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Pacific Northwest
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U.S. Department of Energy

Entry Boreholes Summary Report for the Waste Treatment Plant Seismic Boreholes Project

J. A. Horner

February 2007

Prepared by Gram, Inc. and Fluor Hanford, Inc.
for the Pacific Northwest National Laboratory
under Contract DE-AC05-76RL01830
with the U.S. Department of Energy

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Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

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P.O. Box 1000
Richland, Washington

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ACRONYMS

bgs	below ground surface
btoc	below top of casing
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
DOE-RL	U.S. Department of Energy-Richland
DOW	Description of Work
DQO	Data Quality Objectives
EPA	U.S. Environmental Protection Agency
FH	Fluor Hanford, Inc.
gpm	gallons per minute
HWIS	Hanford Well Information System
ID	inside diameter
NMLS	Neutron Moisture Logging System
NTU	Nephelometric Turbidity Unit
OD	outside diameter
OU	Operable Unit
PNNL	Pacific Northwest National Laboratory
psi	pound per square inch
SAP	Sampling and Analysis Plan
SGLS	Spectral Gamma Logging System
toc	top of casing
RCW	*Revised Code of Washington*
RLM	Ringold Lower Mud
WAC	*Washington Administrative Code*

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METRIC CONVERSION CHART

Into Metric Units

If You Know	*Multiply By*	*To Get*
Length		
inches	25.4	millimeters
inches	2.54	centimeters
feet	0.305	meters
yards	0.914	meters
miles	1.609	kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	0.0836	sq. meters
sq. miles	2.6	sq. kilometers
acres	0.405	hectares
Mass (weight)		
ounces	28.35	grams
pounds	0.454	kilograms
ton	0.907	tonne
Volume		
teaspoons	5	milliliters
tablespoons	15	milliliters
fluid ounces	30	milliliters
cups	0.24	liters
pints	0.47	liters
quarts	0.95	liters
gallons	3.8	liters
cubic feet	0.028	cubic meters
cubic yards	0.765	cubic meters
Temperature		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius
Radioactivity		
picocuries	37	millibecquerel

Out of Metric Units

If You Know	*Multiply By*	*To Get*
Length		
millimeters	0.039	inches
centimeters	0.394	inches
meters	3.281	feet
meters	1.094	yards
kilometers	0.621	miles
Area		
sq. centimeters	0.155	sq. inches
sq. meters	10.76	sq. feet
sq. meters	1.196	sq. yards
sq. kilometers	0.4	sq. miles
hectares	2.47	acres
Mass (weight)		
grams	0.035	ounces
kilograms	2.205	pounds
tonne	1.102	ton
Volume		
milliliters	0.033	fluid ounces
liters	2.1	pints
liters	1.057	quarts
liters	0.264	gallons
cubic meters	35.315	cubic feet
cubic meters	1.308	cubic yards
Temperature		
Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity		
millibecquerel	0.027	picocuries

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1.0 INTRODUCTION

This report describes the 2006 fiscal year field activities associated with the installation of four cable-tool-drilled boreholes located within the boundary of the Waste Treatment Plant (WTP), DOE Hanford site, Washington. The cable-tool-drilled boreholes extend from surface to ~20 ft below the top of basalt and were utilized as cased entry holes for three deep boreholes (approximately 1400 ft) that were drilled to support the acquisition of sub-surface geophysical data, and one deep corehole (1400 ft) that was drilled to acquire continuous core samples from underlying basalt and sedimentary interbeds. The geophysical data acquired from these boreholes will be integrated into a seismic response model that will provide the basis for defining the seismic design criteria for the WTP facilities.

These entry boreholes were installed for Pacific Northwest National Laboratory (PNNL) in accordance with the *Drilling Plan for the Waste Treatment Plant Seismic Test Borehole Project* (FS-RW-SWS-PN-005, Rev.0), and the *Sampling and Analysis Plan (SAP): Waste Treatment Plant Seismic Boreholes Project* (ICN PNNL-15848-1.1 and attached PNNL-15848, Rev. 2). Drilling data for these boreholes are summarized in Table 1-1. Documents supporting field activities as well as procedures followed during borehole characterization and construction are listed in Section 7.0 of this document.

1.1 BACKGROUND

Bechtel National, Inc., is under contract with the DOE to design and construct the WTP, located adjacent to the eastern edge of the 200 East Area of the DOE Hanford site, Washington. During the design/construction phase of the WTP, the data supporting the established seismic design criteria for the WTP was deemed insufficient. The DOE's office of River Protection requested that Battelle direct an extensive seismic investigation to obtain shear-wave seismic velocity data from the basalt and sedimentary interbeds that occur in the Saddle Mountains Basalt of the Columbia River Basalt Group (CRBG) that underlies the WTP site.

To improve the seismic response model for the WTP site, a network of three deep boreholes was selected to be drilled to provide access to the subsurface for collecting geophysical data, primarily shear wave (Vs) and compressional wave (Vp) and downhole geophysical logging data. These boreholes were also designed to provide samples to identify and characterize the geologic units that underlie the WTP site as well as provide sediment core samples (within the Hanford and Ringold Formations) for dynamic laboratory testing. In addition to these boreholes, a single wireline corehole was selected to be drilled to provide continuous core of the basalt and sedimentary interbeds to provide for correlation of the geology to the geophysical data.

1.2 PURPOSE AND SCOPE

The primary purpose of this field effort was to install four entry boreholes located within the boundary of the WTP site, east of the 200 East Area. These boreholes will provide cased entry holes for three deep boreholes and one deep corehole that will be used to acquire seismic data and continuous core from underlying basalt and sedimentary interbeds. The scope of activities described in this report includes the technical data that encompasses the drilling of four entry boreholes and related construction. Additional scope of work described in this report includes waste management and subsurface descriptions. All drilling data in this report are presented in

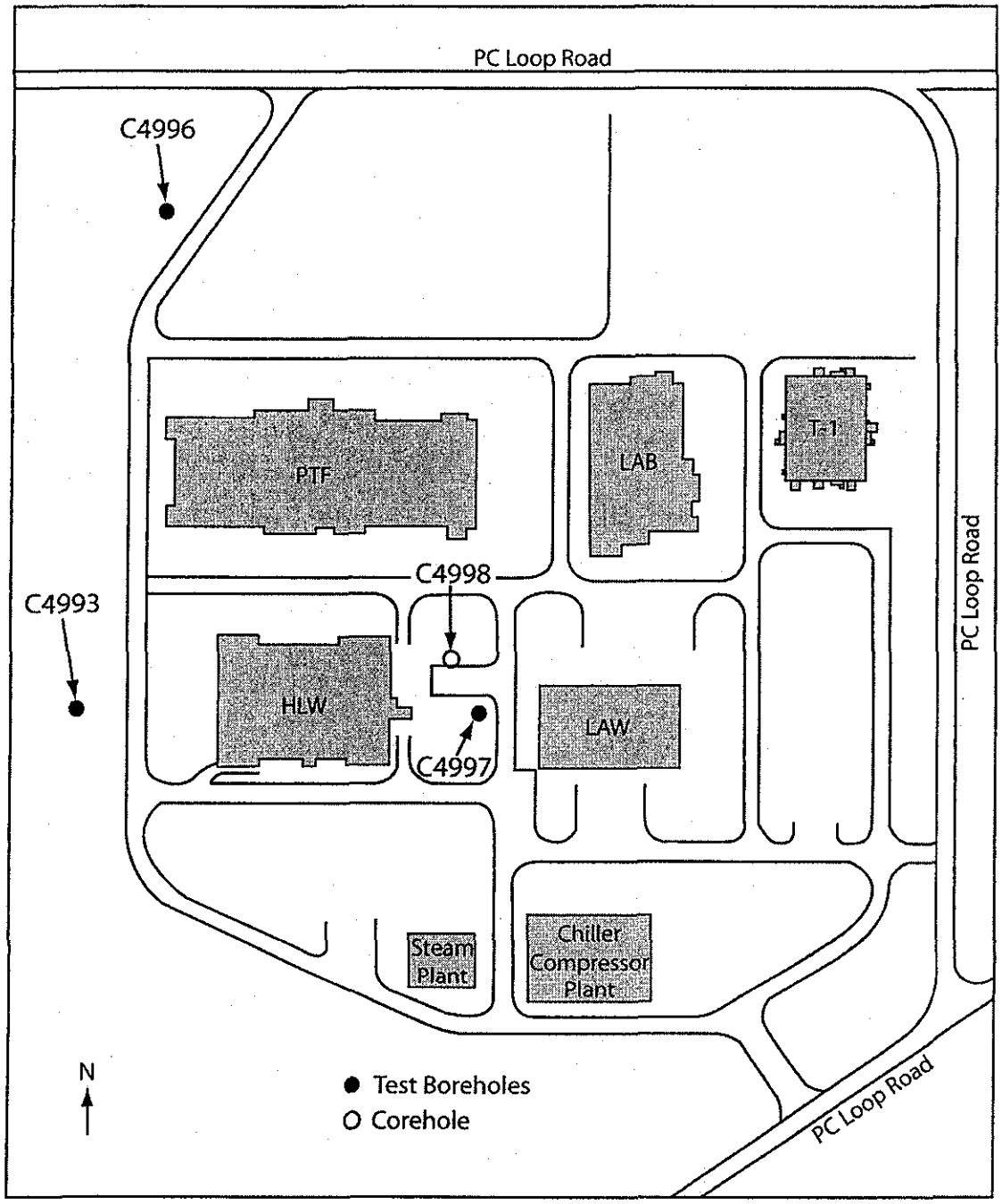
the units in which they were measured in the field, with the exception of survey data where applicable which are reported in metric units. A summary of the cased boreholes is provided in Table 1-1 and the locations are shown in Figure 1-1.

Table 1-1. Drilling Summary of WTP Site Seismic Entry Boreholes

Well Name/Well ID	Area	Drilling Date		Northing (m)	Easting (m)	Ground Surface Elevation[a] (m)	Total Entry Depth (feet bgs)
		Start	Finish				
C4993	WTP Site	8/21/06	9/4/06	135756.7	576087.4	NS	383.5
C4996	WTP Site	7/12/06	7/27/06	136054.2	576145.2	NS	369
C4997	WTP Site	7/30/06	8/18/06	135781.0	576300.3	NS	401
C4998	WTP Site	6/12/06	7/10/06	135755.3	576309.4	NS	401.5

Notes:
Northing and easting coordinates are based on Washington State Plane Coordinates North American Datum of 1983 (NAD83[91]) rounded to 0.1 m.
ft bgs = feet below ground surface.
NS = survey data not available at this time.

Figure 1-1. Location Map for Entry Boreholes Located within the WTP Site Boundary



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2.0 TECHNICAL DATA

This section provides technical details of the drilling methods, and completion during construction of the WTP seismic entry boreholes (see Figure 1-1). Drilling data are presented in Table 2-1 and geologic borehole logs are located in Appendices A through D.

2.1 WTP SITE: SEISMIC ENTRY BOREHOLES

2.1.1 entry Borehole C4998

This section summarizes activities related to the construction of entry borehole C4998.

2.1.1.1 Drilling Summary

Drilling of entry borehole C4998 began on June 12, 2006 using a cable tool drill rig, driving single wall carbon steel temporary casing with a 13 3/8-inch outside diameter (OD) and 12 3/8-inch inside diameter (ID) to a depth of 201.0 ft below ground surface (bgs). Below 201.0 ft bgs the casing was downsized to single wall carbon steel temporary casing with a 9 5/8-inch OD and 8 5/8-inch ID that was driven to a depth of 384.1 ft bgs. The borehole was advanced using both core barrel and hard tool drilling methods to a total depth (TD) of 401.5 ft bgs on July 10, 2006. The water table was initially encountered at approximately 278.1 feet bgs on June 30, 2006.

2.1.1.2 Sample Summary

Archive samples (1-pint glass jars) were collected for FH and PNNL at five-ft intervals, but were not analyzed in the field. In addition to archive samples, lithologic changes were recorded and collected in plastic chip trays for future characterization use by both FH and PNNL.

2.1.1.3 Construction Summary

Entry Borehole construction for borehole C4998 was designed to enable deep wire-line coring operations to advance the borehole to approximately 1300 ft to 1500 ft bgs. Construction materials and formation seal intervals are discussed below. Borehole plumbness testing was performed at approximately 50-ft intervals during borehole advancement using an 10 3/4-inch OD, 20-ft long tool within the 13 3/8-inch OD casing and a 6 5/8-inch OD, 20-ft long tool within the 9 5/8-inch OD casing. Additional plumbness testing was performed at approximately 50-ft intervals using a gyro survey tool. A separate report will provide specific details of these gyro surveys. Construction and completion of this entry borehole was carried out from July 11, 2006 to July 12, 2006. Entry borehole construction summary data are provided in Table 2-1.

- **Construction materials and grout seal interval.** To support wire-line coring operations, 403.0 ft of 4 ½-inch ID carbon steel temporary casing with centralizers placed approximately every 40 ft were installed from 3.9 ft ags to 399.1 ft bgs (1.4 ft off bottom). A grout seal was installed from 348.5 ft to 401.5 ft bgs, consisting of Portland Type I/II cement and 5% bentonite powder by volume per WAC 173-160. After the cement grout was in place the 4 ½-inch temporary casing was lowered to 401.2 ft bgs.

Table 2-1. Construction Summary for Entry Borehole C4998

Borehole ID	Borehole Location	Total Depth (ft bgs)	Water Level (ft bgs)	13 3/8 in. OD casing depth	9 5/8 in. OD casing depth	4 1/2 in. OD casing depth	Grout Seal Interval
C4998	WTP Site	401.5	278.1	201.0	384.5	401.2	348.5 – 401.5

Notes:
ft bgs = feet below ground surface.
in. = inch
OD = outside diameter.

2.1.2 Entry Borehole C4996

This section summarizes activities related to the construction of entry borehole C4996.

2.1.2.1 Drilling Summary

Drilling of entry borehole C4996 began on July 12, 2006 using a cable tool drill rig, driving single wall carbon steel temporary casing with a 13 3/8 inch OD and 12 3/8 inch ID to a depth of 211.3 ft below ground surface (bgs). Below 211.3 ft bgs the casing was downsized to single wall carbon steel temporary casing with a 9 5/8 inch OD and 8 5/8 inch ID that was driven to a depth of 350.0 ft bgs. The borehole was advanced using both core barrel and hard tool drilling methods to a total depth of 369.0 ft bgs on July 27, 2006. The water table was initially encountered at approximately 270.3 feet bgs on July 23, 2006.

2.1.2.2 Sample Summary

Field sampling data are presented in Table 2.2. Six split spoon samples and six corresponding drive barrel samples were collected at discrete intervals and will be used in a laboratory testing program to obtain site-specific soil property data. Soil testing procedures are detailed in ASTM D4015-92 (*Standard Test Methods for Modulus and Damping of Soils by the Resonant-Column Method)* and GR06-4 (Test Procedures and Calibration Documentation Associated with the RCTS and URC Tests at the University of Texas at Austin). Additional soil samples (1-pint glass jars) were collected directly above and below each split spoon interval and will be used in laboratory testing for tritium analysis. Archive samples (1-pint glass jars) were collected for FH and PNNL, at five-ft intervals, but were not analyzed in the field. In addition to archive samples, lithologic changes were recorded and collected in plastic chip trays for future characterization use by both FH and PNNL. Table 2-2 summarizes the field sampling data for entry borehole C4996.

Table 2-2. Sediment Sampling Summary for Entry Borehole C4996 (2 pages)

Date (2006)	Sample Type	Depth Intv. (ft bgs)	HEIS Number	Liner	Liner Depth	Blow Counts	% Rec.		Strat.	
17-Jul	Tritium	187.0	N/A						Gravelly Sand	Hanford fm. Unit H3
	Split Spoon	187.5 - 190.0	N/A	Shoe	189.0 - 190.0	186	53	ND		
			B1K4Y1	A	188.5 - 189.0		7	ND		
			B1K4Y2	B	188.0 - 188.5		31	60 ND		
			B1K4Y3	C	187.5 - 188.0		65	ND		
	Drive Barrel	187.5 - 190.0	B1K4Y5	N/A			ND			
	Tritium	190.0	N/A							
20-Jul	Split Spoon	230.5 - 233	N/A	Shoe	232.5 - 233.0	269	49	0	Gravel	Reworked Ringold Formation
			B1K4Y6	A	232.0 - 232.5		50	ND		
			B1K4Y7	B	231.5 - 232.0		70	95 ND		
			B1K4Y8	C	231.0 - 231.5		82	ND		
			B1K4Y9	D	230.5 - 231.0		18	ND		
	Drive Barrel	187.5 - 190.0	B1K4Y5	N/A			ND			
20-Jul	Tritium	252.0	N/A						Sandy Gravel	
	Split Spoon	252.0 - 254.5	N/A	Shoe	254.0 - 254.5	295	20	ND		
			B1K501	A	25305 - 254.0		71	80 33		
			B1K502	B	253.0 - 25305		116	100		
			B1K503	C	252.5 - 253.0		68	100		
			B1K504	D	252.0 - 252.5		20	83		
	Drive Barrel	252.0 - 254.0	B1K506	N/A			ND			
	Tritium	254.5	N/A							
21-Jul	Tritium	275.5	N/A						Gravel	
	Split Spoon	275.5 - 278.2	N/A	Shoe	277.5 - 278.2	250	60	0		
			B1K505	A	277.0 - 277.5		65	95 100		
			B1K507	B	276.5 - 277.0		60	100		
			B1K508	C	276.0 - 276.5		49	100		
			B1K509	D	275.5 - 276.0		16	90		
	Drive Barrel	275.5 - 278.0	B1K510	N/A	N/A	N/A	ND			
	Tritium	254.5	N/A	N/A	N/A	N/A	N/A			

Table 2-2. Sediment Sampling Summary for Entry Borehole C4996 (2 pages)

Date (2006)	Sample Type	Depth Intv. (ft bgs)	HEIS Number	Liner	Liner Depth	Blow Counts		% Rec.		Strat.	
25-Jul	Tritium	301.0	N/A							Silty Sandy Gravel	Ringold Formation Unit A
	Split Spoon	301.0 - 303.5	N/A	Shoe	303.0 - 303.5	204	39	ND			
			B1K712	A	302.5 - 303.0		68	66	83		
			B1K713	B	302.0 - 302.5		61		100		
			B1K14	C	301.5 - 302.0		28		83		
			N/A	D	301.0 - 301.5		8		0		
	Drive Barrel	301.0 - 303.5	B1K716	N/A							
	Tritium	303.5	N/A								
25-Jul	Tritium	310.0 - 312.0	N/A							Silty Sandy Gravel	
	Split Spoon	312.0 - 314.5	N/A	Shoe	314.0 - 314.5	437	214	ND			
			B1K717	A	313.5 - 314.0		113	95			
			B1K718	B	313.0 - 313.5		35				
			B1K719	C	312.5 - 313.0		45				
			B1K720	D	312.0 - 312.5		30				
	Drive Barrel	312.0 - 314.0	B1K721	N/A							
	Tritium	315.0	N/A								

Notes:
bgs = below ground surface
ft = feet
Jul = July
NA = not applicable
ND = no data
Strat. = Stratigraphy

2.1.2.3 Construction Summary

Entry Borehole construction for borehole C4996 was designed to enable deep mud-rotary drilling to advance the borehole to approximately 1300 ft to 1500 ft bgs. After a total depth of 369.0 ft bgs (20 ft into basalt) was obtained, a grout seal was installed from about 330 ft to 369 ft bgs, consisting of Portland Type I/II cement and 5% bentonite powder by volume per WAC 173-160. After the cement grout was in place the 9 5/8-inch temporary casing was backpulled 5 ft to allow the cement to make contact with the formation and then driven back to 350 ft bgs. Borehole plumbness testing was performed at approximately 50-ft intervals during borehole advancement using a 10 3/4-inch OD, 20-ft long tool within the 13 3/8-inch OD casing and a 6 5/8-inch OD, 20-ft long tool within the 9 5/8-inch OD casing. Additional plumbness testing was performed at approximately 50-ft intervals using a gyro survey tool. A separate report will provide specific details of these gyro surveys. Construction and completion of this entry borehole was carried out on July 27, 2006. Entry borehole construction summary data are provided in Table 2-3.

Table 2-3. Construction Summary for Entry Borehole C4996

Borehole ID	Borehole Location	Total Depth (ft bgs)	Water Level (ft bgs)	13 3/8 in. OD casing depth	9 5/8 in. OD casing depth	Grout Seal Interval
C4996	WTP Site	369.0	270.3	211.3	350.0	330.4 - 369.0

Notes:
ft bgs = feet below ground surface.
in. = inch
OD = outside diameter.

2.1.3 Entry Borehole C4997

This section summarizes activities related to the construction of entry borehole C4997.

2.1.3.1 Drilling Summary

Drilling of entry borehole C4997 began on July 30, 2006 using a cable tool drill rig, driving single wall carbon steel temporary casing with a 13 3/8-inch OD and 12 3/8-inch ID to a depth of 216.5 ft bgs. Below 216.5 ft bgs the casing was downsized to single wall carbon steel temporary casing with a 9 5/8 inch OD and 8 5/8 inch ID that was driven to 383.3 ft bgs. The borehole was advanced using both core barrel and hard tool drilling methods to a total depth of 401.0 ft bgs on August 18, 2006. The water table was initially encountered at approximately 277.5 feet bgs on August 9, 2006.

2.1.3.2 Sample Summary

Field sampling data are presented in Table 2.4. Several split spoon samples and corresponding drive barrel samples were collected at discrete intervals and will be used in a laboratory testing program to obtain site-specific soil property data. Soil testing procedures are detailed in ASTM D4015-92 (*Standard Test Methods for Modulus and Damping of Soils by the Resonant-Column Method)* and GR06-4 (Test Procedures and Calibration Documentation Associated with the RCTS and URC Tests at the University of Texas at Austin). Soil samples (1-pint glass jars) were collected directly above and below each split spoon interval and will be used in laboratory testing for tritium analysis. Additional soil samples (1-pint glass jars) were collected at each split spoon interval and will be used for particle size analysis (ASTM D6913-04e1). Archive samples (1-pint glass jars) were collected for FH and PNNL, at five-ft intervals, but were not analyzed in the field. In addition to the archive samples, lithologic changes were recorded and collected in plastic chip trays for future characterization use by both FH and PNNL. Several water samples were collected via kabis sampler from four isolated depth intervals and will be tested for various chemical properties by FH. Table 2-4 summarizes the sediment sampling data and Table 2-5 summarizes the water sampling data for borehole C4997.

Table 2-4. Sediment Sampling Summary for Entry Borehole C4997 (6 pages)

Date (2006)	Sample Type	Depth Intv. (ft bgs)	HEIS Number	Liner	Liner Depth	Blow Counts		% Rec.	Strat.	
30-Jul	Split Spoon	20.6 - 23.1	N/A	Shoe	22.6 - 32.1	192	47	100	Sand	Hanford Formation Unit H2
			B1K867	A	20.6 - 21.1		25			
			B1K868	B	21.1 - 21.6		35			
			B1K869	C	21.6 - 22.1		40			
			B1K870	D	22.1 - 22.6		45			
	Drive Barrel	20.6 - 23.1	B1K8C5	N/A						
31-Jul	Split Spoon	30.1 - 32.6	N/A	Shoe	32.1 - 32.6	156	33	100	Sand	
			B1K871	A	31.6 - 32.1		39			
			B1K871	B	31.1 - 31.6		45			
			B1K871	C	30.6 - 31.1		29			
			B1K871	D	30.1 - 30.6		10			
	Drive Barrel	30.1 - 32.1	ND	N/A						
	P. S.	30.5	N/A							
31-Jul	Split Spoon	39.4 - 41.9	N/A	Shoe	41.4 - 41.9	302	89	100	Sand	
			B1K875	A	40.9 - 41.4		63			
			B1K876	B	40.4 - 40.9		65			
			B1K877	C	39.9 - 40.4		65			
			B1K878	D	39.4 - 39.9		20			
	P. S.	40.0	N/A							
31-Jul	Split Spoon	50.2 - 52.7	N/A	Shoe	52.2 - 52.7	308	134	100	Sand	
			B1K879	A	51.7 - 52.2		69			
			B1K880	B	51.2 - 51.7		58			
			B1K881	C	50.7 - 51.2		38			
			B1K882	D	50.2 - 50.7		9			
	P. S.	50.5	N/A							
31-Jul	Split Spoon	60.3 - 62.8	N/A	Shoe	62.3 - 62.8	294	134	100	Sand	
			B1K883	A	61.8 - 62.3		55			
			B1K884	B	61.3 - 61.8		60			
			B1K885	C	60.8 - 61.3		25			
			B1K886	D	60.3 - 60.8		20			
	P. S.	60.0	N/A							
1-Aug	Split Spoon	69.8 - 72.3	N/A	Shoe	71.8 - 72.3	228	111	100	Sand	
			B1K887	A	71.3 - 71.8		52			
			B1K888	B	70.8 - 71.3		36			
			B1K889	C	70.3 - 70.8		20			
			B1K890	D	69.8 - 70.3		9			
	Drive Barrel	70.0 - 72.5	B1K8C6	N/A						
	P. S.	70.0	N/A							

Table 2-4. Sediment Sampling Summary for Entry Borehole C4997 (6 pages)

Date (2006)	Sample Type	Depth Intv. (ft bgs)	HEIS Number	Liner	Liner Depth	Blow Counts		% Rec.	Strat.	
1-Aug	Split Spoon	79.7 - 82.2	N/A	Shoe	81.7 - 82.2	287	39	100	Sand	Hanford Formation Unit H2
			B1K891	A	81.2 - 81.7		121			
			B1K892	B	80.7 - 81.2		55			
			B1K893	C	80.2 - 80.7		49			
			B1K894	D	79.7 - 80.2		23			
	Drive Barrel	79.7 - 81.7	B1K8F6	N/A						
	P. S.	80.0	N/A							
1-Aug	Split Spoon	89.6 - 92.1	N/A	Shoe	91.6 - 92.1	245	107	100	Sand	
			B1K895	A	91.1 - 91.6		48			
			B1K896	B	90.6 - 91.1		43			
			B1K897	C	90.1 - 90.6		30			
			B1K898	D	89.6 - 90.1		17			
	Drive Barrel	89.6 - 91.6	B1K8F7	N/A						
	P. S.	90.0	N/A							
2-Aug	Split Spoon	99.7 - 102.2	N/A	Shoe	101.7 - 102.2	244	92	100	Sand	
			B1K899	A	101.2 - 101.7		63			
			B1K8B0	B	100.7 - 101.2		51			
			B1K8B1	C	100.2 - 100.7		24			
			B1K8B2	D	99.7 -100.2		14			
	Drive Barrel	99.7 - 100.2	B1K8F8	N/A						
	P. S.	100.0	N/A							
2-Aug	Split Spoon	109.5 - 111.8	N/A	Shoe	111.5 - 112.0	289	109	100	Sand	
			B1K8B3	A	111.0 - 111.5		102			
			B1K8B4	B	110.5 - 111.0		41			
			B1K8B5	C	110.0 - 110.5		27			
			B1K8B6	D	109.5 - 110.0		10			
	Drive Barrel	109.5 - 112.0	B1K8H0	N/A						
	P. S.	110.0	N/A							
2-Aug	Split Spoon	120.6 - 123.1	N/A	Shoe	122.6 - 123.1	232	92	100	Sand	
			B1K8B7	A	122.1 - 122.6		41			
			B1K8B8	B	121.6 - 122.1		44			
			B1K8B9	C	121.1 - 121.6		35			
			B1K8C0	D	120.6 - 121.1		15			
	Drive Barrel	120.6 - 123.1	B1K8H1	N/A						
	P. S.	120.0	N/A							
2-Aug	Split Spoon	131.0 - 133.6	N/A	Shoe	133.0 - 133.5	209	59	100	Gravelly Sand	
			B1K8C1	A	132.5 - 133.0		35			
			B1K8C2	B	132.0 - 132.5		64			
			B1K8C3	C	131.5 - 132.0		31			
			B1K8C4	D	131.0 - 131.5		20			
	Drive Barrel	130.2 - 132.7	B1K8H2	N/A						
	P. S.	131.0	N/A							

