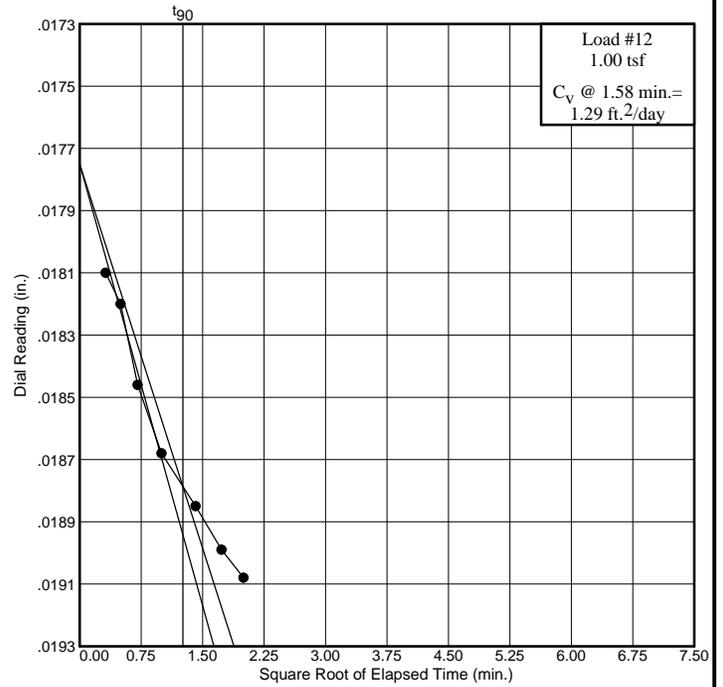
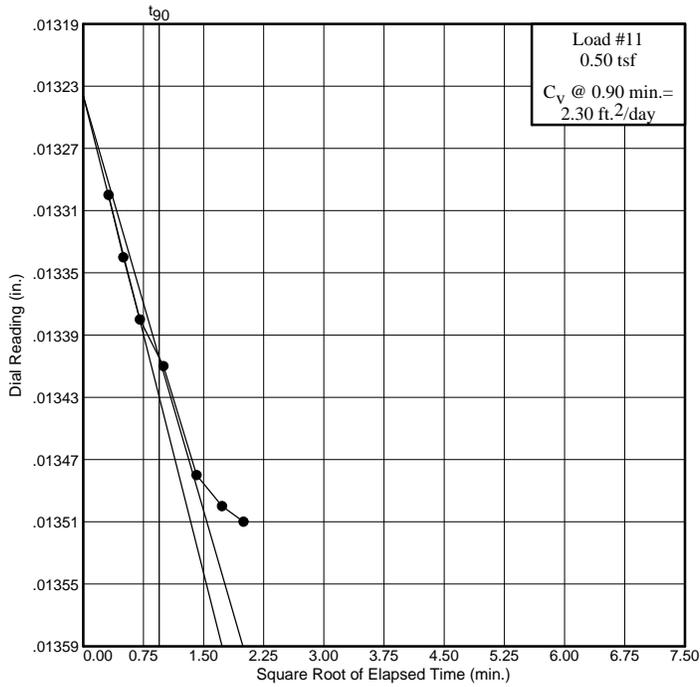
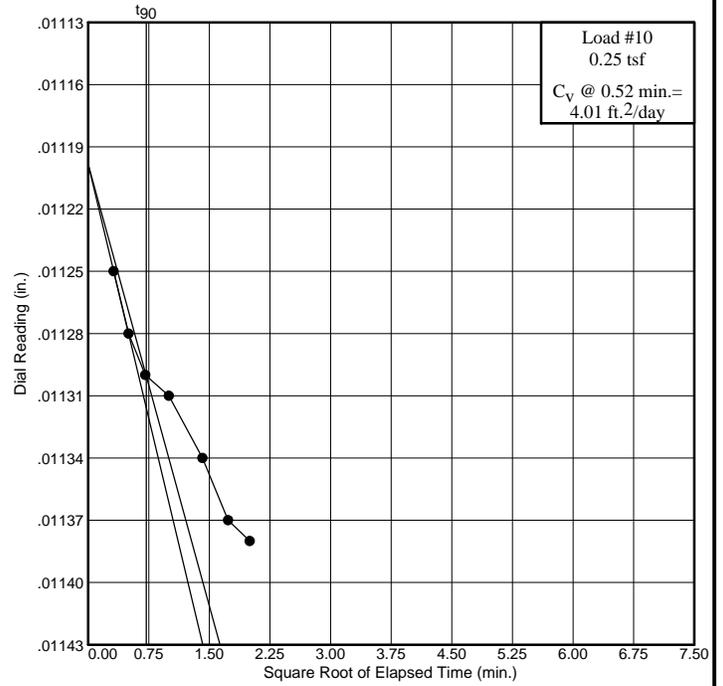
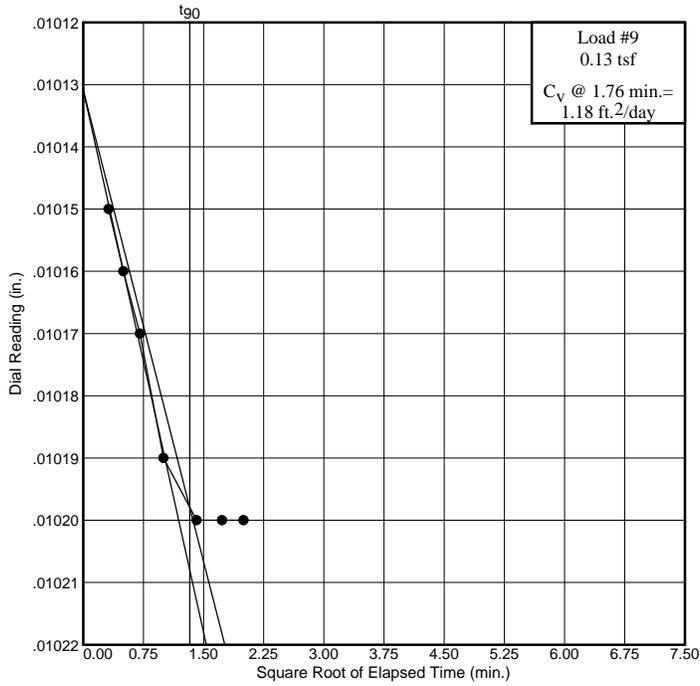
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-101

Sample No.: S-4

Elev./Depth: 16.1-16.2 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 4

Dial Reading vs. Time

Project No.: J-09-2326

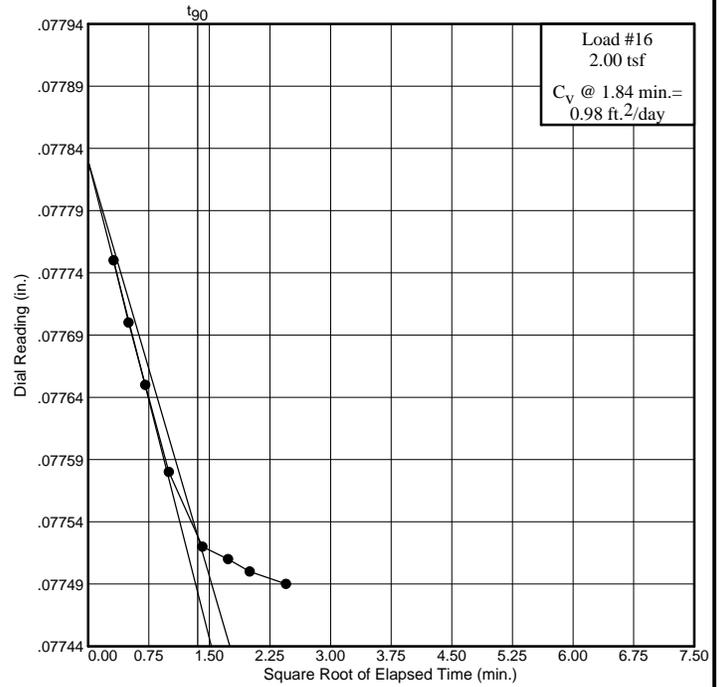
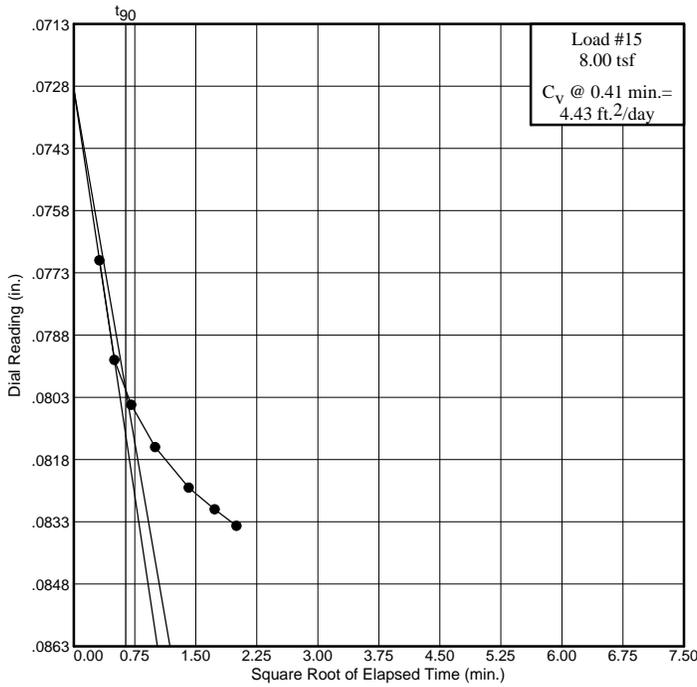
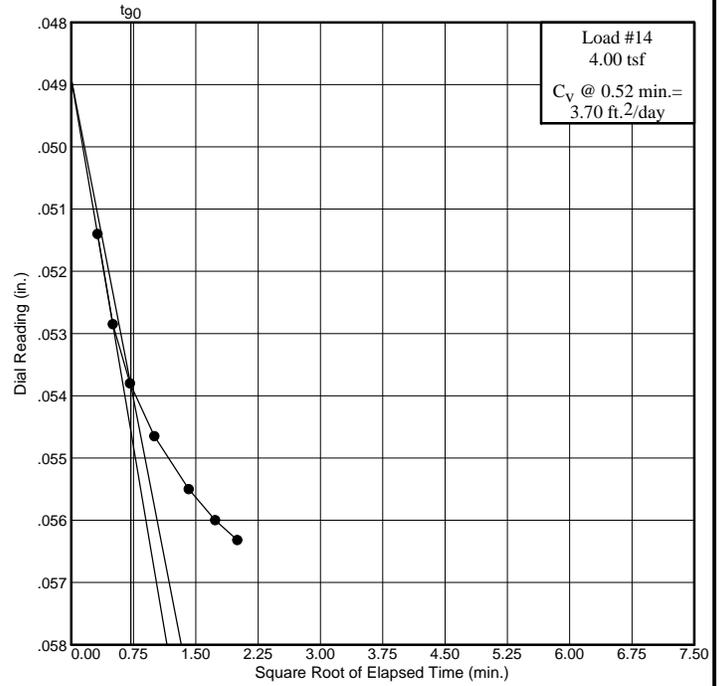
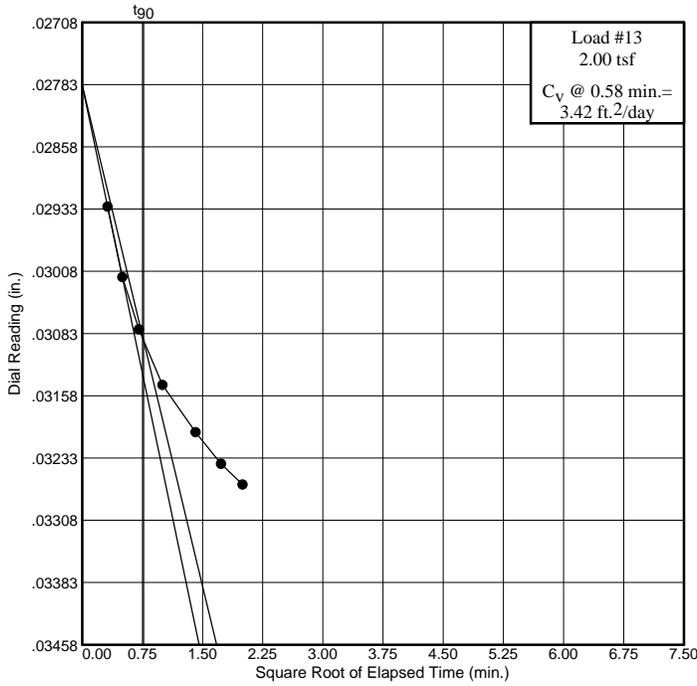
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-101

Sample No.: S-4

Elev./Depth: 16.1-16.2 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 5

Dial Reading vs. Time

Project No.: J-09-2326

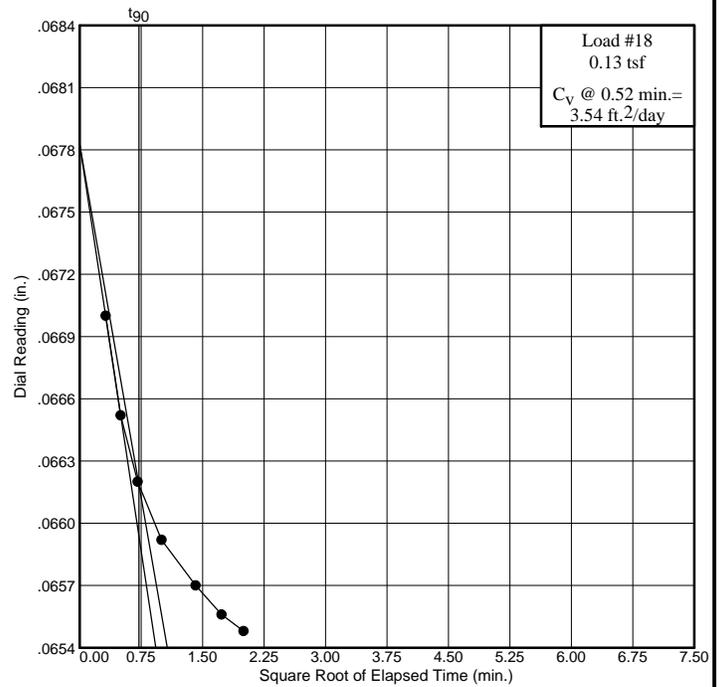
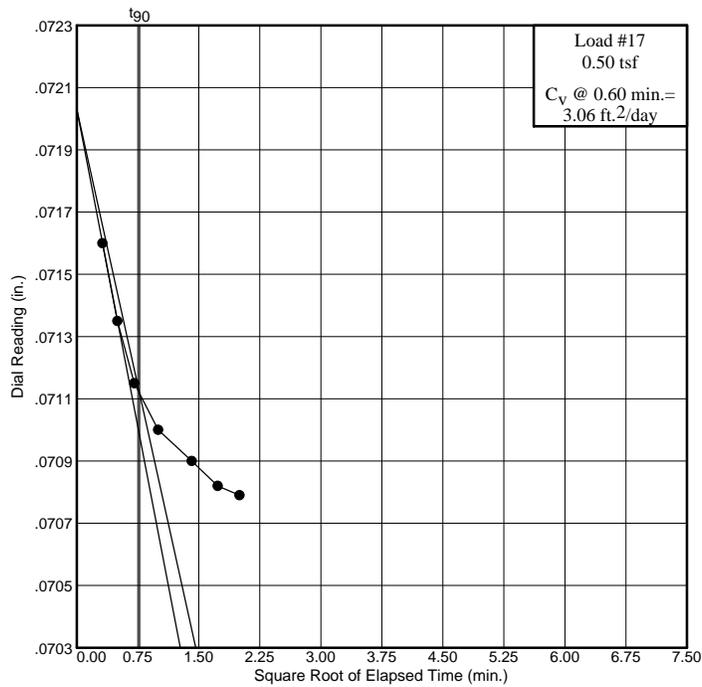
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-101

Sample No.: S-4

Elev./Depth: 16.1-16.2 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 6

Dial Reading vs. Time

Project No.: J-09-2326

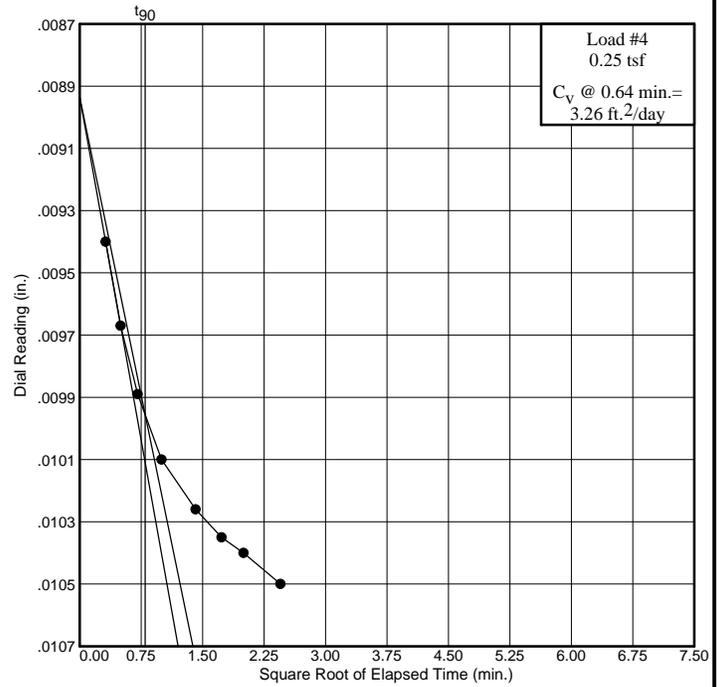
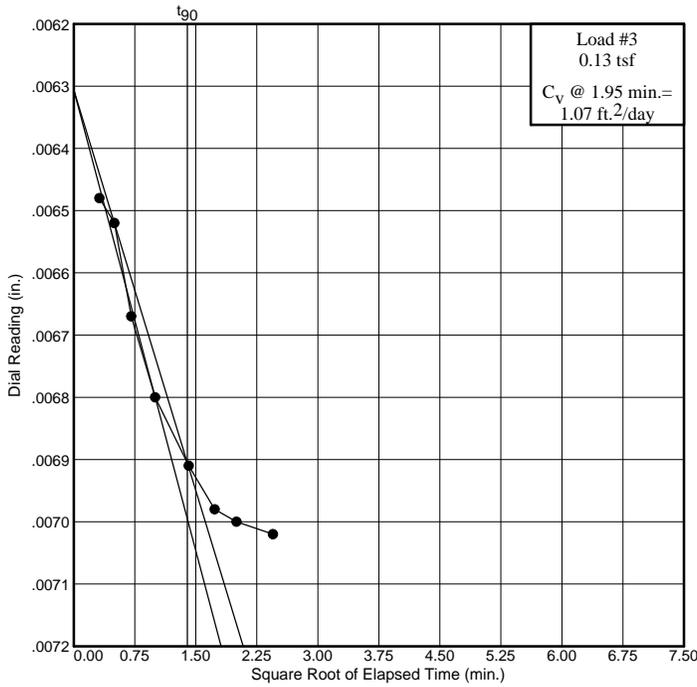
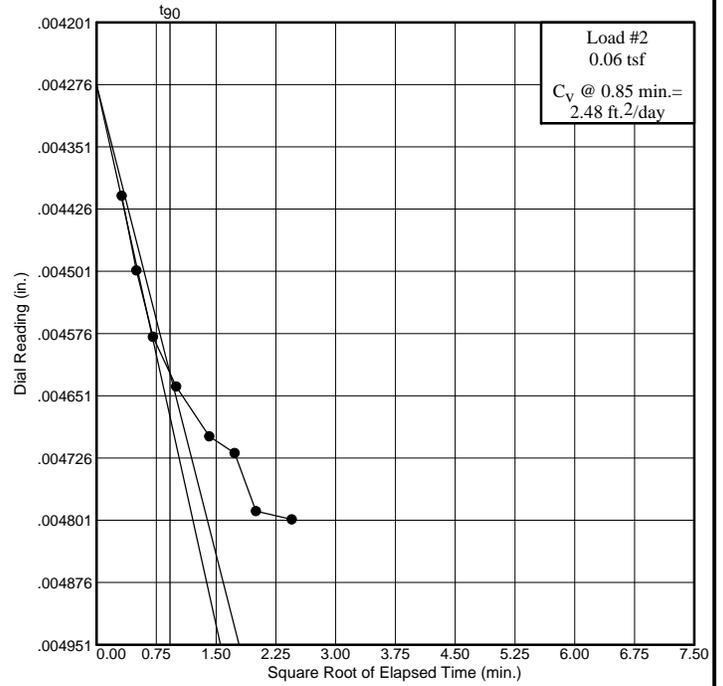
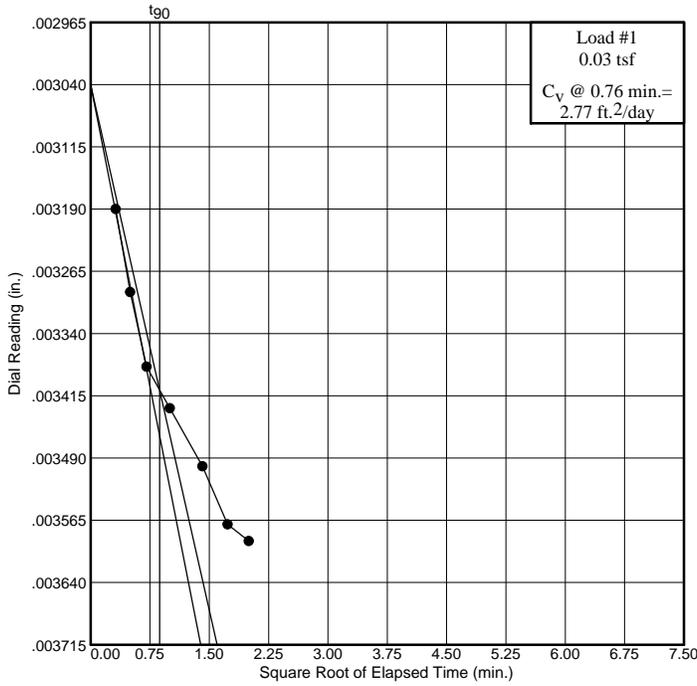
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-101

Sample No.: S-8

Elev./Depth: 31.5-31.6 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 3

Dial Reading vs. Time

Project No.: J-09-2326

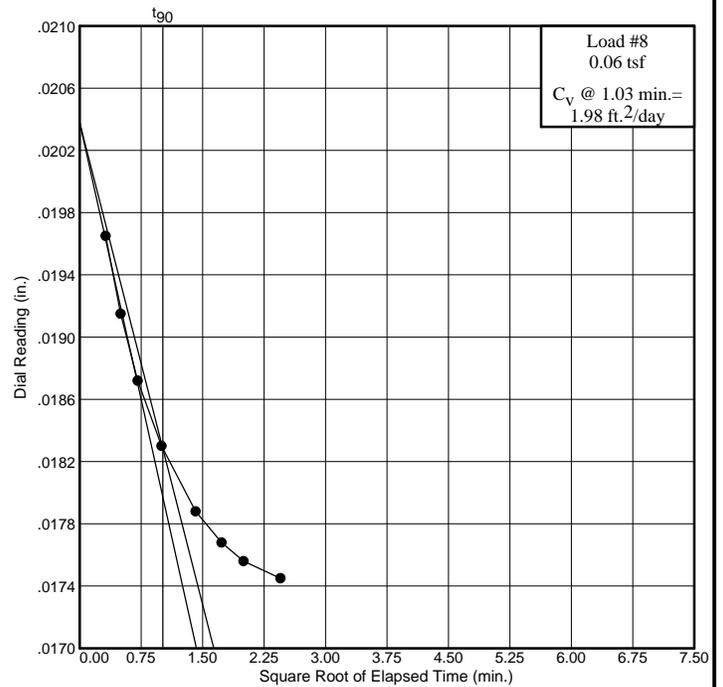
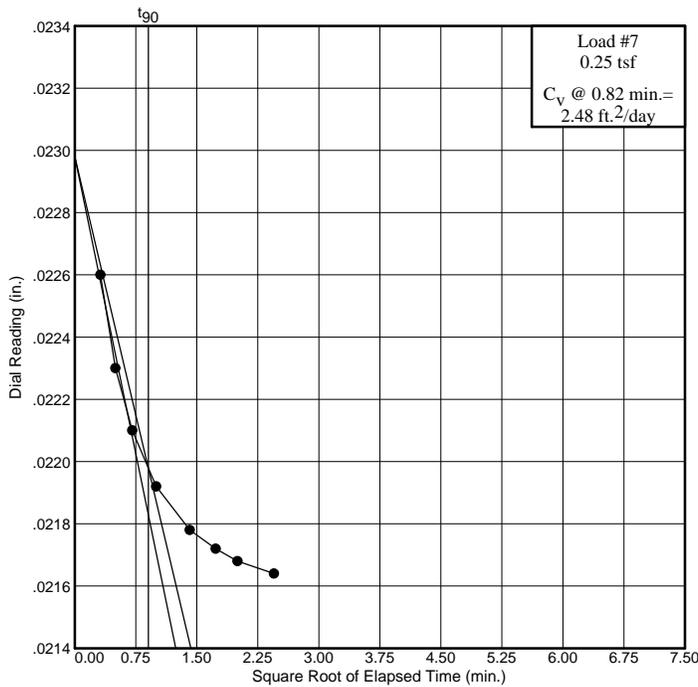
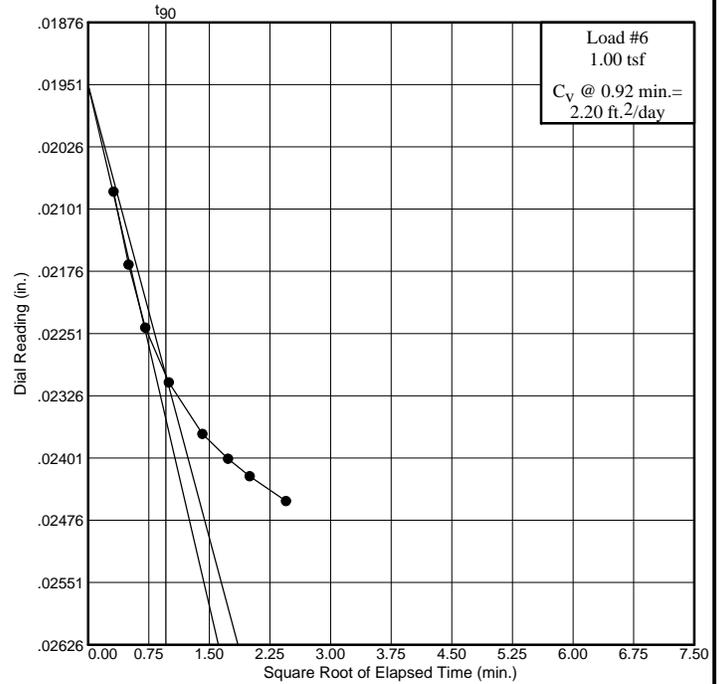
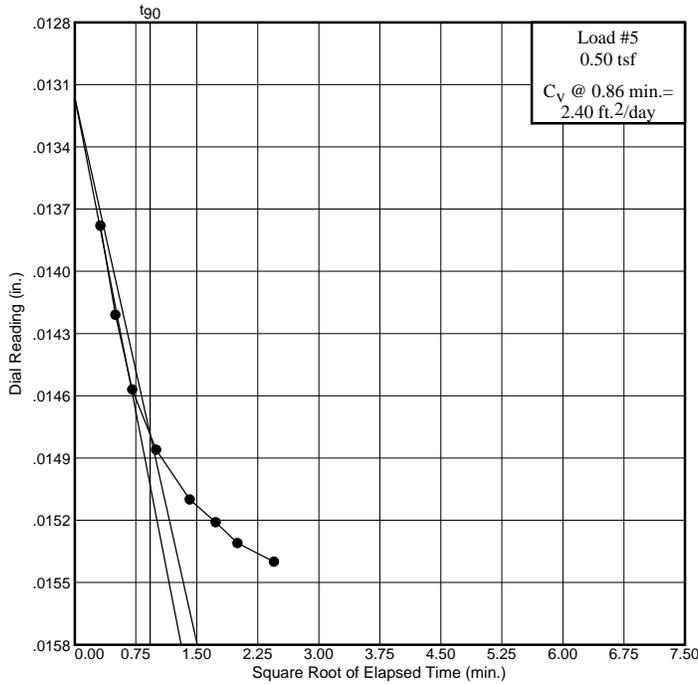
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-101

Sample No.: S-8

Elev./Depth: 31.5-31.6 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 4

Dial Reading vs. Time

Project No.: J-09-2326

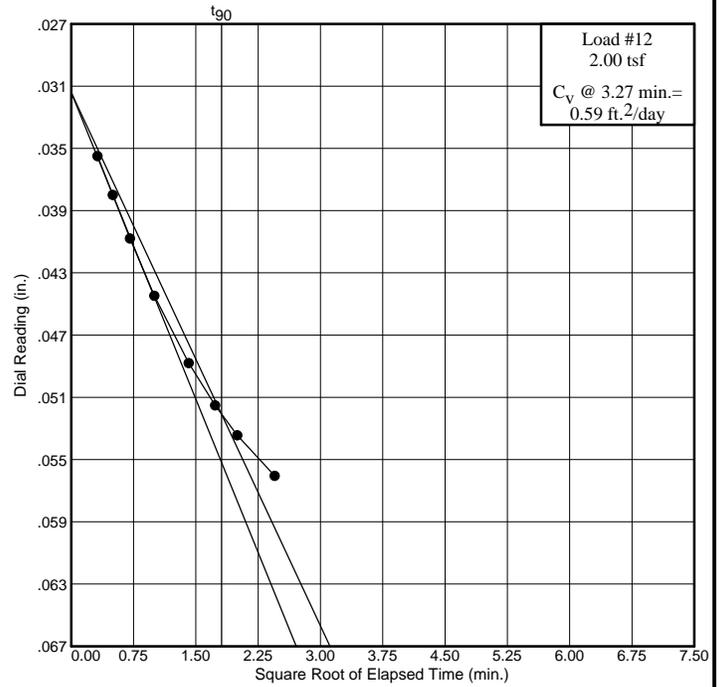
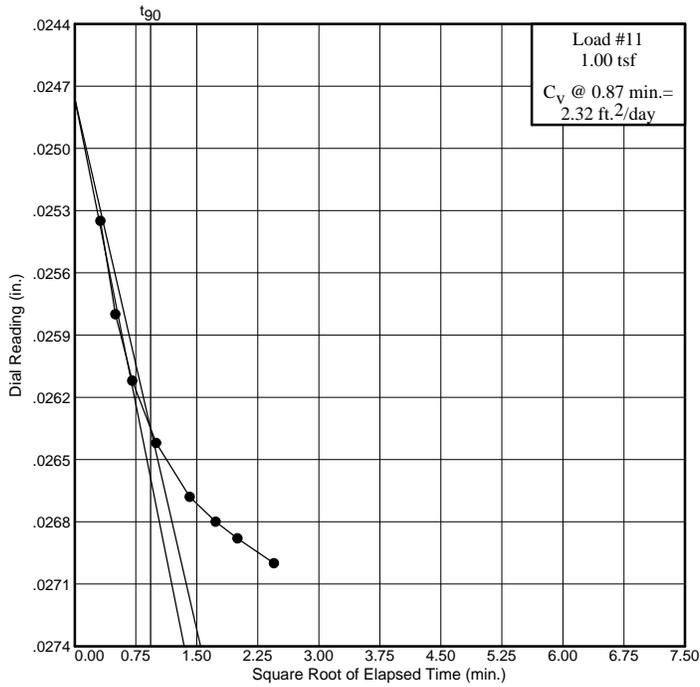
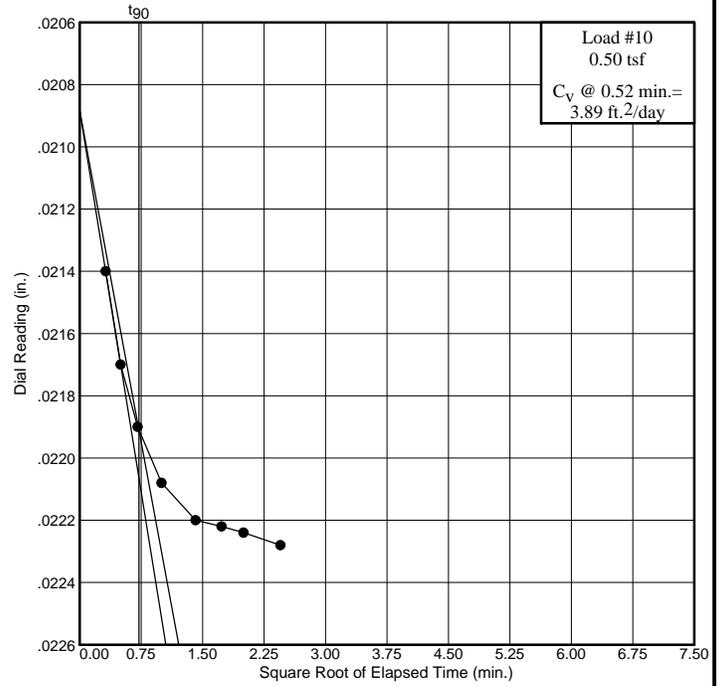
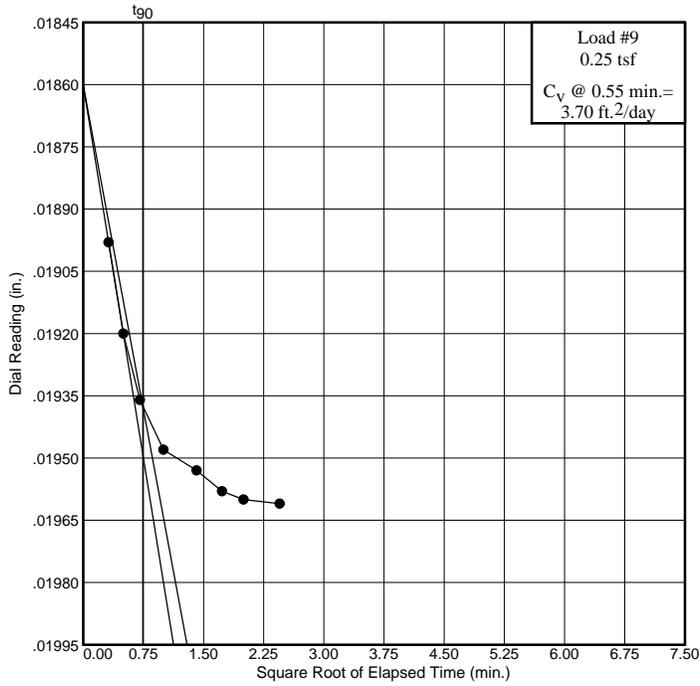
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-101

Sample No.: S-8

Elev./Depth: 31.5-31.6 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 5

Dial Reading vs. Time

Project No.: J-09-2326

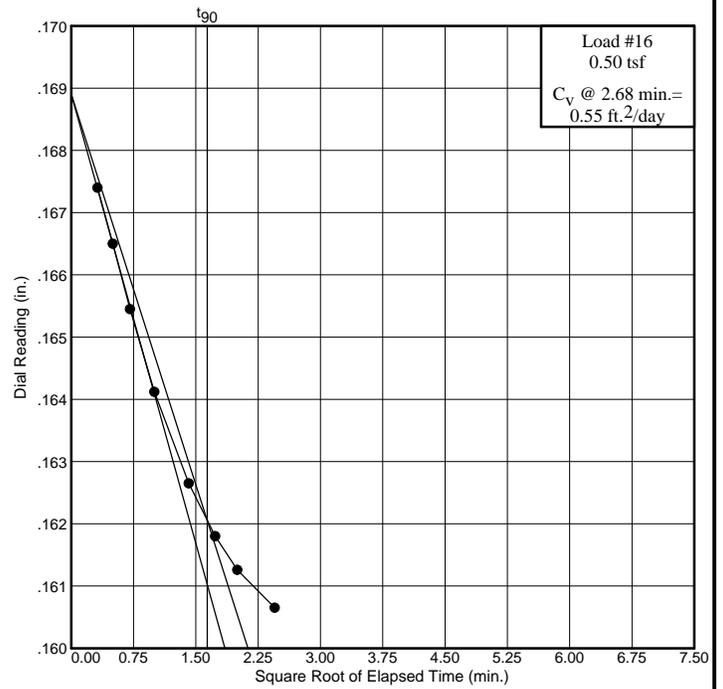
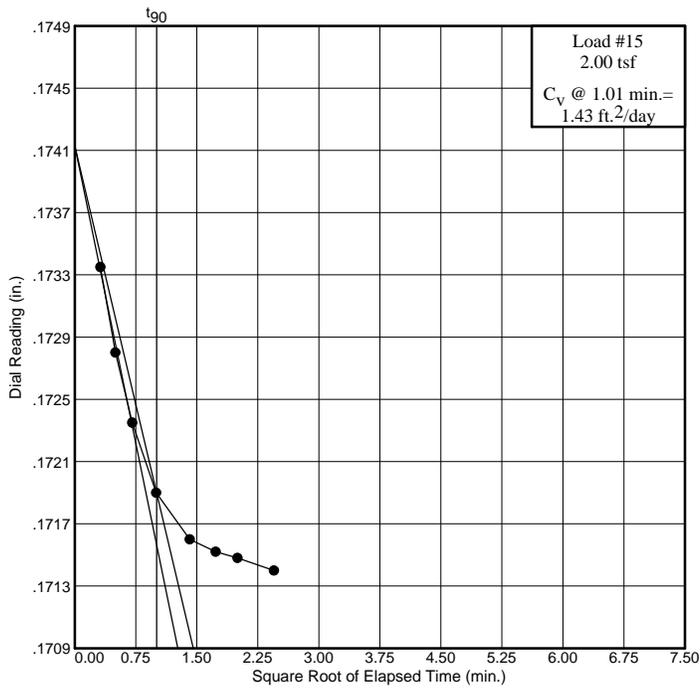
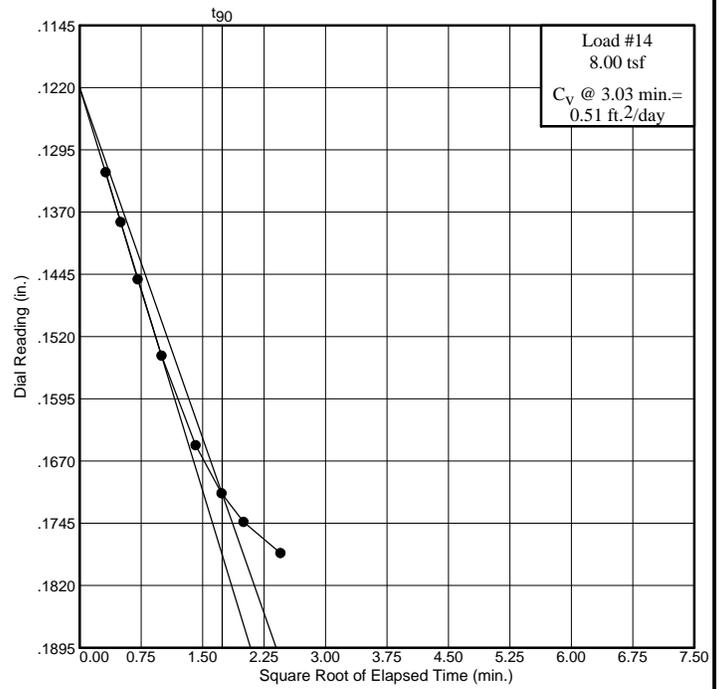
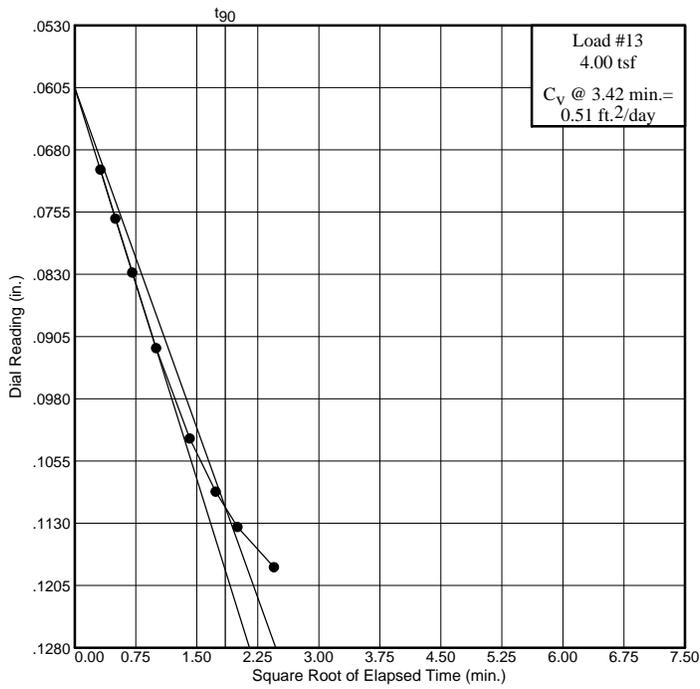
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-101

Sample No.: S-8

Elev./Depth: 31.5-31.6 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 6

Dial Reading vs. Time

Project No.: J-09-2326

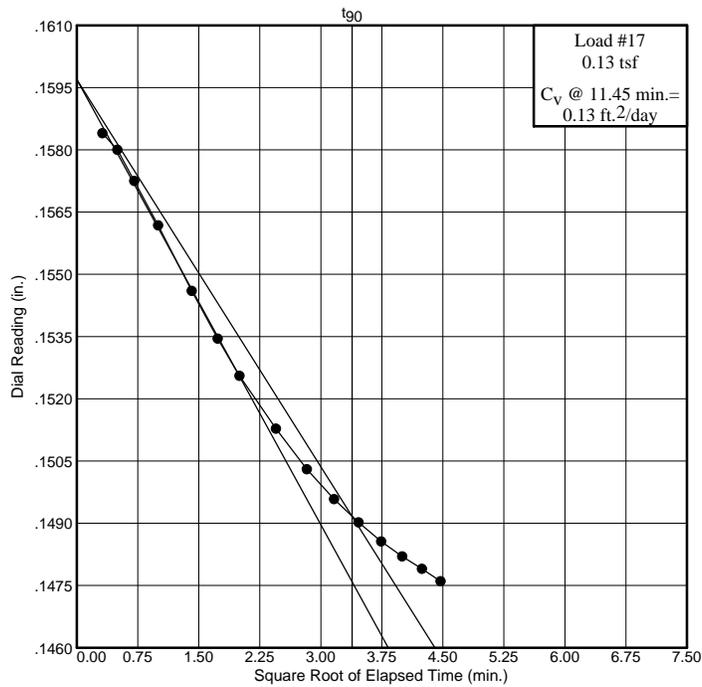
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-101

Sample No.: S-8

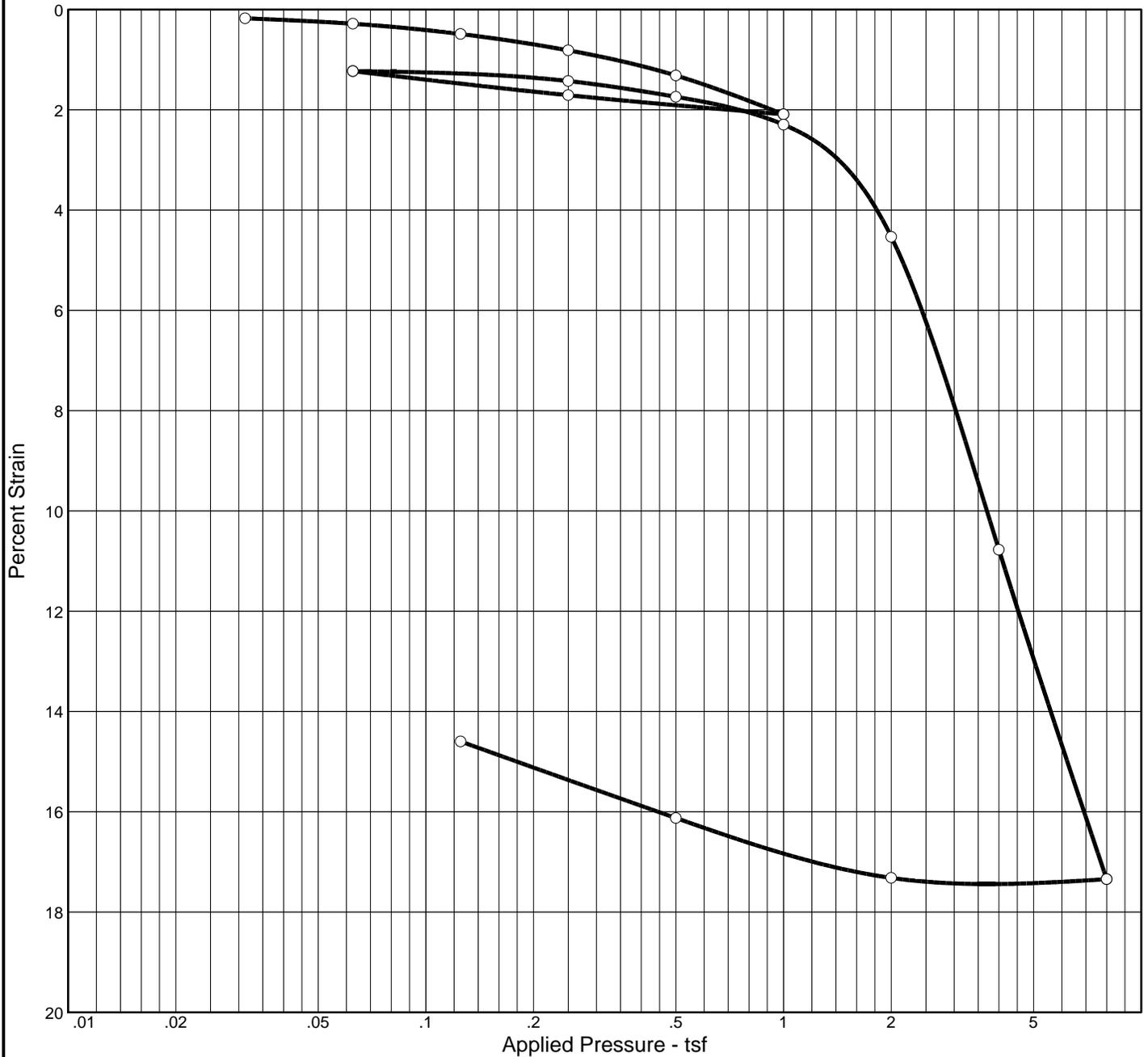
Elev./Depth: 31.5-31.6 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 7

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P _c (tsf)	C _c	C _r	Swell Press. (tsf)	Swell %	e ₀
Sat.	Moist.											
99.8 %	55.0 %	67.9	54	19	2.7		1.72	0.54	0.03			1.487

MATERIAL DESCRIPTION	USCS	AASHTO
M-stiff, moist, grey SILT	MH	----

Project No. J-09-2326 Project: Longview Water Treatment Plant Project No. 133009.010.011 Source: B-102	Client: Landau Associates Sample No.: S-9 Elev./Depth: 36.2-36.3 ft.	Remarks: Specific gravity estimated
--	---	---

SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 3

Dial Reading vs. Time

Project No.: J-09-2326

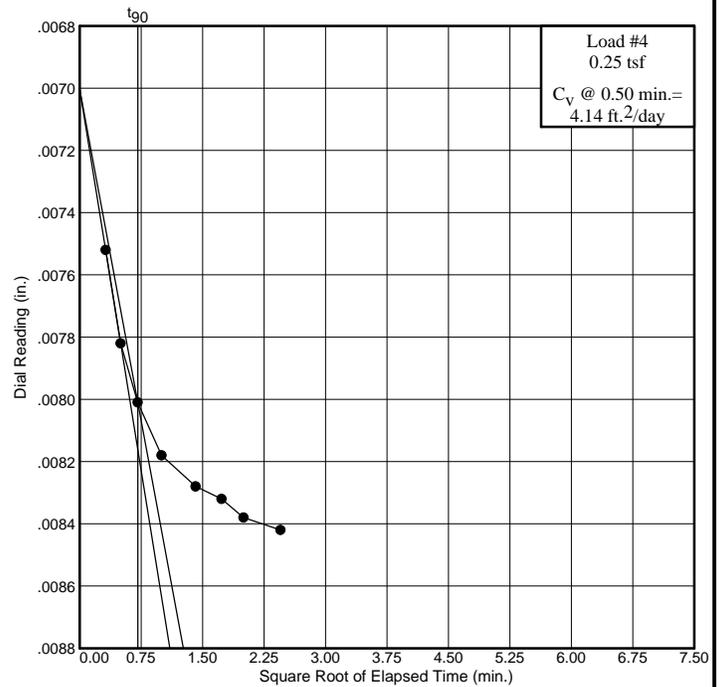
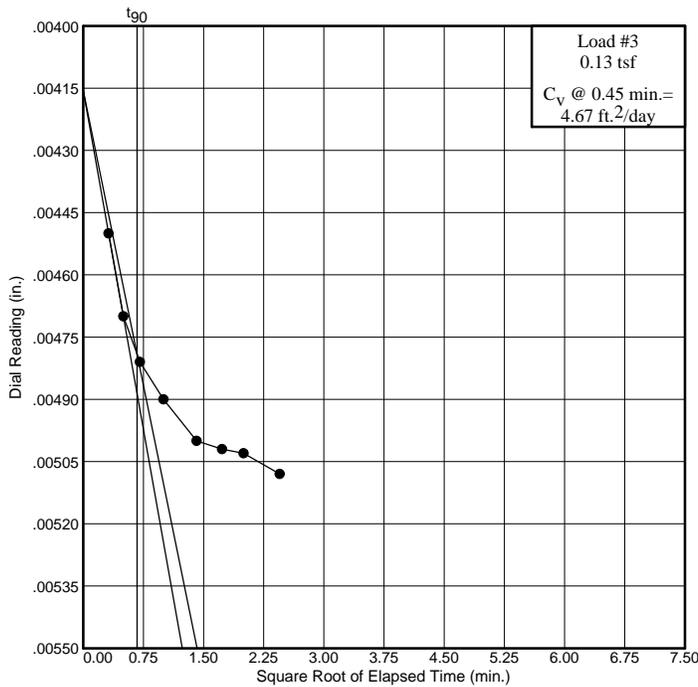
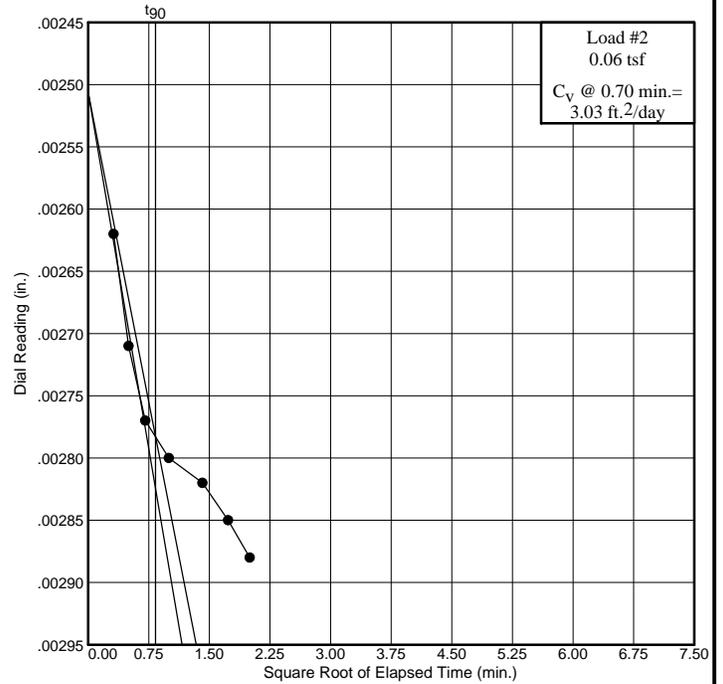
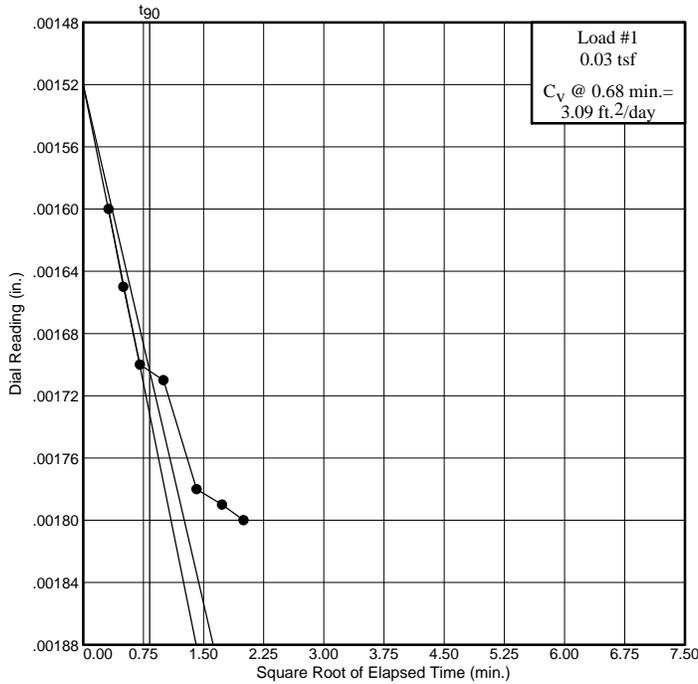
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-102