Table 2-4. Sediment Sampling Summary for Entry Borehole C4997 (6 pages)

Date (2006)	Sample Type	Depth Intv. (ft bgs)	HEIS Number	Liner	Liner Depth	Blow Counts		% Rec.		Strat.	
2-Aug	Split Spoon	139.7 - 142.2	N/A	Shoe	141.7 - 142.2	164	78	100		Sand	Hanford Formation Unit H2
			B1K8H3	A	141.2 - 141.7		31				
			B1K8H4	B	140.7 - 141.2		29				
			B1K8H5	C	140.2 - 140.7		18				
			B1K8H6	D	139.7 - 140.2		8				
	Drive Barrel	139.7 - 141.7	B1K8H7	N/A							
	P. S.	140.0	N/A								
2-Aug	Split Spoon	150.1-152.6	N/A	Shoe	152.1 - 152.6	185	85	100		Sand	
			B1K8H8	A	151.6 - 152.1		45				
			B1K8H9	B	151.1 - 151.6		34				
			B1K8J0	C	150.6 - 151.1		13				
			B1K8J1	D	150.1 - 150.6		8				
	Drive Barrel	150.1 - 152.1	B1K8J2	N/A							
	P. S.	150.5	N/A								
3-Aug	Split Spoon	159.5 - 162.0	N/A	Shoe	161.5 - 162.0	210	102	100		Silty Sand	
			B1K8J3	A	161.0 - 161.5		48				
			B1K8J4	B	160.5 - 161.0		30				
			B1K8J5	C	160.0 - 160.5		15				
			B1K8L0	D	159.5 - 160.0		6				
	Drive Barrel	159.5 - 161.5	B1KL1	N/A							
	P. S.	160.0	N/A								
3-Aug	Split Spoon	169.8 - 172.3	N/A	Shoe	171.3 - 172.3	161	67	73	ND	Silty Sandy Gravel	Hanford Formation Unit H3
			B1K8L2	A	170.8 - 171.3		47		100		
			B1K8L3	B	170.3 - 170.8		20		100		
			B1K8L4	C	169.8 - 170.3		19		95		
			NR	D	NR		8		0		
	Drive Barrel	170.0 - 172.5	B1K8L6	N/A							
	P. S.	170.0	N/A								
3-Aug	Split Spoon	180.1 - 182.6	N/A	Shoe	182.1 - 182.6	244	73	64	ND	Silty Sandy Gravel	
			B1K8L7	A	181.6 - 182.1		56		80		
			B1K8L8	B	181.1 - 181.6		81		100		
			B1K8L9	C	180.6 - 181.1		26		75		
			NR	D	NR		8		0		
	Drive Barrel	180.1 - 182.1	B1K8M1	N/A							
	P. S.	180.5	N/A								
4-Aug	Split Spoon	189.7 - 192.2	N/A	Shoe	191.7 - 192.2	421	125	95	ND	Sandy Gravel	
			B1K8M2	A	191.2 - 191.7		122		90		
			B1K8M3	B	190.7 - 191.2		81		100		
			B1K8M4	C	190.2 - 190.7		72		100		
			B1K8M5	D	189.7 - 190.2		21		90		
	Drive Barrel	189.7 - 191.7	B1K8M6	N/A							
	P. S.	190.0	N/A								

Table 2-4. Sediment Sampling Summary for Entry Borehole C4997 (6 pages)

Date (2006)	Sample Type	Depth Intv. (ft bgs)	HEIS Number	Liner	Liner Depth	Blow Counts		% Rec.		Strat.	
4-Aug	Split Spoon	199.7 - 202.2	N/A	Shoe	201.7 - 202.2	260	80	85	ND	Silty Sandy Gravel	Hanford Formation Unit H2
			B1K8M7	A	201.2 - 201.7		55		50		
			B1K8M8	B	200.7 - 201.2		55		100		
			B1K8M9	C	200.2 - 200.7		45		100		
			B1K8N0	D	199.7 - 200.2		25		90		
	Drive Barrel	200.0-202.5	B1K8N1	N/A							
	P. S.	200.0	N/A								
6-Aug	Split Spoon	209.4 - 211.9	N/A	Shoe	211.4 - 211.9	278	58	100		Silty Sandy Gravel	
			B1K8N2	A	210.9 - 211.4		65				
			B1K8N3	B	210.4 - 210.9		63				
			B1K8N4	C	209.9 - 210.4		61				
			B1K8N5	D	209.4 - 209.9		31				
	Drive Barrel	209.4 - 211.4	B1K8N6	N/A							
	P. S.	210.0	N/A								
8-Aug	Split Spoon	219.6 - 222.1	N/A	Shoe	221.6 - 222.1	464	49	100		Sandy Gravel	
			B1K8N7	A	221.1 - 221.6		146				
			B1K8N8	B	220.6 - 221.1		118				
			B1K8N9	C	220.1 - 220.6		112				
			B1K8P0	D	219.6 - 220.1		39				
	Drive Barrel	219.6 - 221.6	B1K8P1	N/A							
	P. S.	220.0	N/A								
8-Aug	Drive Barrel	228.2 - 230.2	B1K8P6	N/A							
	P. S.	228.2 - 230.2	N/A								
8-Aug	Split Spoon	240.0 - 242.5	N/A	Shoe	242.0 - 242.5	274	ND	100		Silty Sandy Gravel	
			B1K8P7	A	241.5 - 242.0		50				
			B1K8P8	B	241.0 - 241.5		68				
			B1K8P9	C	240.5 - 241.0		62				
			B1K8R0	D	240.0 - 240.5		94				
	Drive Barrel	242.5 - 243.0	B1K8R1	N/A							
	P. S.	240.0	N/A								
8-Aug	Split Spoon	250.0 - 252.2	N/A	Shoe	252.0 - 252.2	495	39	100		Silty Sandy Gravel	
			B1K8R2	A	251.5 - 252.0		137				
			B1K8R3	B	251.0 - 251.5		126				
			B1K8R4	C	250.5 - 251.0		115				
			B1K8R5	D	250.0 - 250.5		78				
	Drive Barrel	250.0 - 252.0	B1K8R6	N/A							
	P. S.	250.0	N/A								
9-Aug	Split Spoon	259.7 - 262.2	N/A	Shoe	261.7 - 262.2	440	135	100		Sandy Gravel	Reworked Ringold Fm.
			B1K8R7	A	261.2 - 261.7		100				
			B1K8R8	B	260.7 - 261.2		100				
			B1K8R9	C	260.2 - 260.7		75				
			B1K9D8	D	259.7 - 260.2		30				
	Drive Barrel	260.0 - 262.5	B1K9D9	N/A							
	P. S.	260.0	N/A								

Table 2-4. Sediment Sampling Summary for Entry Borehole C4997 (6 pages)

Date (2006)	Sample Type	Depth Intv. (ft bgs)	HEIS Number	Liner	Liner Depth	Blow Counts		% Rec.		Strat.	
9-Aug	Split Spoon	269.4-272.0	N/A	Shoe	271.4 - 272.0	339	124	100		Sandy Gravel	Reworked Ringold Formation
			B1K9F0	A	270.9 - 271.4		73				
			B1K9F1	B	270.4 - 270.9		66				
			B1K9F2	C	269.9 - 270.4		48				
			B1K9F3	D	269.4 - 269.9		18				
	Drive Barrel	270.0 - 272.5	B1K9F4	N/A							
	P. S.	270.0	N/A								
9-Aug	Tritium/P.S.	280.0	N/A							Sandy Gravel	
	Split Spoon	280.0 - 282.5	N/A	Shoe	282.0 - 282.5	586	39	100			
			B1K9B8	A	281.5 - 282.0		146				
			B1K9B9	B	281.0 - 281.5		205				
			B1K9C0	C	280.5 - 281.0		132				
			B1K9C1	D	280.0 - 280.5		64				
	Drive Barrel	280.0 - 282.0	B1K9F5	N/A							
	Tritium	283.0	N/A								
10-Aug	Tritium/P.S.	293.0	N/A							Sandy Gravel	
	Split Spoon	292.6 - 295.1	N/A	Shoe	294.6 - 295.1	225	69	100			
			B1K9M8	A	294.1 - 294.6		58				
			B1K9M9	B	293.6 - 294.1		49				
			B1K9N0	C	293.1 - 293.6		34				
			B1K9N1	D	292.6 - 293.1		15				
	Drive Barrel	292.6 - 294.6	B1K9N2	N/A							
	Tritium	295.0	N/A								
10-Aug	Tritium/P.S.	300.0	N/A							Sandy Gravel	
	Split Spoon (FH VOA Samples)	300.0 - 302.5	N/A	Shoe	302.0 - 302.5	159	36	90	ND		
			B1K9C2 B1K9C6	A	301.5 - 302.0		20		50		
			B1K9C3 B1K9C7	B	301.0 - 301.5		15		100		
			B1K9C4 B1K9C8	C	300.5 - 301.0		62		100		
			B1K9C5 B1K9C9	D	300.0 - 300.5		26		100		
	Drive Barrel	300.0 - 302.0	B1K9N2	N/A							
	Tritium	303.0	N/A								
11-Aug	Tritium/P.S.	309.5	N/A							Sandy Gravel	
	Split Spoon	310.5 - 313.1	N/A	Shoe	312.5 - 313.1	416	241	97	ND		
			B1K9N3	A	312.0 - 312.5		95		100		
			B1K9N4	B	311.5 - 312.0		35		100		
			B1K9N5	C	311.0 - 311.5		24		100		
			B1K9N6	D	310.5 - 311.0		11		90		
	Drive Barrel	310.5 - 313.0	B1K9N7	N/A							
	Tritium	313.0	N/A								

Table 2-4. Sediment Sampling Summary for Entry Borehole C4997 (6 pages)

Date (2006)	Sample Type	Depth Intv. (ft bgs)	HEIS Number	Liner	Liner Depth	Blow Counts		% Rec.		Strat.	
15-Aug	Tritium/P.S.	335.0	N/A							Sandy Gravel	Ringold Formation Unit A
	Split Spoon (FH VOA Samples)	336.8 - 339.2	N/A	Shoe	338.8 - 339.2	680	289	100			
			B1K9D0 B1K9D1 B1K9D2	A	338.3 - 338.8		120				
				B	337.8 - 338.3		145				
				C	337.3 - 337.8		56				
				D	336.8 - 337.3		30				
	Drive Barrel	310.5 - 313.0	B1K9F7	N/A							
	Tritium	313.0	N/A								
16-Aug	Tritium/P.S.	351.0	N/A								
	Drive Barrel	351.0 - 352.5	B1K9F8	N/A				30			
	Tritium	353.0	N/A								
16-Aug	Tritium	366.0	N/A								
	P. S.	365.6 - 367.6	N/A								
	Split Spoon (FH VOA Samples)	365.6 - 367.1	N/A	Shoe	366.6 - 367.1	145	71	ND			
			B1KC05	A	366.1 - 366.6		35	50	100		
			B1KC06	B	365.6 - 366.1		39		100		
			B1KC07	NR					0		
			B1KC08	NR					0		
	Drive Barrel	365.6 - 367.6	B1KB68	N/A				50			
	Tritium	313.0	N/A								
17-Aug	Tritium	380.0	N/A								
	P.S.	380.0 - 382.0	N/A								
	Drive Barrel	380.0 - 382.0	B1K8F9	N/A							
	Tritium	385.0	N/A								

Notes:
ft bgs = below ground surface
ft = feet
Jul = July
Aug = August
N/A = not applicable
ND = no data
Strat. = Stratigraphy

Table 2-5. Water Sampling Summary for Entry Borehole C4997

Date (2006)	Sample Type	Sampling Method	Depth Intv. (ft bgs)	HEIS Numbers	Duplicate Set HEIS Numbers
9-Aug	Water	Kabis	279.5 - 280.4	B1K996 B1K997	N/A
10-Aug	Water	Kabis	303.0	B1K9B0 B1K9B1	B1K9B2 B1K9B3
15-Aug	Water	Kabis	334.5 - 339.0	B1K9B4 B1K9B5	N/A
16-Aug	Water	Kabis	364.5 - 367.6	B1KB73 B1KB74	N/A

Notes:
ft bgs = feet below ground surface

Date (2006)	Sample Type	Sampling Method	Depth Intv. (ft bgs)	HEIS Numbers	Duplicate Set HEIS Numbers

Aug = August

2.1.3.3 Construction Summary

Entry Borehole construction for borehole C4997 was designed to enable deep mud-rotary drilling to advance the borehole to approximately 1300 ft to 1500 ft bgs. After a total depth of 401.0 ft bgs (18 ft into basalt) was obtained, a grout seal was installed from about 330 ft to 401.0 ft bgs, consisting of Portland Type I/II cement and 5% bentonite powder by volume per WAC 173-160. After the cement grout was in place the 9 5/8-inch temporary casing was backpulled ~5 ft to allow the cement to make contact with the formation and then driven back to 383 ft bgs. Borehole plumbness testing was performed at approximately 50-ft intervals during borehole advancement using a 10 3/4-inch OD, 20-ft long tool within the 13 3/8-inch OD casing and a 6 5/8-inch OD, 20-ft long tool within the 9 5/8-inch OD casing. Additional plumbness testing was performed at approximately 50-ft intervals using a gyro survey tool. A separate report will provide specific details of these gyro surveys. Construction and completion of this entry borehole was carried out from August 18, 2006 to August 19, 2006. Well construction summary data are provided in Table 2-6.

Table 2-6. Construction Summary for Entry Borehole C4997

Borehole ID	Borehole Location	Total Depth (ft bgs)	Water Level (ft bgs)	13 3/8 in. OD casing depth	9 5/8 in. OD casing depth	Grout Seal Interval
C4997	WTP Site	401.0	277.5	216.5	383.3	330 – 401

Notes:
ft bgs = feet below ground surface.
in. = inch
OD = outside diameter.

2.1.4 Entry Borehole C4993

This section summarizes activities related to the construction of entry borehole C4993

2.1.4.1 Drilling Summary

Drilling of entry borehole C4993 began on August 21, 2006 using a cable tool drill rig, driving single wall carbon steel temporary casing with a 13 3/8-inch OD and 12 3/8-inch ID to a depth of 211.8 ft below ground surface (bgs). Below 211.8 ft bgs the casing was downsized to single wall carbon steel temporary casing with a 9 5/8-inch OD and 8 5/8-inch ID that was driven to a depth of 363.7 ft bgs. The borehole was advanced using both core barrel and hard tool drilling methods to a total depth of 383.5 ft bgs on September 4, 2006. The water table was initially encountered at approximately 258.2 feet bgs on August 29, 2006.

2.1.4.2 Sample Summary

Field sampling data are presented in Table 2.7. Four split spoon samples and four corresponding drive barrel samples were collected at discrete intervals and will be used in a laboratory testing program to obtain site-specific soil property data. Soil testing procedures are detailed in ASTM D4015-92 (*Standard Test Methods for Modulus and Damping of Soils by the Resonant-Column Method)* and GR06-4 (Test Procedures and Calibration Documentation Associated with the RCTS and URC Tests at the University of Texas at Austin). Below groundwater, soil samples (1-pint glass jars) were collected directly above and below each split spoon interval and will be used in laboratory testing for tritium analysis. Additional soil samples (1-pint glass jars) were collected at each split spoon interval and will be used for particle size analysis. Archive samples (1-pint glass jars) were collected for FH and PNNL, at five-ft intervals, but were not analyzed in the field. In addition to the archive samples, lithologic changes were recorded and collected in plastic chip trays for future characterization use by both FH and PNNL.

Table 2-7. Sediment Sampling Summary for Entry Borehole C4993

Date (2006)	Sample Type	Depth Intv. (ft bgs)	HEIS Number	Liner	Liner Depth	Blow Counts		% Rec.		Strat.	
24-Aug	Split Spoon	177.0 - 179.5	N/A	Shoe	179.0 - 179.5	260	70	ND		Sandy Gravel	Hanford Formation Unit H3
			B1KH58	A	178.5 - 179.0		70	100			
			B1KH59	B	178.0 - 178.5		60				
			B1KH60	C	177.5 - 178.0		45				
			B1KH61	D	177.0 - 177.5		15				
	Drive Barrel	177.0 - 179.5	B1KH57	N/A							
29-Aug	Tritium	280.0	N/A							Silty Sandy Gravel	
	Split Spoon	279.8 - 282.3	N/A	Shoe	281.3 - 281.8	352	164	ND			
			B1KH52	A	280.8 - 281.3		112	75	100		
			B1KH53	B	280.3 - 280.8		54		100		
			B1KH54	C	279.8 - 280.3		22		100		
			NR	D	NR	ND			0		
	Drive Barrel	279.8 - 281.8	B1KH56	N/A							
	P.S.	279.8 - 281.8	N/A								
	Tritium	284.0	N/A								
30-Aug	Tritium	311.5	N/A							Silty Sandy Gravel	Ringold Formation Unit A
	Split Spoon	311.5 - 313.1	N/A	Shoe	312.5 - 313.1	326	162	ND			
			B1KB69	A	312.0 - 312.5		130	50	100		
			B1KB70	B	311.5 - 312.0		34		100		
			NR	C/D	NR		0		0		
	Drive Barrel	311.5 - 313.1	B1KJV6	N/A							
	P.S.	311.5 - 313.1	N/A								
	Tritium	311.5 - 313.1	N/A								
31-Aug	Tritium	311.5	N/A							Silty Sandy Gravel	
	Split Spoon	313.5 - 315.3	N/A	Shoe	315.0 - 315.3	446	145	ND			
			B1KJV7	A	314.5 - 315.0		151	75	100		
			B1KJV8	B	314.0 - 314.5		119		100		
			B1KJV9	C	313.5 - 314.0		31		100		
			NR	D	NR				0		
	Drive Barrel	313.5 - 315.5	B1K9T8	N/A							
	P.S.	313.5 - 315.5	N/A								
	Tritium	315.5	N/A								

Notes:
bgs = below ground surface
ft = feet
Aug = August
N/A = not applicable
ND = no data
Strat. = Stratigraphy
P.S. = Particle Size Sample

2.1.4.3 Construction Summary

Entry Borehole construction for borehole C4993 was designed to enable deep mud-rotary drilling to advance the borehole to approximately 1300 ft to 1500 ft bgs. After a total depth

of 383.5 ft bgs (25.5 ft into basalt) was obtained, a grout seal was installed from about 354.7 ft to 383.5 ft bgs, consisting of Portland Type I/II cement and 5% bentonite powder by volume per WAC 173-160. After the cement grout was in place the 9 5/8-inch temporary casing was backpulled 5 ft to allow the cement to make contact with the formation and then driven back to 383.5 ft bgs. Borehole plumbness testing was performed at approximately 50-ft intervals during borehole advancement using a 10 3/4-inch OD, 20-ft long tool within the 13 3/8-inch OD casing and a 6 5/8-inch OD, 20-ft long tool within the 9 5/8-inch OD casing. Additional plumbness testing was performed at approximately 50-ft intervals using a gyro survey tool. A separate report will provide specific details of these gyro surveys. Construction and completion of this entry borehole was carried out on September 5, 2006. Well construction summary data are provided in Table 2-8.

Table 2-8. Construction Summary for Entry Borehole C4993

Borehole ID	Borehole Location	Total Depth (ft bgs)	Water Level (ft bgs)	13 3/8 in. OD casing depth	9 5/8 in. OD casing depth	Grout Seal Interval
C4993	WTP Site	383.5	258.2	211.8	363.7	354.7 - 383.5

Notes:
ft bgs = feet below ground surface.
in. = inch
OD = outside diameter.

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3.0 WASTE MANAGEMENT

The Unit Managers for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Operable Units at the Hanford Site issued a decision to include these test boreholes and corehole in the 200-PO-1 Operable Unit. Under this agreement, waste from the drilling of these holes was disposed of according to DOE/RL-2004-18, *Waste Control Plan for the 200-PO-1 Operable Unit* (February 2004). Waste was designated in accordance with WAC 173-303 and RCW 70.105 using a combination of process knowledge, historical analytical data, and sample analysis. All details concerning handling of waste are addressed by Gardner et al., (2006) and the Waste Control Plan. Final waste management instructions in the field were provided and controlled by the drilling contractor (Energy Solutions), with additional details provided below.

3.1 WTP SITE (200-PO-1 OU)

Cutting spoils for the WTP site were handled as described in the following sections.

3.1.1 Vadose Zone Cuttings

Vadose zone cuttings from the WTP site were designated low risk from chemical or radiological contamination. Vadose zone cuttings from boreholes C4998, C4996 and C4993 were collected in stockpiles near the point of generation and then released back into the ground based on field surveys by radiological control technicians (RCT). All drill cuttings generated from ground surface to TD from entry borehole C4997 were containerized in 55-gallon drums lined with a 10-mil plastic liner. Drums were stored on site for final disposition. Drill cuttings were surveyed in accordance with *Hanford Site Solid Waste Acceptance Criteria* (HNF-EP-0063).

All wastes generated from drilling and sampling operations were handled as CERCLA waste and were managed in accordance with the DOE/RL-2004-18, *Waste Control Plan for the 200-PO-1 Operable Unit* (February 2004).

3.1.2 Saturated Zone Cuttings

All drill cuttings below the highest recorded water table (approximately 220 ft bgs in borehole C4998, 220 ft bgs in borehole C4996 and 215 ft bgs in borehole C4993) were containerized in 55-gallon drums lined with a 10-mil plastic liner. Drums were stored on site for final disposition.

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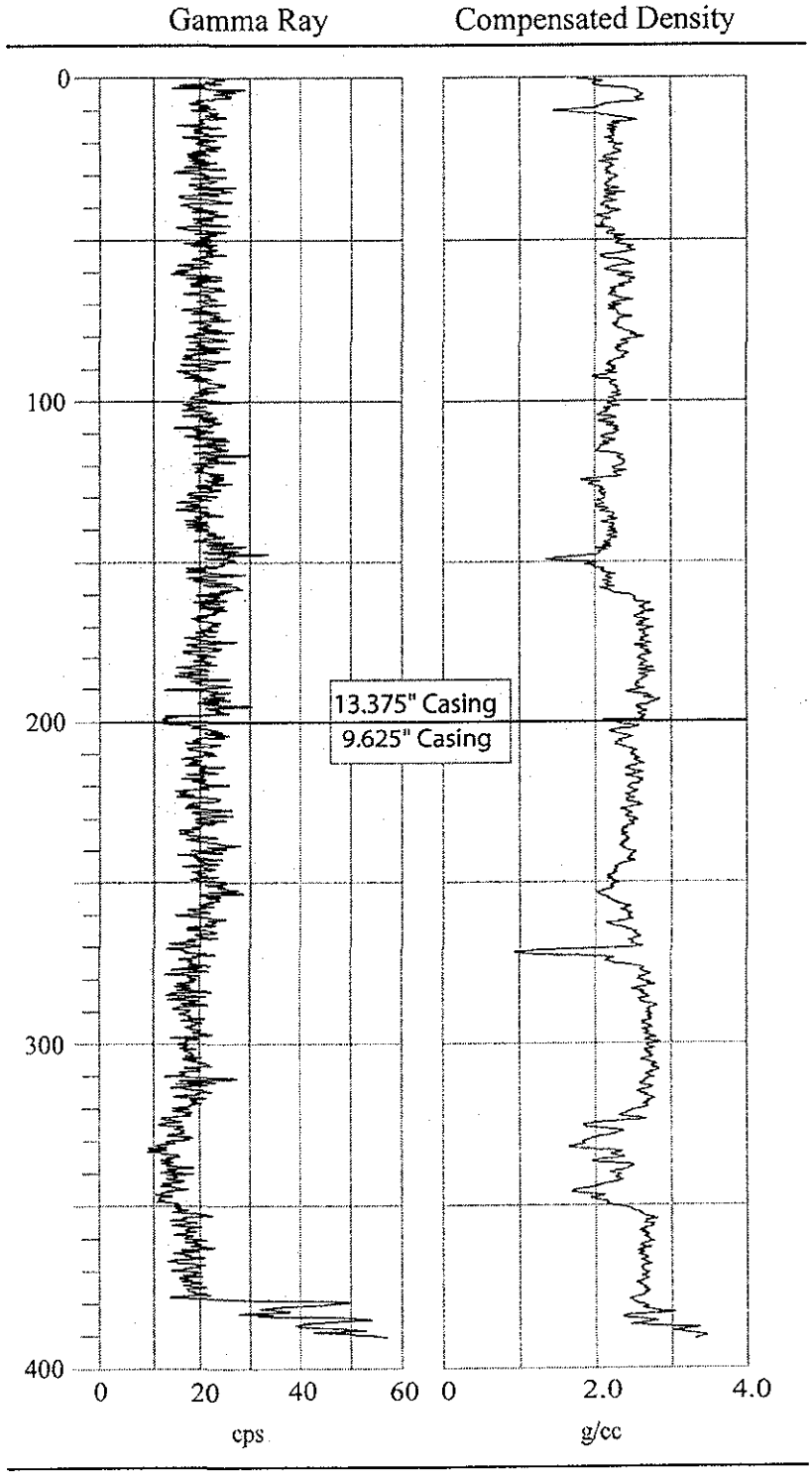
4.0 GEOPHYSICAL SURVEY

Borehole geophysical surveys were performed in entry borehole C4998 on June 22, 2006 and July 10, 2006. Spectral Gamma Logging System (SGLS) and bulk density surveys were carried out from ground surface (0 feet) to 392 feet bgs. Survey results are plotted in figure 4-1. A separate report will provide specific details of these geophysical surveys.

Figure 4-1: Geophysical Data for Seismic Entry Borehole C4998



5.0 CIVIL SURVEY

The civil surveys of all four boreholes had not been completed at the time of report preparation. When available, the civil survey data will be entered into the Hanford Well Information System (HWIS) database.