Sample No.: S-9

Elev./Depth: 36.2-36.3 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 4

Dial Reading vs. Time

Project No.: J-09-2326

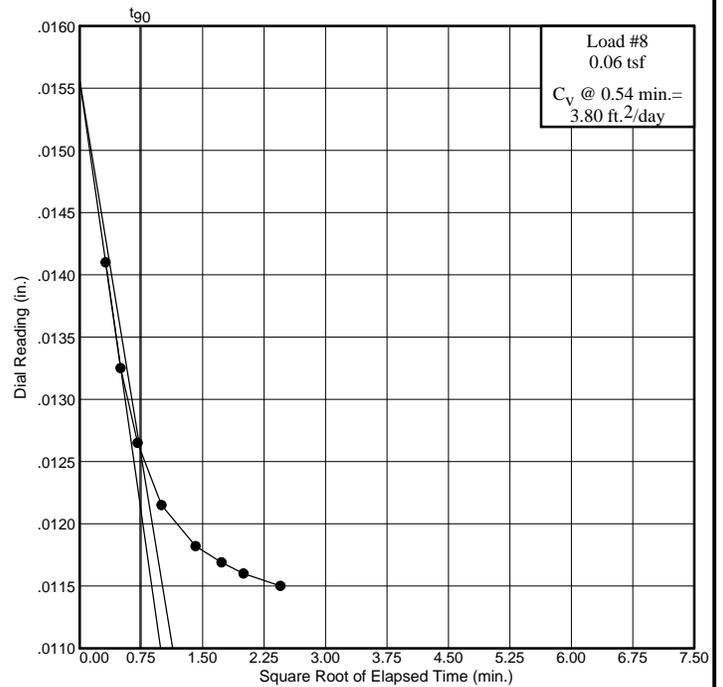
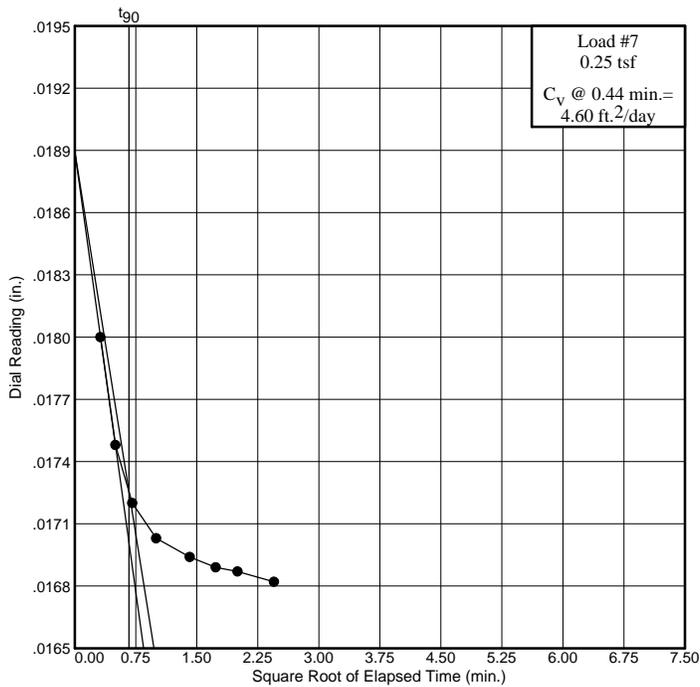
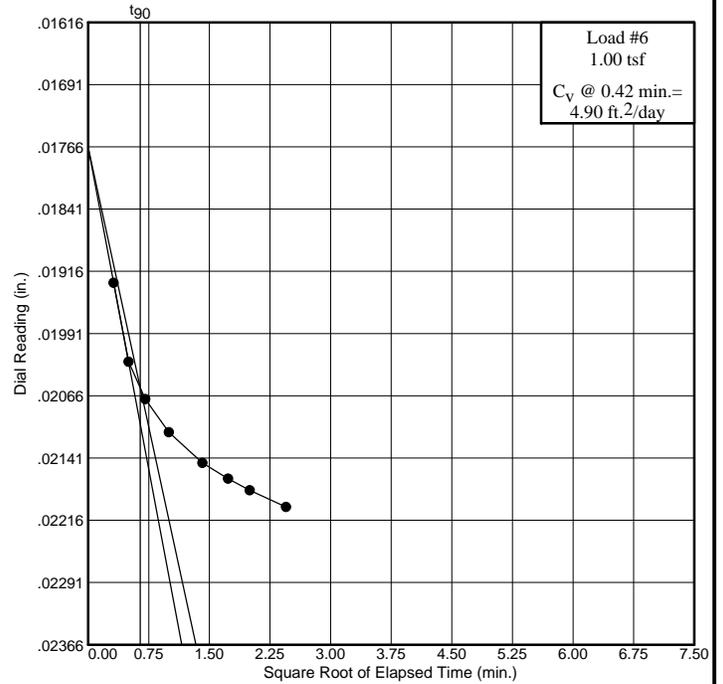
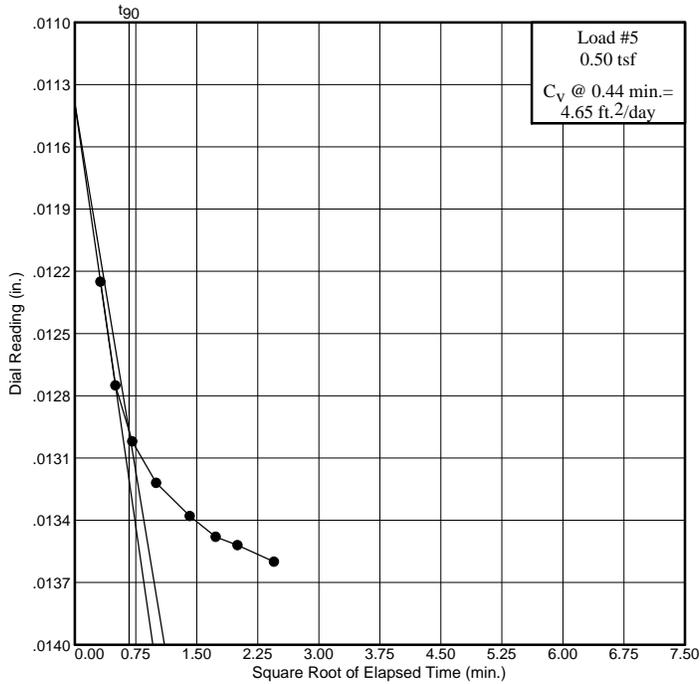
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-102

Sample No.: S-9

Elev./Depth: 36.2-36.3 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 5

Dial Reading vs. Time

Project No.: J-09-2326

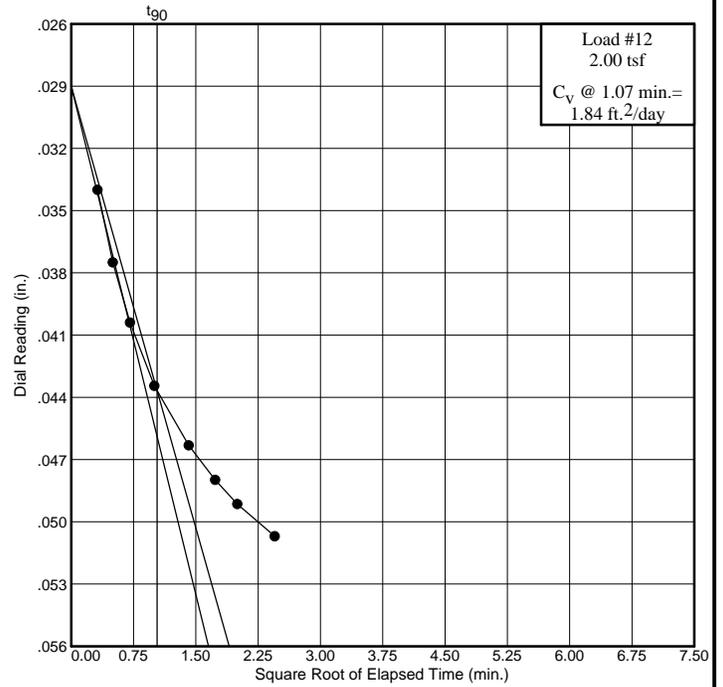
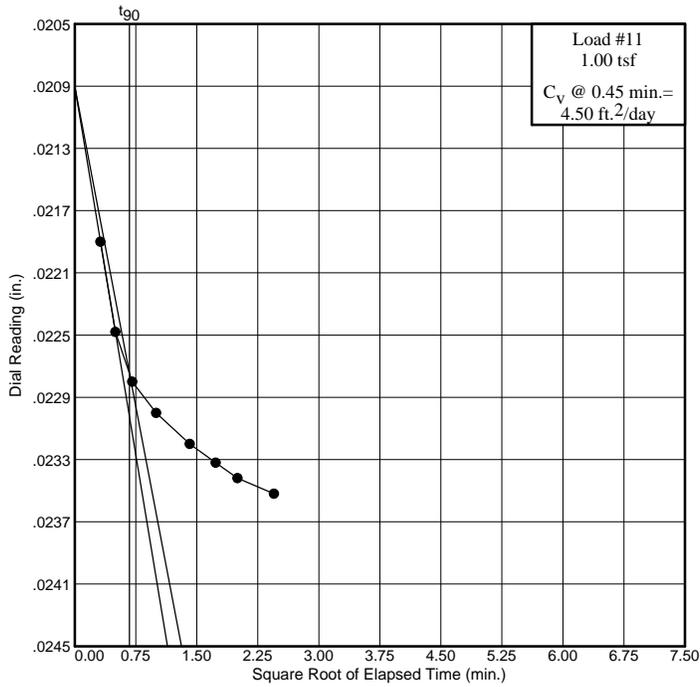
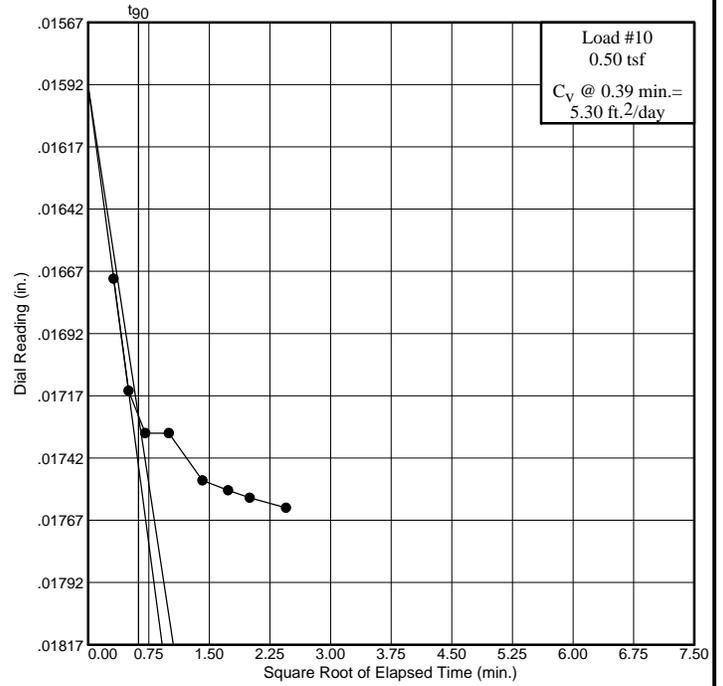
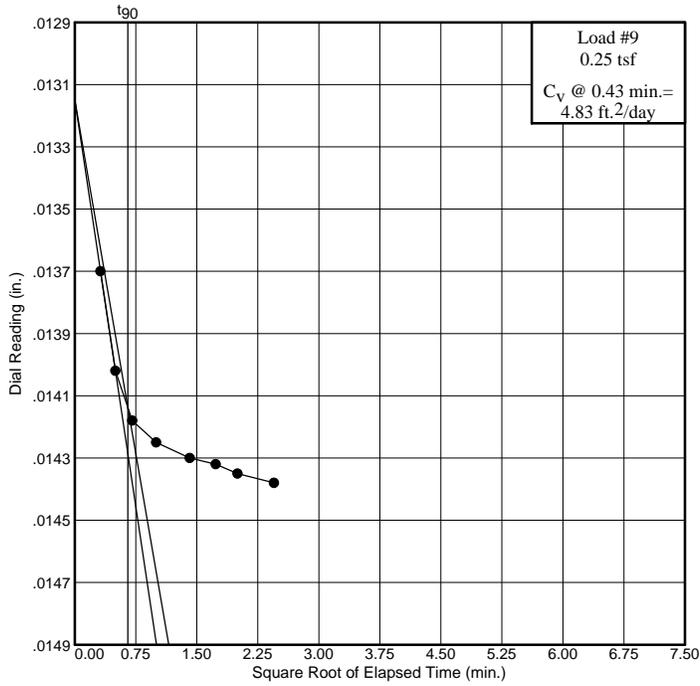
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-102

Sample No.: S-9

Elev./Depth: 36.2-36.3 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 6

Dial Reading vs. Time

Project No.: J-09-2326

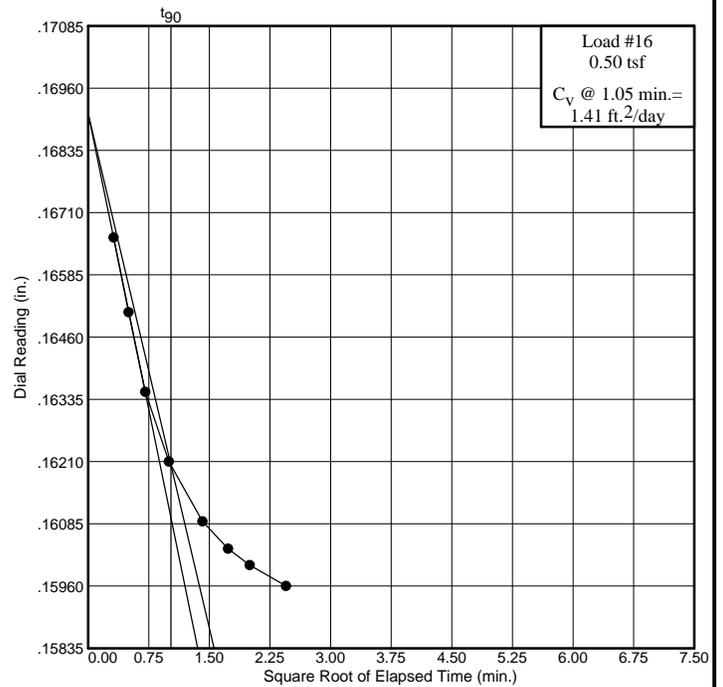
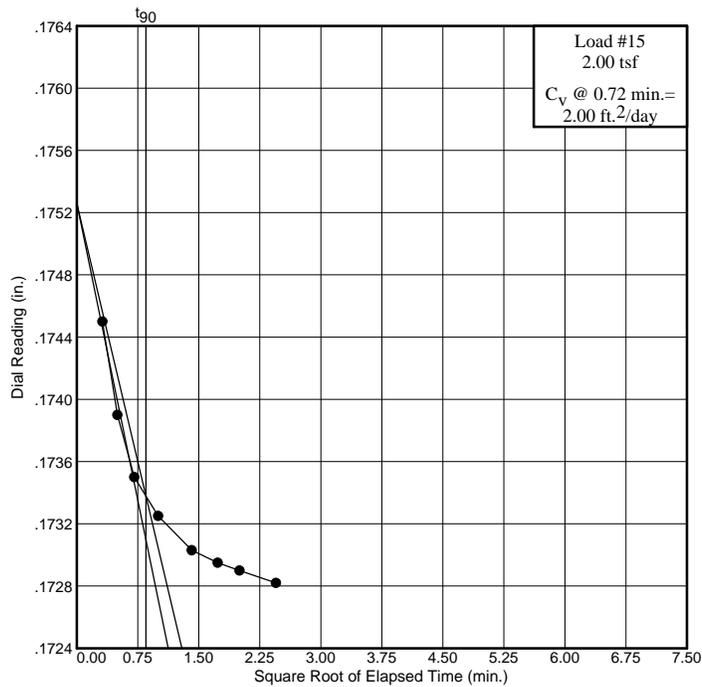
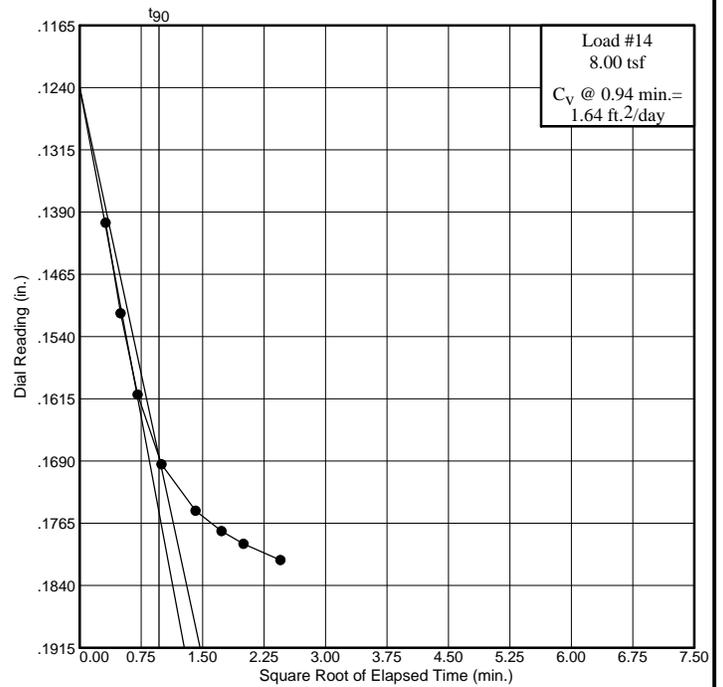
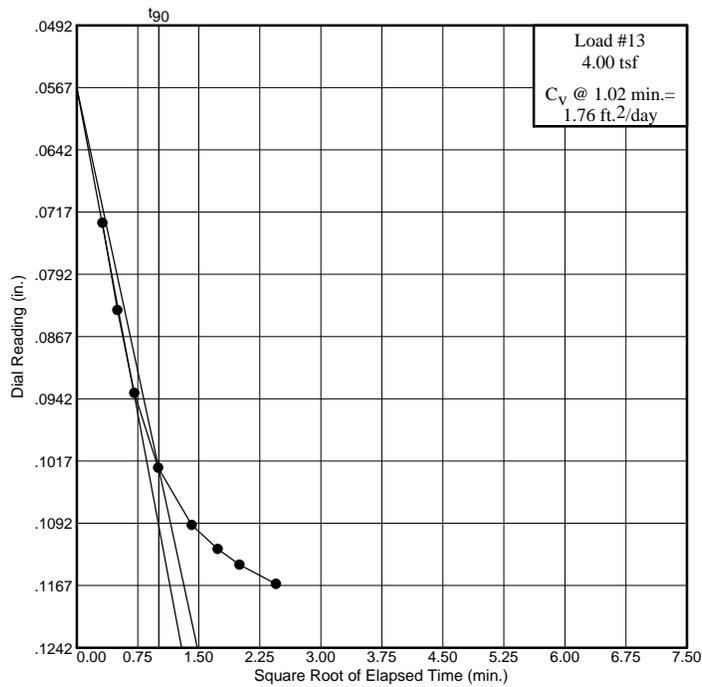
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-102

Sample No.: S-9

Elev./Depth: 36.2-36.3 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 7

Dial Reading vs. Time

Project No.: J-09-2326

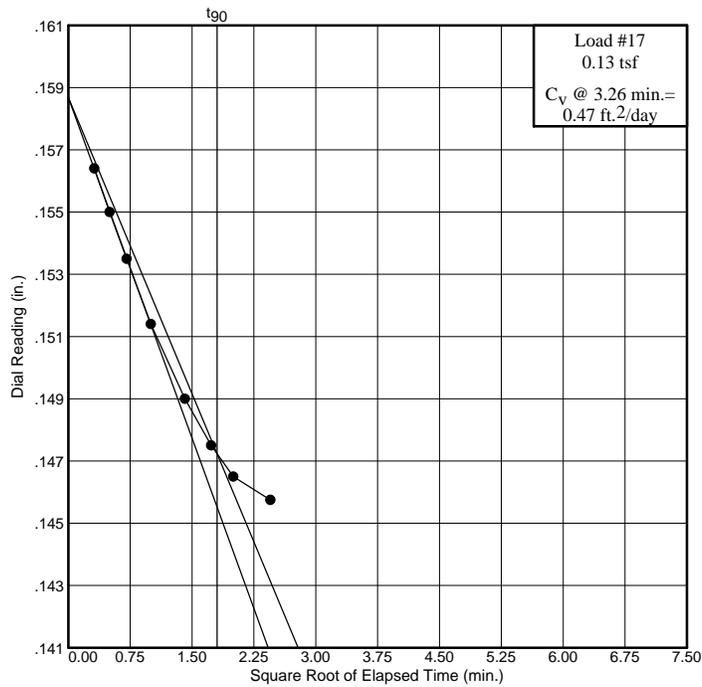
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-102

Sample No.: S-9

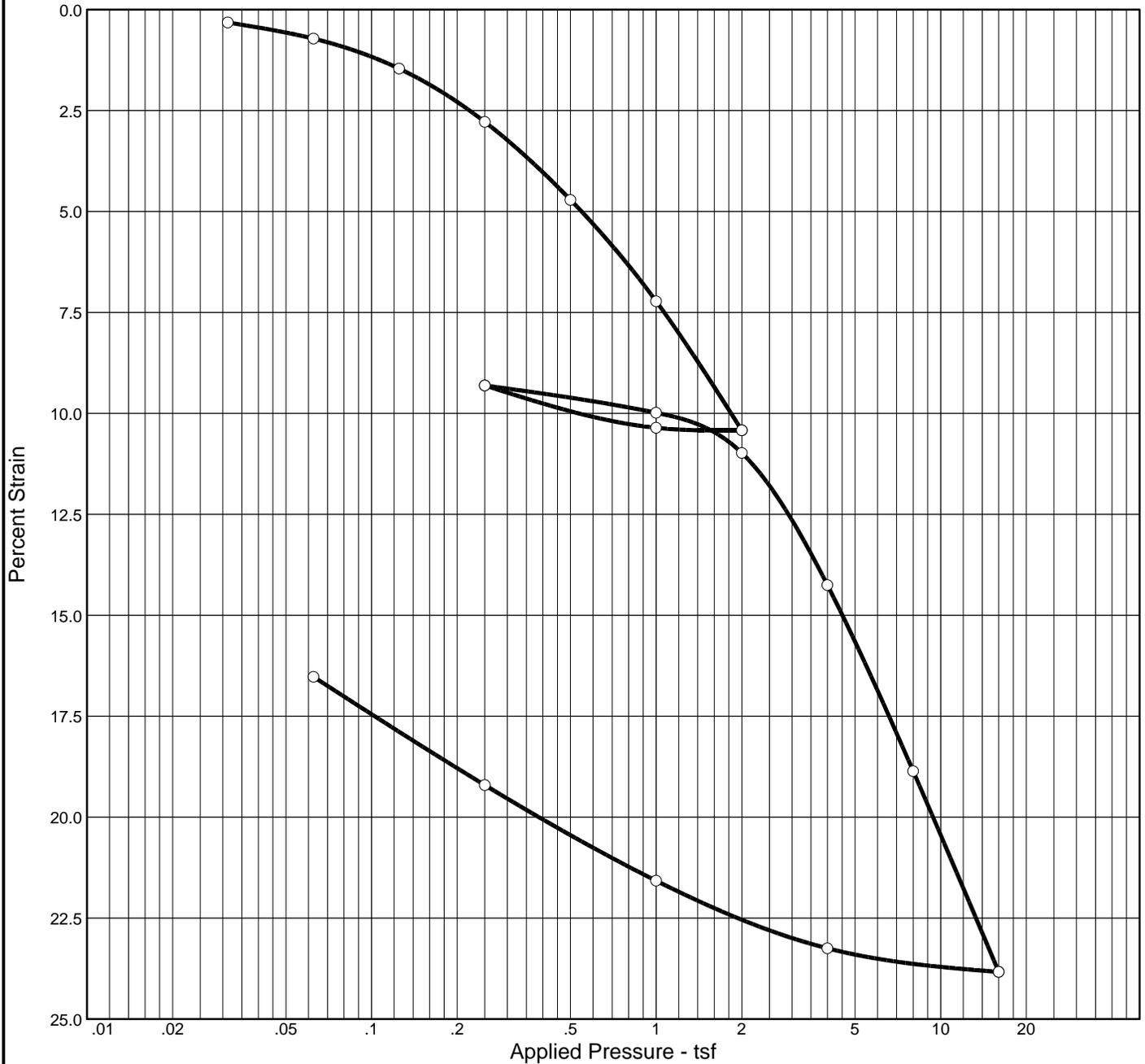
Elev./Depth: 36.2-36.3 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 8

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P _c (tsf)	C _c	C _r	Swell Press. (tsf)	Swell %	e ₀
Sat.	Moist.											
98.5 %	51.7 %	67.6	53	12	2.5		1.63	0.38	0.05			1.313

MATERIAL DESCRIPTION	USCS	AASHTO
M-Stiff, moist, grey SILT w/ organics	MH	----

Project No. J-09-2326 Client: Landau Associates Project: Longview Water Treatment Plant Project No. 133009.010.011 Source: B-102 Sample No.: S-18 Elev./Depth: 72.7-72.8 ft.	Remarks: Specific gravity assumed
SOIL TECHNOLOGY Bainbridge Island, WA	

Figure 4

Dial Reading vs. Time

Project No.: J-09-2326

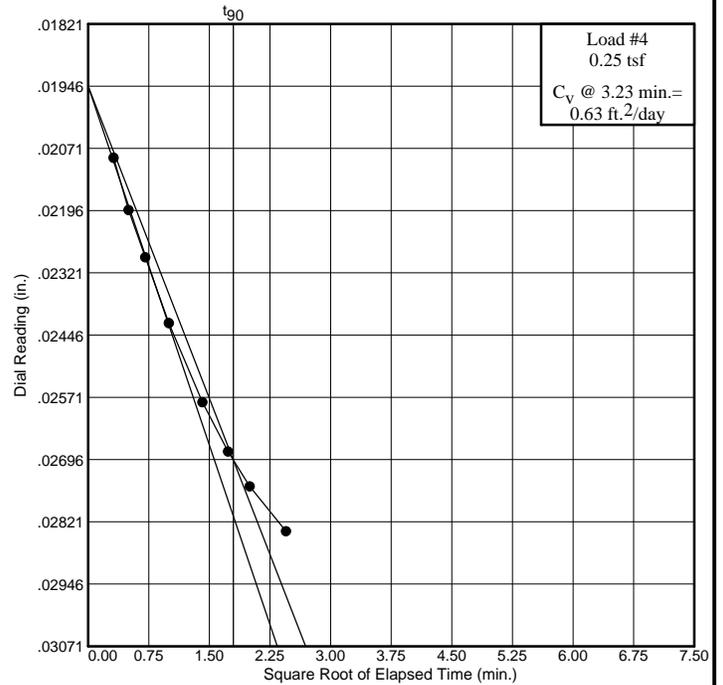
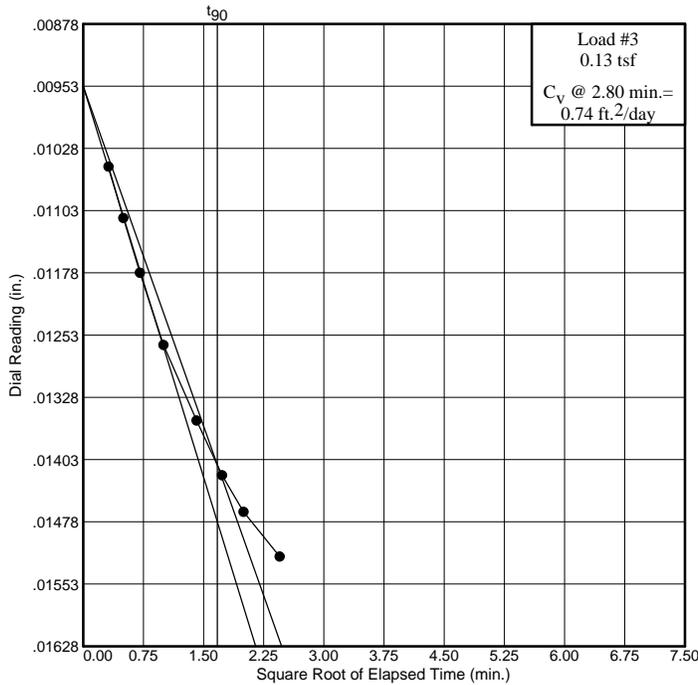
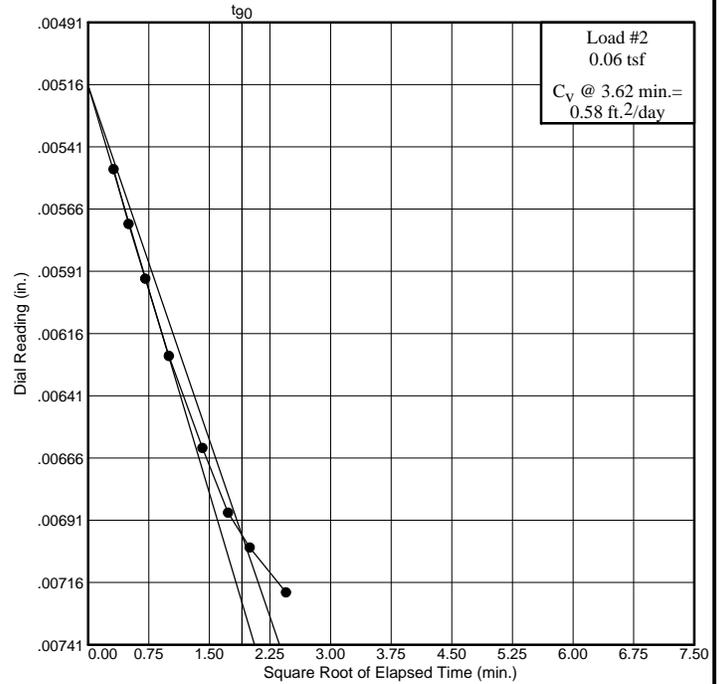
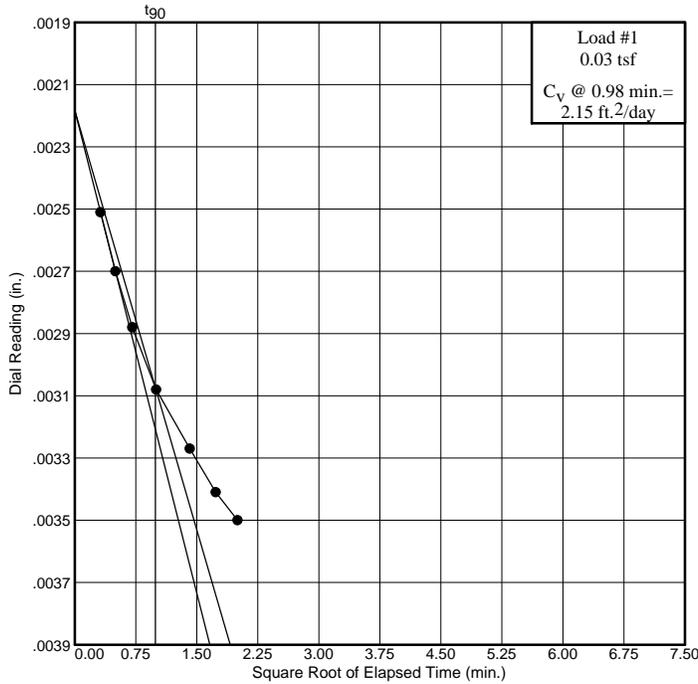
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-102

Sample No.: S-18

Elev./Depth: 72.7-72.8 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 5

Dial Reading vs. Time

Project No.: J-09-2326

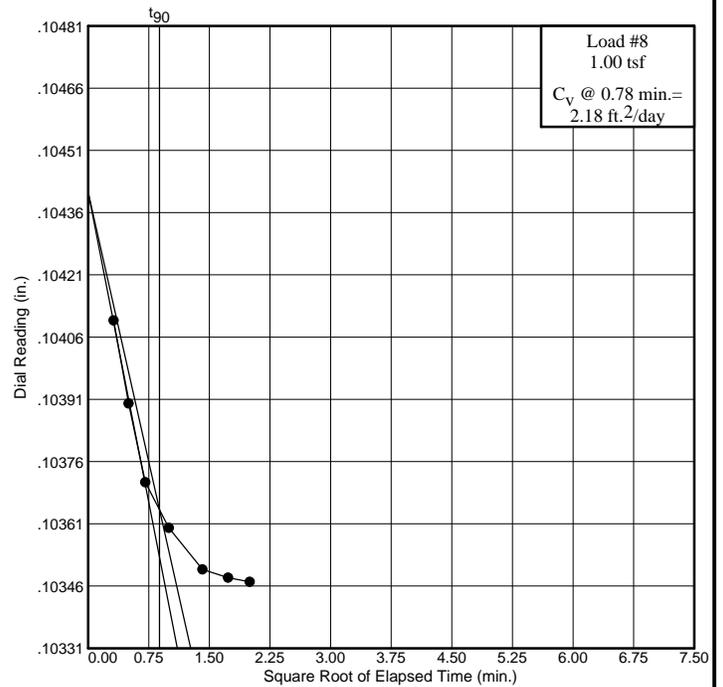
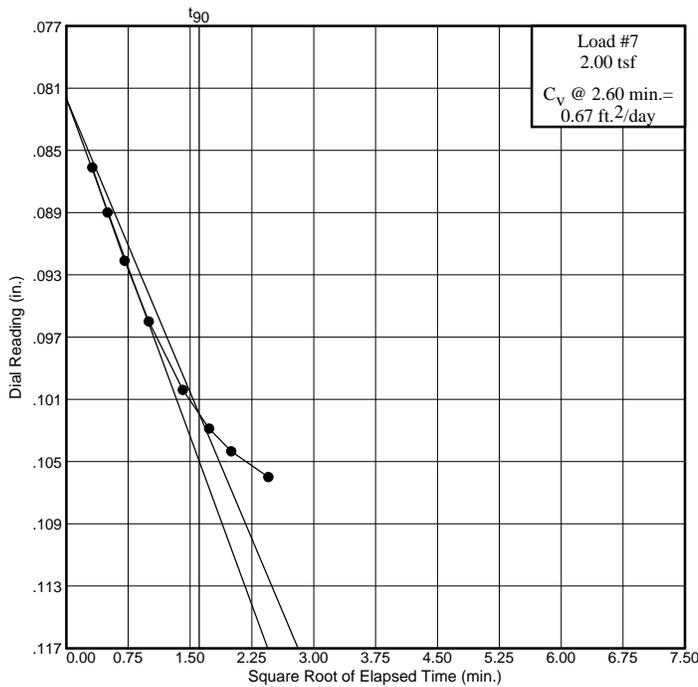
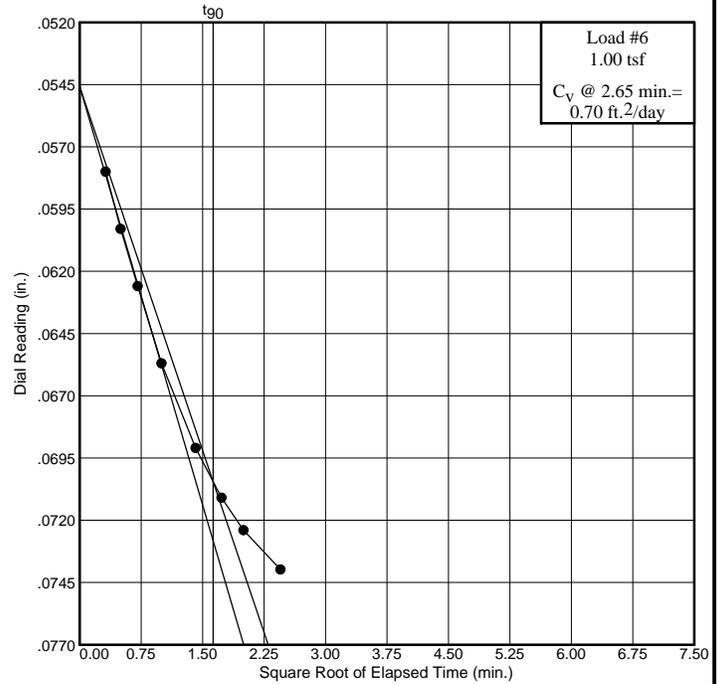
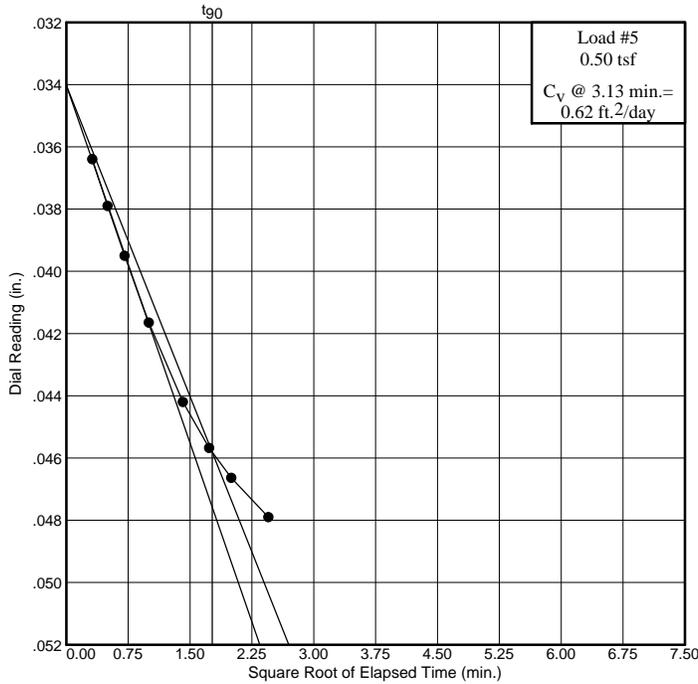
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-102

Sample No.: S-18

Elev./Depth: 72.7-72.8 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 6

Dial Reading vs. Time

Project No.: J-09-2326

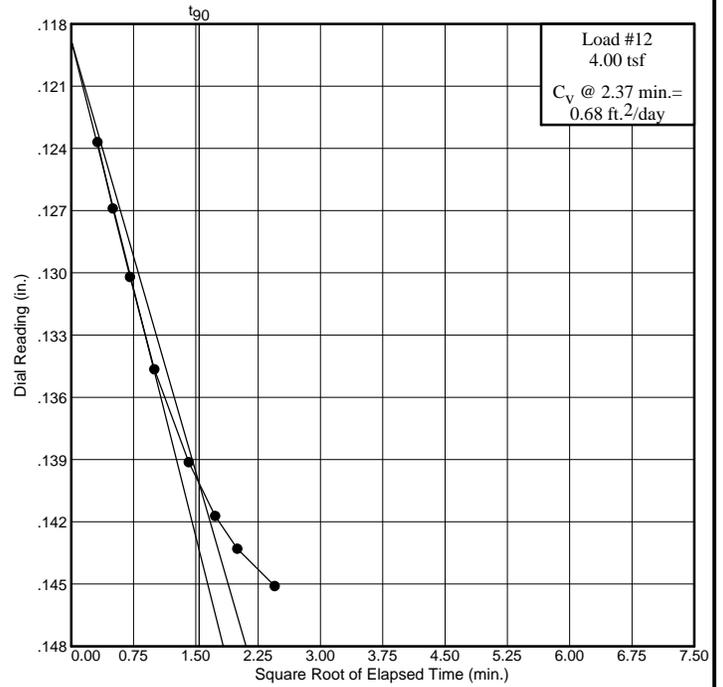
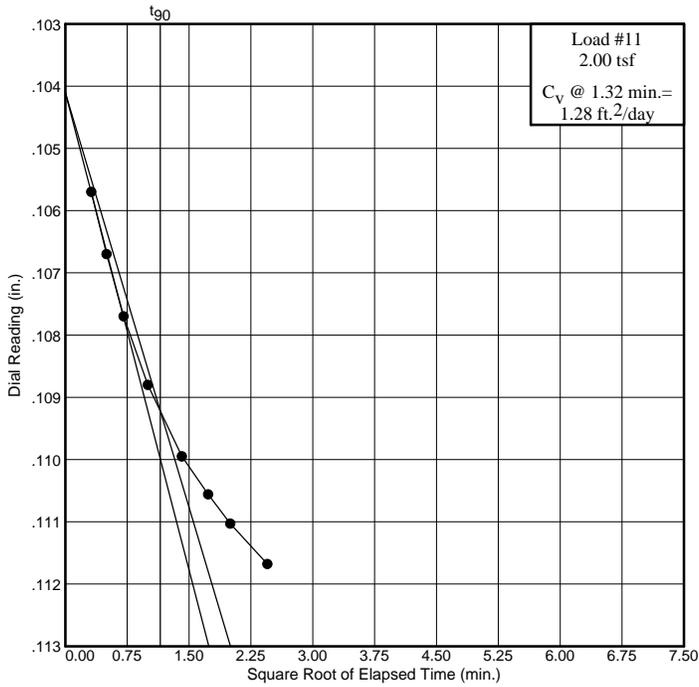
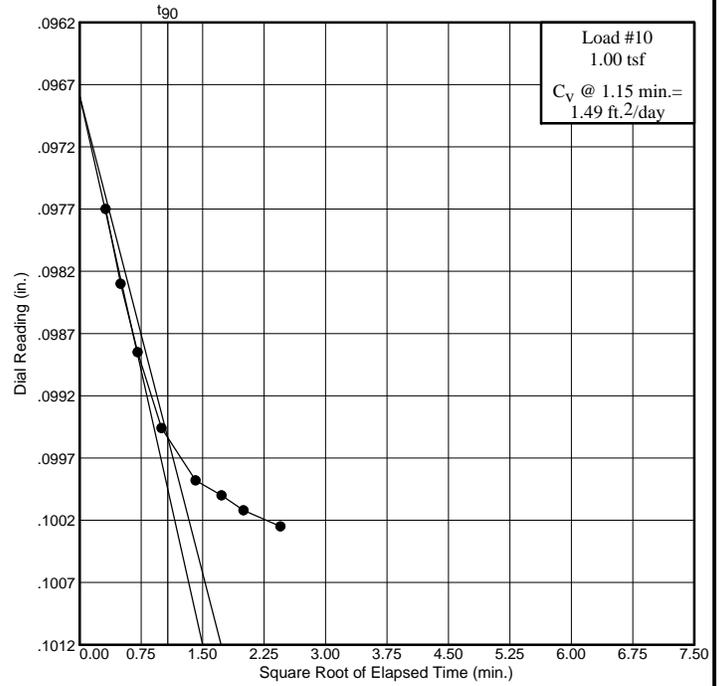
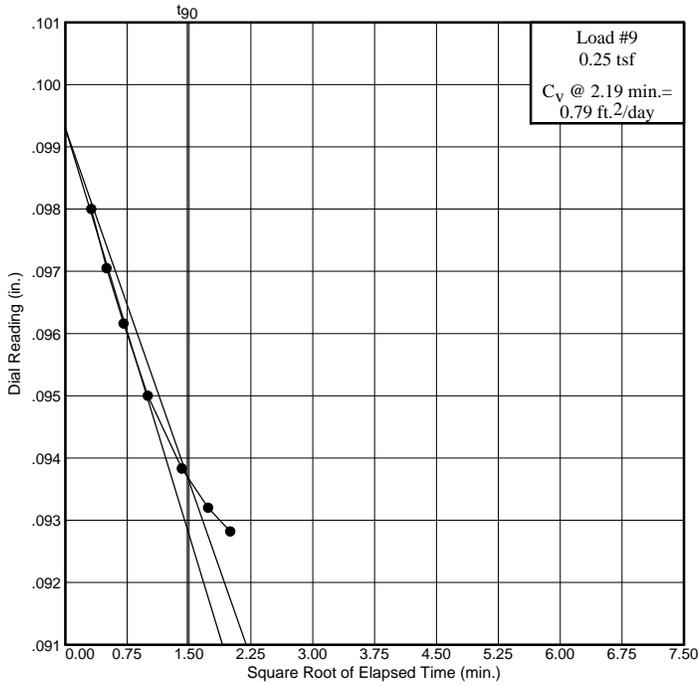
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-102

Sample No.: S-18

Elev./Depth: 72.7-72.8 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 7

Dial Reading vs. Time

Project No.: J-09-2326

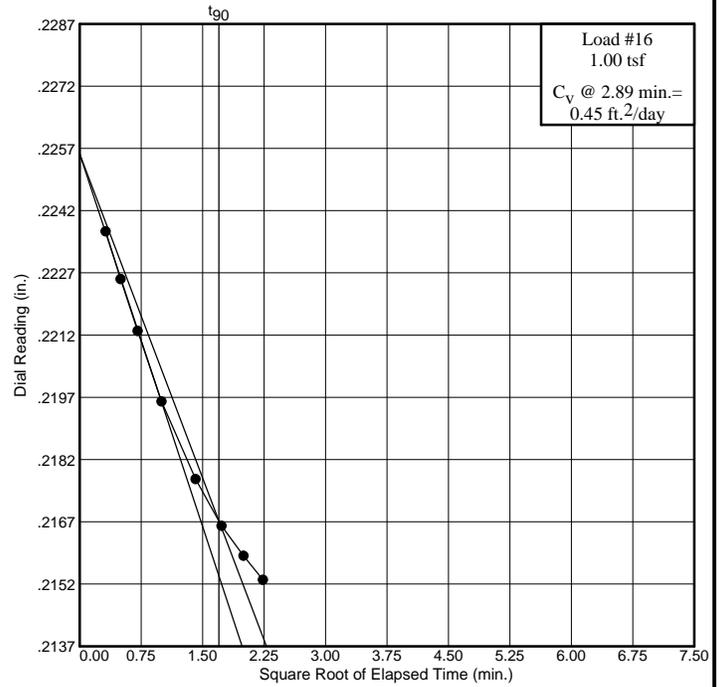
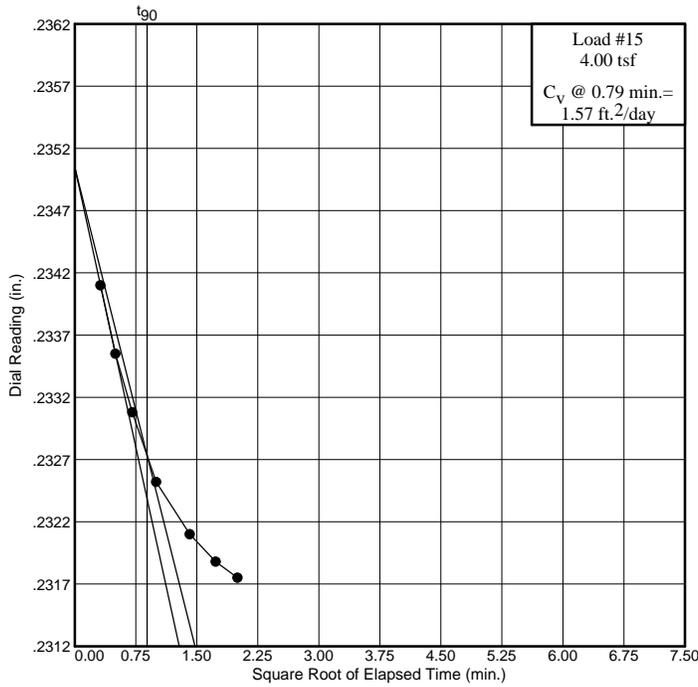
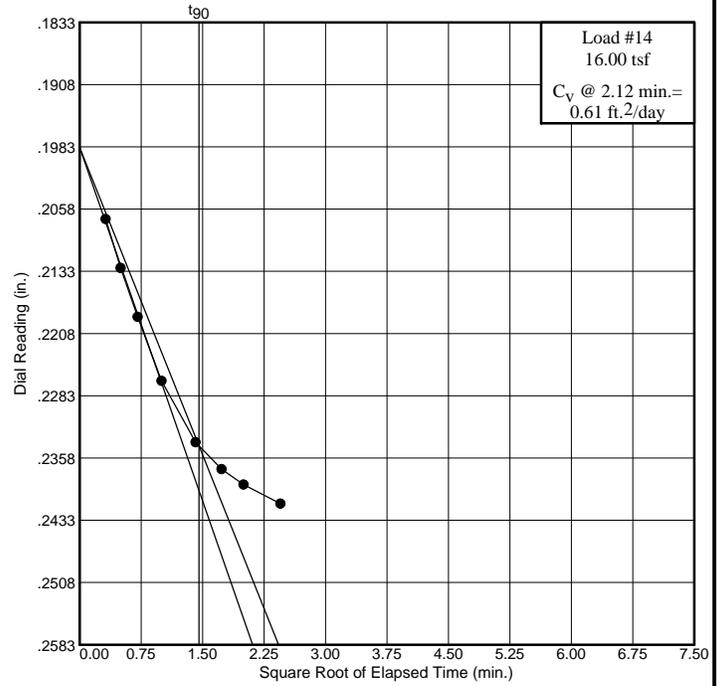
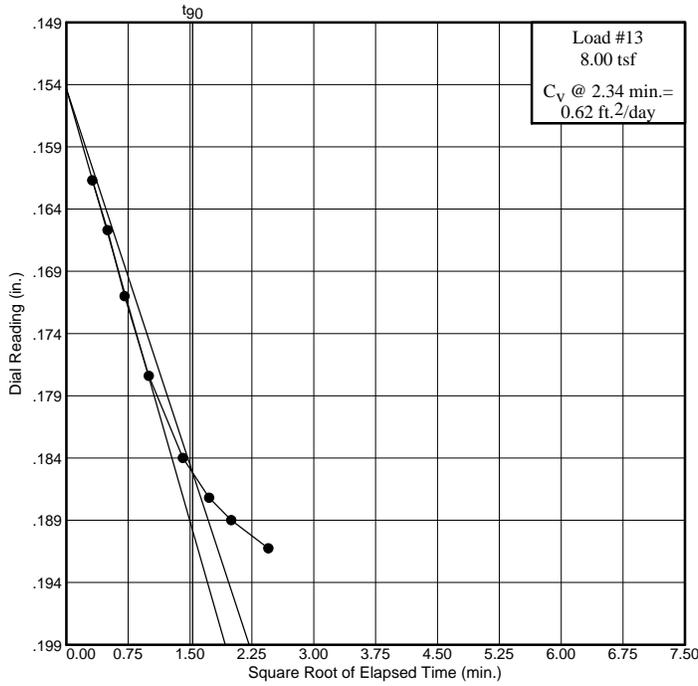
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-102