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6.0 SUBSURFACE DESCRIPTION

6.1 WTP SITE

This section provides the generalized stratigraphy of the WTP site, as well as summaries of field observations

6.1.1 Geology/hydrogeology

Generalized stratigraphy beneath the WTP Site includes sediment backfill that primarily consist of sand, generally less than 5 m in thickness. The backfill sediments overlie unconsolidated sediments of the Hanford formation. The Hanford formation extends for approximately 250 ± 20 ft and consists primarily of fine- course-grained sand, rare silt to clayey silt, and pebble- to boulder-gravel fluvial deposits. At the WTP site these deposits are divided into two groups, sand-dominated (H2 Unit) and gravel-dominated (H3 Unit). The sand-dominated group consists of fine- course-grained sand with variable silt content. The sand typically contains a high basalt content that generally decreases within layers of fine- to very-fine-grained sand. The sand commonly contains small pebbles and intermittent, felsic-dominated silty layers less than 1.0 m thick. The gravel-dominated group consists of coarse-grained sand and granule-to-boulder gravel. The gravel is typically clast-supported and contains a high basalt content. In general, the basalt content decreases with depth, forming a gradual transition to relatively older, more heterolithic gravel deposits. These older deposits, herein referred to as "reworked Ringold Formation", commonly exhibit a slightly higher degree of weathering and were likely derived from scouring and reworking of the underlying Ringold Formation. The reworked Ringold Formation deposits overlie consolidated sandy gravel from Unit A of the Ringold Formation. Sediment of Ringold Formation Unit A beneath the WTP site typically consists of sub- to well-rounded heterolithic pebbles and small cobbles with a felsic-dominated medium-grained sand matrix that is commonly distinguished by its striking light olive brown color. The Ringold Formation disconformably overlies basalt of the Elephant Mountain Member of the Columbia River Basalt Group. A summary of stratigraphic units encountered at the WTP entry borehole sites is presented in Table 2-9.

Table 2-9. Suprabasalt Sedimentary Units Encountered at the WTP Entry Borehole Sites

Borehole ID	C4998 Center		C4996 Northwest		C4997 Center		C4993 Southwest	
Surface Elevation	NS		NS		NS		NS	
Unit	Thickness (feet)	Drilled Depth[a]	Thickness (feet)	Drilled Depth[a]	Thickness (feet)	Drilled Depth[a]	Thickness (feet)	Drilled Depth[a]
Suprabasalt Sediments	382	0	349	0	383	0	358	0
Backfill	9	0	0.5	0	16.8	0	0.3	0
Hanford fm. Unit H2	151.5	9	165	0.5	149.2	16.8	159.7	0.3
Hanford fm. Unit H3	90.5	159.5	89.5	165.5	89.5	166	70	166
Reworked Ringold Fm.	72	250	49	255	63.5	255.5	64	236
Ringold Fm. Unit A	60	322	45	304	64	319	58	300

Notes:
[a] Top of unit in feet
NS = No survey available at this time.

6.1.2 Entry Borehole C4998

At this location, in-situ sediments are overlain by a backfill layer of sand intermixed with aeolian sand and silt, which extend from ground surface to a depth of about 9.0 ft bgs. Sediment below the sand fill, from 9.0-159.5 feet bgs consists of Unit H2 sand-dominated sediment of the Hanford formation. The interval from 159.5-250.0 ft bgs contains Unit H3 gravel-dominated sediment of the Hanford formation. The Hanford formation overlies reworked sediments of the Ringold Formation, which extend from 250-322.0 ft bgs. Sediments of the Ringold Formation Unit A were encountered between 322.0 ft bgs to 382 ft bgs. Basalt of the Elephant Mountain Member of the Columbia River Basalt Group was encountered from 382 ft bgs to a total entry borehole depth of 401.5 ft bgs. Lithologic descriptions and geologic borehole logs for this borehole were prepared in accordance with FH procedure CP-GPP-EE-01-7.0, Rev. 1, "*Geologic Logging*," and are included in Appendix A.

6.1.3 Entry Borehole C4996

At this location, in-situ sediments are overlain by a backfill layer of crushed gravel intermixed with aeolian sand and silt, which extend from ground surface to a depth of about 0.5 ft bgs. Sediment below the gravel fill, from 0.5-165.5 feet bgs consists of Unit H2 sand-dominated sediment of the Hanford formation. The interval from 165.5-255.0 ft bgs contains Unit H3 gravel-dominated sediment of the Hanford formation. The gravel-dominated sequence at this

site, however, contains several intermittent layers of sand-dominated sediment. The Hanford formation overlies reworked sediments of the Ringold Formation, which extend from 255.0-304.0 ft bgs. Sediments of the Ringold Formation Unit A were encountered between 304.0 ft bgs to 349 ft bgs. Basalt of the Elephant Mountain Member of the Columbia River Basalt Group was encountered from 349.0 ft bgs to a total entry borehole depth of 369.0 ft bgs. Lithologic descriptions and geologic borehole logs for this well were prepared in accordance with FH procedure CP-GPP-EE-01-7.0, Rev. 1, "*Geologic Logging*," and are included in Appendix B.

6.1.4 Entry Borehole C4997

At this location, in-situ sediments are overlain by a backfill layer of sand intermixed with aeolian sand and silt, which extend from ground surface to a depth of about 16.8 ft bgs. Sediment below the sand fill, from 16.8-166.0 feet bgs consists of Unit H2 sand-dominated sediment of the Hanford formation. The interval from 166.0-255.5 ft bgs contains Unit H3 gravel-dominated sediment of the Hanford formation. The Hanford formation overlies reworked sediments of the Ringold Formation, which extend from 255.5-319.0 ft bgs. Sediments of the Ringold Formation Unit A were encountered between 319.0 ft bgs to 383.0 ft bgs. Basalt of the Elephant Mountain Member of the Columbia River Basalt Group was encountered from 383.0 ft bgs to a total entry borehole depth of 401.0 ft bgs. Lithologic descriptions and geologic borehole logs for this well were prepared in accordance with FH procedure CP-GPP-EE-01-7.0, Rev. 1, "*Geologic Logging*," and are included in Appendix C.

6.1.5 Entry Borehole C4993

At this location, in-situ sediments are overlain by a backfill layer of crushed gravel intermixed with aeolian sand and silt, which extend from ground surface to a depth of about 0.3 ft bgs. Sediment below the backfill, from 0.3-166.0 feet bgs consists of Unit H2 sand-dominated sediment of the Hanford formation. The interval from 166.0-236.0 ft bgs contains Unit H3, gravel-dominated sediment of the Hanford formation. The Hanford formation overlies reworked sediments of the Ringold Formation, which extend from 236.0-300 ft bgs. Sediments of the Ringold Formation Unit A were encountered between 300.0-358.0 ft bgs. Basalt of the Elephant Mountain Member of the Columbia River Basalt Group was encountered from 358.0 ft bgs to a total entry borehole depth of 383.5 ft bgs. Lithologic descriptions and geologic borehole logs for this well were prepared in accordance with FH procedure CP-GPP-EE-01-7.0, Rev. 1, "*Geologic Logging*," and are included in Appendix D.

Figure 6-1: Subsurface Geology and Geophysical Data for Seismic Entry Borehole C4998

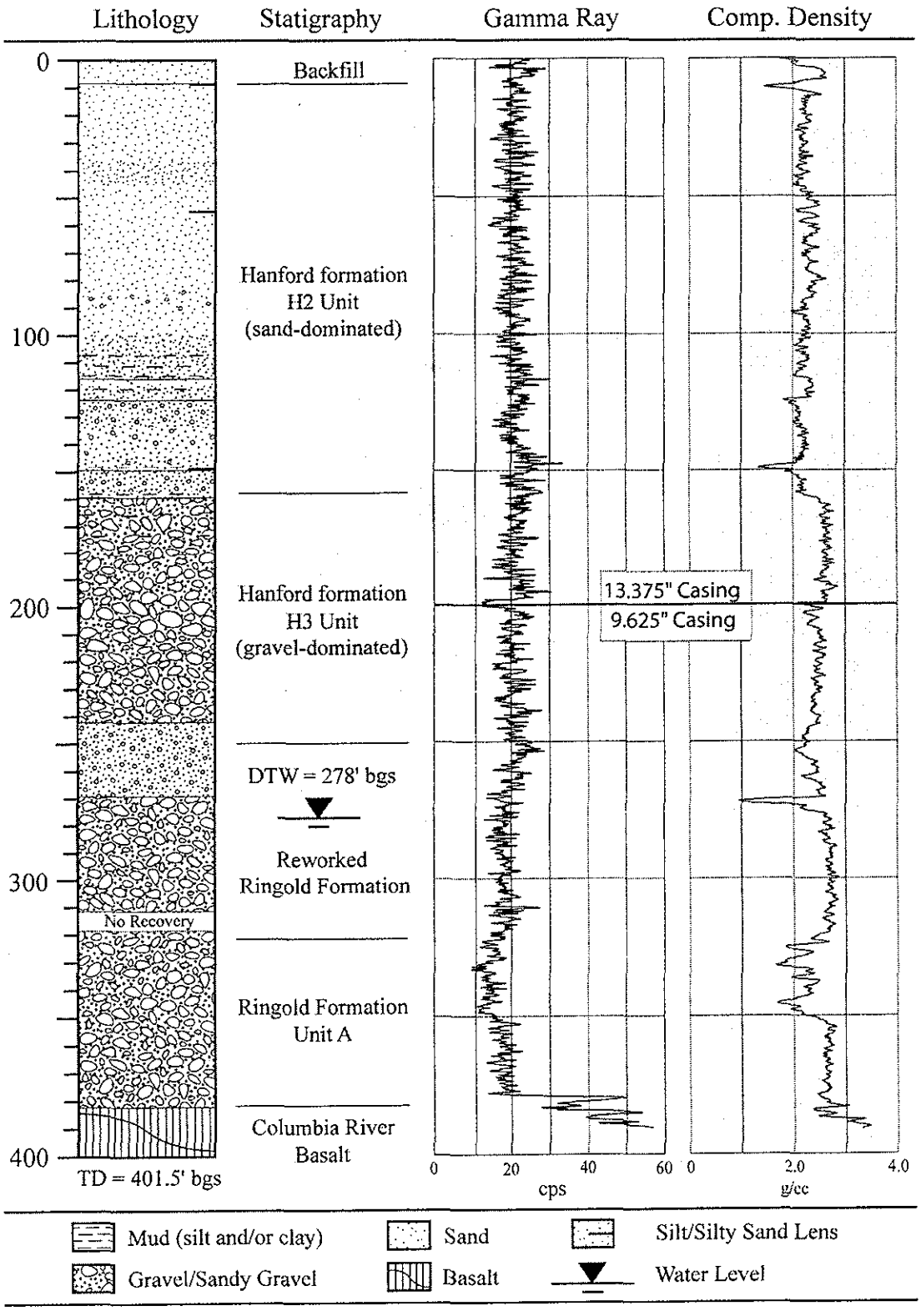


Figure 6-2: Subsurface Geology and Soil Sampling Intervals for Seismic Entry Borehole C4996

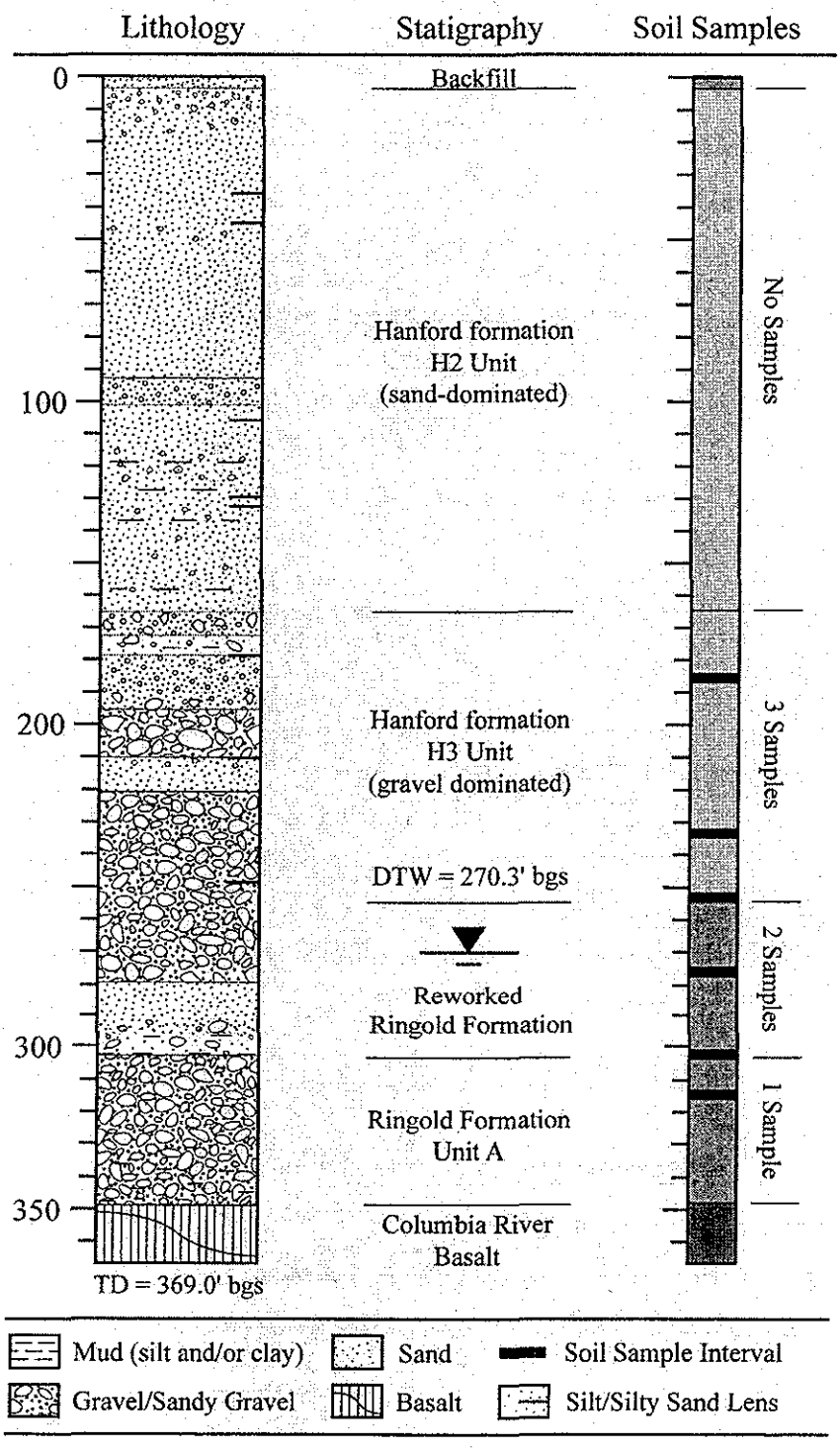


Figure 6-3: Subsurface Geology and Soil Sampling Intervals for Seismic Entry Borehole C4997

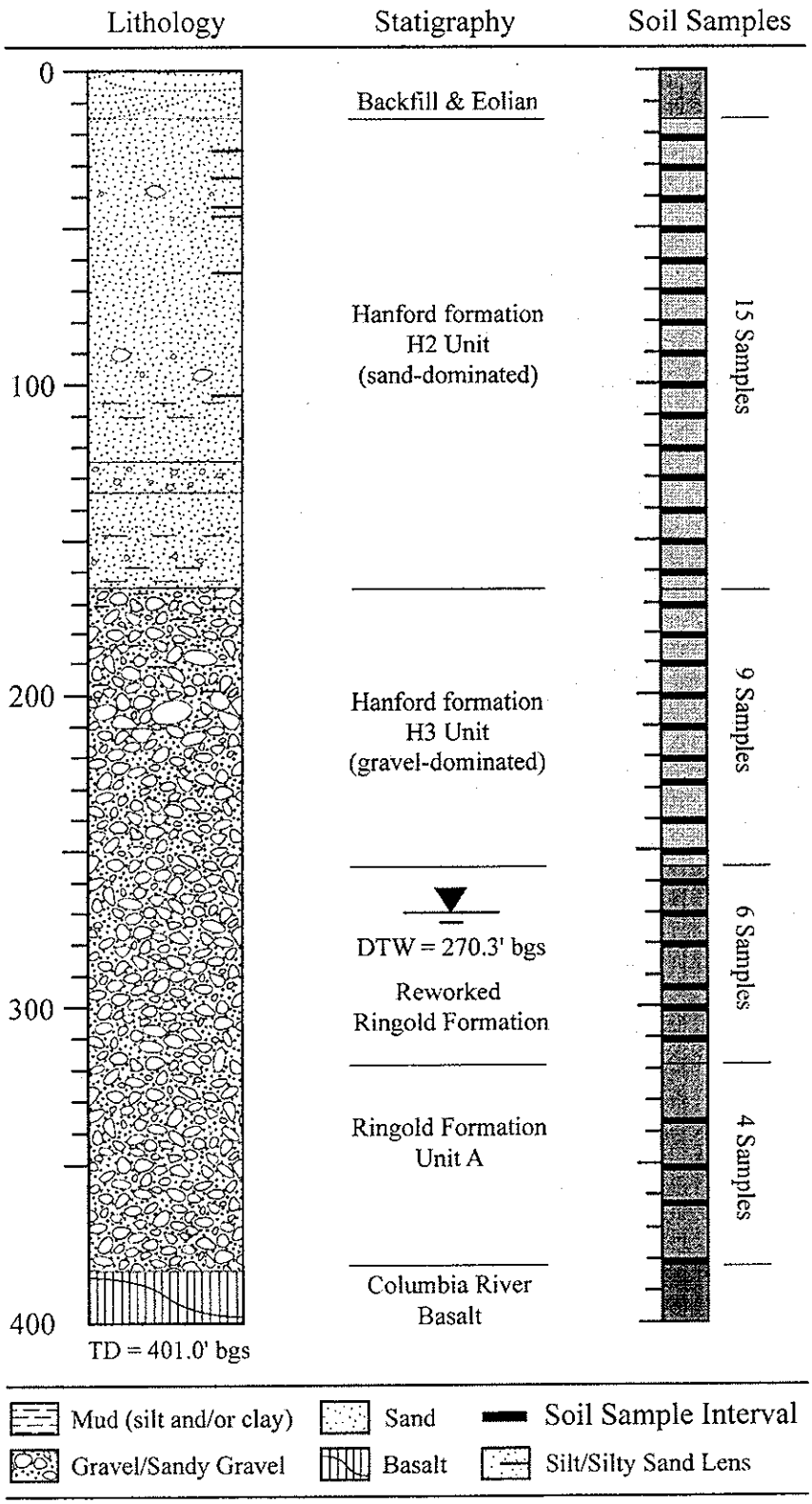
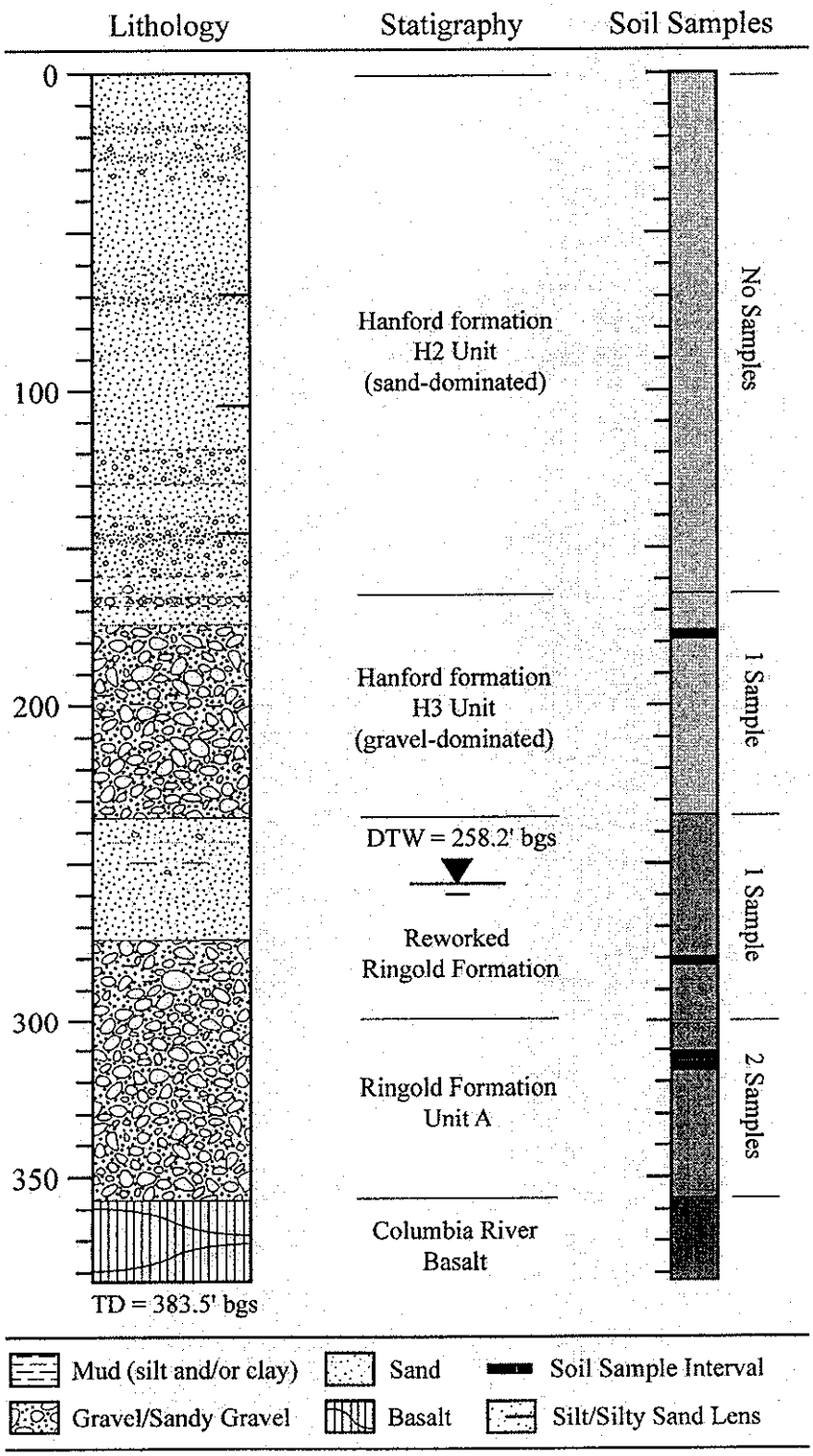


Figure 6-4: Subsurface Geology and Soil Sampling Intervals for Seismic Entry Borehole C4993


Lithology
Statigraphy
Soil Samples
0
100
200
300
350
Hanford formation
H2 Unit
(sand-dominated)
Hanford formation
H3 Unit
(gravel-dominated)
DTW = 258.2' bgs
Reworked
Ringold Formation
Ringold Formation
Unit A
Columbia River
Basalt
TD = 383.5' bgs
No Samples
1 Sample
1 Sample
2 Samples
Mud (silt and/or clay)
Gravel/Sandy Gravel
Sand
Basalt
Soil Sample Interval
Silt/Silty Sand Lens

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7.0 REFERENCES

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UTSD RCTS GR06-4. 2006. *Test Procedures and Calibration Documentation Associated with the RCTS and URC Tests at the University of Texas at Austin,* Geotechnical Engineering Center, Civil Engineering Department, The University of Texas at Austin, Austin, Texas.

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WAC 173-303, "Dangerous Waste Regulations," Washington Administrative Code, as amended

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APPENDIX A

BOREHOLE LOG
ENTRY BOREHOLE C4993

BOREHOLE LOG (using GRP-EE-01-7.0, Rev. 1) — Page 1 of 10

Well ID: C4993 | Well Name: Entry Bh #4 | Location: WTP Seismic Borehole #4 | Date: 8-31-06 start 8/21/06 - finish

Project: WTP Seismic Borehole #4 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0-0.3': Crushed gravel pad	Cable tool drilling with hollow strike barrel
				0.3-17': Sand (S) Med. sort. & sl. moist w/ >90% m-vc, ang to sub-rnd S (>70% basalt) & <10% vf-m ang. pebbles (>30% basalt). Max = 4 cm (v sparse), no HCl rxn, v. dk gray (5Y, 3/1.5).	Grab Sample (G.S.) @ 5' bgs
5	G.S.			• 10' 1 cm layer of 100% vf S (>95% felsic)	
				• 12' sparse small cobbles are present	
				• 15' 1 cm layer of 100% vf S (>95% felsic)	G.S. @ 10' bgs
10	G.S.			17'-20.5': Sand (S) Well-sort. uk. cons. w/ >95% f-vf S (>95% felsic) & <5% silt (limited to isolated layers). dk grayish brn (2.5Y, 4/2)	
				• 19' mod. sort. (m S & c grains present)	GS @ 15' bgs
15	G.S.			• v. thin layers of c-lc mafic sand are present (80% basalt).	
				20.5'-26': Sand (S) Mod. sort, unconsolidated w/ 90% m-vc ang. S (>80% basalt) & <10% vf-c pebbles (>20% basalt) max = 1.5 cm (sparse, cobbles are present), no HCl rxn, v. dk gray (2.5Y, 3/1)	G.S. @ 20' bgs
20	G.S.			• Contains several 2-6 cm layers similar to sand above from 17.0-20.5'.	
25	G.S.			26'-27.5': Sand (S) same as from 17'-20.5' bgs except dark, yellowish brn (10YR, 4/4).	G.S. @ 25' bgs
				27.5-34': Sand (S) Same as from 20.5-26' bgs w/ 2-6 cm layers of vf felsic S (same as above)	
30	G.S.			34-39': Sand (S) Mod. to well sorted, md. to v. cse basalt (~80%) sand (~20 felsic), sub. ang. - ang., moist, lw gravel	G.S. @ 34.5' bgs.
35	G.S.			No HCl Rxn. → @ 39': decrease in grain size to fine to cse S. Also, ~75% basalt, 25% felsic.	