Sample No.: S-18

Elev./Depth: 72.7-72.8 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 8

Dial Reading vs. Time

Project No.: J-09-2326

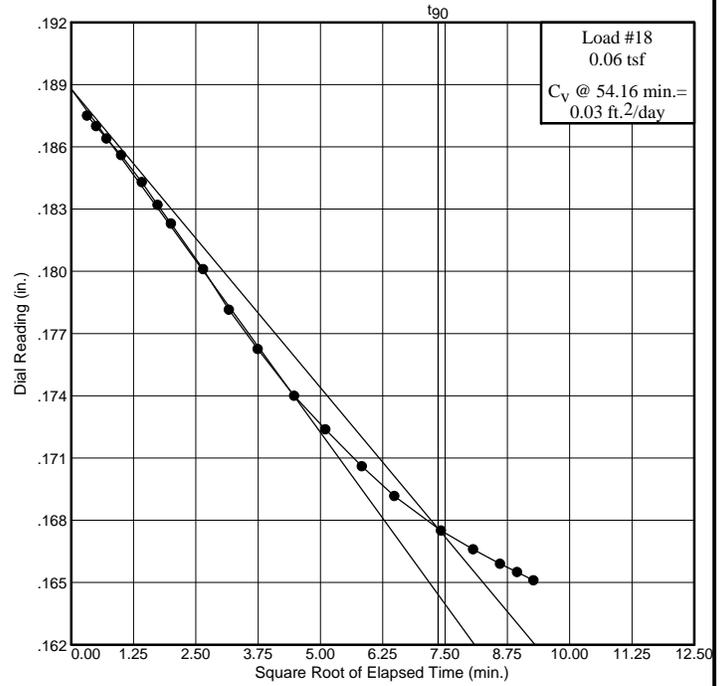
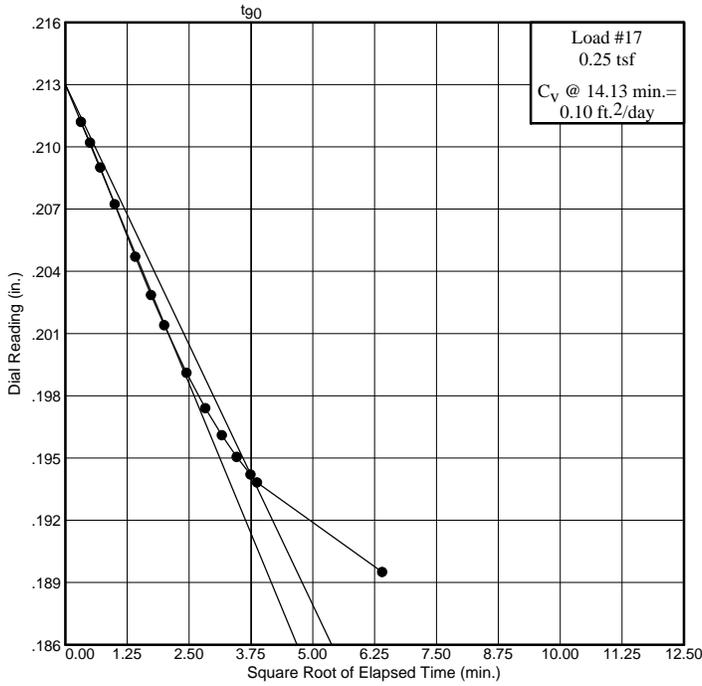
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-102

Sample No.: S-18

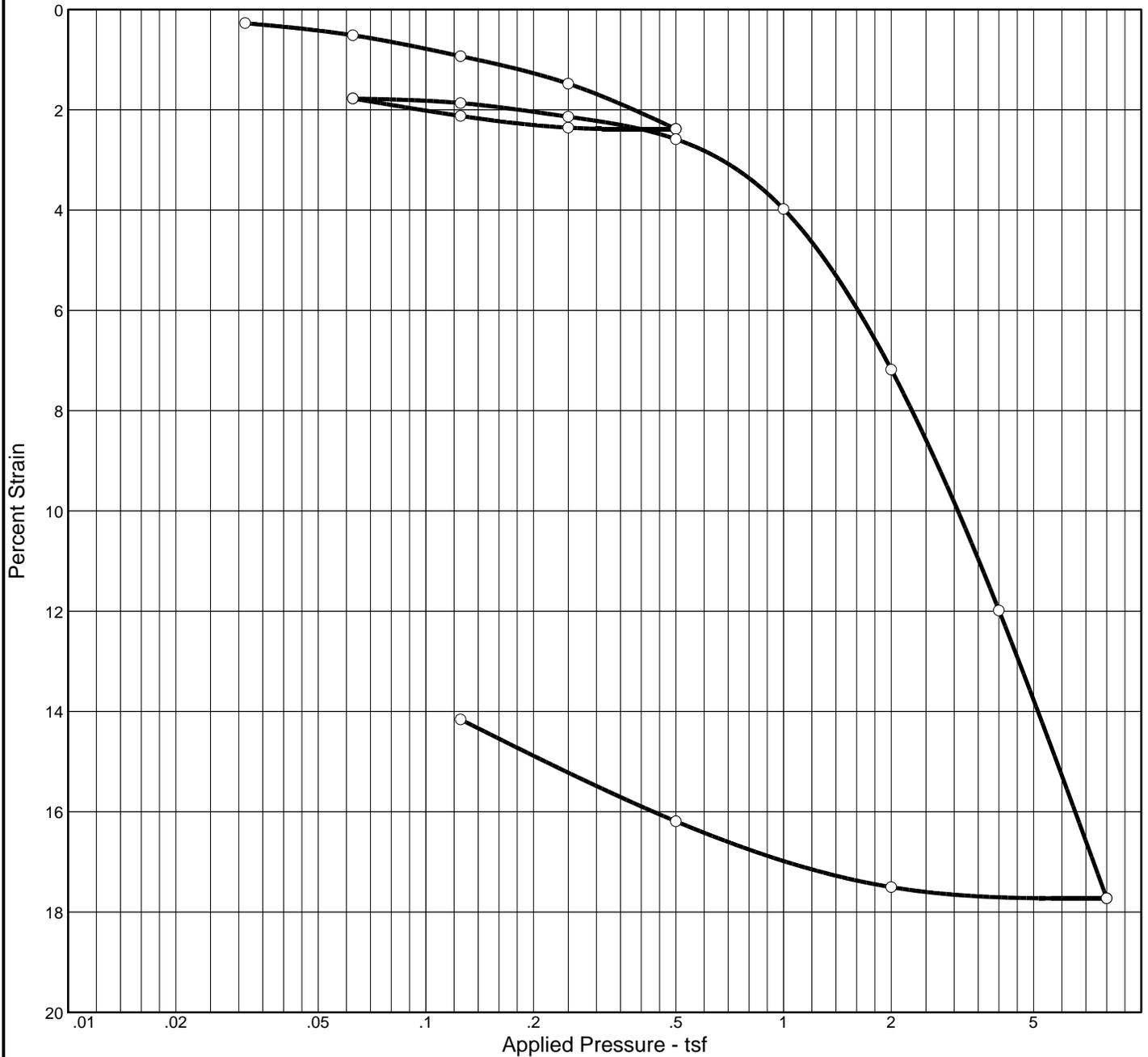
Elev./Depth: 72.7-72.8 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 9

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P _c (tsf)	C _c	C _r	Swell Press. (tsf)	Swell %	e ₀
Sat.	Moist.											
100.0 %	63.4 %	61.8	67	24	2.65		1.73	0.51	0.03			1.680

MATERIAL DESCRIPTION	USCS	AASHTO
M-stiff, moist, grey, organic SILT	OH	----

Project No. J-09-2326 Client: Landau Associates Project: Longview Water Treatment Plant Project No. 133009.010.011 Source: B-103 Sample No.: S-4 Elev./Depth: 16.5-16.6 ft.	Remarks: Specific gravity estimated
SOIL TECHNOLOGY Bainbridge Island, WA	

Figure 5

Dial Reading vs. Time

Project No.: J-09-2326

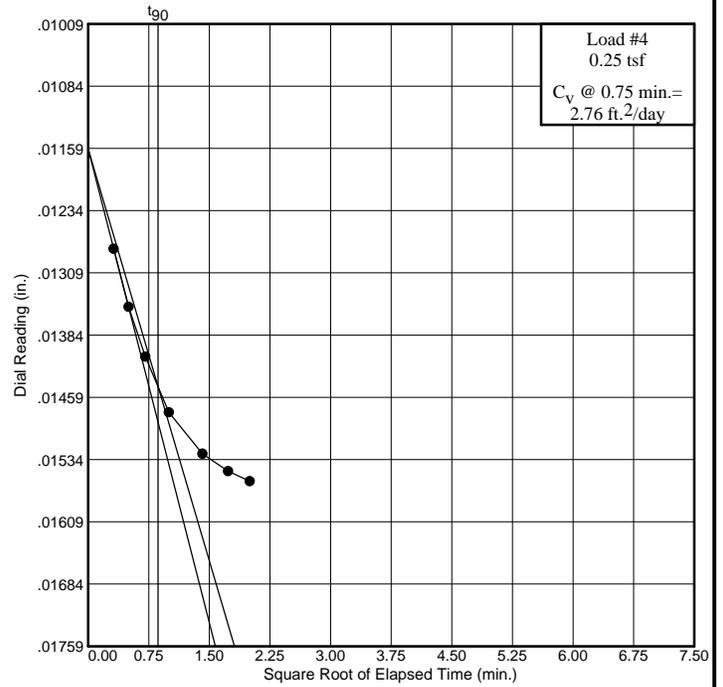
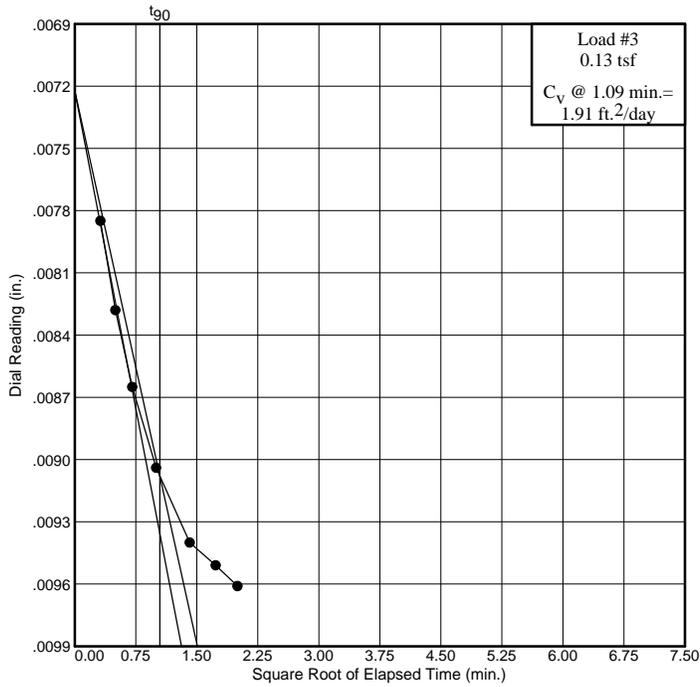
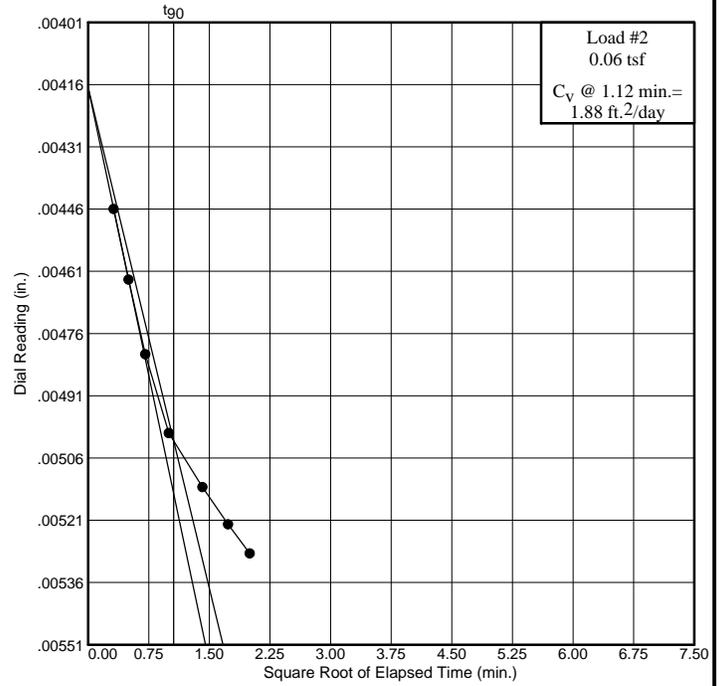
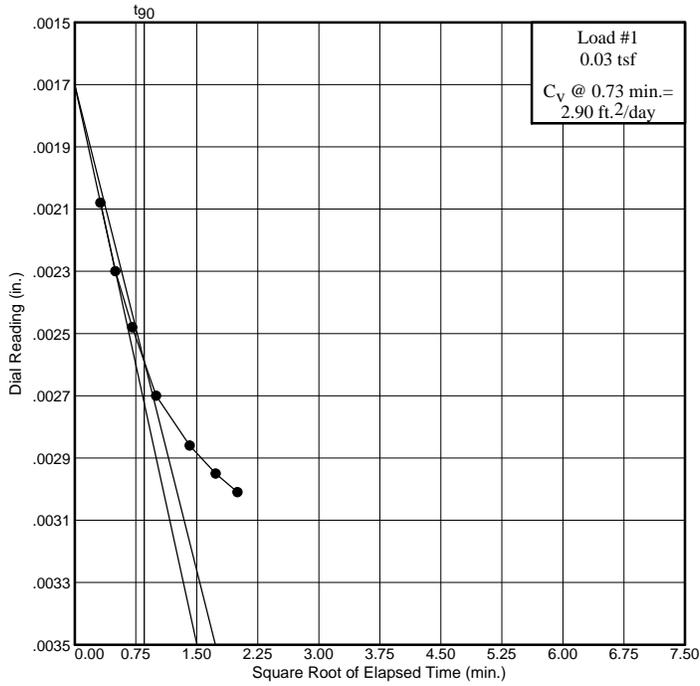
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-103

Sample No.: S-4

Elev./Depth: 16.5-16.6 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 6

Dial Reading vs. Time

Project No.: J-09-2326

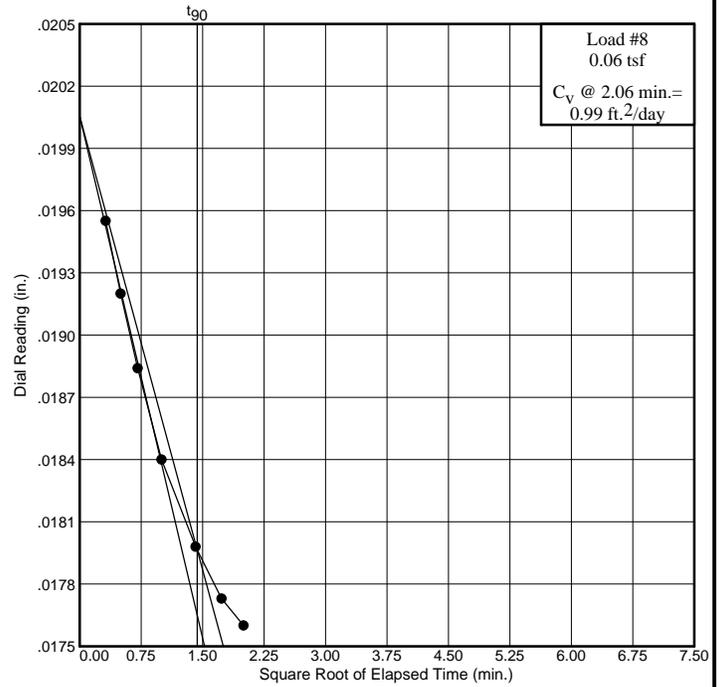
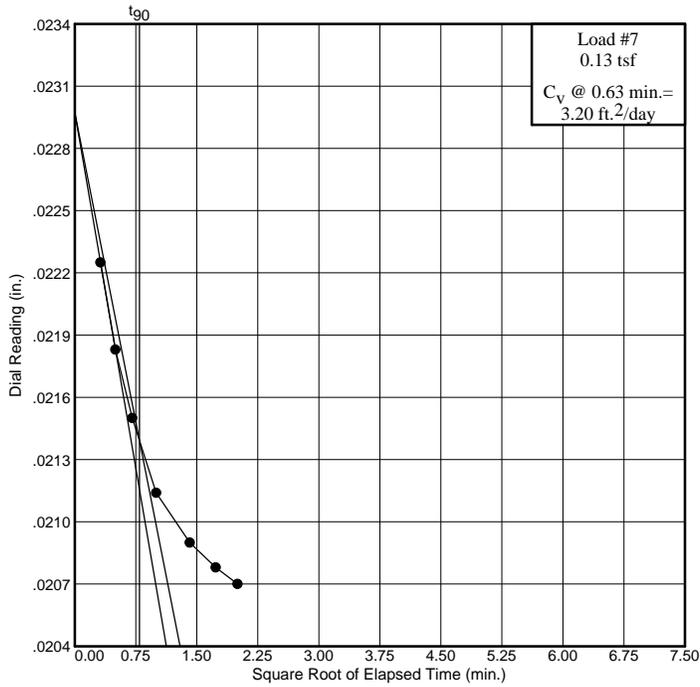
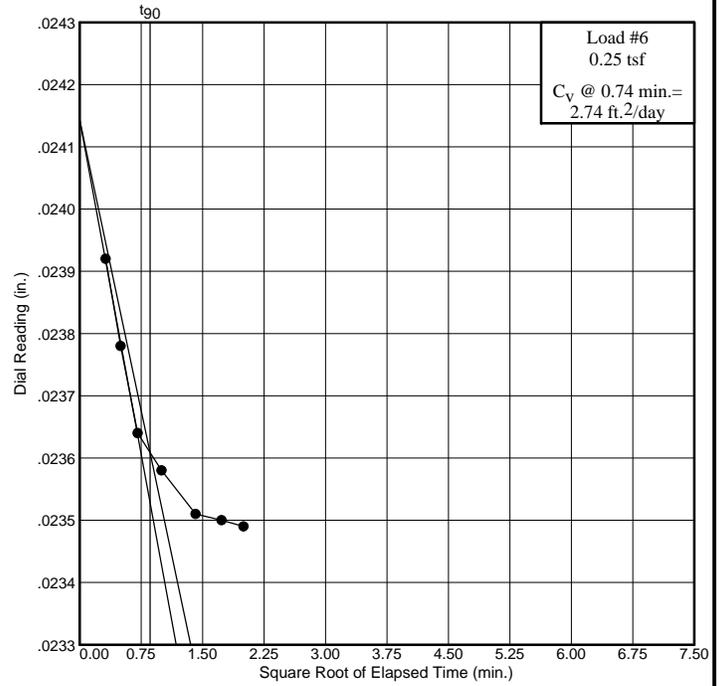
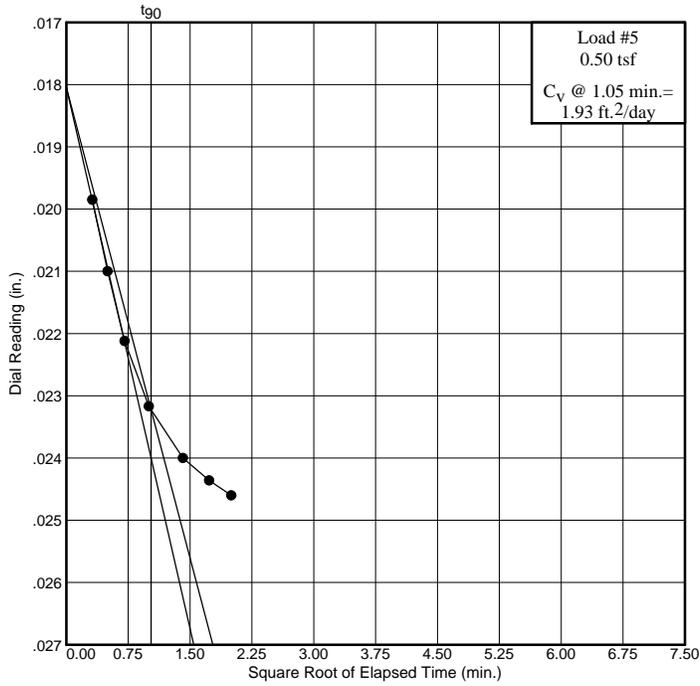
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-103

Sample No.: S-4

Elev./Depth: 16.5-16.6 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 7

Dial Reading vs. Time

Project No.: J-09-2326

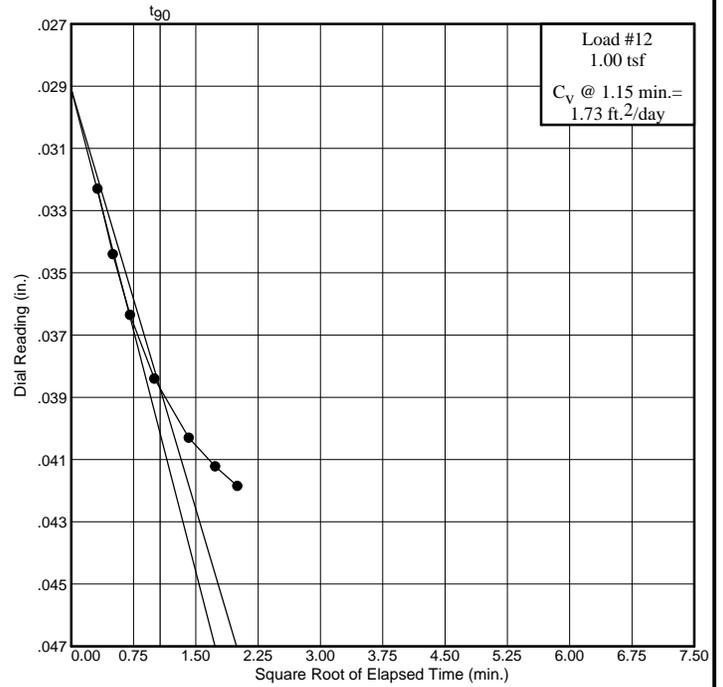
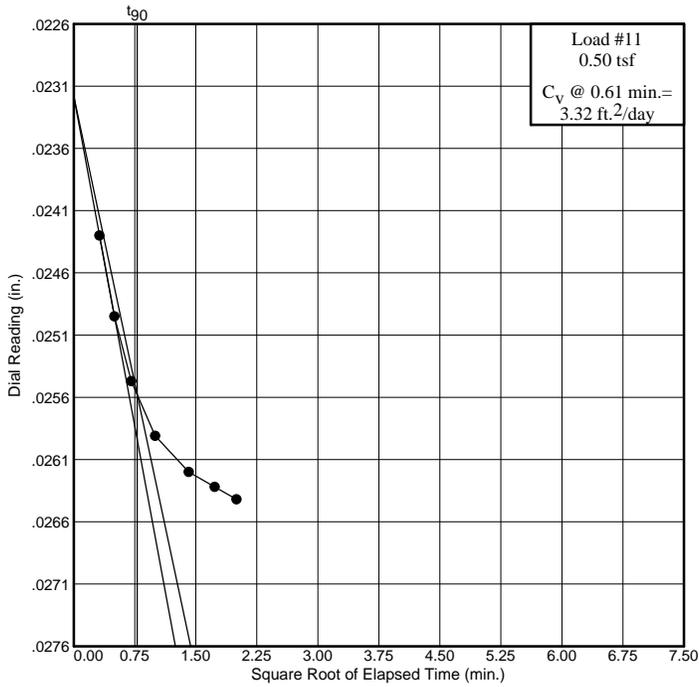
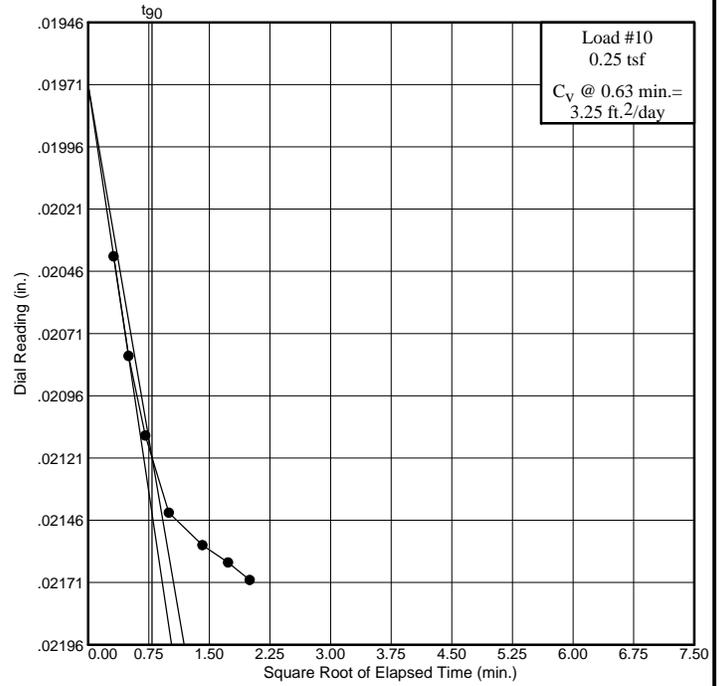
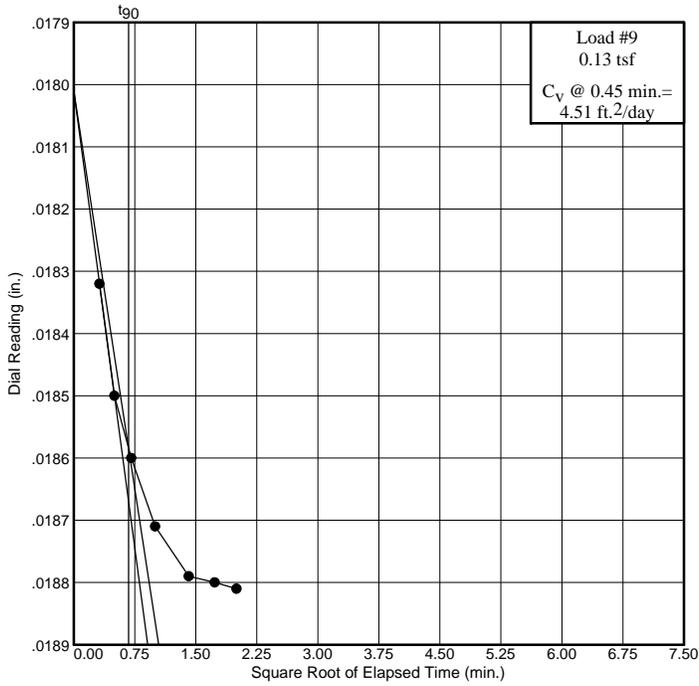
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-103