Reported By: J. Horner / N. Bowles | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: J. Horner / N. Bowles | Date: 8/21/06 | Signature: L.D. Walker | Date: 9/12/06

A-6003-642 (03/03)

BOREHOLE LOG (using GRP-EE-01-7.0, Rv.1) Page 2 of 10 Date: 8/21/06 - Start 8/22/06 - Finish

Well ID: C4993 Well Name: Entry B.H. #4 Location: WIPP Seismic Borehole #4

Project: WIPP Seismic Boreholes Project Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	G.S.			(S cont'd from 34' bgs) ↓	Cable-Tool drilling w/ hollow drive barrel.
					G.S. @ 40' bgs
45	G.S.				G.S. @ 45.5' bgs
					G.S. @ 500' bgs.
50	G.S.				
55	G.S.				G.S. @ 54.5' bgs.
60	G.S.			·60' avg. grain size decreases to md. S & color changes from v. dk gray (2.5Y, 3/1) to dk. grayish brn (2.5Y, 4/2).	G.S. @ 60' bgs
65	G.S.				GS @ 65' bgs
70	G.S.			·69.5': 4cm layer of dk. grayish brn M. ·70': grain size decreases to v.f-m (60%) & basalt fraction decreases to 50-60%.	G.S. @ 70' bgs (includes sample of M @ 69.5') 8-21-06
				·72' same as from 60'-69.5' bgs	
75	G.S.				G.S. @ 76' bgs
				·78' grain size increases to m-c Sand	

Reported By: J. Bowles / J. Horner Reviewed By: L.D. Walker

Title: Geologist Title: Geologist

Signature: [signature] Date: 8-22-06 Signature: [signature] Date: 9/12/06

A-6003-642 (03/03)

BOREHOLE LOG (using GRP-EE-01-7.0, Rev.1) Page 3 of 10

Date: 8-22-06 start 8/24/06 - Finish

Well ID: C4993 | Well Name: Ensley 13.H.#4 | Location: WTP Seismic Borehole #4

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
80	G.S.			79'-80': Sand (S) well sort. vf-m (80%m) S (>70% felsic) with 1-2 cm layers of highly mafic grains containing 10-15% M (mafics). Overall, lt. olive brn. (2.5Y, 5/4) wet. HCl rxn to none. Abundant mica ~3%	Cable-tool drilling with hollow drive barrel G.S. @ 79.5' 8-22-06
85	G.S.			80-84': Sand (S) well-sort. m-vc ang. S (60% basalt 40% felsic) dk. grey (5Y, 4/1) no HCl rxn same as above 79' bgs. ·82' sl. oxid. dk grayish brn (2.5Y, 4/2)	G.S. @ 84.5' bgs
90	G.S.			84'-109': Sand (S) Same as from 79'-80' bgs. ·88' decrease in number of m S layers. Mostly med. S	Difficult to remove drive-barrel from borehole relative to cx, some S above. G.S. @ 90.' bgs. G.S. @ 95' bgs.
95	G.S.				
100	G.S.			→@ 100': fw S layers no longer present in S, felsic content increases to ~80%.	Begin adding water periodically to aid in cuttings Rx @ ~100' G.S. @ 100.5' bgs.
105	G.S.			→106-106.5': thin (~6") Silt (m) layer, moist, non plastic, felsic, mod. to strong HCl Rxn, 75% m, 25% v. fn. S), lt. grayish brn (2.5Y 5/3)	G.S. @ 105' bgs.
110	G.S.			→@ 108': felsic content decreases to ~70%, fn.-md. S. 109'-@ 120': Sand (S) Same as from 80-84' bgs ·111' basalt fraction is ~40% ·113' contains 5% vf-f ang pebbles (30% basalt)	G.S. @ 110.5' bgs.
115	G.S.			·117' grain size inc. m-vc (90% S) w/ ~10% ang. vf-f pebbles (80% basalt) overall, 50-60% basalt.	G.S. @ 115' bgs

Reported By: J. Horner / N. Boudes | Reviewed By: L.B. Walker

Title: Geologist | Title: Geologist

Signature: John Horner / [illegible] Date: 8-22-06 | Signature: [illegible] Date: 9/12/06

A-6003-642 (03/03)

BOREHOLE LOG (using GRP-EE-01-7.0, Rev 2)

Page 4 of 10

Date: 8-23-06 start 8/29/06 - Finish

c4993 | Well Name: Early B.H. #4 | Location: WTP Seismic Borehole #4

WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
G.S.			120'-125.5': Gravelly Sand (gS) Med-poorly sorted with ≤20% m-vc ang. S (50-60% basalt, 40-50% felsic) & 20% vf-f (90% vf) ang. pebbles (>80% basalt) No HCl rxn, Max = 1cm, gray (5Y, 5/1)	Cable-tool drilling with hollow drive barrel G.S. @ 120.5' bgs
G.S.			125.5-126.5': Silty Sand (mS) Moist, well sorted & consolidated with ~60% vf S (>95% felsic) & 40% M. Olive brn (2.5Y, 4/3) v. wk HCl rxn.	G.S. @ 125' bgs G.S. @ 126' bgs
G.S.			126.5'-130': Gravelly Sand (gS) Same as gS above mS ·130' pebble fraction decreases (<10%)	G.S. @ 129.5' bgs
G.S.			130'-140': Sand (S) Same as above, with <10% pebbles	G.S. @ 135.5' bgs
G.S.			140'-146.5': Gravelly Sand (gS) Pebble fraction increases to 10-20% still ~90% vf pebbles, v. sparse cm pebbles.	G.S. @ 140' bgs
G.S.				G.S. @ 145' bgs
G.S.			146.5'-147': Silty Sand (mS) well-sorted, weakly cons. w/ >70% vf-f S (>90% felsic) with <30% M. Overall, lt. yellowish brn (2.5Y, 5/3, sl. moist)	G.S. @ 149' bgs
G.S.			147'-150': Sand (S) Well-sorted f-c (90% m) sub-ang Sand with ~60-70% felsics & 30-40% basalt	G.S. @ 151' bgs
G.S.			150'-159': Gravelly Sand (gS) Poorly sorted w/ 75% m-vc ang. S (60-70% basalt) & 25% vf-f ang. pebbles (>80% basalt), Max = 1cm v. wk. HCl rxn, dk gray (2.5Y, 4/1)	G.S. @ 155.5' bgs

Reported By: J. Horner / N. Bowles | Reviewed By: L. D. Walker

Title: Geologist | Title: Geologist

Signature: John Horner / Nicholas Bowles | Date: 8-23-06 | Signature: L. D. Walker | Date: 9/12/06

A-6003-642 (03/03)

BOREHOLE LOG (using GRP-EE-01-7.0, Rev1) Page 5 of 10 Date: 8/23/06 - Start 8/28/06 Finish

Well ID: C4993 Well Name: Entry B.H. #4 Location: WTP Seismic Borehole #4

Project: WTP Seismic Boreholes Project Reference Measuring Point: Ground Surface.

Depth (FL)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
160	G.S.			(gs cont'd from 150')	Cable tool drilling w/ hollow drive barrel.
				-D @ 153': max G size increases to 2" (sub rd. to rd.), v. sparse.	G.S. @ 160.5' bgs
				159'-166': Sand (S)	
165	G.S.			v. similar to S from 147-150' fine to coarse S (~95%), w/ v. sparse (<5%) G to max 10mm (md. pebble), ~40% felsic, no HCl Rxn!	G.S. @ 165.' bgs
				-D @ 162': G size increases to ~4" max (sub rd. to sub ang., sm. cobble).	Begin adding H_2O @ ~166' bgs. (~5 gal.).
170	G.S.			-D @ 164': G. size decreases to 4 mm max (v. fine pebble), v. sparse;	G.S. @ 170.' bgs.
				166'-168': Sandy Gravel (sG)	G.S. @ 175' bgs
175	G.S.			~50% G, v. fn to sm (cobbles (~4" max), subang. to sub rd., ~50% basalt, clast supported/poorly sorted, No HCl Rxn!	G.S. @ 177' bgs
	G.S.	100% rec. 260 Blows (5/49/60/70/70)		~50% S, md. to v. cse, subang, ~40% felsic.	Split Spoon 177'-179' bgs A: 1765-179; 70%; D1KH58 B: 176-1765; 60%; D1KH59 C: 1756-176; 95%; D1KH60
180	G.S.			168'-169': Gravel (G)	D: 177-1775; 60%; D1KH61 Bulk: 177'-179.5'; D1KH62
				~80% G, v. fn pebbles to lg. cobbles (4" max) sub. ang. to sub rd.	All ss. liners 100% rec. "D" is likely slough
185	G.S.			~15% S, v. fn. to v. cse, subang, ~50% basalt/50% felsic.	G.S. @ 180' bgs
				<5% m	G.S. @ 185' bgs
				overall: clast supported, poorly sorted, mod. consolidation, no HCl Rxn.	
190	G.S.			169'-175': Sand (S)	Adding H_2O @ ~188' bgs.
				v. similar to S from 159'-166'. (159-162' D sent to [illegible] @ 8/24/06)	G.S. @ 190' bgs
				<5% G to 10 mm max, 95% S.	
195	G.S.			175-176.2': Sandy Gravel (sG)	max cobbles @ 175': ~20cm
				Poorly sort., clast supported, unconsolidated w/ fn (60% vf pebbles to lg. cobbles (50% ang. pebbles w/ ~60% basalt, 50% rounded basalt/felsic cobbles) & 40% m-vc ang. gravish brn (5Y, 5/2) S (50% mafic/felsic).	G.S. @ 195' bgs. Adding H_2O after 195' bgs.

Reported By: D. Bowles / J. Horner Reviewed By: L. D. Walker

Title: Geologist Title: Geologist

Signature: [signature] Date: 8-25-06 Signature: [signature] Date: 9/12/06

A-6003-642 (03/03)

BOREHOLE LOG (using GAP-EE-01-7.0, Rv.1) Page 1 of 10

Date: 8-24-06 start 8/28/06 - Finish

Well ID: C4993 | Well Name: Entry B.H. #4 | Location: WTP seismic Borehole #4

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
200	G.S.			• 176.2 - 176.5': Sand (S) well-sorted, well consolidated w/ >90% c-vc ang. S (60% basalt) & <10% vf ang. pebbles (>80% basalt). $CaCO_3$ cem. w/ v. strong HCl rxn.	Cable tool drilling w/ 4" hollow drive barrel
205	G.S.			• 176.5 - 198': Sandy Gravel cont... Well cemented from 176.5' to 177' bgs w/ v. strong HCl rxn. Did not check w/ HCl from 177' - 179' bgs (S.S. intv.) @ 179', loose SG, wk HCl rxn, Same as from 175' - 176' bgs.	G.S. @ 200' bgs G.S. @ 205' bgs
210	G.S.			• 182' M fraction is ~5-10%, G ~70% & S is ~20-25%.	G.S. @ 210' bgs
215	G.S.			• 186' M fraction decreases to <2% S increases to ~40%, ~60% G. lg. cobbles still present.	G.S. @ 215' bgs
220	G.S.			→ @ 193': (SG)vmst: M increases to ~5% (8/25/06) S: ~50% vf-m to v. vc, subang., >80% felsic; ~45% bl. (~40% vf-m to vc pebbles) & ~60% sm. to lg. (cobbles), subang. to sub rd. ~70% basalt, Overall: poorly sorted, loose/uncons. dbnd, clast supported, dry, v. strong HCl Rxn. • Boulders present 198' - 200'	8/28/06 G.S. @ 220.5' bgs
225	G.S.			198' - 210': Gravel (G) Poorly sorted, unconsolidated & clast supp. w/ >80% pebbles/cobbles/boulders; ~60% vf - vc ang - sub-rnd pebbles (~70% basalt) ~20% rnd small to lg. cobbles w/ a few basalt boulders, 15-20% m-vc ang. to sub-rnd S (~60% felsic, 40% basalt) & <5% M. Max fragment in barrel is ~10"	G.S. @ 225' bgs
230	G.S.			• 208' <5% cobbles	G.S. @ 230' bgs Adding H_2O @ 233' bgs
235	G.S.			• 210' S increases to ~25%, no cobbles. S & vf-f pebbles contains ~50% basalt m-vc pebbles ~50% basalt. Matrix is grayish brn (2.5Y, 5/2.5)	G.S. @ 235' bgs

Reported By: J. Horner / N. Bowles | Reviewed By: L. D. Walker

Title: Geologist | Title: Geologist

Signature: J. Horner / N. Bowles | Date: 8/28/06 | Signature: L. D. Walker | Date: 9/12/06

A-6003-642 (03/03)

BOREHOLE LOG (using 699-EE-01-7.0, Rv. 1) Page 7 of 10 Date: 8-28-06 - start 8/29/06 - F

Well ID: C4993 Well Name: Entry B-4th Location: WTP Seismic Borehole #4

Project: WTP Seismic Boreholes Project Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
240	G.S.			210'-236': Sandy Gravel (s/G) Poorly sorted, unconsolidated, clast supp. w/ ~70% vf-vc, ang(sl) to sub-rnd (vc) with ~50% basalt & 25% vf-vc ang - sub-ang S(~60% felsic, f-m s.; up to 80% felsic) & < 5% silt. Max particle = 5cm, gray(sh brn(2.5Y, 5/2)) wk HCl rxn. @215' >50% G; 45% S; <5% M	Cable-tool drilling with hollow drive barrel
245	G.S.				G.S. @ 240' bgs. G.S @ 245' bgs.
250	G.S.			236-242': Sand (S) 100% vf. to crs S (~30% fine sand, ~5% crs, ~5% v. fine) ~60% felsic / ~40% basalt, mod. to well sorted (moisture unknown due to added H2O), No silt, No gravel, No HCl Rxn.	G.S. @ 250' bgs.
255	G.S.			-D @ 238': grain size inc. to md. to v. crs. sand. -D @ 240': ~90% fine to v. crs S, ~50% felsic / 50% basalt (lg. grains); <10% G, v. fine to crs pebbles sub aug., 50% basalt / 50% felsic gravel: poorly sorted, unconsolidated,	G.S. @ 255' bgs. 8-29-06 DTW = 258.2'
260	G.S.			242-D 244': Sand/Silt (S/M) ~60% Silt, nonplastic; ~30% f. fine Sand; well sorted, mod. consolidated, moist (possibly due to H2O added @ higher heating), mod. to strong HCl Rxn, lt. ol. Brn. (5Y 6/3).	G.S. @ 260' bgs
265	G.S.				G.S. @ 269.5' bgs.
270	G.S.			244'-274': Sand (S) Poorly sorted, unconsolidated, moist Sand (~90%), w/ <5% G & <5% M. Sand is v. fine to v. crs (80% v. fine to md; <20% crs to vcrse) sub aug. to ang., 60% felsic; Silt is present in small clumps (possibly representing v. thin silt layers w/in G formation), mod plasticity, Gravel is v. sparse to max size 1" (v. fine to crs. pebbles), sub. rd., 50% basalt.	G.S. @ 270' bgs. Cobble at 270' *Casing refusal @ 272.75' while drive barrel was
275	G.S.				G.S. @ 275.5' bgs

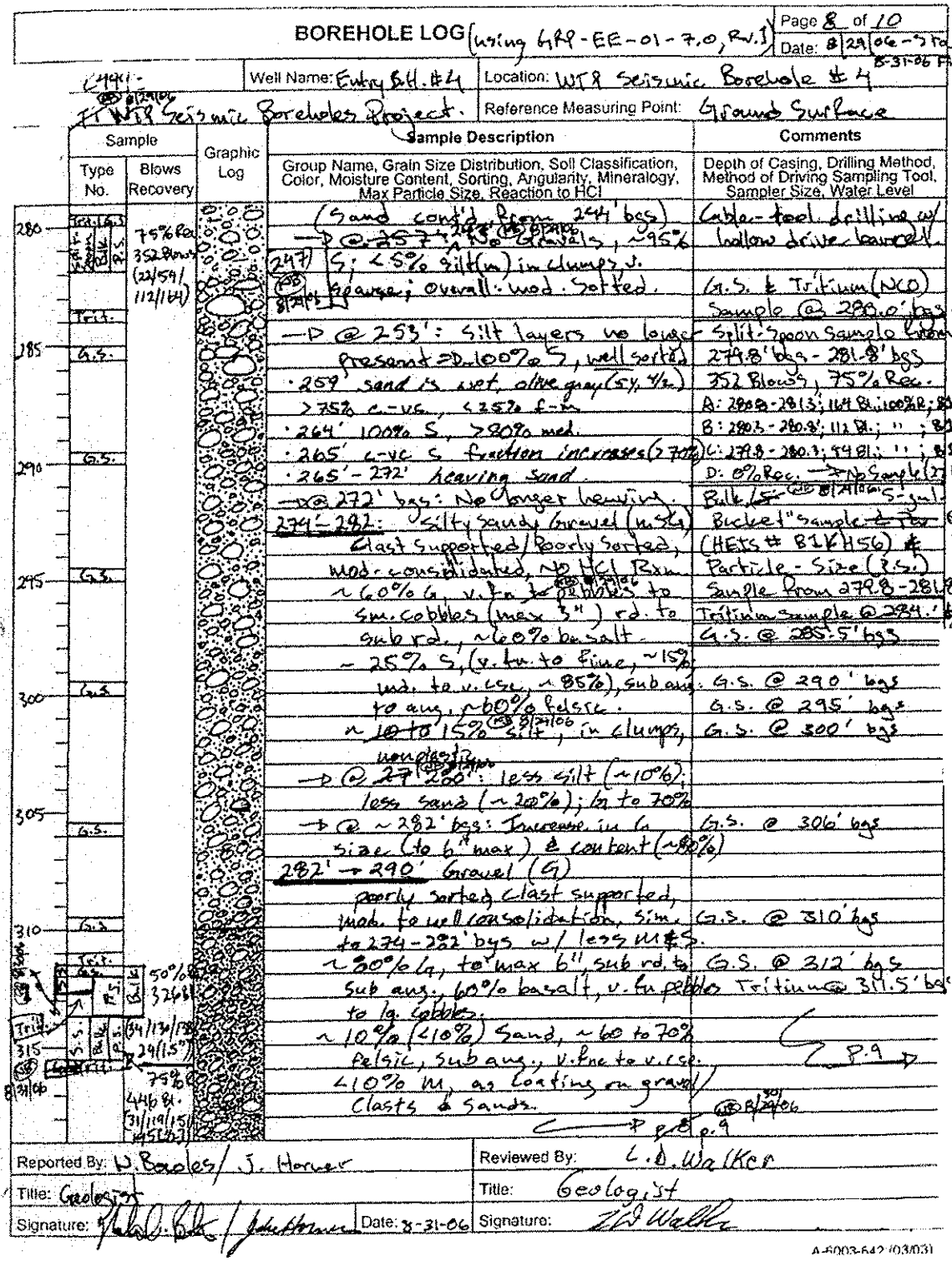
→ p.8

Reported By: J. Horner / N. Bowles Reviewed By: L. D. Walker

Title: Geologist Title: Geologist

Signature: [signature] Date: 8/29/06 Signature: [signature] Date: 9/12/06

A-6003-642 (03/03)



BOREHOLE LOG (using GRP-EE-01-7.0, Rev.1) Page 8 of 10 Date: 8/29/06 - Start 8-31-06 Finish

Well Name: Entry Bh. #4 Location: WTP Seismic Borehole # 4

WTP Seismic Boreholes Project. Reference Measuring Point: Ground Surface

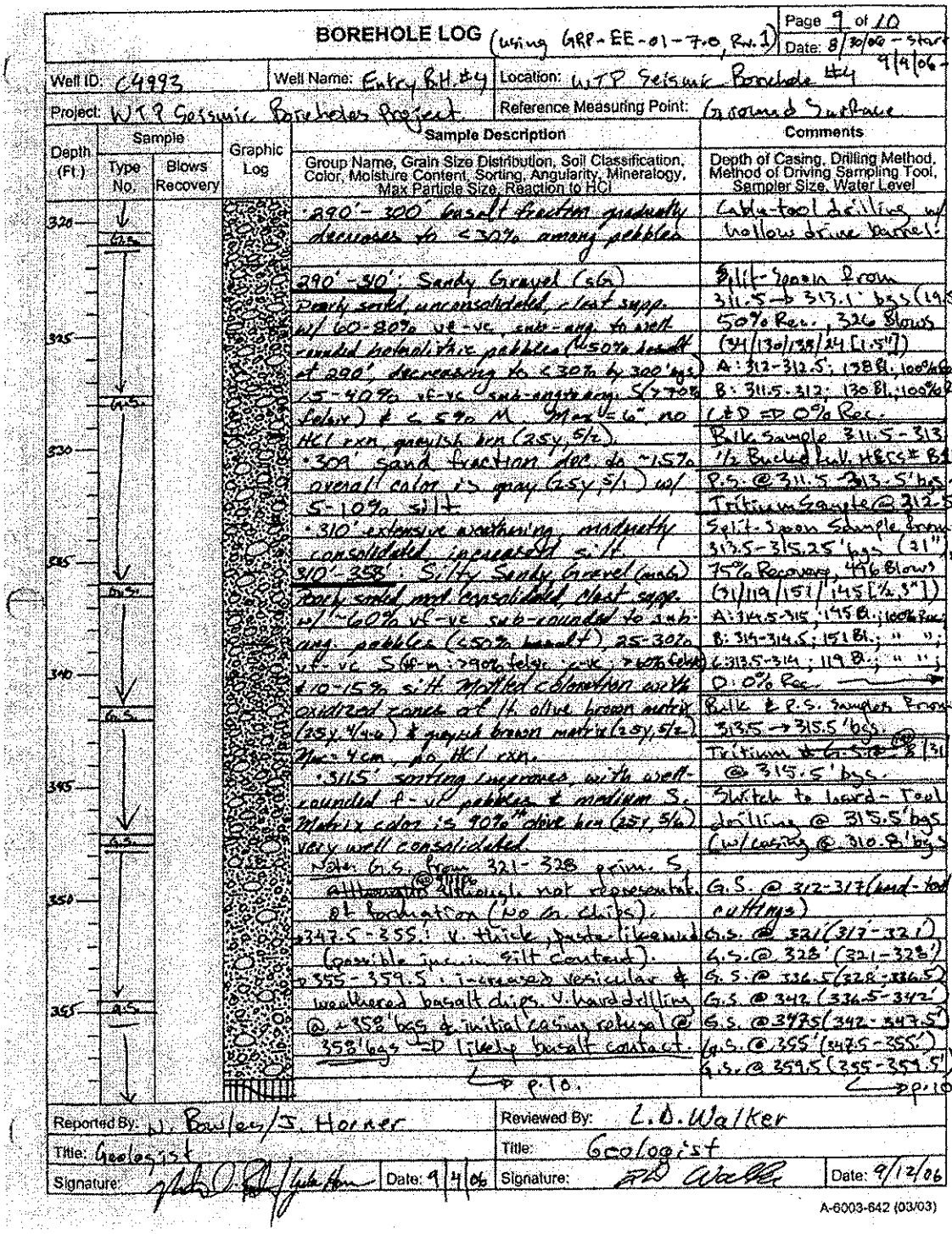
Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
Trit. G.S.	75% Rec 352 Blows (22/59/112/141)		(Sand cont'd from 244' bgs) → @ 253': No Gravels, ~95% S; <5% silt(m) in clumps; v. coarse; overall: mod. sorted.	Cable-tool drilling w/ hollow drive barrel. G.S. & Tritium (NCO) Sample @ 280.0' bgs.
Trit. G.S.			→ @ 253': silt layers no longer present → 100% S, well sorted. · 259' sand is wet, olive gray (5Y 4/2) >75% c-vc, <25% f-m · 264' 100% S, >90% med. · 265' c-vc S fraction increases (>70%) · 265'-272' heaving sand. → @ 272' bgs: No longer heaving.	Split-Spoon Sample from 279.8' bgs - 281.8' bgs 352 Blows, 75% Rec. A: 280.3-281.3; 141 Bl.; 100%R; B/KHS. B: 280.3-280.8'; 112 Bl.; "; B/KHS. C: 279.8-280.3'; 59 Bl.; "; B/KHS. D: 0% Rec. → No Sample (22 Blows)
G.S.			274'-282': Silty, sandy, Gravel (mSG) Clast supported/poorly sorted, mod. consolidated, No HCl Rxn ~60% Lg, v.f. to pebbles to 5in. cobbles (max 3") rd. to sub rd., ~60% basalt. ~25% S, (v. fn. to fine, ~15%; med. to v. crse, ~85%), sub ang. to ang., ~60% felsic. ~10 to 15% silt, in clumps, nonplastic.	Bulk (5-gal Bucket) Sample (CHES # B1KH56) Particle-Size (P.S.) Sample From 279.8-281.8' bgs. Tritium Sample @ 284.' bgs. G.S. @ 285.5' bgs
G.S.			→ @ 287.200': less silt (~10%); less sand (~20%); Lg to 70%	G.S. @ 290' bgs G.S. @ 295' bgs G.S. @ 300' bgs
G.S.			→ @ ~282' bgs: Increase in Lg size (to 6" max) & content (~80%)	G.S. @ 306' bgs
G.S.			282'→290' Gravel (G) poorly sorted, clast supported, mod. to well consolidation, sim. to 274-282' bgs w/ less M $. ~80% Lg, to max 6", sub rd. to sub ang., 60% basalt, v. fn pebbles to lg. cobbles. ~10% (<10%) Sand, ~60 to 70% felsic, sub ang., v. fine to v. crse. <10% M, as coating on gravel/clasts & sands.	G.S. @ 310' bgs G.S. @ 312' bgs Tritium @ 311.5' bgs → p.9
Trit.	50% Rec 326 Bl. (34/134/192) 24 (1.5")			
Trit.	75% Rec 446 Bl. (31/119/151/145)			→ p.9

Reported By: D. Barnes / J. Horner Reviewed By: L.D. Walker

Title: Geologist Title: Geologist

Signature: [signature] / [signature] Date: 8-31-06 Signature: [signature]

A-6003-642 (03/03)



BOREHOLE LOG (using GRP-EE-01-7.0, Rev. 1) Page 9 of 10 Date: 8/30/06 – Start 9/9/06 – Finish.

Well ID: C4993 Well Name: Entry B.H. #4 Location: WTP Seismic Borehole #4

Project: WTP Seismic Borehole Project. Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
320	G.S.			·290'-300' basalt fraction gradually decreases to <30% among pebbles	Cable-tool drilling w/ hollow drive barrel
				290'-340': Sandy Gravel (SG) Poorly sorted, unconsolidated, clast supp. w/ 60-80% vf-vc, sub-ang. to well rounded basaltic pebbles (>50% basalt at 290', decreasing to <30% by 300'bgs) 15-40% vf-vc sand-angularity, S(>70% felsic) & ≤5% M. Max=6", no HCl rxn, grayish brn (2.5y, 5/2).	Split Spoon from 311.5→313.1' bgs (19.5") 50% Rec., 326 Blows (91/130/138/24 [1.5"]) A: 312-312.5'; 138 Bl., 100% Rec., B1K867 B: 311.5-312; 130 Bl., 100% Rec., B1K870 L+D ⇒ 0% Rec.
325	G.S.			·309' sand fraction doc. to ~15% overall color is gray (2.5y, 5/1) w/ 5-10% silt	Bulk Sample 311.5-313.5' bgs ½ Bucket Full, HBSS# B1K346 P.S. @ 311.5-313.5' bgs. Tritium Sample @ 312-5' bgs.
330				·310' extensive weathering, moderately consolidated, increased silt.	Split-Spoon Sample from 313.5-315.25' bgs (21") 75% Recovery, 496 Blows (91/119/151/145 [¾"])
335	G.S.			310'-358': Silty Sandy Gravel (smG) Poorly sorted, not consolidated, clast supp. w/ 60% vf-vc sub-rounded to sub-ang. pebbles (<50% basalt), 25-30% vf-vc S (W-m: >90% felsic, c-vc, >40% felsic) & 10-15% silt. Mottled colorations with oxidized zones of lt olive brown matrix (2.5y, 5/6) & grayish brown matrix (2.5y, 5/2). Max=4cm, no HCl rxn.	A: 314.5-315; 145 Bl.; 100% Rec; B: 314-314.5; 151 Bl.; " "; C: 313.5-314; 119 Bl.; " "; D: 0% Rec.
340	G.S.				Bulk & P.S. Samples From 315→315.5' bgs. Tritium #6.5 @ 315.5' bgs. 8/31/06
345	G.S.			·315' sorting increases, with well-rounded f-vf pebbles & medium S. Matrix color is 90% dark brn (2.5y, 5/6) very well consolidated	Switch to Hard-Tool Drilling @ 315.5' bgs (w/ casing @ 310.8' bgs) *
350	G.S.			Note: G.S. from 321-328 prim. S although not representat. of lithology (no m. chips).	G.S. @ 312-317 (hard-tool cuttings)
				·347.5-355': v. thick, pasty (likewise (possible increase silt content).	G.S. @ 321 (317-321') G.S. @ 328' (321-328')
355	G.S.			·355-359.5': increased vesicular & weathered basalt chips, v. hard drilling @ ~358' bgs & initial casing refusal @ 358' bgs ⇒ likely basalt contact.	G.S. @ 336.5 (328-336.5') G.S. @ 342 (336.5-342') G.S. @ 347.5 (342-347.5') G.S. @ 355' (347.5-355') G.S. @ 359.5 (355-359.5')

→ p. 10.