Sample No.: S-4

Elev./Depth: 16.5-16.6 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 8

Dial Reading vs. Time

Project No.: J-09-2326

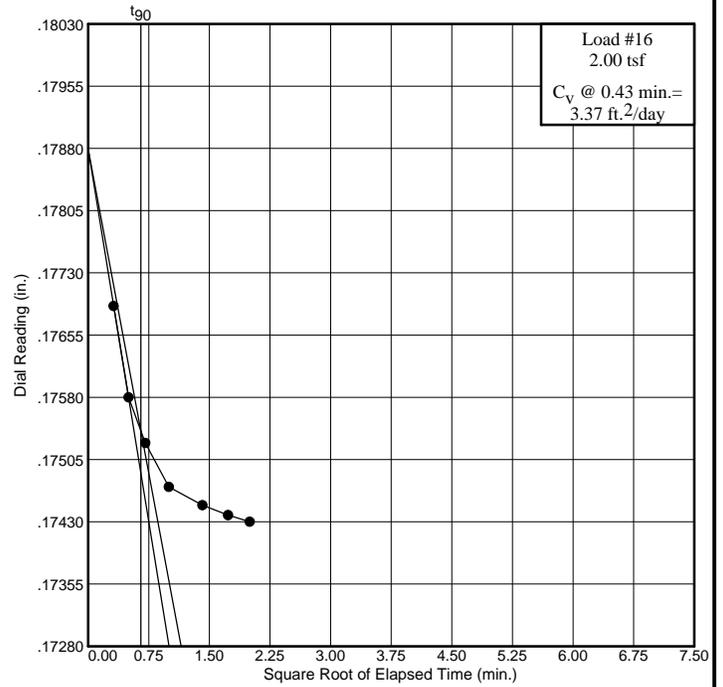
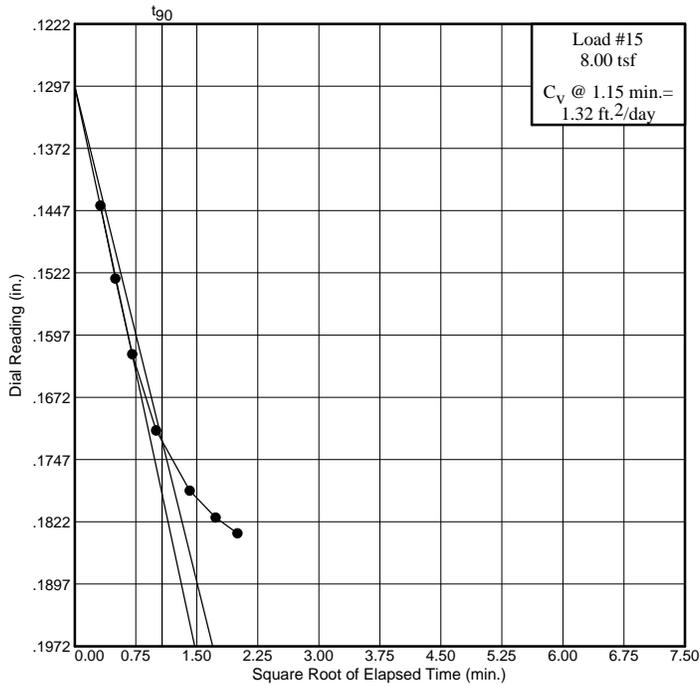
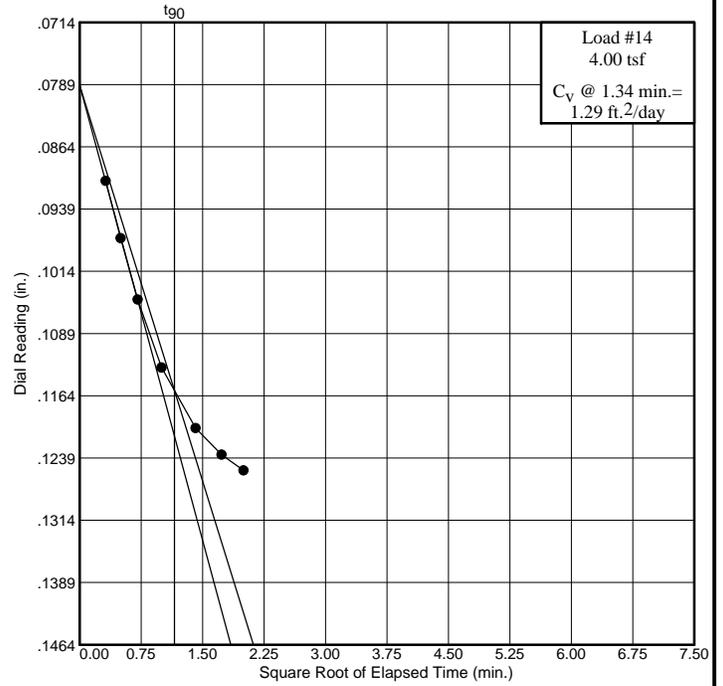
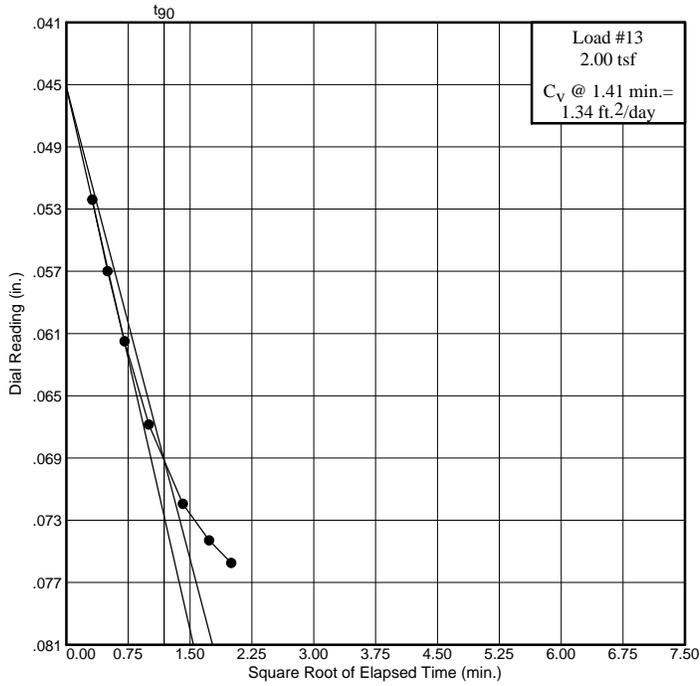
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-103

Sample No.: S-4

Elev./Depth: 16.5-16.6 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 9

Dial Reading vs. Time

Project No.: J-09-2326

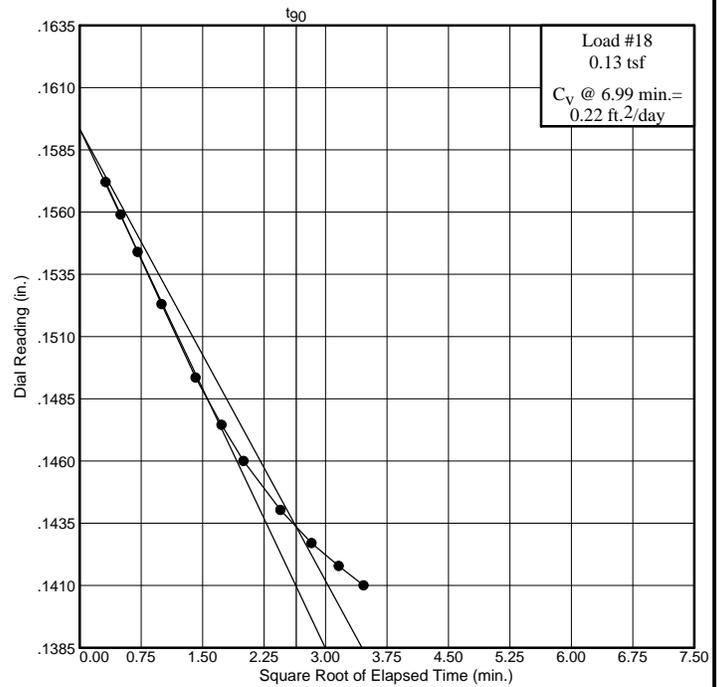
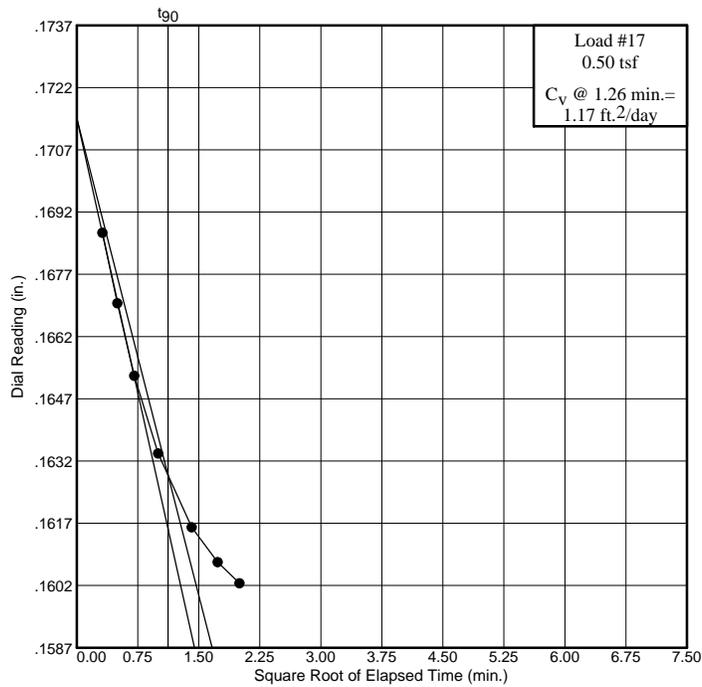
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-103

Sample No.: S-4

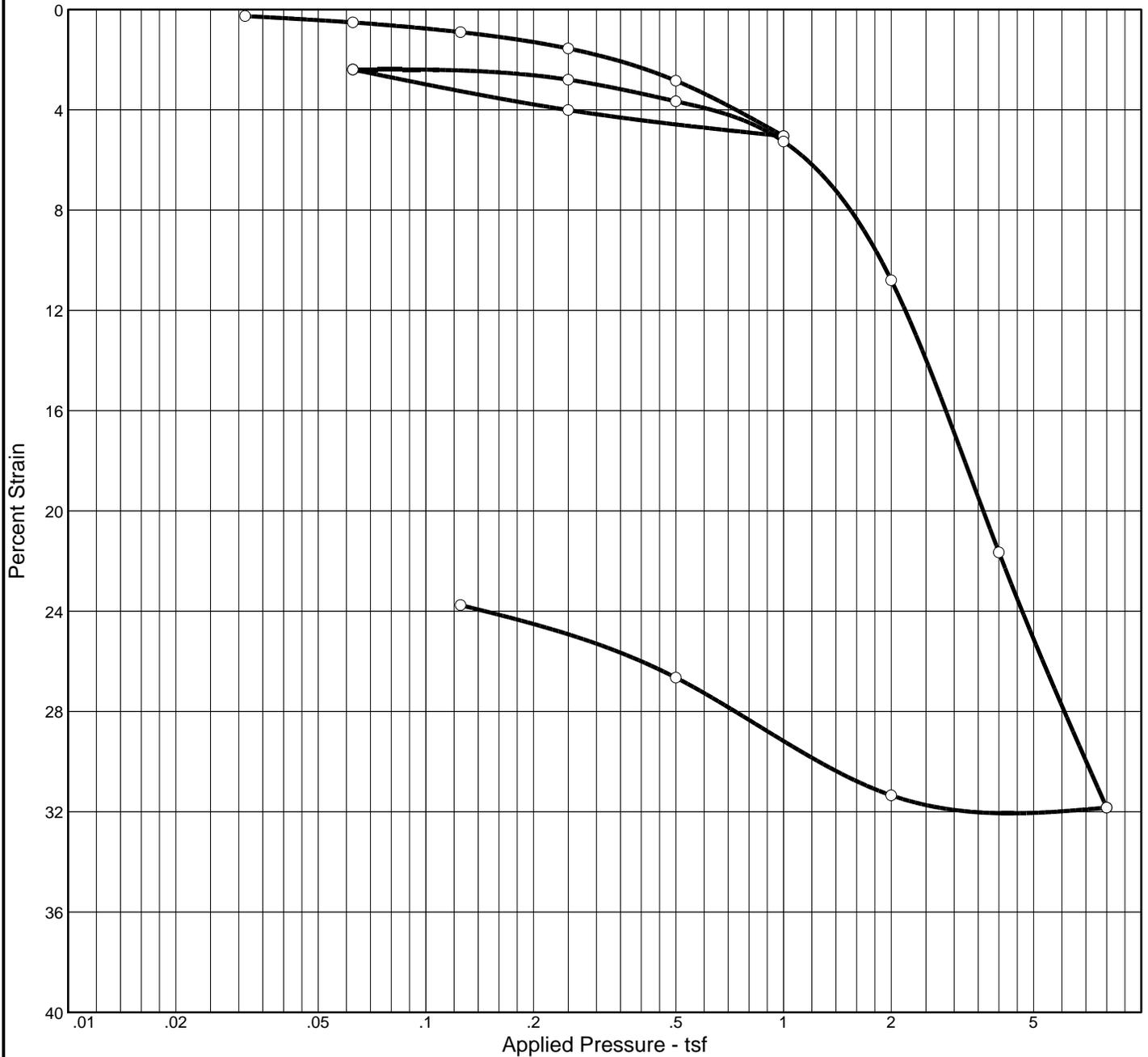
Elev./Depth: 16.5-16.6 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 10

CONSOLIDATION TEST REPORT



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (tsf)	P _c (tsf)	C _c	C _r	Swell Press. (tsf)	Swell %	e ₀
Sat.	Moist.											
99.7 %	106.8 %	42.6	131	84	2.55		1.34	1.25	0.12			2.734

MATERIAL DESCRIPTION	USCS	AASHTO
M-stiff, moist, grey-green organic CLAY	OH	---

Project No. J-09-2326 Project: Longview Water Treatment Plant Project No. 133009.010.011 Source: B-103	Client: Landau Associates Sample No.: S-9 Elev./Depth: 36.1-36.2 ft.	Remarks: Oven dried LL=68 Specific gravity estimated
SOIL TECHNOLOGY Bainbridge Island, WA		Figure 6

Dial Reading vs. Time

Project No.: J-09-2326

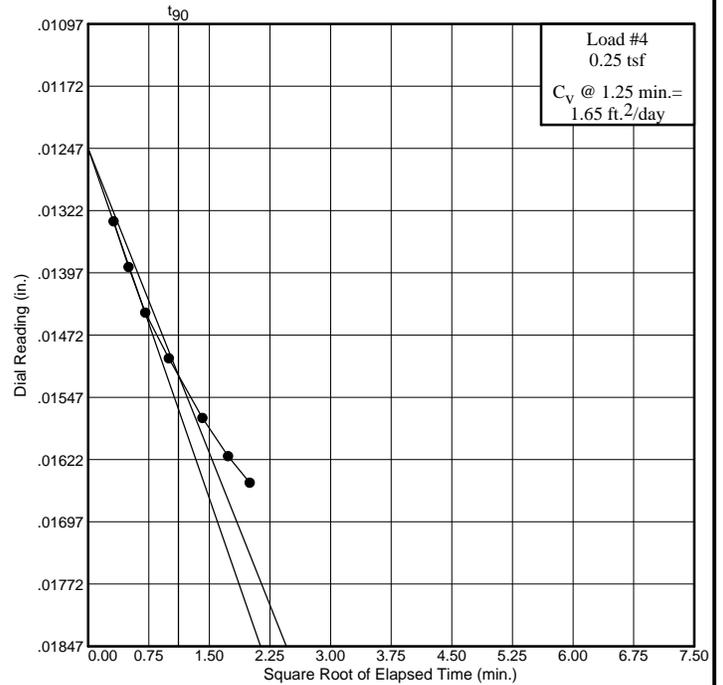
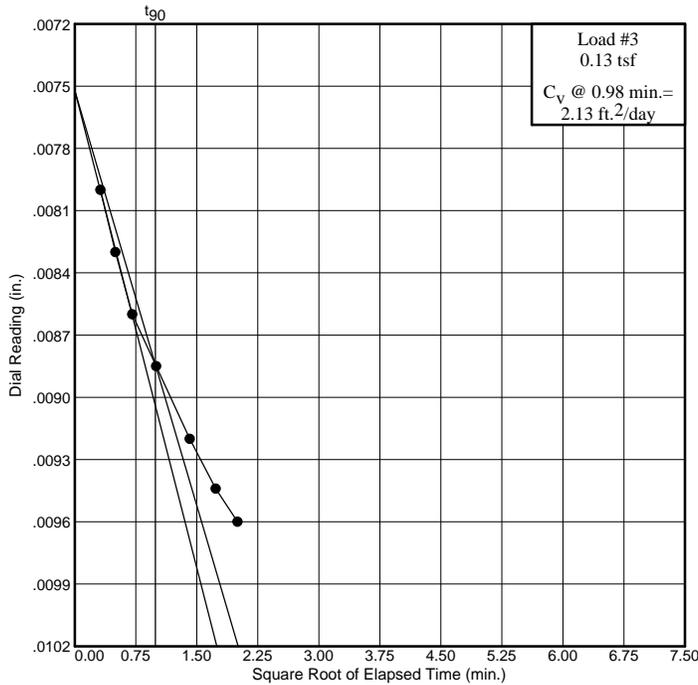
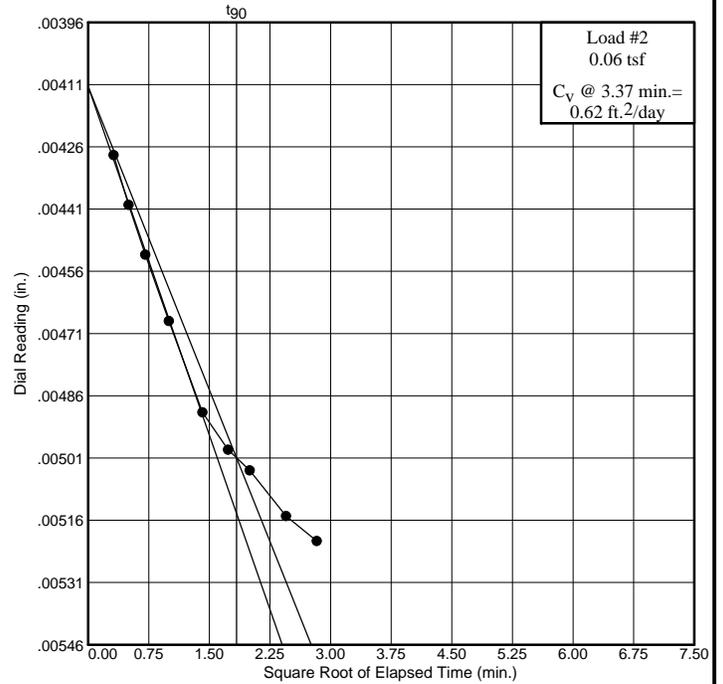
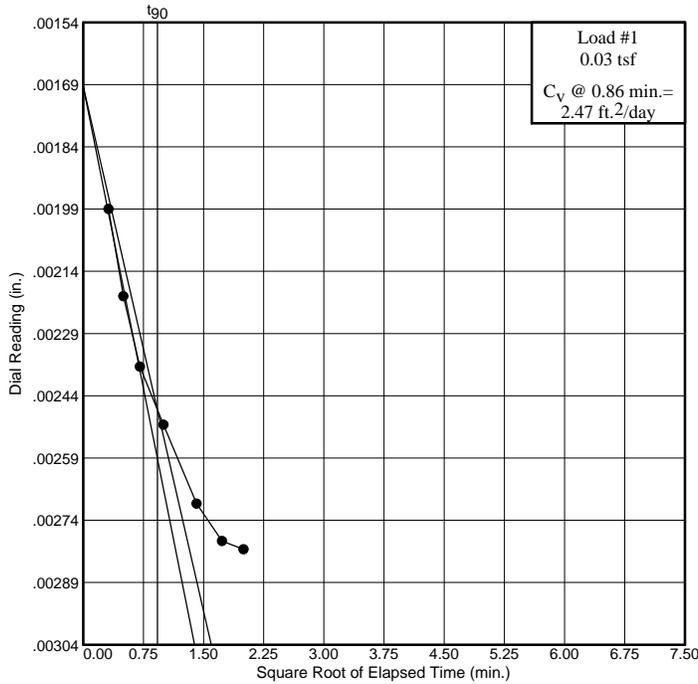
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-103

Sample No.: S-9

Elev./Depth: 36.1-36.2 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 7

Dial Reading vs. Time

Project No.: J-09-2326

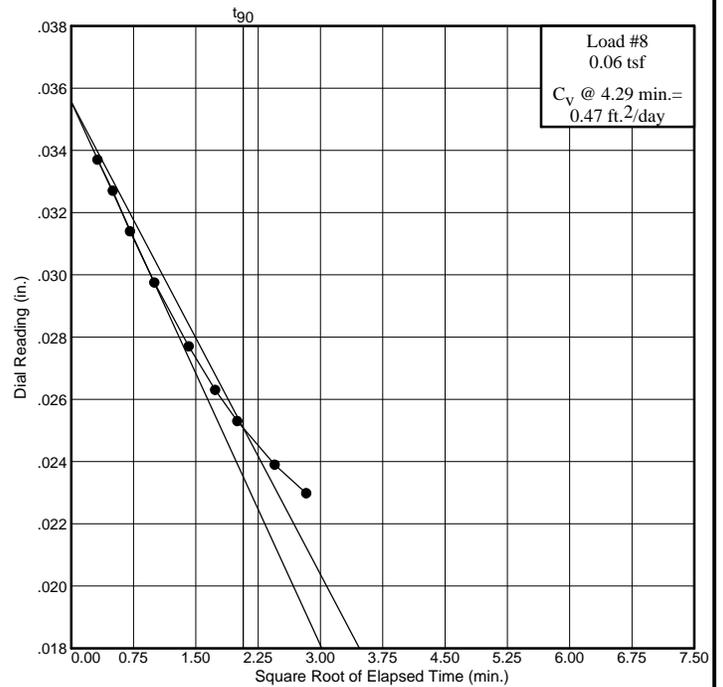
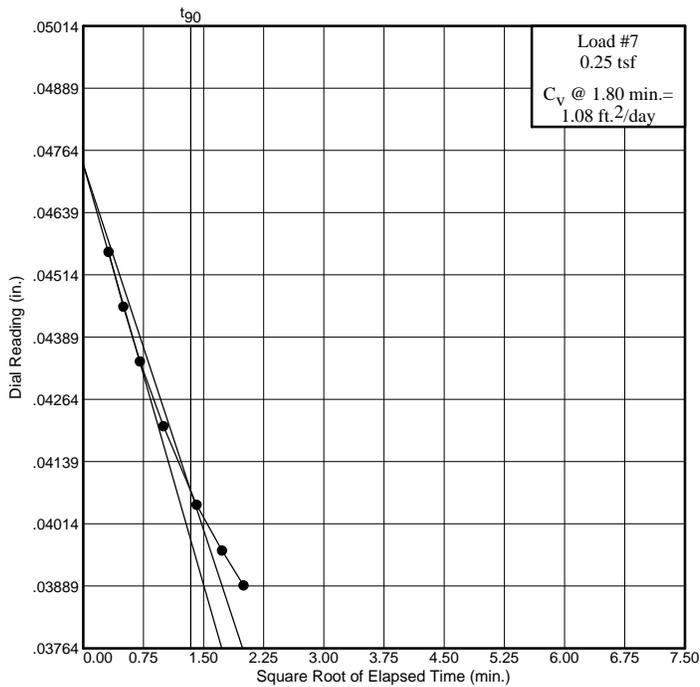
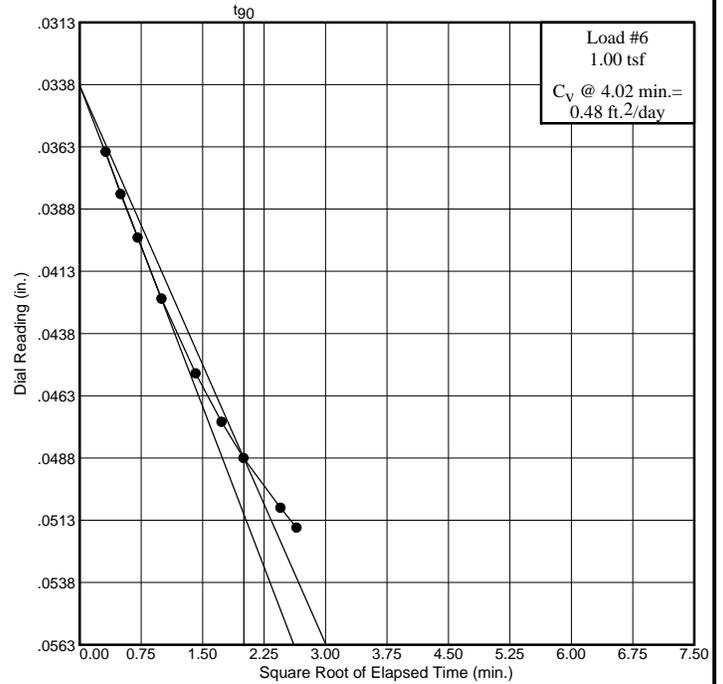
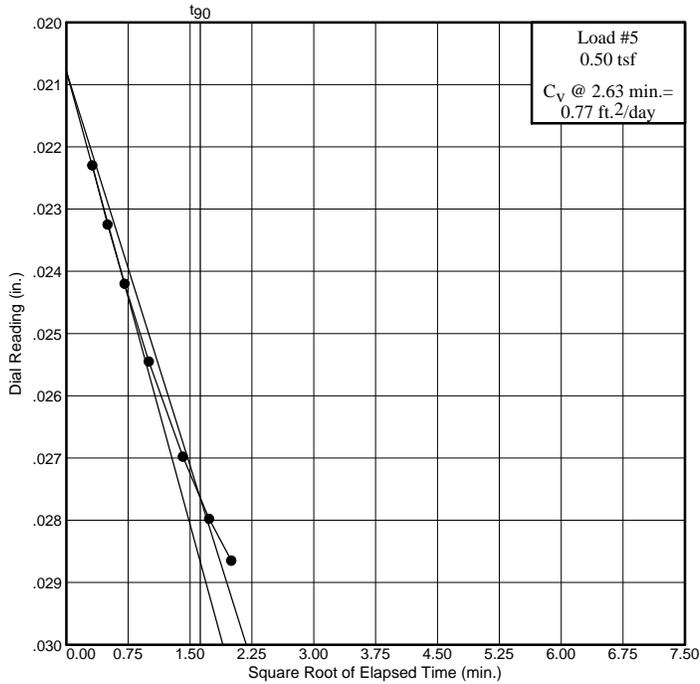
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-103

Sample No.: S-9

Elev./Depth: 36.1-36.2 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 8

Dial Reading vs. Time

Project No.: J-09-2326

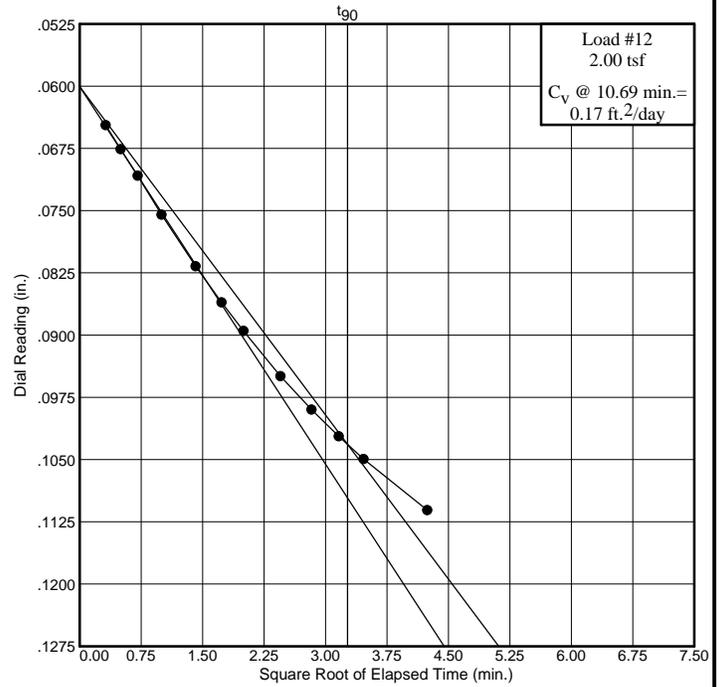
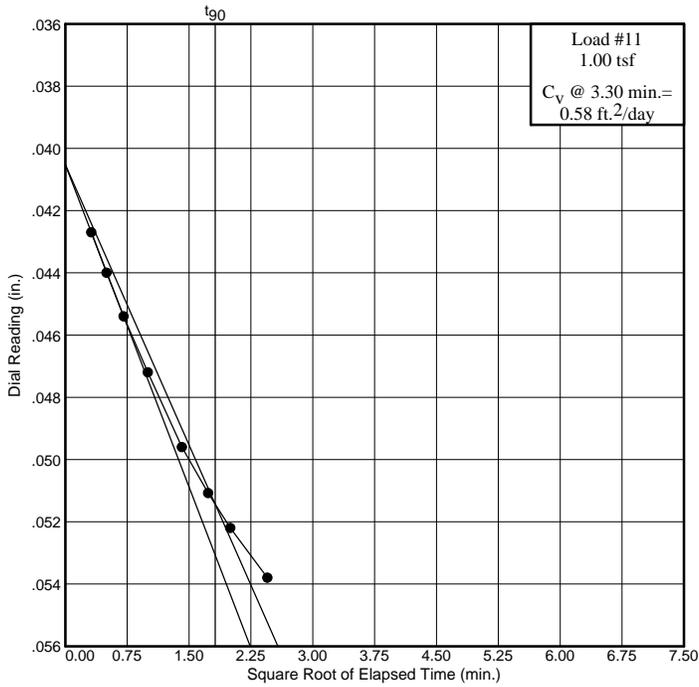
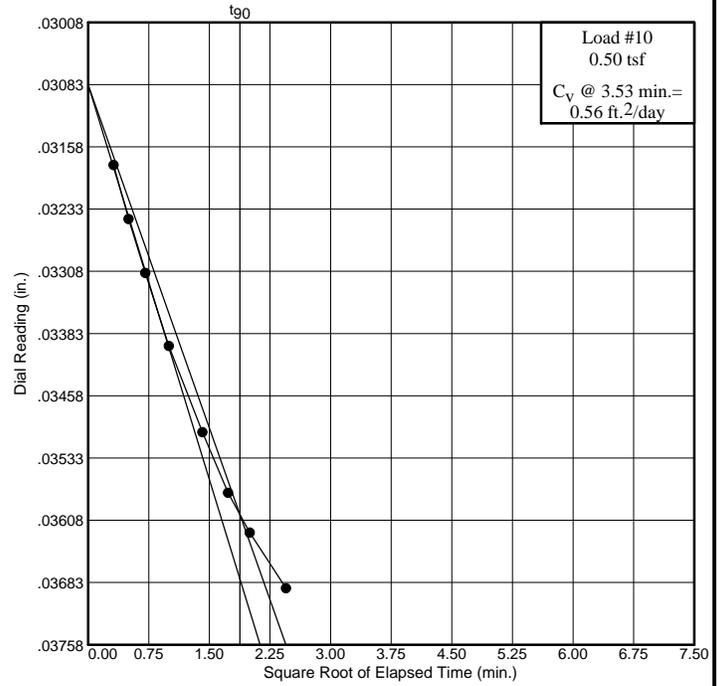
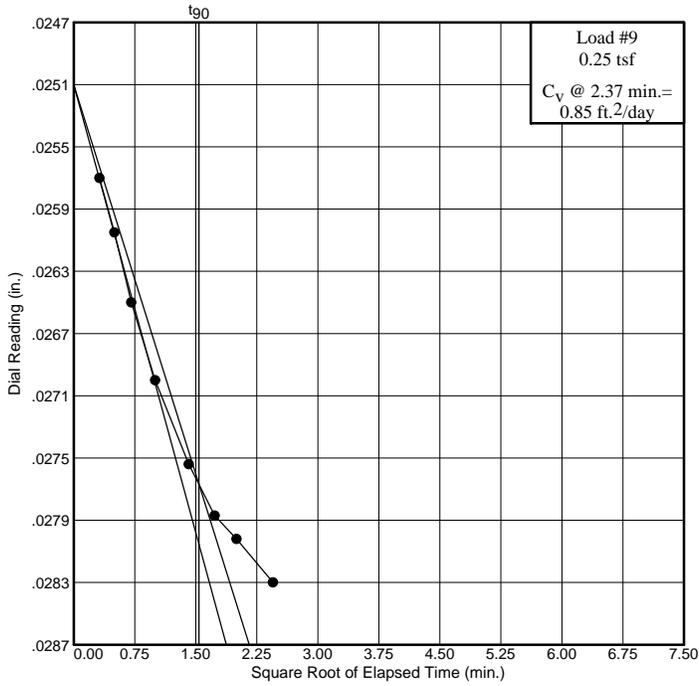
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-103

Sample No.: S-9

Elev./Depth: 36.1-36.2 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 9

Dial Reading vs. Time

Project No.: J-09-2326

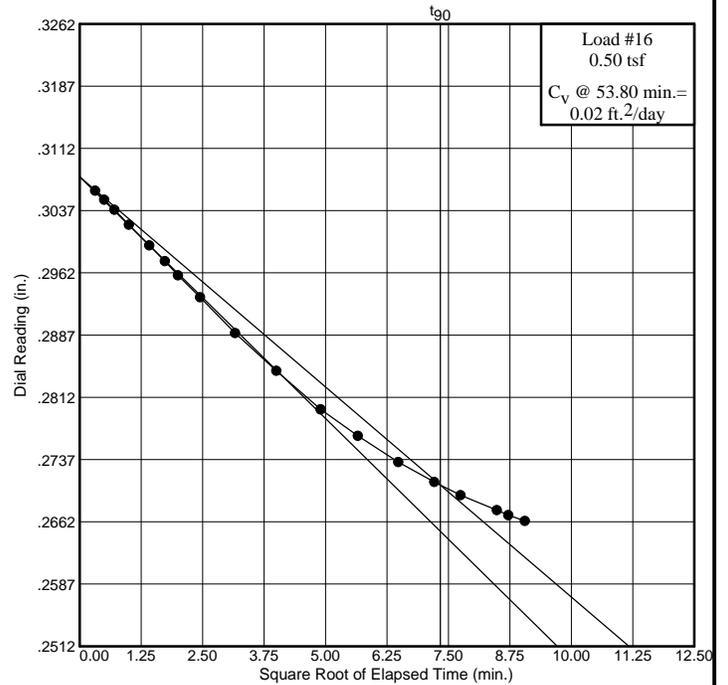
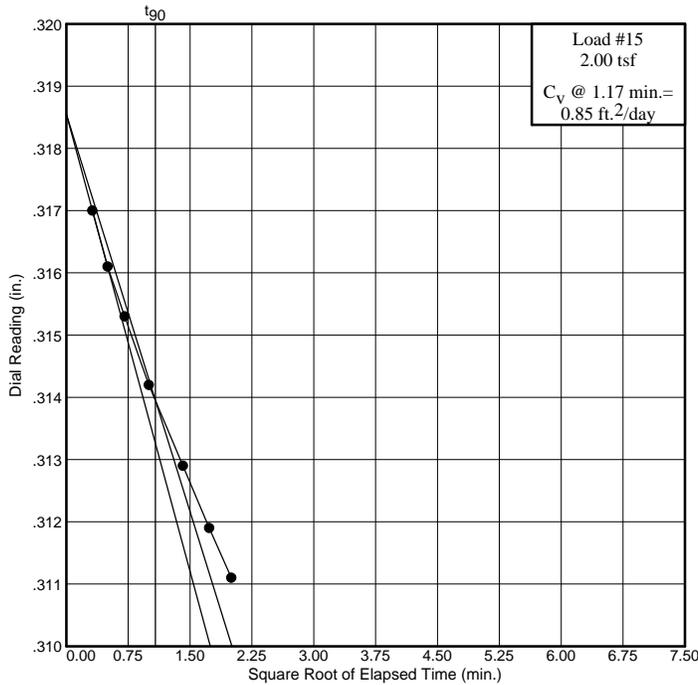
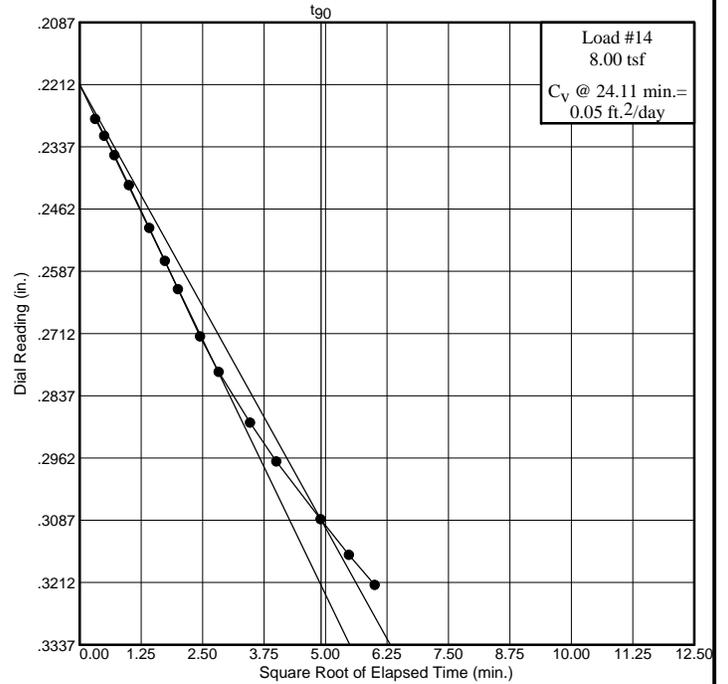
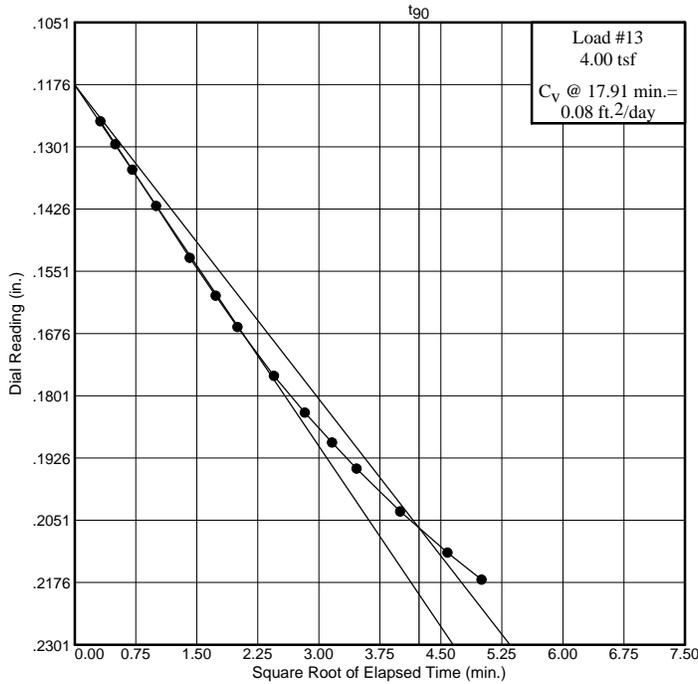
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-103

Sample No.: S-9

Elev./Depth: 36.1-36.2 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 10

Dial Reading vs. Time

Project No.: J-09-2326

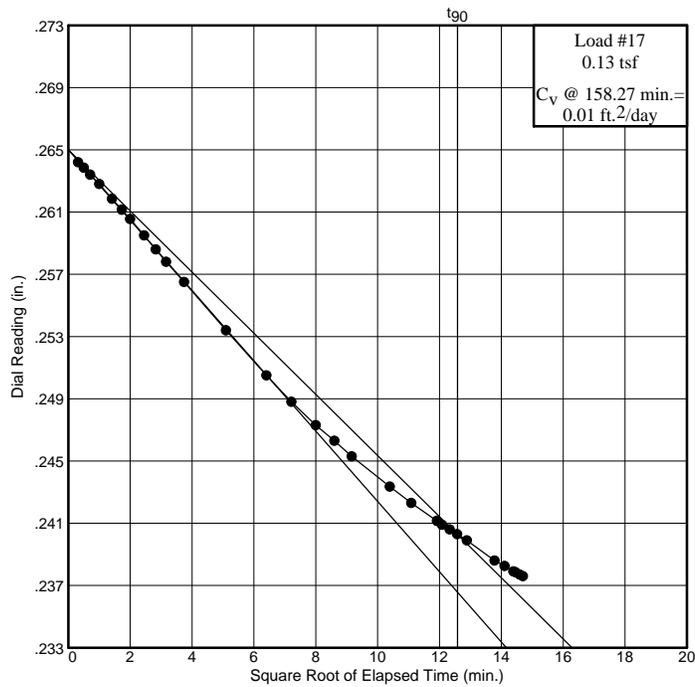
Project: Longview Water Treatment Plant

Project No. 133009.010.011

Source: B-103

Sample No.: S-9

Elev./Depth: 36.1-36.2 ft.



SOIL TECHNOLOGY
Bainbridge Island, WA

Figure 11



Analytical Resources, Incorporated

Analytical Chemists and Consultants

August 25, 2009

Brian Bennetts
Landau Associates, Inc.
950 Pacific Ave # 515
Tacoma, WA 98402

RE: Project No: 133009.010.011
Project Name: Longview Water Treatment Plant
ARI Job No: PK67

Dear Brian:

Please find enclosed copies of the chain of custodies (COC) and the final results from the project referenced above. Analytical Resources, Inc. accepted three soil samples in good condition on August 14, 2009.

The samples were analyzed for AWWA C105 Corrosion tests and sulfide, as requested on the COC.

There were no anomalies associated with the analysis.

A copy of these reports and all corresponding raw data will remain on file electronically with ARI. If you have any questions or require additional information, please contact me at your convenience.

Sincerely,
ANALYTICAL RESOURCES, INC.

A handwritten signature in black ink, appearing to read "Kelly Bottem".

Kelly Bottem
Client Services Manager
(206) 695-6211
kellyb@arilabs.com

Enclosures



Analytical Resources,
Incorporated
Analytical Chemists and
Consultants

Cooler Receipt Form

ARI Client: Landau

Project Name: Longview water treatment plant

COC No(s): _____ (NA)

Delivered by: Fed-Ex UPS Courier (Hand Delivered Other: _____)

Assigned ARI Job No: PK167

Tracking No: _____ NA

Preliminary Examination Phase:

Were intact, properly signed and dated custody seals attached to the outside of to cooler? YES NO

Were custody papers included with the cooler? YES NO

Were custody papers properly filled out (ink, signed, etc.) YES NO

Temperature of Cooler(s) (°C) (recommended 2.0-6.0 °C for chemistry)..... 4.8

If cooler temperature is out of compliance fill out form 00070F Temp Gun ID#: 101886

Cooler Accepted by: AV Date: 8/14/09 Time: 1405

Complete custody forms and attach all shipping documents

Log-In Phase:

Was a temperature blank included in the cooler? YES NO

What kind of packing material was used? ... Bubble Wrap Wet Ice Gel Packs Baggies Foam Block Paper Other: _____

Was sufficient ice used (if appropriate)? NA YES NO

Were all bottles sealed in individual plastic bags? YES NO

Did all bottles arrive in good condition (unbroken)? YES NO

Were all bottle labels complete and legible? YES NO

Did the number of containers listed on COC match with the number of containers received? YES NO

Did all bottle labels and tags agree with custody papers? YES NO

Were all bottles used correct for the requested analyses? YES NO

Do any of the analyses (bottles) require preservation? (attach preservation sheet, excluding VOCs)... NA YES NO

Were all VOC vials free of air bubbles? NA YES NO

Was sufficient amount of sample sent in each bottle? YES NO

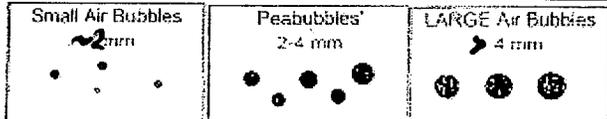
Samples Logged by: AV Date: 8/14/09 Time: 1531

**** Notify Project Manager of discrepancies or concerns ****

Sample ID on Bottle	Sample ID on COC	Sample ID on Bottle	Sample ID on COC

Additional Notes, Discrepancies, & Resolutions:

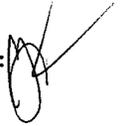
By: _____ Date: _____



Small → "sm"
Peabubbles → "pb"
Large → "lg"
Headspace → "hs"

SAMPLE RESULTS-CONVENTIONALS
PK67-Landau Associates, Inc.



Matrix: Solid
Data Release Authorized: 
Reported: 08/19/09

Project: LONGVIEW WATER TREATMENT PLA
Event: 133009.010.011
Date Sampled: 08/12/09
Date Received: 08/14/09

Client ID: B-101
ARI ID: 09-19084 PK67A

Analyte	Date	Method	Units	RL	Sample
pH	08/14/09 081409#1	SW9045	std units	0.01	6.49
Redox Potential	08/14/09 081409#1	SM 2580	mv	0.1	386.0
Preserved Total Solids	08/17/09 081709#1	EPA 160.3	Percent	0.01	69.90
Sulfide	08/17/09 081709#1	EPA 376.2	mg/kg	1.37	< 1.37 U

RL Analytical reporting limit
U Undetected at reported detection limit

pH determined on 1:1 soil:D.I. water extracts.

SAMPLE RESULTS-CONVENTIONALS
PK67-Landau Associates, Inc.



Matrix: Solid
Data Release Authorized: 
Reported: 08/19/09

Project: LONGVIEW WATER TREATMENT PLA
Event: 133009.010.011
Date Sampled: 08/13/09
Date Received: 08/14/09

Client ID: B-102
ARI ID: 09-19085 PK67B

Analyte	Date	Method	Units	RL	Sample
pH	08/14/09 081409#1	SW9045	std units	0.01	6.48
Redox Potential	08/14/09 081409#1	SM 2580	mv	0.1	421.0
Preserved Total Solids	08/17/09 081709#1	EPA 160.3	Percent	0.01	62.70
Sulfide	08/17/09 081709#1	EPA 376.2	mg/kg	1.57	< 1.57 U

RL Analytical reporting limit
U Undetected at reported detection limit

pH determined on 1:1 soil:D.I. water extracts.

SAMPLE RESULTS-CONVENTIONALS
PK67-Landau Associates, Inc.



Matrix: Solid
Data Release Authorized: 
Reported: 08/19/09

Project: LONGVIEW WATER TREATMENT PLA
Event: 133009.010.011
Date Sampled: 08/13/09
Date Received: 08/14/09

Client ID: B-103
ARI ID: 09-19086 PK67C

Analyte	Date	Method	Units	RL	Sample
pH	08/14/09 081409#1	SW9045	std units	0.01	5.42
Redox Potential	08/14/09 081409#1	SM 2580	mv	0.1	444.0
Preserved Total Solids	08/17/09 081709#1	EPA 160.3	Percent	0.01	72.50
Sulfide	08/17/09 081709#1	EPA 376.2	mg/kg	1.36	< 1.36 U

RL Analytical reporting limit
U Undetected at reported detection limit

pH determined on 1:1 soil:D.I. water extracts.

METHOD BLANK RESULTS-CONVENTIONALS
PK67-Landau Associates, Inc.



Matrix: Solid
Data Release Authorized
Reported: 08/19/09

A handwritten signature in black ink, appearing to be 'M. J. Landau', written over the 'Data Release Authorized' text.

Project: LONGVIEW WATER TREATMENT PLA
Event: 133009.010.011
Date Sampled: NA
Date Received: NA

Analyte	Date	Units	Blank
Preserved Total Solids	08/17/09	Percent	< 0.01 U
Sulfide	08/17/09	mg/kg	< 1.00 U

LAB CONTROL RESULTS-CONVENTIONALS
PK67-Landau Associates, Inc.



Matrix: Solid
Data Release Authorized:
Reported: 08/19/09

A handwritten signature in black ink, appearing to be 'M. J. Landau', written over the 'Data Release Authorized' line.

Project: LONGVIEW WATER TREATMENT PLA
Event: 133009.010.011
Date Sampled: NA
Date Received: NA

Analyte	Date	Units	LCS	Spike Added	Recovery
pH	08/14/09	std units	7.01	7.00	0.01
Redox Potential	08/14/09	mv	424.0	424.0	100.0%
Sulfide	08/17/09	mg/kg	124	116	107.3%

pH is evaluated as the Absolute Difference between the values rather than Percent Recovery.

REPLICATE RESULTS-CONVENTIONALS
PK67-Landau Associates, Inc.



Matrix: Solid
Data Release Authorized: 
Reported: 08/19/09

Project: LONGVIEW WATER TREATMENT PLA
Event: 133009.010.011
Date Sampled: 08/12/09
Date Received: 08/14/09

Analyte	Date	Units	Sample	Replicate(s)	RPD/RSD
ARI ID: PK67A Client ID: B-101					
pH	08/14/09	std units	6.49	6.60	0.11
Redox Potential	08/14/09	mv	386.0	412.0	6.5%
Preserved Total Solids	08/17/09	Percent	69.90	70.10 68.90	0.9%
Sulfide	08/17/09	mg/kg	< 1.37	< 1.35	NA

pH is evaluated as the Absolute Difference between the values rather than Relative Percent Difference

MS/MSD RESULTS-CONVENTIONALS
PK67-Landau Associates, Inc.



Matrix: Solid
Data Release Authorized:
Reported: 08/19/09

A handwritten signature in black ink, appearing to be 'M' or 'B', written over the 'Data Release Authorized' line.