→ p. 10

Reported By: J. Bowles/S. Horner Reviewed By: L.D. Walker

Title: Geologist Title: Geologist

Signature: [signature] Date: 9/4/06 Signature: [signature] Date: 9/12/06

A-6003-642 (03/03)

BOREHOLE LOG (Using GRP-EE-01-709 Rv.1) Page 10 of 10 Date: 9-4-06 s/mt

Well ID: C4993 Well Name: Entry Bh. #4 Location: WTP Seismic Borehole #4

Project: WTP Seismic Boreholes Project Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
360	G.S.			358'-383.5': Basalt	Hand tool drilling
				Baked mud is dark gray (5Y, 4/1) with >90% v. angular & sl. vesicular basalt chips. Some fragments showing signs of weathering. Clay filled fractures & vesicles present.	w/ cable tool rig.
					G.S. @ 364' bgs (357.5-364')
365					
370	G.S.				G.S. @ 370' bgs (364'-370')
375	G.S.				G.S. @ 377.5' (370'-377.5')
380	G.S.			T.D. = 383.5' bgs.	G.S. @ 383.5' (377.5'-383.5')
385					
390					
395					

Reported By: J. Horner / N. Bowles Reviewed By: L.D. Walker

Title: Geologist Title: Geologist

Signature: Jake Horner / Date: 9-4-06 Signature: L.D. Walker Date: 9/12/06

A-6003-642 (03/03)

APPENDIX B

BOREHOLE LOG
ENTRY BOREHOLE C4996

BOREHOLE LOG

Page 1 of 15

Date: 7-12-06 start

Well ID: C4996 | Well Name: Entry B.H. # 2 | Location: WTP Seismic Borehole # 2

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0					Cable-tool drilling w/ hollow drive barrel.
				0 – 0.5': gravel (G), crushed gravel drillpad. Max size to 1". Angular, dry, compacted. <20% Sand (crushed fines).	
5	Grab			0.5 – 4.5': Sand (S) >90% v.f. to f.m. sand <10% Silt, no gravels. Unconsolidated / loose, moist, weathered, Strata (t. Brn.	Grab Sample (G.S.) @ ~5' bgs. Note: Begin adding H_2O @ ~5' bgs
10	Grab			4.5 – 6.0': Sand (S) >90% m.d. to v. cse sand <10% gravels (to max 1") moist, loose, Blk. & Wht, native Source Brn (decreasing w/ depth)	G.S. @ ~ 10' bgs.
15	Grab			6.0 – 9.0': gravelly Sand (gS) Same as from 4.5 – 6.0, except increase in gravels to ~25%, Max size increase to ~4" (Sm. Cobble), Sub rounded to Sub angular.	G.S. @ ~ 15' bgs.
20	Grab			9.0 – ': Sand (S) ~95% cse to v. cse sand <5% gravel, Blk & Wht Sands, v. loose (adding water to keep load). Gravels to ~2" max	G.S. @ ~ 20' bgs
25	Grab			@ ~ 13' bgs → v. dry (No water added) @ ~ 15' bgs → lg. Cobble ~ (10") in cuttings, Sub rounded @ ~ 20' bgs → decreasing grain size for sand, → f.m. to cse, decrease in gravel content, dry, increase in brn. sand content.	G.S. @ ~ 25' bgs
30	Grab			·25' f-c sand (60-80% basalt) w/ < 3% pebbles. Mod. rxn w/ HCl & ≤ 5% M. ·28' large cobble ~ 20 cm ·30' well-sort. m sand, ang. w/ ≤ 30% basalt & 70% felsic. Grayish brown (10YR 5/2). Mod. rxn w/ HCl. Felsic fraction increases with depth (85% @ 33') & grainsize decreases (vf-m w/ ~10% m)	GS @ 30.5' bgs
35	Grab				GS @ 35' bgs

Reported By: N. Bowles / J. Horner | Reviewed By: L.D. Walker

Title: Geologist | Title: Ecologist

Signature: N. Bowles / J. Horner | Date: 7-13-06 | Signature: L.D. Walker | Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 15
Date: 7-13-06 start

Well ID: C4996 | Well Name: Entry B.H. #2 | Location: WTP Seismic Borehole #1
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40'	Grab			32-34' : Loose well-sort m-vc sub-ang. mafic S(70% basalt, 30% felsic) Black(2.5Y, 2.5/1)	Cable tool drilling with halfbarrel
				34-34.5': Loose vf-m ang felsic S(70% felsic, 30% basalt)	GS @ 40' bgs
	Grab			34.5-36' : Mod. sort, loose m-vc sub-ang. mafic S(~70% basalt, 30% felsic) w/	GS @ 44.5' bgs
45				several 2-4 cm layers vf-m dk grayish brn (10YR, 3/2, moist) S(50-60% felsic, 40-50% basalt)	
				36'-37': Silty Sand (mS)	
				Mod. sort. weakly consolidated w/ 70-80% vf-m	
50	Grab			ang S(40-50% basalt, 50-60% felsic) & 20-30%	GS @ 50' bgs.
				Silt, dark grayish brn (2.5Y, 4/2, moist) &	
				lt. brownish gray (2.5Y, 6/2, dry) strong rxn	
				with HCl.	
				37'-42.5': Sand (S)	
55	Grab			Loose, mod. sort, m-vc ang to sub-ang.	GS @ 55' bgs.
				S(70-80% basalt) w/ several 2-6 cm	
				layers of consolidated (m)S(80-85% vf-f S	
				& 15-20% M)(m)S is v. dk-dk grayish brn.	Begin adding water @ ~58' bgs
				(10YR, 3-5/2, moist). Loose S has wk rxn	
60	Grab			w/ HCl. (m)S has v. strong rxn. Sprse	
				(<5%) pebbles & small cobbles max= 10cm.	GS @ 60' bgs.
				42.5-43': Sand (S)	
				Well-sort, v. wk cons, vf-f (80% f) ang.	
				S(70-80% felsic, 20% basalt). Strong rxn HCl	
65	GRAB			43'-45.5': Sand (S)	GS @ 65' bgs.
				Same as S @ 37-42.5' w/ c-vc S.	
				45.5-46': (mS) ~75% vf-f sand	
				25% silt, Vstr rxn w/ HCl Rxn, lt. Brn (10YR 7/3)	
				46-48.5': Sand (S), same as 37-42.5'	
70	GRAB			48.5-49.5': Sand (S), vf-m to vc. S	GS @ 70' bgs.
				<5% silt, loose & dry, ang, ~75% felsic &	
				25% basalt. No HCl Rxn, No gravels.	
				49.5-54': Sand (S),	
				cse to v. cse sand, loose 70-80% Basalt	
75	Grab			(Similar to 43-45.5' w/ more mS lenses to ~6").	GS @ 75' bgs
				54-58': Sand (S), v.fn to cse. S	
				<5% silt, loose & dry, ~60% felsic/40% basalt.	
				No HCl Rxn, No gravels.	

→ P.3

Reported By: J. Horner / N. Bowles | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: [signature] | Date: 7-13-06 | Signature: [signature] | Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 15

Date: 7/13/06 - start; 7/16/06 - finish

Well ID: C4996 | Well Name: Entry B.H. #2 | Location: WTP Seismic Borehole # 2

Project: WTP Seismic Borehole Project. | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
80	Grab			@ 7/13/06	Cable-Tool drilling w/ hollow drive barrel
				58'–61.5': Sand (S) similar to 48–58' w/ increased basalt content (60% basalt).	G.S. @ 80' bgs
				61.5 – 63': Sand (S) same as 48.5 to 49.5.	
85	Grab			63. – 64.5 : Sand (S), v.fn to fine. 80% felsic, well sorted, lt. Brn (2.5Y 4/2). Mod. HCl Rxn. @ 7/13/06 < 10% silt.	GS @ 85' bgs
				64.5 – 93. : Sand (S), v.fn to cse S (~75% v.fn - fn., 25% md - cse.) ~60% felsic/40% Basalt, mod to strong HCl Rxn, ~5% @ 7/13/06 10% silt, no gravels. → Some v. thin (~1 to 2") layers of m S present. Well sorted & v. compacted.	GS @ 90' bgs @ 7/13/06
90	Grab			-> @ 68': decrease in grain size, v.fn to md. S, <10% silt.	GS @ 95' bgs
95	Grab			→ @ 73.5': return to v.fn to cse S and increase in basalt to ~50% No silt layers, <5% silt.	
				→ @ 76': v.fn to md. S, 60% felsic/40% basalt.	
100	Grab			→ @ 78': v.fn to cse S, 50% felsic/50% basalt.	
				· 80' f-c sand (~90% medium) 50% basalt gray-gray ish brn (2.5y, 4.5/1.5, moist)	GS @ 100' bgs
				· 82' f-m (70/80) & olive brn (2.5y, 4/3, moist) 40-50% basalt, 50-50% felsic @ 7-14-06	~83' Driller noted harder drilling
105	Grab			· 83' @ 7/14/06 consolidated, slightly oxidized & strong rxn w/ HCl otherwise, the same	
				· 86' m-c S w/ 5-10% M.	~93' Drilling much faster (loose S & G S)
				· 90.5' felsic fraction increases (60-70%)	
				93'–93.5': Sand (S) - loose, mod. sort. f-c slightly moist S (70% felsic 30% basalt) grains are ang. to sub-ang.	G.S. @ 105.5' bgs.
110	Grab			93.5'–94.5': Gravelly Sand (gS) loose & Poorly sorted with 80% f-c ang. S (f-m = 70% felsic; c-vc = 80% basalt) with ang. to sub-rounded vf-m pebbles (80–90% basalt), v. sparse m cobbles, mod. rxn.	G.S. @ 110.5' bgs
				94.5–95': Sand (S) same as from 93'–93.5' bgs except w/ c-vc S has 80% basalt (m-f = felsic, 70%)	G.S. @ 115.' bgs.
115	Grab				

Reported By: N. Bowles / J. Horner | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: [signature] Date: 7/14/06 | Signature: [signature] Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 1 of 15 — Date: 7-14-06 start, 7/16/06 finish

Well ID: C4996 | Well Name: Entry B.H. #2 | Location: WTP Seismic Borehole #2

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
90		7/16/06		95' - 101.5': Gravelly Sand (gS)	Cable-Tool drilling w/ hollow drive barrel.
				Same as 93.5' - 94.5' bgs.	
				100' No cobbles, pebble fraction (10-15%) 7-14-06	
				5-10% M S (75-85%)	
				(Same to 101.5')	
				101.5' - 106.5': Sand (s), fine to coarse, well sorted, loose, moist (likely due to addn'l water from previous shift), 70% Felsic/30% basalt, sub ang. to sub rnd.	
				→ @ 104': change to v. fine to mod. S.	
				106.5 - 107': ~~Sandy~~ Silt (sM) 7/16/06	
				~~100%~~ 60% silt, ~40% v. fine sand 7/16/06	
				7/14/06 well sorted, compacted, moist, >95% Felsic, ~5% basalt, lt. brn (10YR 7/3)	
				Strong HCl Rxn. 7/16/06	
				107 - 114.5': Sand (s) v. fine to coarse, well sorted 7/14/06 Mod. sorted, loose, moist, 70% Felsic/30% basalt, sub ang., v. slight HCl Rxn.	
				→ @ 110': change to fine to coarse, increase in basalt content to ~40%.	
				→ @ 111.5': ~5% gravels (v. sparse) to max 4" (cm. cobble) subang to subrd.	
				→ @ 112.5' v. thin (~1") layer of v. compacted mS w/ Fe oxides. No gravels 7/16/06	
				114.5' - 115.5': gravelly Sand (gS) 7/16/06	
				85% sand (fine to v. coarse)	
				15% gravel (v. fine to mod. pebbles)	
				- Sands are subang, 60% Felsic/40% basalt.	
				- Gravels are sub ang. 70% basalt/30% felsic	
				No HCl Rxn.	
				115.5 - 139': Sand (s) fine to v. coarse w/ v. sparse gravels (<5%) to max ½" 7/16/06	
				Similar to 114.5 - 115.5 w/ less gravel.	
				→ @ ~116': v. thin SM layer, oxidized & high calcium caliche, brittle compaction, Strong to v. strong HCl Rxn (~1" thick).	
				→ @ ~121': increase in gravel size to ~2" max. 7/16/06	

Graphics on previous Page (@3) 7/16/06

Reported By: J. Horner / N. Bowles — Reviewed By: L.D. Walker

Title: Geologist — Title: Geologist

Signature: John Horner / N. Bowles — Date: 7/16/06 — Signature: L.D. Walker — Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

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Date 7/16/06 – Start.

Well ID: C4996 | Well Name: Entry B.H. # 2 | Location: WTP Seismic B.H. # 2
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120	Grab			(cont'd of Sand from 115.5').	Cable-Tool drilling w/ hollow drive barrel.
				→ @ 123': Increase gravel content to ~10%, size to ~3" max, signs of cementation/coating on grains, & periodic layers (v. thin (~1")) of slM similar to that found @ 116'.	G.S. @ 120' bgs.
125	Grab			Note: Cementation increasing w/ depth	G.S. @ 125' bgs.
				→ @ 126': Decrease gravel content to ~5%, inc. size to ~4" max, sub rd. to subang., less cementation, cont. layers of slM like seen @ 116'.	G.S. @ 130' bgs.
130	Grab			→ @ 128', increase gravel to ~10% (Gravel Dist: >90% v. fine to fine pebbles), cementation & v. thin slM layers cont. w/ both showing increased oxidation.	
135	Grab			→ @ 133', decrease overall grain size to fine to v. cse sand, no gravels.	G.S. @ 135' bgs.
				139 – 139.25': Silt (M) 100% silt, well sorted, compact, moist, lt. brn (2.5Y 4/2). Sl. to mod. HCl rxn.	
140	Grab			139.25 – 141.5': Sand (S) >90% md. to v. cse sand, ~10% gravel (v. fine to fine pebbles) ~50% felsic/50% basalt. No cementation. v. slight cementation/oxidation, well sorted, dry.	G.S. @ 140.5' bgs. (NB) 7/17/06
145	Grab				- GS @ 145' bgs
				141 – 141.25': Silt (M) Same as silt from 139. – 139.25	
				141.25 – : Sand (S) Same as sand from 139.25 – 141'	G.S. @ 150' bgs
150	Grab			146 – 147 pebble fraction → ~40% (gS) 147 – 152 ≤10% pebbles, 85% S, 5% M 152 – 158' ≤5% pebbles, 90% S, 5% M	
155	Grab			158' – 159.5': Slightly Silty Sand (M) S Poorly sort. with 80-85% vf-vc ang. S (50-60% felsic, 40-50% basalt) C-VC S (15-80% basalt), 10-15% M (lt. brownish gray 2.5Y 6/2 sl moist) & ~5% vf pebbles. Mod. HCl rxn	G.S. @ 155' bgs

Reported By: N. Bowles / J. Horner | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: [signature] / [signature] | Date: 7-17-06 | Signature: [signature] | Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 7-17-06 start 7/18/06 - Finish

Well ID: C4996 | Well Name: Entry B.H. #2 | Location: WTP Seismic Borehole #2

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
160	Grab			159.5'-165.5': Sand (S)	Cable tool drilling w/
				well sort. w/ 95-98% vf-m ang. S (75-80%	hollow drive barrel.
				felsic, 20% basalt) + <5% vf-f	
				ang. pebbles. Max = 1cm, mod HCl rxn	G.S @ 160' bgs
				light brownish gray (2.5Y, 6/1.5, slightly moist)	
165	Grab			161-162 - pebble fraction = 20-30% (gS)	
				165 moist, light olive brn (2.5Y 5/3, moist)	GS @ 165' bgs
				vf-c (70% m) Sand (80% felsic)	
	Grab			165.5'-170': Sandy Gravel (sG)	
				Poorly sort. & matrix supported w/ 65%	GS @ 168' bgs
170	Grab			vf-vc ang. S (65-75% felsic, 25-35% basalt)	GS @ 170' bgs
				+ 35% well-rounded vf-vc pebbles	
				(60-70% basalt) max = 5cm, mod. HCl rxn.	
				<5% silt lt. brownish gray (2.5Y, 6/1.5, sl. moist)	
				dark grayish brown (2.5Y, 4/2, wet)	
175	Grab			167' small cobbles, max = 12cm (S=80%)	G.S. @ 175' bgs.
				50% G, 50% S	
				170'-172': Silty Sandy Gravel (msG)	
				Poorly sort. matrix supported w/ 50-60%	
				vf-vc sub-rounded - ang. pebbles +	
180	Grab			small cobbles (60%-70% basalt),	
				20-30% m-vc ang. S (50-70% basalt)	G.S. @ 180' bgs.
				+ 15-20% dark grayish brn (2.5Y, 3/2,	
				moist), silt. Max = 70cm, mod. HCl rxn.	
				Consolidated (harder drilling)	
185	Grab			172'-175.5': Sand (S), fine to vc.	
	Tritium			(>95%), w/ v. sparse gravels	G.S. @ 185' bgs.
	Split-Spoon	60% rec. (50% rec. / 86 Blows)		to max 1/2" (md. pebble). Sands	Grab "Tritium" Sample @ 187'
				are 60% felsic/40% basalt, subang,	Split-Spoon Sample
190	Grab/Tritium			well sorted, unconsolidated/loose.	From 187.5 to 190.0'
				→@ 173.5': reduce grain size: fine to vc.	(Driven 2.5 [w/ Shoe] w/ 65%
				→@ 175': increase max gravel to 1"	recovery)
				175.5'-176.5': Sandy gravel (sG)	Liners: A: 188.5-190.0', HEIS
				~40% gravel (v.fine to vc. pebbles,	# B1K4411; 7 Blows
				subrd. to subang, 70% basalt.	B: 188.0-188.5', HEIS
195	Grab			~60% Sand (fine to v. cse), subang,	# B1K4412; 31 Blows
				60% basalt/40% felsic.	C: 187.5-188.0', HEIS
				- poorly sorted, unconsolidated, dry	# B1K4413; 45 Blows.
				& no H — v. Slight HCl Rxn,	Grab S-sal Bulk Sample From
				Matrix supported 7/18/06 p.7 →	187.5-190.0', HEIS # B1K4415

Reported By: J. Horner / N. Bowles | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: John Horner / N Bowles | Date: 7/18/06 | Signature: L D Walker | Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 7/17/06 - Start; 7/18/06 - Finish

Well ID: C4996 | Well Name: Entry B.H. #2 | Location: WTP Seismic Borehole #2

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				176.5 – 178.5': Sand (S)	Cable-Tool drilling w/ hollow drive barrel
				>90% v. fine to md. sand, mod. to well sorted, loose, dry, 60 to 70% Felsic/30-40% basalt, <10% silt.	Grab "Tritium" sample @ 190'
				v. slight to no HCl Rxn.	G.S. @ 190' bgs
					G.S. @ 1955' bgs.
				178.5 – 179': Silt (M)	
				~90% silt, nonplastic, mod. to strong HCl Rxn, lt. brn (2.5Y 6/3)	
				~<10% v. fine to fine sand, >95% felsic, subang.	
				179 – 190.5': gravelly sand (gS), Matrix Supported (S) 7/17/06	
				~15% gravel to max 1" (v.c. pebble),	
				80% basalt, subrd to subang.	
				~80 (S) 7/17/06 ~85% sand, fine to v.c.se,	
				~50% basalt/50% felsic, subang,	
				loose/unconsolidated, poorly sorted.	
				→ @ 183': sporadic silty sand laminations v. thin (<1"), ~25% silt, 75% v. fine to md. sand.	
				→ @ 185': increase in gravel cont. to ~25%, no more silts.	
				→ @ 187' increase in gravel size to ~2" max (v.c. pebble). Overall gravel cont. ~<30%.	
				190.5 – 195': Sandy Gravel (sG)	
				matrix supported, poorly sorted,	
				~40% gravel (90% v. fine to c.se pebbles, max to ~6" (lg. cobble),	
				80% basalt, subang. to subrd.	
				~60% sand (fine. to v.c.se),	
				50% basalt/50% felsic, subang.	
				(unconsolidated/loose (caving)	
				→ @ 192': increase gravel content to 60% Clast supported (S) 7/17/06	
				→ @ 194': presence of v. thin (<1") silty sand laminations (sporadic).	
				195 – 204': gravel (G)	
				>90% clast supported gravels	
				(NS) 7/18/06 To 6" max size (80% v. fine to md. pebbles, ~20% c.se to v.c.se pebbles)	
				~80% basalt, subrd. to subang.	
				<10% md. to v.c.se sand. Poorly sorted, No HCl Rxn. (NS) 7/18/06	

Graphics on previous page (p.6) (S) 7/18/06

Reported By: J. Bowles (NS) 7/18/06	Reviewed By: L.D. Walker
Title: Geologist	Title: Geologist
Signature:	Date: 7/18/06
Signature: L.D. Walker	Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 7-18-06 start

Well ID: C4996 | Well Name: Entry B.H. #2 | Location: WTP Seismic Borehole #2
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
200	Grab			201': 75% G, 20% S & 5% M 202'-204': Large cobbles are present Silt is dark gray (2.5Y, 3.5/1, moist)	Cable tool drilling w/ hollow drive barrel GS @ 200' bgs
205	Grab			204'-208.5': Silty Sandy Gravel (msG) P sort w/ ~60% vf-vc sub-rnd-rnd pebbles (80% basalt) & cobbles (50-60% basalt), 25% vf-vc ang.-sub-ang. S (80% basalt) & ~15% silt, dark gray (2.5Y, 4/1, moist; 2.5Y, 6/1, dry) max = 35 cm, wk HCl rxn. Clast supported. Note: silt content likely due to crushing of gravels during wireline drilling.	GS @ 205' bgs {Adding water low recovery.}
210	Grab				G.S. @ 209.5' bgs.
215	Grab			208.5 - 210': Sandy gravel (sG) return to <10% silts, similar to 204'-208.5; w/ less silt, reduce max gravel size to ~4" (sm. cobble), clast supported, v. weak HCl Rxn. ~60%G, ~30%S	G.S. @ 215' bgs.
220	Grab			210 - 212': Sandy silt (mS) (s) (M) (NS) 7/18/06 - 40% sand, v.fine to fine w/ v.sparse. md. to cse sand grains, >95% felsic, sub ang. - 60% silt, nonplastic, lt. Brn (2.5Y 6/3). - well sorted, mod. to strong HCl Rxn, moisture unknown due to added H2O).	G.S. @ 220' bgs.
225	Grab			212 - 230': Sand (S) <10% gravel to max 2", sub rd. to sub ang, 90% basalt >90% Sand (80% fine to md, 20% f/se to v.cse), 70% felsic, 30% basalt, dry, mod. to strong HCl Rxn. Sand is ang. to sub ang, Poorly sorted. →@ 214': No gravels, otherwise same. →@ 216': decrease grain size to Sand: 80% v.fine to fine (SS 7/24/06), <10% cse to v.cse; silt: <10%; 90% to 90% felsic,	GS @ 225' bgs GS @ 230' bgs GS @ 235' bgs 7-20-06 Split spoon @ 230.5' - 233' bgs 230.5'-231': B1K4Y9 231'-231.5': B1K4Y8 231.5-232': B1K4Y7 232'-232.5': B1K4Y6 232.5'-233': shoe (NO rec) Bucket Sample 230.5-233' B1K500
230	Grab				
	Split-Spoon sample	18, 32, 70, 50/5"		269 Total blows >5" rec.	
235	Grab				

Reported By: J. Horner / N. Bowles | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: [signature] Date: 7-16-06 | Signature: [signature] Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 7/20/06 - Start; 7/20/06 - Finish

Well ID: C4996 | Well Name: Entry B.H. #2 | Location: WTP Seismic Borehole # 2
Project: WTP Seismic Boreholes Project. | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
					Cable-Tool drilling w/ hollow drive barrel
				221' – 222.5': Sandy Gravel (sG) Similar to sG from 208.5 to 210' max 6 to 2", sub rd to sub ang. clast supported, v. wk-HCl Rxn 75% G, 25% v. fn. to v. crse S, G is 80% basalt, ~~Sand~~ PB 7/20/06	
				222.5-224': ~~Sand (S)~~ PB 7/20/06 Sandy (S) 25% silt, v. sparse G to max 2" (5%). 90% S, 90% v. fn. to md., <10% crse to v. crse, ~80% Felsic, slightly moist, mod. to strong HCl Rxn. wk consolidated, lt brownish gray (2.5Y, 6/2, sl. moist)	
				224'-230.5': Sandy Gravel (sG) Poorly sort. & clast supported w/ 70-80% ang.-sub-rnd vf-m pebbles (70% basalt) ~20-25% f-vc (30% vc) ang. S (60-70% basalt) & <5% silt. Dark grayish brn (2.5Y, 4/2, moist) with a lt yellowish brn oxide coating on many grains. Max = 4cm, wk HCl rxn. Soil is slightly moist, S above is dry. 228' sand & silt fraction increase slightly light yellowish brn staining is less prevalent 230.5' S & M fraction decrease (~80% G) f-vf pebbles - ang.-sub-rnd m-c pebbles rnd-well-rnd.	* Paleosol ? water added below 233'
				230.5'-252': Gravel (G) Similar to sG above, with ~80% G (basalt ~80%). 240-249 PB 7-20-06 G fraction & S fraction range from 70/30 – 90/10 (S/G) minor silt is present. Dominatly clast supported gravel.	

Reported By: N. Bowles / J. Horner | Title: Geologist | Signature: [signature] | Date: 7/20/06
Reviewed By: L.D. Walker | Title: Geologist | Signature: [signature] | Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 7-20-06

Well ID: C4996 | Well Name: Entry Bh. #2 | Location: WTP Seismic Borehole #3
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No	Sample Blows Recovery	Graphic Log	Sample Description	Comments
240	Grab				Cable tool drilling w/ hollow drive barrel
					GS @ 240' bgs
245	Grab				GS @ 245' bgs
250	Grab				GS @ 250.5' bgs
	Tri-Cone split spoon	245 blows/ 80%Rec			Grab "Tritium" sample from 252' bgs
255	Tri-Cone Grab			252 – 254.5': Sandy Gravel (sG) poorly sorted, clast supported sG; ~75% Gravel, v. fine to coarse, v. sparse v. crse. pebbles (<5%) Subang to subrd, 80% to 90% basalt, ~20% Sand, crse. to v. crse, subang to subrd, 80% to 90% basalt. ~10% silt, lt. reddish brn to dk. gray (10YR 5/4 to 10YR 3/2, mixed) Moisture is artificial due to H2O (from earlier drilling). → @ ~253? within (~2" thick) layer of silty Sand, Weathered, oxidized, w/ <10% gravels, (same silt material as described above), found in fragments; incr. Pebble content in the sands (~60%) ~40% basalt, fairly cemented.	Split Spoon Sample from 252 to 254' bgs. Lowers: Blows? Depth Int: A: / 71 blows / 253.5-254' bgs B: / 116 blows / 253-253.5' bgs C: / 68 blows / 252.5-253' bgs D: / 20 blows / 252-252.5' bgs 80% overall recovery: (33%/100%/100%/83%) HEIS# BIK501 BIK502 BIK503 BIK504
260	Grab				Bulk sample (5 gal. bucket.) from 252' to 254' bgs HEIS# BIK506
265	Grab Grab			No HCl Rxn	Grab "Tritium" sample @ 254.5' bgs
					GS @ 254.5' bgs
					G.S. @ 260' bgs
					G.S. @ 265' bgs
270	Sand	W.L. ▽			G.S. @ 266' bgs Hiatus. GS @ 270.5' bgs
				254.5 – 256': Sandy Gravel (sG) v. similar to that found from 230.5 to 252' bgs, but w/ increased Pebble content in the sands (~60%) ~40% basalt, fairly cemented.	GS @ 275' bgs
275	Tritium sample Sand Split Spoon sample	16 51 60 65 70 250 blows 75% rec.		256 – 258': Sandy Gravel (sG) increase sand content to ~30%. v. cemented, weathered/oxidized.	Split-spoon sample information on pg. 11 DTW = 279.3' bgs on 2/22/06

Reported By: J. Herner / N. Bowles | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Jake Herner / Nate Bowles | Date: 7-21-06 | Signature: L.D. Walker | Date: 8/3/06

A-6093-642 (03/03)

BOREHOLE LOG

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Date: 7/20/06 – start; 7/21/06 – finish

Well ID: C4996 | Well Name: Fatty B.H. #2 | Location: WTP Seismic @ #2 Fatty Borehole #2

Project: WTP Seismic Boreholes Project. | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				258 – 259.5: silty sand (mS) ~75% v. fine sand (w/ v. coarse fine sand). ang. to subang., >95% felsic Tritium GS @ 275.5' ~25% silt, lt. brn. (2.5Y 6/2). 7-21-06 Split-spoon - v. well sorted w/ v. slight moisture 275.5 – 278.2' bgs (HCl rxn unknown, out of solution). Liner : Intv : HETS# : Blows : rec	
				259.5 – 261: Sandy gravel (sG) ~40 to 50% gravel, to max size 1.5" (v. fine to v. coe pebbles) ~40% basalt, subrd. to subang. ~40 to 50% sand, ~90 to 95% felsic (75% v. fine to fine, 25% md. to v. coe) - Poorly sorted, v. slight moisture (HCl rxn unknown, out of solution), ~10% silt, lt brn overall (silt & sand; 2.5Y 6/2). @ 7-21-06	D: 275.5-276': BIK509: 16 : 90 % C: 276'-276.5': BIK508: 49 : 100 % B: 276.5-277': BIK507: 60 : 100 % A: 277'-277.5': BIK506: 65 : 100 % Bulk: @ 7-21-06 shoe/277.5-278.2/70 blows/no rec. Bucket sample: BIK510 Total blows = 250
				261 – 266': Sandy gravel (sG) Poorly sorted, clast supported, ~75% ang. to subang. gravels (v. fine to max 1.5", v. coe pebbles), 70% basalt. ~20% (~20%) sand, ang to subang. (~60% felsic - v. hard/compacted, cemented w/ iron staining/oxidation (yellowish- brown/red oxides coating grains) <5% silts. Moisture unknown due to added H_2O. HCl Rxn unk. → @ 264.5 increase in gravel max size to 3" (sm. cobble), increase in silt content to <10%, v. dry.	
				266' – 270: sG Poorly sort. w/ ~60% vf-c pebbles (vf-f, ang ~50% basalt; m-c, subrnd to rnd ~30% basalt), ~30% m-vc ang. S (~50% basalt), ~20% f-vf sub rnd S (70-80% felsic/qtz) small pockets →	

Reported By: J. Bowler / J. Horner | Title: Geologist | Signature: [signature] | Date: 7-21-06

Reviewed By: L.D. Walker | Title: Geologist | Signature: [signature] | Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 7-21-06/7/25/06 Finish

Well ID: C 4996 | Well Name: Entry DH. #2 | Location: WTP Seismic Borehole #2

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
280	Grab			of oxidized, v.f-f(SH) yellowish brn S (2.5Y, 5.5/6, moist) are present (2-3cm) dominant matrix color is dark grayish (2.5Y, 4/1, moist) Mod. weathering max grain = ~4cm. HCl rxn unknown (no solution)	Cable tool drilling w/ hollow drive barrel G.S. @ 280' bgs
285	Grab			G fraction increases from 60-80% between 268 & 270' bgs. Saturated @ ~268'	G.S. @ 285' bgs.
290	Grab			270' - 279: Gravel (G) Mod sort, clast supported w/ bimodal distribution of ~80% well-rounded-sub-rnd Mod-crs pebbles (~50% basalt & ~5% uc-s ang. S (~50% basalt, <5% M & v.f-vf S (~80% qtz). Max = 4-5 cm.	G.S. @ 290.5' bgs.
295	Grab			~271 M fraction increases to ±10%. M is concentrated on pebble surfaces. ~273-274: loose vf-f S (poor recovery) ~274 G cont. w/ <5% M	G.S. @ 295.5' bgs.
300	Grab Trit. Split Spoon Trit. Grab Grab	66% rec 204 blows (8/21/50/183)		279 - 293.5': Sand (S) >95% sand (90% vfg. to crse., <5% fine., 65% v.crse.) Sub. ang. to ang., ~70% felsic, Wk. HCl Rxn. <5% silt in clumps (representing likely v. thin (< 1") silty sand layers at unknown depths, well sorted (Note: V. easy drilling / loose).	G.S. @ 300.0' bgs. Grab "Tritium" Sample from 301.0' bgs. Split spoon sample from 301.0 to 303.0' bgs
305	Grab Grab			→ @ ~288': "Sands" appear to be heaving (coming up (using mixing Rod).	(B) 303-302.5', 63% rec, Hess # B1K712, 68 blows. (B) 302.5-302', 100% rec,
310	Grab ? Trit. + Split-Spoon Sample Grab	95% rec 437 blows (50/4" 50/3" 50/3" 214)		→ @ ~289.5': Increase silt to ~10%. → @ ~290.5': Increase in S grain size to 10% rnd., 90% crse to v.crse also v. sparse rd. gravels to 1" max (1 pebble), S grains 60% felsic, Silts back to ~5% or less, no longer heaving. → @ ~293.8': increase silt to ~10%.	Hess # B1K713, 61 blows. @ 301.5-302', 83% rec., Hess # B1K714, 68 28 blows 7/25/06 (B) 301-301.5 → No rec, No sample. 5.99 bucket Bulk Sample from 301-303' bgs, B1K716 Grab "Tritium" Sample from 303.5' bgs. G.S. @ 304.5' bgs.

Reported By: J. Horner/N. Bowles | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: [signature] Date: 7-25/06 | Signature: [signature] Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 12 of 15
Date: 7/24/06 - Start 7/24/06 - Finish

Well ID: C4996 | Well Name: Entry Bh. #2 | Location: WTP Seismic Borehole #2
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				293.5 – 295': Slightly silty gravelly sand ((m)gS). ~60% (a) md. to v.cse sand, subang. - ang., ~60% felsic. ~15% gravel, to max 1.5" (v.cse pebble), sub ang. to sub rd. ~15% silt, H. grey/brn (10YR 4/1) v. wk. to no HCl Rxn, matrix supported. → @ 294.5': inc. in silt to ~20%, gravel dec. to >10% (Note: Silt cont. appears in thin (<1") laminations throughout). → Poorly sorted (esp. w/ silt layers).	G.S. @ 305.5' bgs G.S. @ 310' bgs G.S. @ 315' bgs
				295 – 297': Sand (S) Similar to S. Found @ 285' bgs (in interval 279 – 293.5), but w/ v. sparse gravel to max 1".	
				297 – 304': Silty sandy gravel (ms(G)) ~60% G, sub rd., wide fn to cse. pebbles (max 1"), 60% basalt ~25% S, (~80% md. to v.cse; <20% v. fine to fine). ~60% felsic, ang. to subang. ~15% silt, non plastic, 10YR 5/3 overall: poorly sorted, clast supported, Signs of discoloration due to weathering/oxidation, v.wk. HCl Rxn. → @ 300': Silt cont. red. to >10%, Gravel max size to 6" max (v. sparse at this size). → @ 303.5', Gr. cont. inc. to ~70% G (>10% silt, ~20% S).	
				304' – 305': Silty Gravel (m G) Similar to above, although increase G. to 75%; Silt inc. to 15%, w/ discoloration ranging from lt. yellowish brn (2.5Y 6/4) to H. pink/lavender (10R 8/2); Sand dec. to <10%. Overall: V. poorly Sorted, high consolidation, clast supported.	

Not used

Reported By: N. Bowles for 7/24/06 | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: for 7/24/06 | Date: 7/24/06 | Signature: L.D. Walker | Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 14 of 15
Date: 7/24/06 - Start
7/25/06 - Finish

Well ID: C4996 | Well Name: Entry B.H. # 2 | Location: WTP Seismic Borehole # 2
Project: WTP Seismic Boreholes Project. | Reference Measuring Point: Ground Surface

Depth (Ft)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
320	Grab			305-312: Gravel (G), v. poorly sorted, clast supported, highly consolidated Gravels consisting of >80% G, to max size of ~6 to 8" (fragments) subrd. to subang, 60% basalt, ranging from v.f. pebbles to lg cobbles; <10% sand, v. fine to v. crse, subang. to subrd., >70% felsic, <10% silt, lt yellowish-brown (2.5Y 6/4) overall: No HCl Rxn, yellowish-brn coating all grains/gravels (silt fraction). (Note: Begin hard-tool drilling @ 305.5' [305' tagged w/ tools]). 7-24-06	Cable-Tool drilling w/ hollow drive barrel. Switch to Hard Tool @ 305.5' bgs. (v. hard drilling @ 305' bgs). GS @ 321' bgs (315-324) Split-spoon 312-314.5' 312-312.5' - BIK717 312.5-313 - BIK718 313-313.5 - BIK719 313.5-314 - BIK720 Bulk sample 312 - BIK721
325	Grab				
330	Grab				
335	Grab			312'-336': Sandy Gravel (sG) well consolidated, poorly sort (bimodal) with 50% G: f-vc, rnd-sub-rnd heterolithic pebbles (20-40% basalt), 40-45% S: f-c, ang. (60% med.), olive yellow (5Y, 6/6, moist) 5-10% M present in small weathered pockets (secondary minerals), max = 6cm, nonreflective	G.S. @ 326' bgs Hard Tool (321-326') G.S. @ 330' bgs (326-330' Hard tool)
340	Grab			→ 326-330: Highly pulverized, possibly higher silt content (pud. v. thick mud, not settling out). → 330-336: Less muddy (less silt?) → 336-341: v. thick mud retrieved w/ bailer, consistency of thick paste; lower gravel content? Increased silt fraction. Also (AB) 7/26/06	(note: cuttings from 326 to 330' v. muddy!) G.S. @ 336' bgs (330-336' Hard tool) G.S. @ 341' bgs (336'-341' w/ Hard Tool) (note: v. thick mud / thick paste).
345	Grab			336-349': silty sandy gravel (msG) → Poorly sorted, v. well consolidated, msG (mud overall gray/brn, 2.5Y 5/2) ~40% G, v. fine to fine pebble (pulverized), likely up to ~1" max (rse pebble). ~40% basalt, ang (pulv.) to rd. (unbroken) ~35% sand, v.f. to v. crse, ~40% basalt ang. to subang. ~25% silt (v. thk. mud in cuttings)	Note: Drilling became m. harder @ 343' bgs. G.S. @ 345' (341'-345' Hard tool) GS @ 349.5' (345'-349.5' Hard tool) GS @ 355.5' (349.5'-355.5' Hard tool)
350	Grab				
355	Grab				

Reported By: N. Bowles / J. Horner | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: [signature] | Date: 7/25/06 | Signature: [signature] | Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 15 of 15
Date: 3/26/06 - Start; 7/27/06 - Finish

Well ID: C4996 | Well Name: Entry B.H. #2 | Location: WTP Seismic Borehole #2
Project: WTP Seismic Boreholes Project. | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
360	Grab			·349.5 bailed mud is slightly darker, (dk grayish brn, 2.5Y, 4/1.5, wet), cuttings contain 60-70% basalt	Hand tool drilling w/ cable tool drill rig
				349 - 369': Basalt	Casing stopped @ 349.1' & used hand tool to ~357'
365	Grab			Bailed mud is v. dark gray (5/gley 1, 3/N, wet), washed grains consist of med- vc angular sand sized cuttings ~80% basalt, 20% felsic granule (felsic grains are likely carried down from above 249' bgs)	Change out bit to 8" button bit @ 358' bgs
	Grab	T.D. -			G.S. @ 360' bgs (358 - 360' Hard Tool)
370				7/26/06 359 → @ 358 to 360': Thin mud, dk grey (5Y 4/2) w/ highly ang. pulv. basalt fragments. V. sparse non-basalt chips (likely from higher intervals). Basalt is somewhat vesicular and v. fragments coated w/ other minerals	G.S. @ 365' bgs (360 - 365' Hard Tool)
				Drill time: 2ft/35 min ⇒ ~4.75 ft/hr	G.S. @ 369' bgs (365 - 369' Hard Tool)
				→ @ 360 - 365': v. thick mud, dk grey (5Y 4/1) w/ highly ang. pulv. basalt chips, similar to previous interval. Remains slightly vesicular.	Drilled to 369' bgs & a final tag @ 387.7' bgs (~1.3' of settled cuttings)
				Drill time: 5ft/2hr, 5min ⇒ ~1.75 ft/hr.	
				→ @ 365 - 369' v. thick mud, 7/27/06 v. dk grey (5Y 3/1). similar to above w/ vesicular basalt chips showing signs of weathering on some surfaces (discoloration). Also v. sparse, compressed silt-like fragments, v. brittle, dk. yellowish-gray (2.5Y 3/2).	
				Drill time: 4ft/1hr, 30min ⇒ ~2.67 ft/hr.	
				T.D. = 369' bgs.	
				* Rotary borehole will continue below this point.	

Reported By: N. Bowles / J. Horner
Title: Geologist
Signature: [signature] / Jake Horner | Date: 7-27-06

Reviewed By: L.D. Walker
Title: Geologist
Signature: [signature] | Date: 8/3/06

A-6003-642 (03/03)

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APPENDIX C

BOREHOLE LOG
ENTRY BOREHOLE C4997

BOREHOLE LOG

Page 1 of 13

Date: 7/30/06 - Start
7/31/06 - Finish

Well ID: C4997 | Well Name: Entry B.H. #3 | Location: WTP Seismic Borehole #3

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0 - 16.8': Sand (s) fill material (non-native), well consorted, slight moisture, v. sparse gravels (to max ~1") subrd to subang, ~5% silt, >90% v. fn to fn Sand, mod. HCl Rxn, lt. brn to grayish color.	Cable Tool drilling w/ hollow drive barrel.
5	Grab			@ 7': increase in moisture, compaction. Also, increase silt cont. to <10%, color: dk. brn (5Y4/2), mod to strong HCl Rxn.	Note: v. poor lighting conditions for examining soils (0' → 5' bgs). G.S. @ 5' bgs.
10	Grab			~16.8'-17'-2" layer of s.s. vf. sub-ang. S(~80% felsic, 20% basalt) dk. brn (2.5Y4/3) weakly cons. sl. moist, no HCl rxn	G.S. @ 10' bgs.
15	Grab			17' - 63': Sand (S), Native, well sort m-vc ang. S(~80% basalt) dk gray to black, no HCl rxn, max = 2mm, no silt, 80% m-vc S. 18' grain size decrease to ~70% m 20' grain size increases back to 70% c	G.S. @ 15' bgs. Split spoon 20.6-23.1' 20.6-21.1'; 25 blows; BIK867 21.1-21.6'; 35 blows; BIK868 21.6-22.1'; 40 blows; BIK869 22.1-22.6'; 45 blows; BIK870
20	Grab			@ ~26.5' bgs: v. thin (2") layer of w.s., v.f.-m.S, 80% felsic, brn, v. similar to layers from 16.8 to 17'.	20.6-23.5': Bulk; G.S. @ 20' bgs. G.S. @ 25.5' bgs.
25	Split-Spoon ↓	192 blows 100% rec		@ 33.5' bgs: Same as above (v. thin, <1", vf. m.S), No HCl Rxn	7/31/06
	Grab			@ ~36.5' bgs: Showing v. sparse gravel to max size 2" subrd. to subang, <5% (v. fine pebble)	7/31/06
30	G.S. IBS Split Spoon	100% Rec 156 Blows (10/29/45/39/33)		@ ~37.5' v. sparse (<5%) Gr. to max 6" (lg. cobble) rd. to subrd, Continues ↓	G.S. @ 30.5' bgs (PS Particle Size analysis) Sample @ 30.5' bgs: Split Spoon sample from 30.1' to 32.1' bgs A: 31.6-32.1', 39 Bl.# B1K871 B: 31.1-31.6', 4581.# B1K872 C: 30.6-31.1', 2981.# B1K873 D: 30.1-31.1', 1081.# B1K874
35	G.S.			7/31/06 P.2	Water initially → Slough 7/31/06 G.S. @ 35.5' bgs.

Reported By: N. Bowles / J. Horner | Reviewed By: L. D. Walker

Title: Geologist | Title: Geologist

Signature: [signature] Date: 7/31/06 | Signature: [signature] Date: 8/23/06

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 7/31/06 - 8/1/06 - finish

Well ID: C4997 | Well Name: Entry B.H. #3 | Location: WTP Seismic Borehole # 3

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	G.S. 1&2 S. Split Spoon	100% Rec 30# Blows (20/45/65/ (63/84)		(Cont'd) Sand from 7' → to ± 44' bgs (WB) 7/31/06	Cable-Tool drilling w/ hollow drive bastel. G.S. @ 40' bgs
				→ @ ~43' bgs: v.fn to v.c.se Sand (80% v. fn to fn, 20% md. to v.c.se) poorly sorted, ~70% felsic w/ v. sparse gravels to ~ 1/2" (md. pebbles) & <5% silt. v. wk to No HCl Rxn., overall lt brn/gray (5Y 5/2).	P.S. @ 40' bgs. Split-Spoon Sample From 39.4' → 41.4' bgs. A: 40.9'-41.4'; 63BL, B1K875 B: 40.4-40.9'; 65BL, B1K876 C: 39.9-40.4'; 65BL, B1K877 D: 39.4-39.9'; 20BL, B1K878
45	G.S.				
50	G.S. 1&2 Split Spoon	100% Rec 30# Blows (9/38/58/ (69/134)		→ @ 44' bgs: 1 cont. w/ S sim. to above. 43'. Max @ to 1/2" (md. pebble), v. sparse. → @ 46' bgs: return to S sim. to 43'-44', w/ 60% felsic to 47' bgs. 70% basalt	*D is all slough G.S. @ 45' bgs G.S @ 50.5' bgs P.S @ 50.5' bgs Split-Spoon Sample From 50.2' - 52.2' bgs.
55	G.S.			→ @ 47': Return to ~~50%~~ basalt Sand, Mod. Sorted, fn. to v.c.se., sub ang. to sub rd., v. wk. to No HCl Rxn., <5% silt.	A: 51.7'-52.2'; 6BL; B1K879 B: 51.2-51.7'; 5BL; B1K880 C: 50.7-51.2'; 3BL; B1K881 D: 50.2-50.7'; 9BL; B1K882 *D has ~0.3' of slough.
60	G.S.	& P.S.		→ @ 54': Inc. in Basalt cont. to ~ 80%, md. to v.c.se.	G.S. @ 55' bgs.
	Split Spoon	29 46 blows 100% rec (29, 25, 60, 55, 134)		→ @ 55' return to same as 47-54' (70% basalt, fn. to v.c.se Sand).	G.S. @ 60' bgs. Split spoon sample 60.3-62.8' A: 61.8-62.3'; 55BL; B1K883 B: 61.3-61.8'; 60BL; B1K884 C: 60.8-61.3'; 25BL; B1K885 D: 60.3-60.8'; 20BL; B1K886
65	Grab Split Spoon 69.8-72.5	BH B-1-06		.57' silt fraction inc. to ± 10% S is weakly cons. in small zones w/ higher silt concentrations. 65'-64': Slightly Silty Sand (m) S Mod. sort. weakly cons. w/ 85% S: m-vc ang., 60% felsic, 40% basalt & <5% M: greyish brn (2.5Y, 4.5/2, sl. moist) Strong rxn w/ HCl. Sparse vc S grains.	*D is likely slough G.S. @ 65' bgs. Split spoon sample 69.8-72.5' A: 71.3-71.8'; 52BL; B1K887 B: 70.8-71.3'; 36BL; B1K888 C: 70.3-70.8'; 20BL; B1K889
70	Grab/GS Split Spoon 69.8-72.5	100% rec 32 28 blows (9, 24, 65, 117, BH B-1-06 9, 20, 36, 52, 111)		64'-~~66~~ 65': Sand (S) dk greyish brn (2.5Y, 4/2, moist) Mod.-poorly sort. loose S: vf-vc (80% m-c) ang. 270% basalt (no silt) 64.5'-: silt fraction inc. to ≤10%, inc. moisture, sl. oxidized weak soil development. Ol. brn (2.5Y, 4/4, moist)	G.S. @ 70' bgs D: 69.8-70.3'; 9BL; B1K890 Bulk (~70-72.5'): B1K891
75	G.S.				G.S. @ 75' bgs

Reported By: N. Bowles / J. Horner | Title: Geologist | Signature: | Date: 8/1/06

Reviewed By: L.D. Walker | Title: Geologist | Signature: | Date: 8/23/06

A-6003-842 (03/03)

BOREHOLE LOG

Page 3 of 13

Date: 8-1-06 - Started. 8/2/06 - Finish

Well ID: C4997 | Well Name: Entry B.H. #3 | Location: WTP Seismic Borehole # 3

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
80	G.S. / 9.5 Split-Spoon	100% Rec 287 Blows (23/49/55/121/59)		66.5'-103.5': Sand (S) well-sort, loose S: vf-vc (90% vc) v. ang. >75% basalt, minor silt (<2%), many oxid. grains, no HCl rxn, v. dk gray (5Y, 3/1, dry) .69' silt fraction → sto ≤ 10% v. sparse pebbles, max = 5 cm. Grayish brn (2.5Y 4/2) strong HCl rxn.	Cable tool drilling w/ hollow drive barrel G.S. @ 80' bgs. P.S. @ 80' bgs. Split-Spoon Sample From 79.7' to 81.7' bgs. (#8 8/1) G.S. @ 85' bgs.
85	G.S.			72.5 Silt fraction ≤ 5% 1-2 cm layers ~~of M~~ (8-1-06) concentrated with M & mod. oxidized lt. yellowish brn (2.5Y, 6/4 sl. moist)	
90	G.S. / 9.5 Split Spoon	100% Rec 245 blows (17/30/43/48/10/69)		77' 98% S, ang. 75% basalt, sl. oxid. 1% M no HCl rxn, v. sparse pebbles (1-4 mm) dk gray 84' bgs: ~90% v. f-to-md. S w/ ≤ 5% vcse & v. sparse pebbles to max 1 cm. <5% silt. moist, well to mod. sorted. v. compacted, v. wk. HCl Rxn., lt. gry/brown (2.5Y 4/2), 60% Feldsis. to ~85.5'	G.S @ 90' bgs. P.S @ 90' bgs. Split-Spoon Sample From 89.6' - 91.6' bgs A: 91.1-91.6'; 1 Bl.; BLK895 B: 90.6-91.1; 4 Bl.; BLK896 C: 90-90.6; 30 Bl.; BLK897 D: 89.6-90.1; 17 Bl.; BLK898
95	G.S.			→@ 85.5': Return to ~75% basalt. (Sim to that from 72.5-77') weathered/oxidized grains increase, 80% fine to md. S., ~15% vcse. to vcse S., v. Sparse v. fine pebbles (to max 3 mm). <5% silt lft v. hm. S. Note: Hole Sloughing open v. well & casing driven harder	(#5 8/1/06) 100% Rec. 245 Blows total Bulk "5-gal bucket" sample From 89.6 - 91.6' bgs HEIS # B1K8F7
100	G.S. / 9.5 Split Spoon	100% Rec 244 Blows (64/24/61/63/92)			Split-Spoon Sample Even 79.7' to 81.7' bgs (#6 8/1/06) A: 81.2-81.7'; 12 Bl.; B1K891 B: 80.7-81.2; 55 Bl.; B1K892 C: 80.2-80.7; 49 Bl.; B1K893 D: 79.7-80.2; 23 Bl.; B1K894
105	G.S.			→@ 88' v. thin (<1") layer of highly oxidized sand laminations w/ lt yellow & orange grains. Mod. to Strong HCl Rxn.	100% Rec. / 287 Blow tot. Bulk "5-gal. Bucket" Sample From 79.7-81.7' bgs HEIS # B1K8F6
110	G.S. / 9.5 Split-Spoon	100% rec. 289 blows (60, 27, 41, 102, 109)		→~~90'~~ (#8 8/1/06) ~ <10% silt. →@ 98.5': v. Sparse cobbles to max 6", rd. ~1" (#8 8/1/06) →@ ~92': v. thin (~~<2"~~) layer of well consolidated, oxidized & bleached sand w/ lt. yellow to orange grains (v. similar to that @ 88', <10% silt, →@ 94': same as 92' & 88' (<2").	G.S. @ 95' bgs. G.S. @ 100' bgs. P.S @ 100' bgs (#C2) Split-Spoon Sample From 99.7 to 101.7' bgs, 100% recovery, 244 blows total
115	G.S.				