Project: LONGVIEW WATER TREATMENT PLA
Event: 133009.010.011
Date Sampled: 08/12/09
Date Received: 08/14/09

Analyte	Date	Units	Sample	Spike	Spike Added	Recovery
---------	------	-------	--------	-------	-------------	----------

ARI ID: PK67A Client ID: B-101

Sulfide	08/17/09	mg/kg	< 1.37	139	158	88.0%
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Client: Landau Associates, Inc.

ARI Project No.: PK67

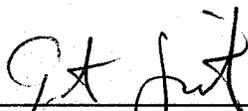
Client Project: Longview Water Treatment Plant

Client Project No.: 133009.010.011

Case Narrative

1. Three samples were received on August 14, 2009, and were in good condition.
2. The samples were submitted for minimum resistivity testing according to ASTM G57. The samples contained particles greater than 2.36mm. The samples were air dried, run over a #8 (2.36mm) sieve, rewetted with deionized water and allowed to sit overnight before resistivity determination testing.
3. Moisture content was run according to ASTM D2216.
4. The data is provided in summary tables.
5. There were no further anomalies in the samples or test method.

Approved by: _____


Lead Technician

Date: _____

8/20/09

Previous Logs by Others

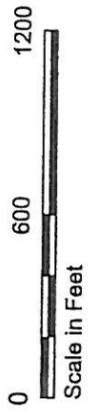
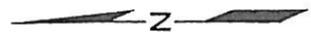
Site and Exploration Plan



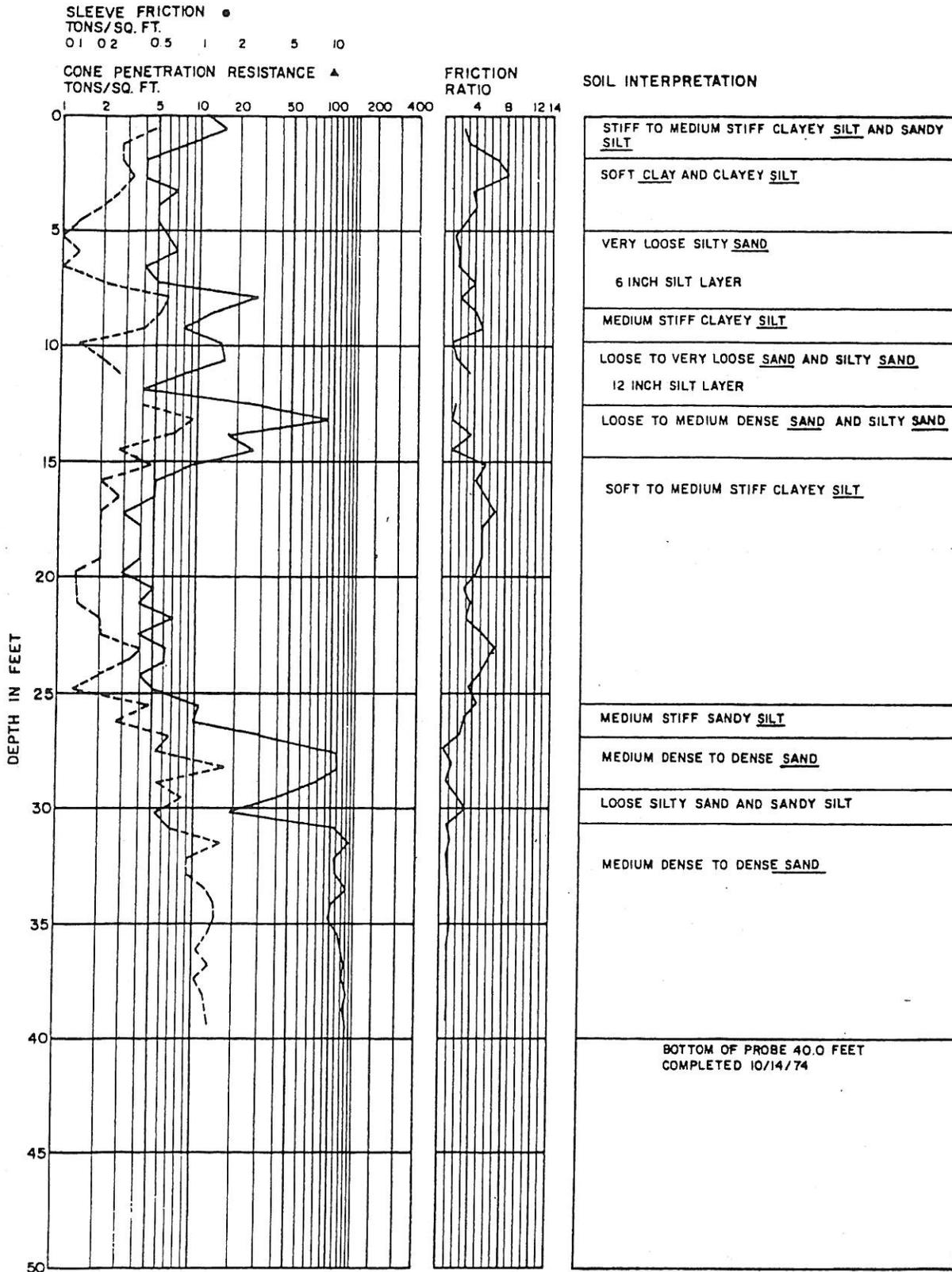
Note: Base map prepared from electronic file provided by Huit-Zollars, Inc.,

Exploration Location and Number

- ⊕ B-205 Boring (Current Study)
 - ⊙ P-203 Cone Probe (Current Study)
 - ⊠ TP-216 Test Pit (Current Study)
 - ⊙ P-1(76) Cone Probe (1976 Study)
 - ⊙ B-1(74A) Boring (October 1974 Study)
 - P-3(74A) Cone Probe (1974 Study)
 - ⊕ B-1(74B) Boring (July 1974 Study)
 - ⊙ P-6(74B) Cone Probe (July 1974 Study)
- ↔ AA' ↔ Cross Section Location and Designation



LOG OF PROBE P-3 OCT. 1974
STATION NO. 43+60



LOG OF PROBE P-1 MARCH 1976

SLEEVE FRICTION

Tons/sq. ft. -----

0.1 0.2 0.5 1 2 5 10

CONE PENETRATION RESISTANCE

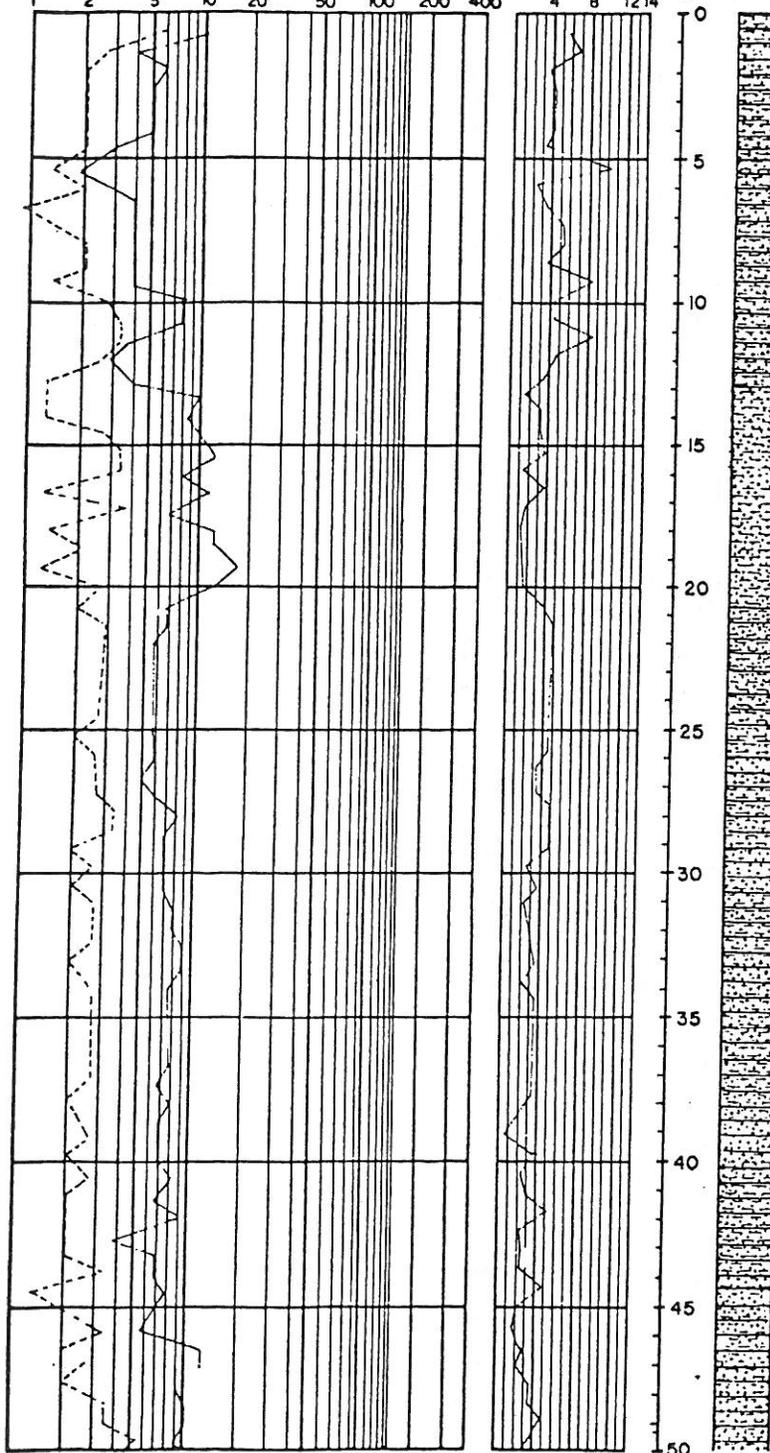
Tons/sq. ft. -----

1 2 5 10 20 50 100 200 400

FRICTION RATIO

4 8 12 14

DEPTH, Feet



SOIL INTERPRETATION

SOFT TO MEDIUM STIFF CLAYEY AND/OR SANDY SILT

LOOSE SILTY SAND OR SAND

MEDIUM STIFF CLAYEY AND/OR SANDY SILT

J-287

MARCH 1976

HART-CROWSER & associates inc.

Figure A-3 1/4

LOG OF PROBE P-1 MARCH 1976

SLEEVE FRICTION

Tons/sq. ft. -----
 Q.1 0.2 0.5 1 2 5 10

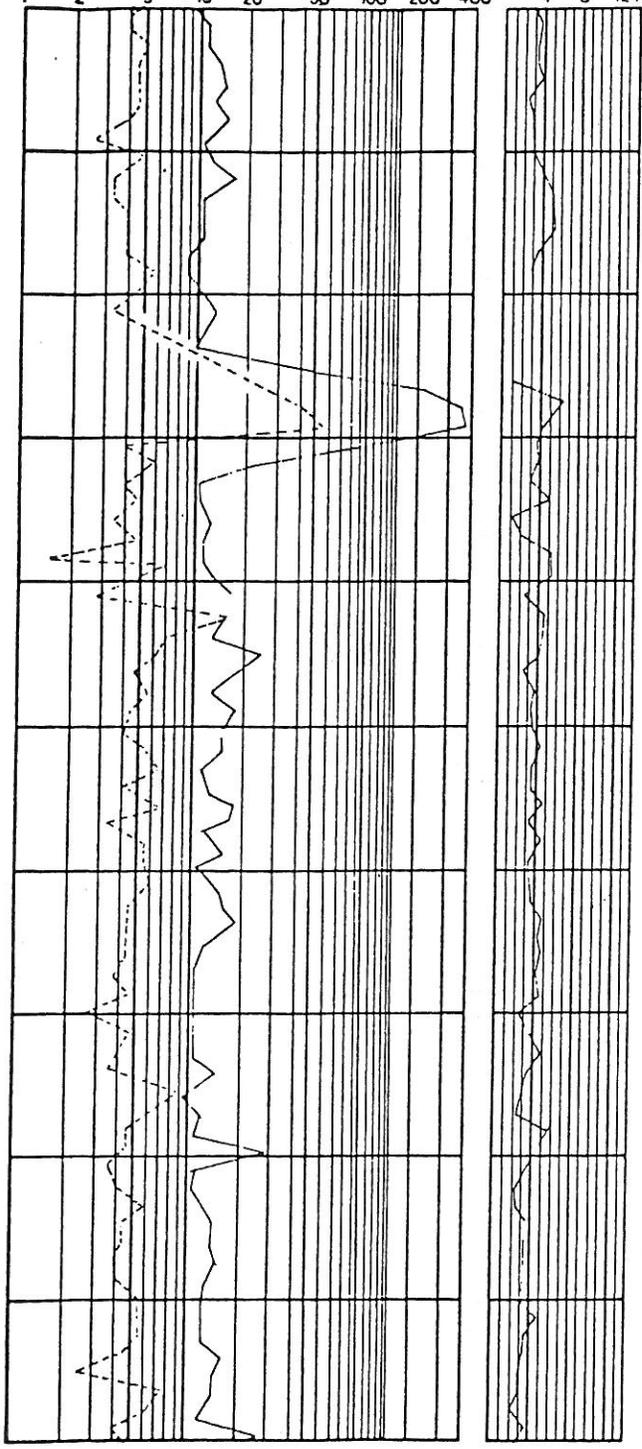
CONE PENETRATION RESISTANCE

Tons/sq. ft. -----
 1 2 5 10 20 50 100 200 400

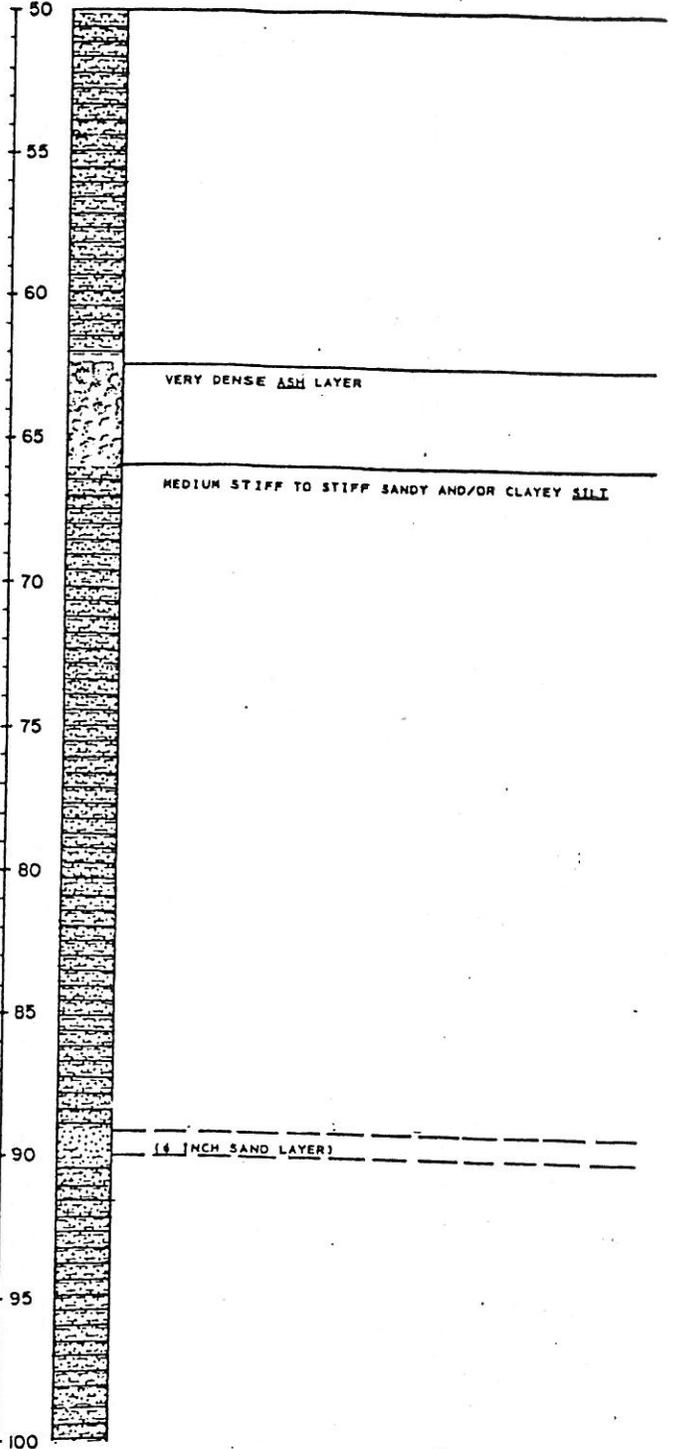
FRICTION RATIO

4 8 12 14

DEPTH, Feet



SOIL INTERPRETATION



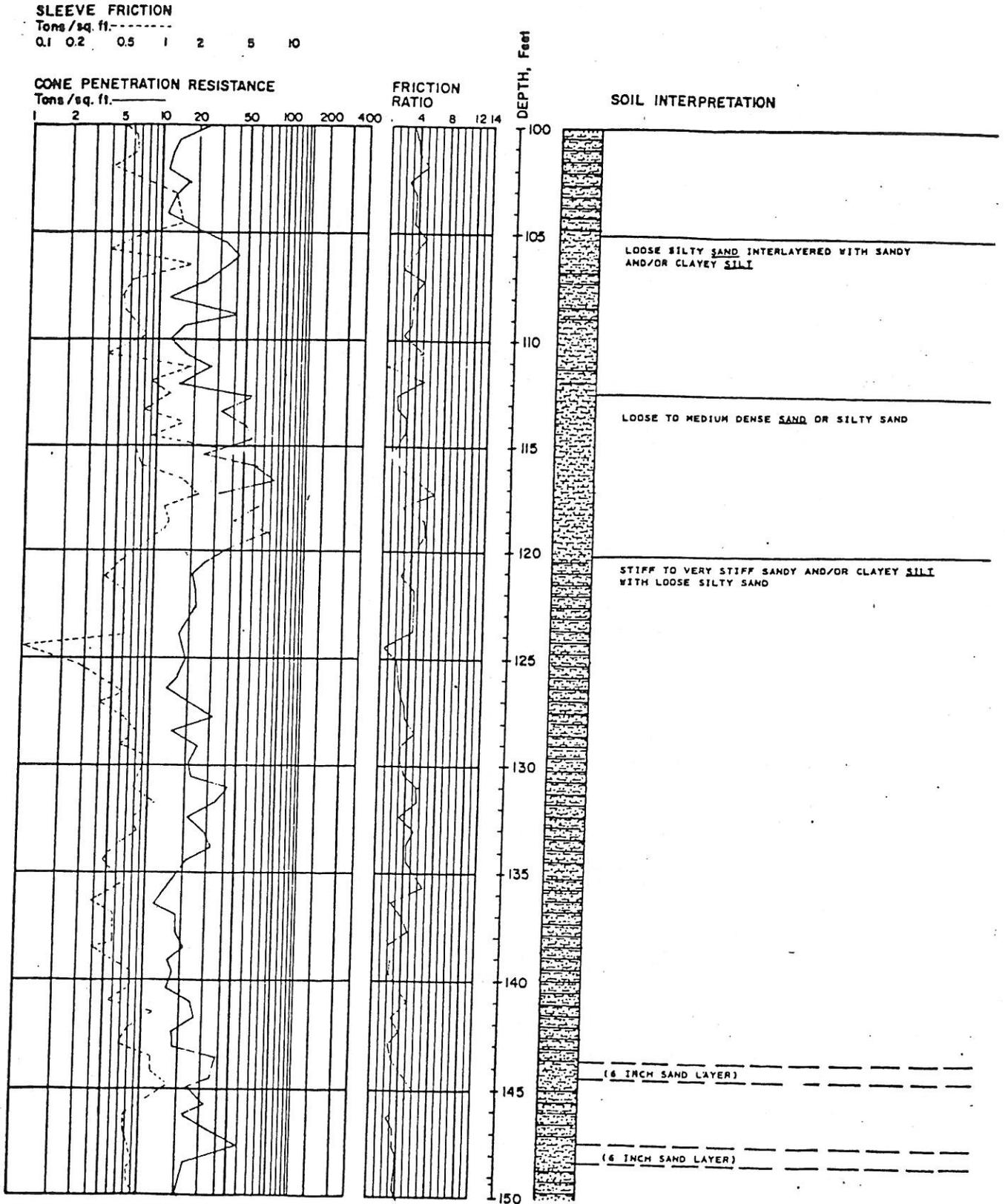
J-287

MARCH 1976

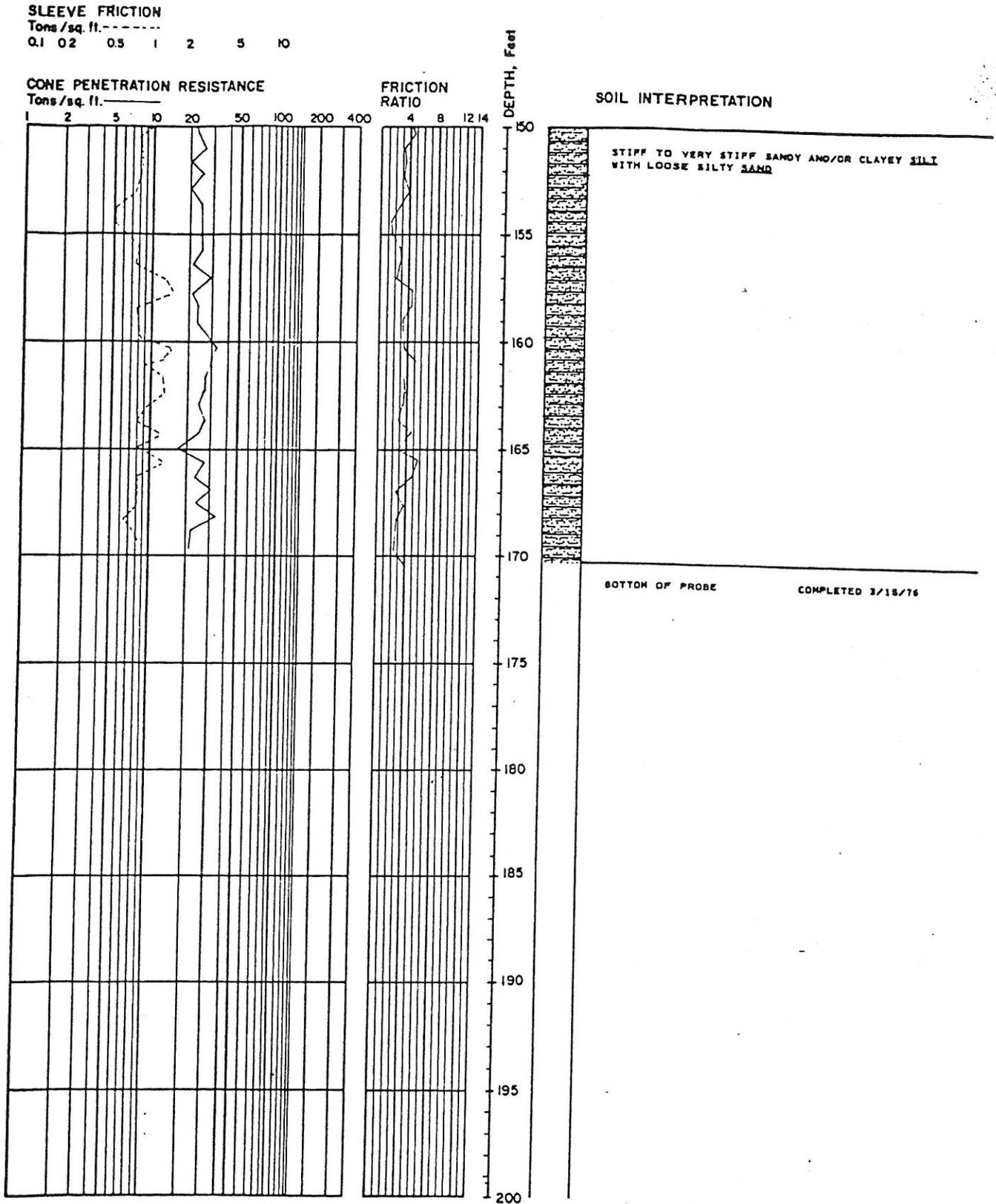
HART-CROWSER & associates inc.

Figure A-3 2/4

LOG OF PROBE P-1 MARCH 1976



LOG OF PROBE P-1 MARCH 1976



J-287 MARCH 1976

HART-CROWSER & associates inc.

Figure A-3 4/4

Test Pit Log TP-213

Sample	Water Content in %	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS
S-1	24		0	(Medium stiff), moist, brown SILT.
S-2	16		1	(Soft), moist, mottled, non-plastic, sandy SILT.
S-3	35	AL	2	(Soft), wet, mottled SILT.
S-4	35		3	(Loose), wet, gray, silty, fine SAND.
			4	
			5	
			6	
			7	
			8	
			9	Bottom of Exploration at 8.5 Feet. Completed 10/16/02.
			10	
			11	
			12	

Test Pit Log TP-214

Sample	Water Content in %	Lab Tests	Depth in Feet	SOIL DESCRIPTIONS
S-1	40		0	(Medium stiff), damp, mottled SILT.
S-2	38		1	(Soft), wet, tan SILT.
S-3	30		2	(Soft to medium stiff), wet, brown, non-plastic SILT.
S-4	55		3	(Very soft), wet, gray SILT.
			4	
			5	
			6	
			7	
			8	Bottom of Exploration at 8.0 Feet. Completed 10/15/02.
			9	
			10	
			11	
			12	

2 LOGS PER PAGE 459602TP.GPJ HC_CORP.GDT 12/17/02

1. Refer to Figure A-1 for explanation of descriptions and symbols.
2. Soil descriptions and stratum lines are interpretive and actual changes may be gradual.
3. Groundwater conditions, if indicated, are at time of excavation. Conditions may vary with time.



4596-02

10/02

Figure A-18