P.4 → Cont'd P.4 →

Reported By: J. Horner / N. Barcles | Title: Geologist | Signature: [signature] | Date: 8-2-06

Reviewed By: L. D. Walker | Title: Geologist | Signature: [signature] | Date: 8/23/06

End

A-6003-642 (03/03)

BOREHOLE LOG

Page 4 of 13
Date: 8/1/06 – Start

Well ID: C4997 | Well Name: Entry B.H. #3 | Location: WTP Seismic Borehole #3
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120					Cable-Tool drilling w/ hollow drive barrel.
				→ 95': cont w/ ~75% basalt & s/w/ weathered/oxidized gravels), v. similar to that described @ 85.5'.	Continuation of Split-Spoon into:
				→ @ ~103.5': thin (up to 2" thick max) layer of Silt(m) <5% v.fine sand, 95% non-plastic, moist, v. compacted, strong to v. strong HCl reaction, lt brn (5YR 5/3), v. well sorted.	A: 101.2-101.7; 63BL; B1K899 B: 100.7-101.2; 51BL; B1K880 C: 100.2-100.7; 24BL; B1K881 D: 99.7-100.2; 14BL; B1K882 Bulk "5-gal. Bucket" Sample From 99.7-101.7' bgs HEIS # B1K8F8
				103.5 → 124.5 Sand (s) Mod. Sorted, v. slight moisture, 70% v.fn. to md S, w/ source rock to v. coarse grains, subang, 50-60% basalt/40 to 50% basalt, overall color: lt gy/brn (5Y 5/2), <10% silt, v. wk HCl Rxn, fairly well consolidated, some clumps of oxidized/discolored silty sand to max ~ 2 to 3 mm.	G.S. @ 105.5' bgs G.S./P.S. @ 110' bgs split-spoon 109.5'-111.8' 289 blows 100% rec. A: 111-111.5'; B1K8B3; 180 blows B: 110.5-111'; B1K8B4; 78 " C: 110-110.5'; B1K8B5; 37 " D: 109.5-110'; B1K8B6; 10 " Bulk: ~~110~~ 8-2-06 109.5-112'; B1K8M5 G.S. @ 115' bgs
				→ @ 108': increase silt to ~15% ⇒ Slightly silty Sand ((m) S).	
				·110' ≤10% silt	
				·115' 50% vf-m S 50% m-vc S	
				·117' 95% vf-m S well-consolidated no HCl rxn lt grayish brn (2.5Y, 4/2, moist) 40% basalt 60% felsic. No a 113-124.5'	
130					

not used @ 8-2-06

Reported By: N. Bowles / J. Horner
Title: Geologist
Signature: [signature] / [signature] Date: 8-2-06

Reviewed By: L.D. Walker
Title: Geologist
Signature: [signature] Date: 8/23/06

A-6003-642 (03/05)

BOREHOLE LOG

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Date: 8-2-06 start 8/3/06 - Finish

Well ID: C4997 | Well Name: Entry B.H. #3 | Location: WTP Seismic Borehole #3

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120	G.S./P.S.			124.5-127.5': Sand (S)	Cable-tool drilling w/ hollow drive bucket
	Split-Spoon	100% rec. 232 blows @ (15, 35, 99, 41, 92)		Mod. sort, unconsolidated S with 90% f-vc (>80% c/vc) ang. S (60% felsic, 40% basalt) & ≤ 5% M & ≤ 5% vf ang. pebbles. Max grain = 3mm, no HCl rxn. lt gray (2.5Y, 5/5/2, sl. moist)	G.S./P.S. @ 120' bgs. Split-spoon 120.6'-123.1' (8-2-06) A: 122.1-122.6'; 135 bl.; 41 bl.; B1K887 B: 121.6-122.1'; 99 bl.; 44 bl.; B1K888 C: 121.1-121.6'; 500 bl.; 35 bl.; B1K889 D: 120.6-121.1'; / ; 15 bl.; B1K8E0
125	G.S.			·127' no silt ~45-50% basalt ≤ 10% vf-f ang. pebbles (~70% basalt). Normal grading from 124.5' down, changing to gS @ ~127.5' bgs	Bulk: 120.6-123.1' B1K8H1 G.S. @ 125' bgs
130	G.S./P.S.			127.5'-135': Gravelly Sand (gS) Same as above, with ~70% c-vc S & ~30% vf-f ang. pebbles	G.S./P.S. @ 131' bgs. Split-spoon 131'-133.6'
	Split-Spoon	100% rec. 209 blows @ (10, 31, 64, 35, 59)		·129' Isolated cobbles present (sparse) (8-2-06)	A: 132.5-133'; 35 bl.; B1K8C1 B: 132-132.5'; 64 bl.; B1K8C2 C: 131.5-132'; 31 bl.; B1K8C3 D: 131-131.5'; 20 bl.; B1K8C4
135	G.S.			·130' pebble fraction dec. ≤ 10% (S). 1475 (8/2/06)	Bulk: 130.2-132.7' B1K8H2
				135'→ 146': Sand (S) same as above (127.5-135') w/ ≤ 10% G, highly unconsolidated (hole caving in)	G.S. @ 135' bgs. G.S. & P.S. (NCO) @ 140' bgs
140	G.S./P.S. Split-Spoon	100% Rec. 164 Blows (8/10/29/31/78)		146.5': v.f.m. to v.c.se S (80% v. fine to fine/20% c.se to v.c.se) mc. in felsic cont to 60 to 70% felsic, mod. consolidation, weathered/oxid. w/ lt. yellowish brn to orange grains found in clumps, poor sorting, overall coloring: lt. yellowish brown (2.5Y 5/4), NO to v. wk. HCl effer Rxn, except on clumps of weath/ox'd. grains ⇒ mod. to strong Rxn. (8-2-06)	Split-Spoon Sample from 139.7'-141.7' bgs. A: 141.2-141.7'; 31 Bl.; B1K8H3 B: 140.7-141.2'; 28 Bl.; B1K8H4 C: 140.2-140.7'; 15 Bl.; B1K8H5 D: 139.7-140.2'; 8 Bl.; B1K8H6 100% recovery, 164 Blows. Bulk "5 gal Bucket" Sample from 139.7-141.7' bgs HESS # B1K8H7
145	G.S.				G.S. @ 145-5' bgs.
150	G.S./P.S. Split-Spoon	100% Rec. 185 Blows (8/13/34/45/85)		147.5→ 149.5': slightly silty Sand (SW) ~85-90% vf. to md. S, ~80% Felsic, sub ang. ~10-15% silt. Mgry/brn (5Y5/2). Mod consolidation/well sorted, mod. HCl Rxn.	G.S. & P.S. (NCO) @ 150.5' bgs. Split-Spoon Sample from 150.1-152.1' bgs A: 151.6-152.1'; 45 Bl.; B1K8H8 B: 151.1-151.6'; 34 Bl.; B1K8H9
155	G.S.			149.5-151': Sand (S) ≥ 90% S: (v.f.m. to v.c.se) sub-ang. (~60 to 70% basalt). ≤ 10% G: v.f.m. to f.m. pebbles w/ v. sparse max size to 1/2" (md. pebbles). C→ 9.6	C: 150.6-151.1'; 13 Bl.; B1K8J0 D: 150.1-150.6'; 8 Bl.; B1K8J1 100% Recovery, 185 Blows. → P.6

Reported By: J. Horner / N. Bowles | Reviewed By: L. D. Walker

Title: Geologist | Title: Geologist

Signature: John Horner / N. Bowles | Date: 8/3/06 (End) | Signature: L. D. Walker | Date: 8/23/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 6 of 13
Date 8/2(06 - start

Well ID: C4997 | Well Name: Burial B.H. #3 | Location: WTP Seismic Borehole #3

Project: WTP Seismic Boreholes Project. | Reference Measuring Point: Ground Surface

Depth (Ft)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
160	GS/PS Split Spoon & Bulk	100% Rec 210 Blows (6/15/30/48/102)		Cont'd from 149.5': mod. sorted, unconsolidated, dry, v. wk to no HCl Rxn.	Cable-Tool drilling w/ hollow drive barrel. Bulk "5-gal. Bucket" sample from 150.1 - 152.1' bgs HEIS # B1K8J2
165	G.S.			@ 154' increase in overall grain size of sands. Inc. in gravels (25%) → 154 - 157': gravelly Sand (gS) Same as above w/ ~25% gravels to max 1/2", ~75% sand (~25% vf to f-m, 75% med. to v.cse.) Otherwise, same as 149.5 - 154'	G.S. @ 155' bgs. G.S. & P.S (NCO) @ 160' bgs. Split-Spoon Sample from 159.5 - 161.5' bgs A: 161'-161.5'; 4 Bl.; B1K8J3 B: 160.5'-161.'; 3 Bl.; B1K8J4 C: 160.'-160.5'; 1 Bl.; B1K8J5 D: 159.5'-160.'; 6 Bl.; B1K8L6
170	GS/PS Split Spoon & Bulk	~73% rec 161 blows (8,19,20,47,67)		157 - 158': Silty Sand (mS) ~60% S, v.f. to med, 70 to 80% felsic, w/ v. sparse cse to v. cse grains, subang. ~35% silt (t: brn/gray 5YR 3/2). <5% G (to fine pebble); v. dry & consol'd to strong to v. strong HCl Rxn.	100% Recovery, 210 Blows total Bulk "5-gal. Bucket" Sample from 159.5 - 161.5' bgs. HEIS # B1K8L1 G.S. @ 165' bgs -168' adding H2O to improve rec.
175	G.S.			158 - 159.5': Sand (S) v. similar to mS from 157 - 158' w/ out silt cont. (~5% silt)	G.S./P.S. @ 170' bgs Split-Spoon 169.8 - 172.3 A: 170.8 - 171.3'; 20 Bl.; B1K8L2; 100% B: 170.3 - 170.8'; 19 Bl.; B1K8L3; 100% C: 169.8 - 170.3'; 9 Bl.; B1K8L4; 95% D: 0% rec
180	GS/PS Split Spoon & Bulk	64% Rec 249 Blows (8/26/81/56/73)		159.5 - 160': Silt (m) ~95% m, non plastic, lt. brn/pale brown (2.5Y 6/3), v. slight moisture, well sorted & highly consolidated w/ strong HCl Rxn. <5% v.fn. S. 100% felsic.	Bucket: 170 - 172.5'; B1K8L6 G.S. @ 175' bgs G.S. & P.S (NCO) @ 180.5' bgs.
185	G.S.			160 - 166': Silty Sand (mS) (v. similar to mS from 157 - 158' w/ increased felsic content 80 to 85%, and no G, max v. cse S.) → G. @ 165' bgs	Split-Spoon Sample From 180.1 - 182.1' bgs: A: 181.6 - 182.1'; 5 Bl., 8% R; B1K8L7 B: 181.1 - 181.6; 8 Bl., 100% R; B1K8L8 C: 180.6 - 181.1; 5 Bl. 75% R.; B1K8L9
190	GS/PS Split Spoon & Bulk	95% Rec. 421 Blows (21/72/81/122/125)		166' - 187': Silty Sandy Gravel (msG) P sort., unconsolidated, clast supported w/ >60% sub-rnd - rnd vf - vc pebbles (70% basalt) >20% vf - vc ang S (50% basalt, 50% felsic) & <20% lt gray silt (6.8/1, dry). Max = 5cm, strong HCl rxn ~168' sparse cobbles up to 10cm	~64% Tot. Rec., 244 Blows (V. loose sample!). Bulk "5-gal. Bucket" Sample from 180.1 - 182.1 bgs, HEIS # B1K8M1 G.S. @ 185' bgs. → p.7.
195	G.S.				

Reported By: N. Barker / J. Horner | Reviewed By: L. D. Walker

Title: Geologist | Title: Geologist

Signature: [signature] / John Horner | Date: 8-4-06 End, 8-4-06 | Signature: [signature] | Date: 8/23/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 7 of 13
Date: 8-3-06 start

Well ID: C4997 | Well Name: Entry B.H. # 3 | Location: WTP Seismic Borehole #3
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
200	GS/PS Split Spoon	85% rec. 260 blows (20, 45, 85, 80)		~17½' silt fraction ≤ 10%, 30% S, 60% G	Cable-tool drilling w/ hollow drive bit/rod
				~17.5' silt fraction 20%, 20% S, 60% G large cobbles present max = 20cm	
	G.S.			~179': silt down to ~10% to 15%.	Note: Began adding water
				~183': G size decreases to 10cm max (some cobbles)	@ ~185.5' bgs.
205				~187': G size increases to ~8" max & silt down to ~5% ⇒ SG	for cuttings retrieval.
				187'-198': Sandy Gravel (SG)	G.S. & P.S (NCO) @ 190.1' bgs
				~75% G, (~75% v.fn. to v.crse Pebbles, ~25% sm. to lg. cobbles to max size ~8"), subrd. to sub ang., w/ sparse rd. cobbles; ~60% basalt. ~20% S (90% md. to crse., ≤10% v.fn. to sm.) sub ang. to ang., ~60% basalt ~5% silt. Overall: poorly sorted, clast supported, w/ v.wk. to mod HCl Rxn. (Moisture unknown due to added H2O w/ drilling, although, likely dry).	Split-Spoon Sample From 189.7-191.7' bgs A: 191.2-191.7; 122Bl.; B1K8M1 50%R. B: 190.7-191.2; 81Bl.; B1K8M3 100%R. C: 190.2-190.7; 72Bl.; B1K8M5 100%R. D: 189.7-190.2; 21Bl.; B1K8M5 90%R.
210	GS/PS Split-Spoon	100% Rec. 278 Blows (81/61/63/65/58)			95% Rec. 421 Tot. Blows 4 Bucket. Bulk "5-gal. Bucket" Sample From 196.7-196.7' bgs, HFTS# B1K8M6
215	G.S.				Split-spoon 199.7-202.7 lined: 199.7-201.7'
220	GS/PS Split-Spoon	100% Rec 464 Blows (39/112/118/146/49)		~185-: lg. cobbles & boulders max = 30cm ~198' M Grad. inc. to ~10%-15%	A: 201.2-201.7; 55 blows; 50%; B1K8M7 B: 200.7-201.2; 55 blows; 100%; B1K8M8 C: 200.2-200.7; 45 blows; 100%; B1K8M9 D: 199.7-200.2', 25 blows, 90%; B1K8M10
				198'-206': Silty Sandy Gravel	Bulk: 200-202.5'; B1K8N1
225	G.S.			Same as above w/ M, to 20% M lt. brownish gray (2.5Y 6/2, dry)	GS/PS @ 200' bgs G.S. @ 204.5' bgs
				~204' 50%-60% vc-vc pebbles (no cobbles) ~25% S (vc-vc) & 25% lt brownish gray M	Began adding H2O @ ~206' (8/6/06).
	Bulk Sample			@ ~206' reduction in silt content to ~10%	G.S. & P.S (NCO) @ 210' bgs.
230	GS/PS			206'→ : Sandy Gravel (SG) ~75% G. (~50% v.fn to v.crse pebbles, ~40% sm. to lg. subang/subrd. cobbles, <10% Sub ang. to ang (due to drilling) boulders (Basalt)) 60 to 70% Basalt Overall Poor Gr. (90%) Max = ~12", ~20% md. to v.crse Sand (w/ ~10% v.fine to fine). subang to subrd, ~60% basalt <5% Silt. Overall, poorly sorted clast supported. v.sim to 187-198' w/	Split-Spoon Sample From 209.4-211.4' bgs ~100% Rec, 278 tot. Blows A: 209.9-211.4; 65Bl., 100%R. B1K8N2 B: 210.4-210.9; 63Bl., 100%R.; B1K8N3 C: 209.9-210.4; 61Bl., 100%R.; B1K8N4 D: 209.4-209.9; 38Bl., 100%R.; B1K8N5
235	G.S.				Bulk "5-gal. Bucket" Sample from 209.4-211.4' bgs. Boulders; HFTS# B1K8N6

Reported By: J. Horner / N. Bowles | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: [signature] Date: 8-8-06 | Signature: [signature] Date: 8/23/06

A-6003-642 (03/03)

BOREHOLE LOG

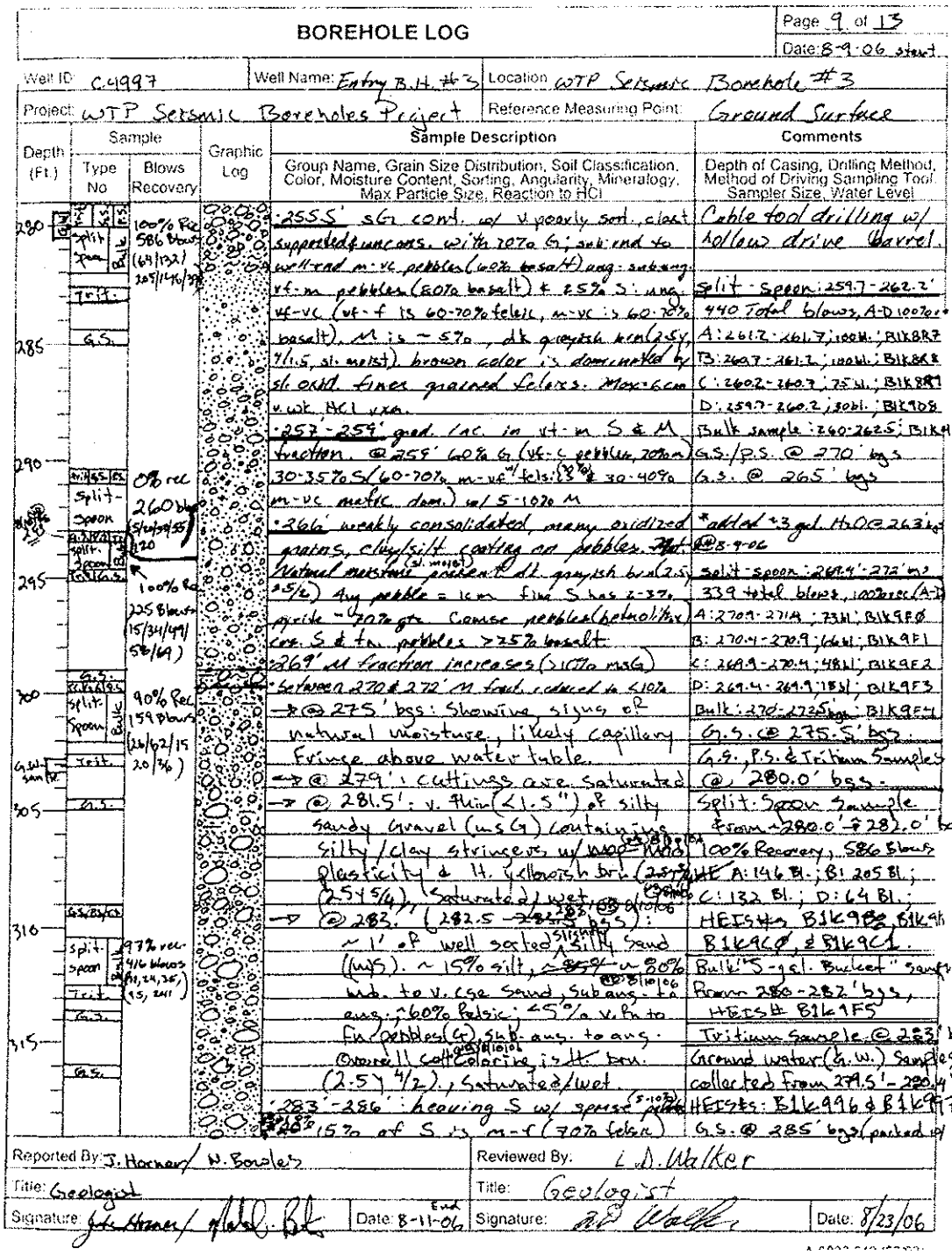
Page 8 of 13
Date 8/6/06 - 8/10/06 - Finish

Well ID: C4997 | Well Name: Entry B.H. #3 | Location: WTP Seismic Borehole #3
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
240	G.S./P.S. SG/ bulk	100% rec. 274 BC (94/156/ 224/274)		(cont'd S/G from 206':	Cable-Tool drilling
				→D@ 208': Increase silt(m) to ~10%.	w/ hollow drive barrel
				→D@ 212': Increase sand cont. to ~40%, same general dist. & desc., Decrease Gravel cont. to ~50%, similar to above, silt @ <10%. Also, no more boulders.	G.S. @ 215.5' bgs. G.S. & P.S. (PEA) @ 220' bgs Split-Spoon Sample from 219.6 → 221.6' bgs
245	G.S.			→D@ 214': Boulders return (v. sparse) max size ~ 14"	A: 221.1 - 221.6; 146 Bl.; B1K8N7 B: 220.6 - 221.1; 118 Bl.; B1K8NE C: 220.1 - 220.6; 112 Bl.; B1K8NC
				→D@ 215': Significant decrease in overall grain size: ~40% G, ~50% S (80% f to vcse, pebbles, <20% sm. to lg cobbles) ~50% S (80% f to vcse, <20% v. fine to med), <10% silt.	D: 219.6 - 220.1; 39 Bl.; B1K8NP All liners 100%, 4/4 Blows/6"
250	G.S./P.S. Split Spoon	100% Rec. 4/5 Blows (78/119/124 137/91)			G.S. @ 225' bgs Drive barrel sample from 228.2' - 230.2' bgs B1K8P6 G.S./P.S. @ 230' bgs
255	G.S.			·224' G fraction increased to ~60-70% ·230' G is >90% pebbles & 10% small cobbles ·233' large cobbles are present (~10%) M & S fraction increases (~60% fine to coarse) grains are slightly oxidized 7.5YR grayish brn. (2.5Y, 4/2), no HCl rxn (70% G 30% S).	G.S. @ 234.5 bgs G.S. @ 240' bgs, P.S. @ 240' bgs. Split spoon from 240-242.5' (BC = 247 - 274 / REC/BOTTOM)(rec. = 100%) Drive barrel sample (242.5 - 243'), B1K8R1
260	G.S./P.S. Split-Spoon	100% rec. 4/40 blows 3/30, 75, 100, 109, 135)		·235' M fraction inc. to ~10% ·240' (70% G, 25% S, 5% M): Gravel sub. rnd - ang., v. poor sort., basalt (trace quartzite), dry, granule - mod. cobble (2-60mm); Sand f (80%) - crse (20%), slt. damp - dry, 7.5YR 5/3 mst/6/1, well sort, 10YR 4/3 d. grayish brown; Silt % low - trace, no HCl to test, dry, loose.	G.S. @ 245' bgs. G.S. & P.S. @ 250' bgs. Split-Spoon Sample from 250 - 252' bgs: A: 251.5 - 252; 157 Bl., B1K8R3 B: 251 - 251.5; 126 Bl., B1K8R2 C: 250.5 - 251; 115 Bl., B1K8RL D: 250 - 250.5; 78 Bl., B1K8RC
265				·245' (65% G, 35% S): Gravel ang - sub. rnd basalt, quartzite, quartz, v. poor sort, granule - sm. cobble (2-30mm); Sand crse (50%) - v. crse (50%), 90 mst/10 fol, mod. sort, 10YR 3/1 v.d. gray, no rxn to HCl. [H2O ADDED FOR SPOIL RECOVERY]	
270	G.S./P.S. Split-Spoon	100% rec (18, 48, 66, 73, 124)		·248' (65% G, 30% S, 5% M): silt matrix conglomerates observed - small ~ gritty to break apart, silt % increases, wet due to H2O added earlier.	All 100% Rec.; 495 Tot. Blows Bulk "5-gal. Bucket" Sample from 250-252' bgs; HEIS # B1K8R6. G.S. @ 255.5' bgs. G.S. & P.S. @ 260' bgs added water @ 263 bgs W.L. = 277.45' bgs (8/9/06)
275	G.S.	W.L.		→D@ 253': silt content reduces <5%, Sand to ~40%, Gravel to ~55%	(8/9/06) Clast-supported

Reported By: N. Bowles / J. Harmer / J. Hocking
Title: Geologist
Signature: [signatures] Date: 8/10/06

Reviewed By: L.D. Walker
Title: Ecologist
Signature: [signature]



BOREHOLE LOG

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Date: 8-9-06 start

Well ID: C4997 | Well Name: Entry B.H. #3 | Location: WTP Seismic Borehole #3

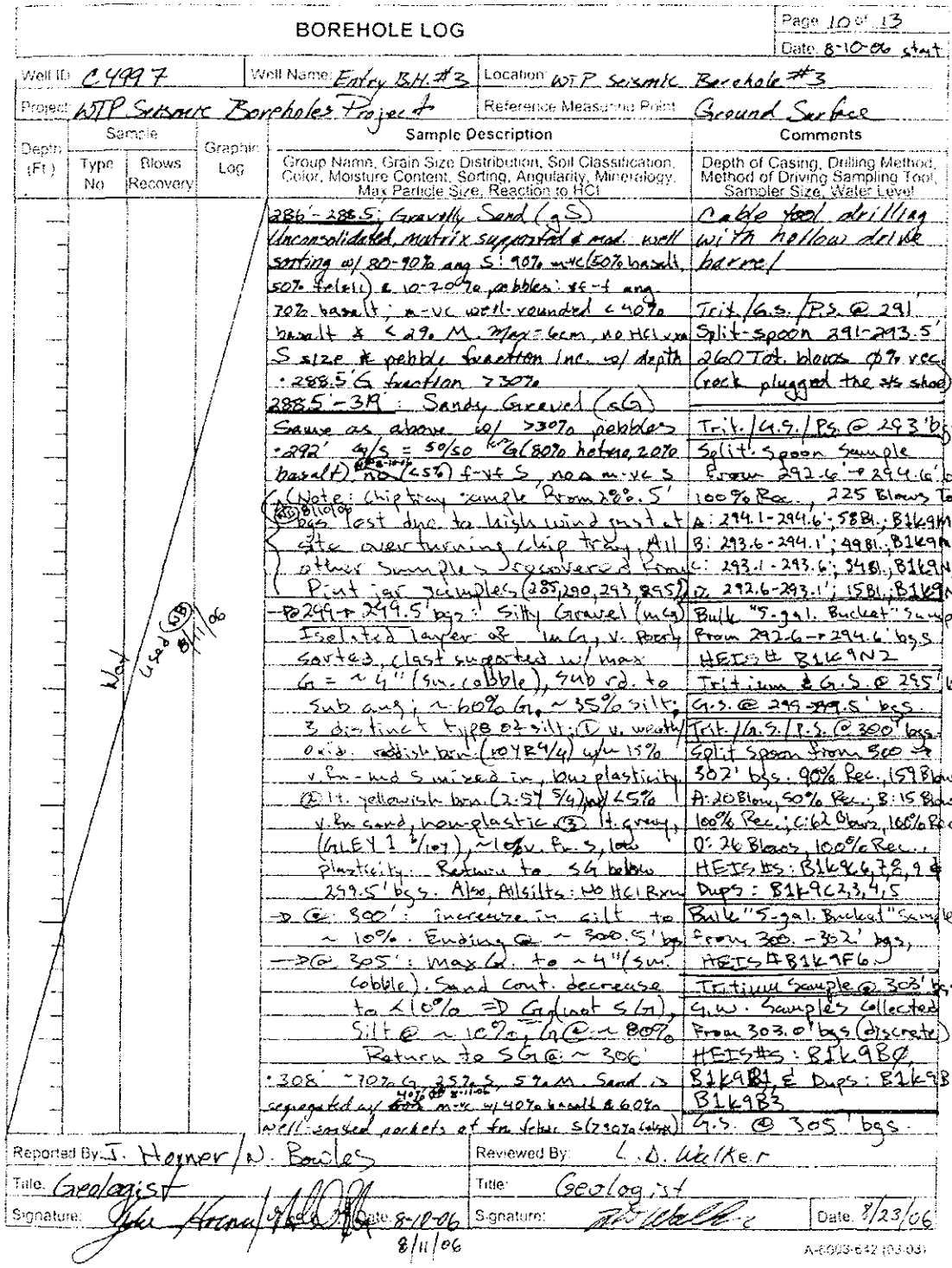
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
280	Split Spoon	100% Rec 586 Blows (69/132/205/146/39)		·255.5' sGr cond. w/ v poorly sort., clast supported & uncons. with 20% G; sub rnd to well rnd m-vc pebbles (60% basalt) ang-subang vf-m pebbles (60% basalt) + 25% S: ang. vf-vc (vf-f is 60-70% felsic, m-vc is 60-70% basalt). M is ~5%, dk grayish brn (2.5Y 4/1.5, sl. moist), brown color is dominated by sl oxid. fines grained felsics. Max=6cm v. wk. HCl rxn.	Cable tool drilling w/ hollow drive barrel. Split-Spoon: 259.7-262.2' 440 Total blows, A-D 100% A: 261.7-261.7; 100#; BLK887 B: 260.7-261.2; 100#; BLK888 C: 260.2-260.7; 75#; BLK889 D: 259.7-260.2; 300#; BLK908
285	Tr. lt. G.S.			·257-259' grad. inc in vf-m S & M fraction. @ 255' 60% G (vf-c pebbles, 20cm) 30-35% S/60-70% m-vf felsic (30%) & 30-40% m-vc mafic dom.) w/ 5-10% M	Bulk sample: 260-262.5; BLK910 G.S./P.S. @ 270' bgs G.S. @ 265' bgs
290	Split-Spoon	0% rec 260 blows (5/40/89/55) 20		·266' weakly consolidated, many oxidized grains, clay/silt coating on pebbles. Natural moisture (sl. moist) at 266' grayish brn (2.5Y 5/2) Any pebble = 1cm fine S has 2-3% opside - 70% gr. Coarse pebbles (helmolithic) cgr. S & fn. pebbles >75% basalt	*added ~3 gal. H2O @ 263' @ 8-9-06 Split-Spoon: 269.4-272' ms 339 total blows, 100% rec (A-D) A: 270.9-271.4; 75#; BLK9F0 B: 270.4-270.9; 66#; BLK9F1 C: 269.9-270.4; 48#; BLK9F2 D: 269.4-269.9; 150#; BLK9F3
295	Split-Spoon	100% Rec 225 Blows (15/31/49/56/69)		·269' M fraction increases (>10% maG) ·Between 270 & 272' M fract. reduced to <10%	Bulk: 270-272.5' bgs; BLK9F4
300	Split-Spoon Tr. lt.	90% Rec 159 Blows (26/62/15 20/3%)		→* @ 275' bgs: Showing signs of natural moisture, likely capillary fringe above water table.	G.S. @ 275.5' bgs G.S., P.S. & Tritium Samples @ 280.0' bgs.
305	G.S.			→ @ 279': cuttings are saturated → @ 281.5': v. thin (<1.5") of silty sandy gravel (msG) containing silty/clay stringers w/ LL=NM, PL=NP, Plasticity & H. yellowish brn (2.5Y 5/4), saturated/wet	Split-Spoon Sample from ~280.0' (+2) 282.0' bgs 100% Recovery, 586 Blows HE A: 146 Bl.; B: 205 Bl.; C: 132 Bl.; D: 64 Bl.; HEIS#s B1K9B8, B1K9B9, B1K9C0, & B1K9C1.
310	Split-Spoon Tr. lt. G.S.	97% rec 446 blows (91, 24, 25, 15, 241)		→ @ 283': (282.5 - 285 bgs): ~1' of well sorted, silty sand (msG). ~15% silt, ~80% vf-m to vc sand, subang-to ang.; ~60% felsic; <5% v. fn to fn pebbles (G), subang. to ang. Overall color is lt. brn (2.5Y 6/2), saturated/wet	Bulk 5-gal. Bucket "Sump" Brown 280-282' bgs, HEIS# B1K9F5 Tritium Sample @ 283' bgs. Ground water (G.W.) Samples collected from 279.5' - 280.4' bgs
315	G.S.			·283'-286': heaving S w/ sporadic 15% of S is m-c (70% felsic)	HEIS#s: B1K996 & B1K997. G.S. @ 285' bgs (packed w/ drive barrel)

Reported By: J. Horner / W. Bowles | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: John Horner / W. Bowles | Date: 8-11-06 | Signature: L.D. Walker | Date: 8/23/06



BOREHOLE LOG

Page 10 of 13
Date: 8-10-06 start

Well ID: C4997 | Well Name: Entry BH #3 | Location: WTP Seismic Borehole #3
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				286'-288.5': Gravelly Sand (gS) Unconsolidated, matrix supported & mod. well sorting w/ 80-90% ang S: 90% m-vc (50% basalt, 50% felsic) & 10-20% pebbles: vf-f ang 70% basalt; m-vc well-rounded < 40% basalt & < 2% M. Max = 6cm, no HCl rxn S size & pebble fraction inc. w/ depth ~288.5' G fraction > 30%	Cable tool drilling with hollow drive barrel. Trit./G.S./P.S. @ 291' Split-spoon 291-293.5' 260 Tot. blows @ 0% rec. (rock plugged the ss shoe)
				288.5'-292': Sandy Gravel (sG) Same as above w/ >30% pebbles	Trit./G.S./P.S. @ 293' bgs
				~292' G/S = 50/50 to G (80% hetero, 20% basalt), no (<5%) f-vf S, non-vc S	Split-spoon Sample From 292.6' to 294.6' bgs
				(Note: Chip tray sample from 288.5' bgs lost due to high wind gust at site overturning chip tray. All other samples recovered from Pint jar samples (285, 290, 293, 295))	100% Rec., 225 Blows Tot. A: 294.1-294.6'; 58Bl.; B1K9M8 B: 293.6-294.1'; 99Bl.; B1K9M9 C: 293.1-293.6'; 54Bl.; B1K9N0 D: 292.6-293.1'; 15Bl.; B1K9N1
				~294'-294.5' bgs: Silty Gravel (mG) Isolated layer of m G, v. poorly sorted, clast supported w/ max G = ~4" (sm. cobble), sub rd. to sub ang; ~60% G, ~35% silt; 3 distinct types of silt: ① v. weath. oxid. reddish brn (10YR 4/4) w/ ~15% v. fn - md S mixed in, low plasticity ② lt. yellowish brn (2.5Y 5/4) w/ <5% v. fn sand, non-plastic ③ lt. grey (5YR 7/1), ~10% v. fn S, low plasticity. Return to SG below 294.5' bgs. Also, all silts: NO HCl Rxn	Bulk "5-gal. Bucket" Sample From 292.6-294.6' bgs HEIS # B1K9N2 Trit. from & G.S. @ 295' bgs. G.S. @ 294-294.5' bgs. Trit./G.S./P.S. @ 300' bgs. Split spoon from 300 to 302' bgs. 90% Rec., 159 Blows Tot. A: 20 Blows, 50% Rec.; B: 15 Blows, 100% Rec.; C: 62 Blows, 100% Rec.; D: 26 Blows, 100% Rec., HEIS #s: B1K9K6, 7, 8, 9 & Dups: B1K9C3, 4, 5
				@ 300': increase in silt to ~10%. Ending @ ~300.5' bgs	Bulk "5-gal. Bucket" Sample From 300.-302' bgs, HEIS # B1K9F6
				@ 305': Max G to ~4" (sm. cobble). Sand cont. decrease to <10% ⇒ G/(not S/G), Silt @ ~10% in G @ ~80% Return to SG @ ~306'	Tritium Sample @ 303' bgs G.W. Samples Collected From 303.0' bgs (discrete) HEIS #s: B1K9B0,
				~308': ~70% G, 25% S, 5% M. Sand is segregated w/ ~40% basalt & 60% well-sorted pockets of fn felsic S (75% felsic)	B1K9B1 & Dups: B1K9B2, B1K9B3 G.S. @ 305' bgs.

Not used (GS) 8/11/06

Reported By: J. Heyner / N. Bowles | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: [signature] Date: 8-10-06 8/11/06 | Signature: [signature] Date: 8/23/06

A-6003-642 (03-03)

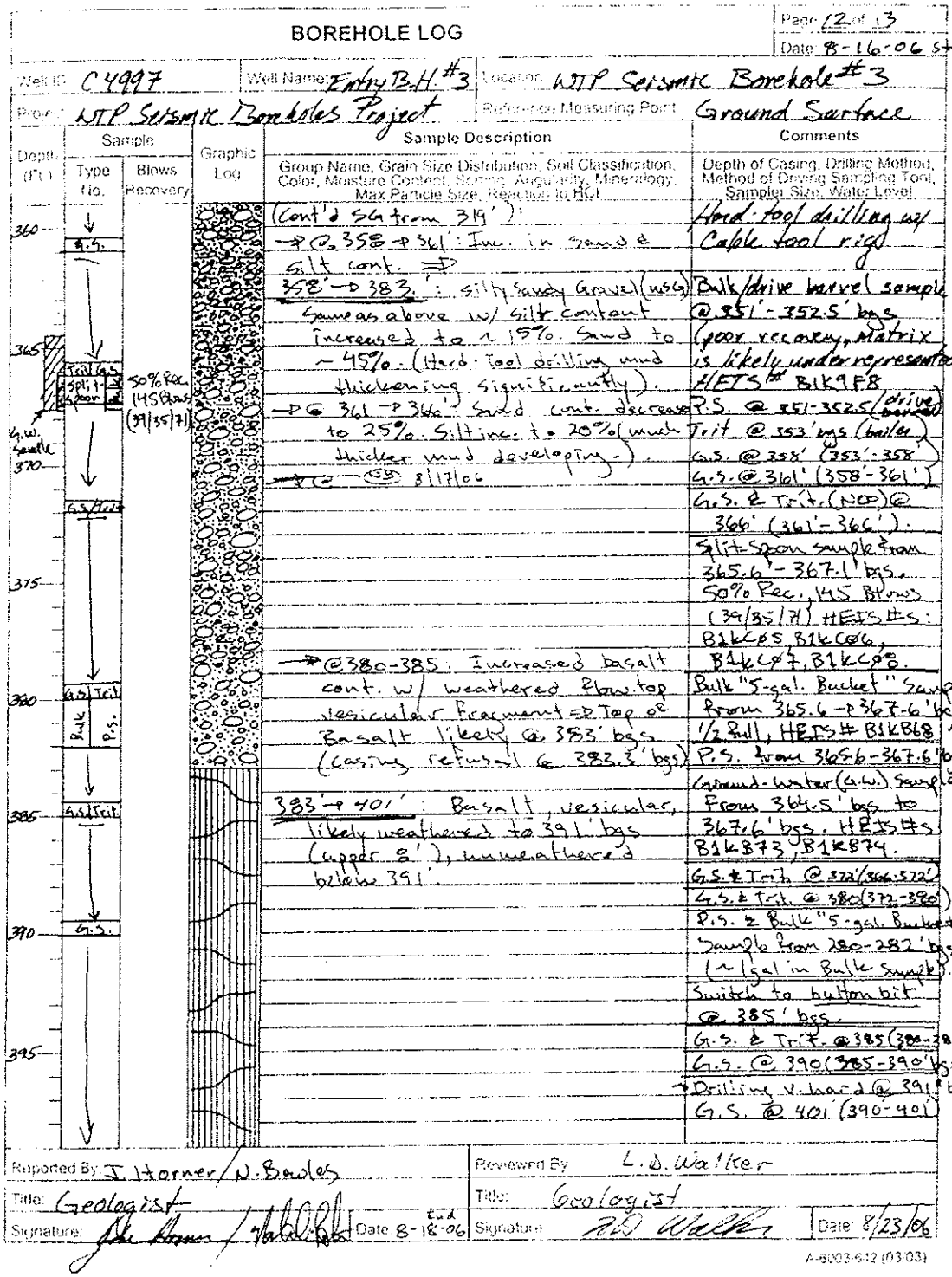
BOREHOLE LOG

Page 11 of 13	Date: 8-11-06 start
Well ID: C4997	Well Name: Entry B.H. #3
Location: WTP Seismic Borehole #3	
Project: WTP Seismic Boreholes Project	Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
	G.S.			·310' sG cont. w/ no silt, 60-70% G (f-m pebbles ~60% basalt; m-vc pebbles & sm. cobbles	Cable tool drilling w/
320				~40% basalt) 30-40% m-vc S (40-50% basalt)	hollow drive barrel
				·316' improved sorting w/ 70% well-	G.S./P.S./Trit. @ 309.5' bgs
				sorted f-vc pebbles (≥60% c-vc) w/ 30-	Split spoon 310.5-313.1 (416 blows)
				40% basalt throughout. 30% vf-vc S:	A: 312-312.5; 95 bl.; B1K9N3
325	G.S.			50% vf-m felsic (70%) & 50% m-vc	B: 311.5-312; 36 bl.; B1K9N4
				with only 30-40% basalt. Color Δ's f/	C: 311-311.5; 24 bl.; B1K9N5
				dk. grey (2.5Y, 4/1) @ 314' to greyish brn	D: 310.5-311; 113 bl.; B1K9N6
				/ lt. olive brn (2.5Y, 5/2.5) @ 316' bgs.	D-90% rec. A-C 100% rec.
				·318' chroma decreases to 1.5 (lt. gray brn)	Bulk: 310.5-312: B1K9N7
330	G.S.			319'-358': Ringold Unit A sG	Tritium sample @ 313' bgs
				Well-sorted (bimodal), clast supported, cons.	G.S. @ 314' bgs
				with >75% G: m-vc (≤50% vc) sub-well	G.S. @ 316.5' bgs
				rounded pebbles (heterolithic, ≤20% basalt	G.S. @ 319.5' bgs
				abundant qtzite) & <25% S: f-m (>80%)	
335	G.S./Trit./P.S.			sub-ang. lt. olive brn. (2.5Y, 5.25/6) >90%	Switch to "Hard-Tool"
	Split Spoon	680 blows (39, 50, 75, 120, 235)		felsic. Max = 5cm, no HCl rxn.	drilling @ 320' bgs.
				·320' well consolidated w/ increase in	
				silt fraction (>5%)	G.S. @ 326' (320-326')
340		8/15/06		→* @ 327.5-328: thin zone of easier	G.S. @ 331' (326-331')
	G.S.			drilling (drillstring dropped ~6" quickly)	G.S./P.S./Trit. @ 335' bgs 8-15-06
				·339' small clumps of matrix (2-4cm)	Split-spoon 336.8-338.8'
				in bulk sample show no change.	(339.2 w/ shoe) ~680 blows
				The sample was collected by drive	*Could not open SS sampler @ 8-15-06
345				barrel on 4th attempt & was mixed.	taken/scooped out from bottom.
	G.S.			Bulk color is grayish brn (2.5Y, 5/1.5)	B1K9D0, B1K9D1, B1K9D2 (VOA)
				undisturbed clumps are still lt. d. brn.	(Bulk) Bucket: B1K9F7: 337-339'
				NB 8/15/06 → @ 335-341: Hard tool cuttings prim.	Split spoon 8-15-06 (B1K9B4; B1K9B5)
				Sand (>95%) ⇒ Not representative	*Note: Mark on cable indicated
350				of formation in this zone, v. thin	GS/Trit/P.S. @ 335. Tag on
	G.S./Trit.			mud (watery) ⇒ v. low silt content.	bottom = 336.8' bgs.
	Bulk Sample			→ @ 341-346': Cont. w/ SG. Inc.	HEIS #s for water sample
	Trit.			in silt content to ~5% (NB 8/15/06)	w/ open hole 334.5'-339' bgs
				mud thickening slightly & cuttings	
355				suspending more.	W.L. = 278.0' bgs on 8/15/06
				· Drilling rate increased to ~1ft/5min	G.S. @ 341' (335-341' bgs).
				from 356'-361' bgs	G.S. @ 346' (341-346' bgs).
	G.S.			·351-352.5' very similar to sample	G.S./Trit. @ 351 (346-351')
				@ 339' bgs with small cobbles present	Max = 10cm.

Reported By: J. Horner / N. Bowles	Reviewed By: L.D. Walker
Title: Geologist	Title: Geologist
Signature: [signature] / [signature] Date: 8-16-06 End	Signature: [signature] Date: 8/23/06

A-6003-642 (03/03)



BOREHOLE LOG

Page 12 of 13

Date 8-16-06 start

Well ID: C4997 | Well Name: Entry B.H. #3 | Location: WTP Seismic Borehole #3

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (ft)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Strong, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
360	G.S.			(Cont'd SG from 319'):	Hand-tool drilling w/ Cable tool rig
				→ @ 358 → 361': Inc. in Sand & Silt cont. ⇒	
				358' → 383': silty Sandy Gravel (wSG) Same as above w/ Silt content increased to ~ 15%. Sand to ~ 45%. (Hard-tool drilling mud thickening significantly).	Bulk/drive barrel sample @ 351' - 352.5' bgs (poor recovery, Matrix is likely underrepresented) HETS # B1K9F8
365	Trit / G.S. / Split Spoon / Bulk	50% Rec. (14S Blows) (39/35/71)		→ @ 361 → 366': Sand cont. decrease to 25%. Silt inc. to 20% (mud thicker mud developing).	P.S. @ 351-352.5 (drive barrel) Trit @ 353' bgs (bailer)
	G.W. Sample			→ @ SB 8/17/06	G.S. @ 358' (353'-358')
370	G.S. / Trit				G.S. @ 361' (358'-361')
					G.S. & Trit. (NOD) @ 366' (361'-366').
375					Split-Spoon sample from 365.6' - 367.1' bgs. 50% Rec, 14S Blows (39/35/71) HETS #s: B1KC05, B1KC06, B1KC07, B1KC08.
				@ 380-385: Increased basalt cont. w/ weathered Blow top vesicular Fragment ⇒ Top of Basalt likely @ 383' bgs (casing refusal @ 383.3' bgs)	Bulk "5-gal. Bucket" Sample from 365.6 - 367.6' bgs 1/2 Full, HETS # B1KB68
380	G.S. / Trit / Bulk / P.S.				P.S. from 365.6-367.6' bgs.
					Ground-water (G.W.) Sample From 366.5' bgs to 367.6' bgs. HETS #s B1KB73, B1KB74.
385	G.S. / Trit			383' → 401': Basalt, vesicular, likely weathered to 391' bgs (upper 8'), unweathered below 391'.	G.S. & Trit @ 372' (366-372')
					G.S. & Trit. @ 380 (372-380).
390	G.S.				P.S. & Bulk "5-gal. Bucket" Sample from 280-282' bgs. (~1 gal in Bulk Sample).
					Switch to button bit @ 385' bgs.
395					G.S. & Trit. @ 385 (380-385').
					G.S. @ 390 (385-390' bgs).
					→ Drilling v. hard @ 391' bgs.
					G.S. @ 401' (390-401')

Reported By: J. Horner / N. Bowles | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: [signature] Date 8-18-06 | Signature: [signature] Date 8/23/06

A-6003-612 (03/03)

BOREHOLE LOG

Page 13 of 13
Date: 8-18-06 sht

Well ID: C4997 | Well Name: Entry B.H. #3 | Location: WTP Seismic Borehole #3
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
400	↓ C.S.			Basalt 383' - 401' bgs	Hard-tool drilling with cable-tool rig.
				Total Entry Borehole Depth = 401' bgs	
					C.S. @ 401' bgs (390'-401')
405					
410					
415					
420					
425					
430					
435					

Reported By: J. Horner
Title: Geologist
Signature: J. Horner
Date: 8-8-06 End

Reviewed By: L.D. Walker
Title: Geologist
Signature: L.D. Walker
Date: 8/23/06

A-6003-642 (03/93)

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APPENDIX D

BOREHOLE LOG
ENTRY BOREHOLE C4998

BOREHOLE LOG

Page 1 of #12 (SB) 7/10/06
Date: 6/12/06 - Start

Well ID: C4998 | Well Name: | Location: WTP Seismic Borehole # 1

Project: WTP Seismic Boreholes Project. | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0					Cable-tool drilling w/ hollow drive barrel.
				0. → 5.0': Sand (S), likely Fill v. well compacted w/ slight moisture, <5% gravel (to small cobble, max 3") subrounded; <5% silt; Sand is v. fn. to v. cse., Brn. to grey. - Slight HCl Rxn. @ 4' bgs: increased moisture.	
5	GRAB				- Grab archive samples from ~5' bgs.
				5.0 → 7.0': Sand (S), likely Fill <5% gravel to max 1". Moist; Sand is md. to v. cse. No Silt; Dk. Brn & Blk.	
10	GRAB				- Grab samples @ ~10' bgs.
				7.0 → 9.0': Sand (S), likely Fill v. fn. to md., w/ ~10% silt Dk. Brn. + Blk.; moist; slight HCL Rxn.	
15	GRAB				- Grab samples @ ~15' bgs.
				9.0 → 10.0': Silty Sand (mS) ~60% v. fn. to fn. sand ~40% silt; moist, lk. Tan/Brn. to lt. grey, wht.; No gravels & No HCl Rxn. @ 6/12/06	
20	GRAB				- Grab samples @ ~20' bgs.
				10.0 → 13.0': Sand (S) <10% silt; 90% fn. to cse. Sand; moist, loose, Blk. & Wht.; w/ No HCl Rxn; No gravels; Appears native, although possibly disturbed.	
25	GRAB				- Grab samples @ ~25' bgs.
				13.0 → 14.0': gravelly Sand (gS) ~20% gravel to max 4" (Sm. cobble) ~80% Sand, md. to v. cse. Gravels: Basalt & Qtz; Sand: Blk. & Wht; Moist; No silt; Native & undisturbed	
30	Grab				- Grab Sample @ ~30' bgs
				14.0' → 33.5': Sand (S) 95% md. to cse. sand; <5% v. fn. to fn.; No gravels; moist, Blk. & Wht, loose ~70% Basalt, remainder mostly Qtz.	- Grab Sample @ ~35' bgs
35	Grab				

Reported By: N. Bowles / Jake Horner | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: [signature] / [signature] Date: 6-13-06 | Signature: [signature] Date: 8-3-06

End

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 11 (12) 7/10 PG
Date: 6/12/06 - Start

Well ID: C4998 | Well Name: | Location: WTP Seismic Borehole #1
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	Grab				Cable tool drilling w/ hollow drive barrel.
	Grab			→ @ 16.5' Increase gravels (to ~1") (<5%, v. sparse); less moisture	
				→ Back to No gravels, less moist. (@ ~19' bgs, loose (falling out).	- Grab Sample (GS) @ ~40' bgs.
45	Grab			@ 23' bgs → v. thin silt lense (<3") across. lt. brown w/ blk & wht. sand. ~80% silt, ~20% v. fu to fu sand, nonplastic, moist.	- GS @ ~43' bgs - GS @ ~45' bgs
				@ 27.5' bgs similar silt lense	
50	Grab				- GS @ ~50' bgs
				33.5' - 34': Sand Mod. sorted lt. brown sub-ang. to sub-rounded sand (60% qtz) with 20% silt. sand is fine to med. Very sparse pebbles are present (max - 5 cm). Moderate to mild rxn with HCl.	
55	Grab				- GS @ ~55' bgs
	Grab			34' - 36': Sand Mod. sorted sub-rounded to sub-ang. med. to v. coarse matrix sand (70% matrix), very weak rxn with HCl. No gravel, <5% silt.	- GS @ 57' - 57.5' bgs
60	Grab				- GS @ 60' bgs
				36' - 39': Sand Mod. sorted sub-rounded - sub, ang. fine to med. felsic sand (70% felsic) with <5% silt. Sparse pebbles are present (<10%) Max particle is 8-10 cm. Weak rxn with HCl.	- GS @ 65' bgs
65	Grab				
70	Grab				- GS @ 69.5' - 70' bgs
				39' - 39.5': Sand Mod. sorted - well-sorted sub-rounded med. to coarse matrix sand (60-70% matrix) with ~30% v.f. to m. pebbles (max = 10 cm) & v. weak rxn with HCl.	
75	Grab				- GS @ 75' bgs

Reported By: N. Bowles / Jake Horner | Reviewed By: L. D. Walker
Title: Geologist / Geologist | Title: Geologist
Signature: [signature] / Jake Horner | Date: 6-13-06 (6/13/06) cnd | Signature: [signature] | Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 11 12 (SB) 7/10/06
Date: 6-13-06 Start

Well ID: C4998 | Well Name: | Location: WTP Seismic Borehole #1
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
80	Grab			39.5'-47.0': Sand (S) Well sorted, sub-rounded, slightly moist medium sand (50-60% basalt, 40-50% felsic) with <5% silt & very sparse pebbles. v. weak rxn with HCl.	Cable tool drilling w/ Hollow drive barrel
					- Grab Sample (GS) @ 80' bgs
85	Grab			• 43'-44' matic fraction increases to 70% (m.-vc. sand)	- GS @ 85' bgs
					• 6-14-06 Gyro survey (<0.1° deviation @ 81' bgs)
				47.0'-57.0': Sand (S) Mod. sorted with 90-95% med. to v.c. sub-ang. to sub-rounded matic sand (70% basalt) with ~5% silt throughout with additional silt lenses (¼"-2" thick). Sand is well consolidated, forming large clumps with a weak rxn to HCl	- GS @ 89.5' bgs
90	Grab				
95	Grab			• 50'-57' tighter Fm., drilling slows down	- GS @ 95' bgs
				57'-57.5': Sandy Silt (sM) 80% lt. brown silt thinly laminated (.2-2.0 cm) with 15% v.f. sand.	
100	Grab			Small pockets of coarse (S) & v.f. pebbles are present (5% comp.). Max pebble = 10 mm.	- GS @ 100' bgs
				57.5'-86.0': Sand (S) Mod-well sorted with 90-95% moderately consolidated med.-v.c. sub-ang.-sub-rounded matic sand (70-80% basalt) with 5-10% silt/clayey silt lenses (2-4 cm) & sparse v.f. to med. pebbles <5%. Max particle is ~5 cm (very rare) Soil is slightly moist with a mod. rxn to HCl. Silt lenses are lt. brown-brown.	GS @ 105' bgs
105	Grab				
110	Grab				- GS @ 110' bgs
					• 6-16-06 Gyro survey ( )
115	Grab			86.0'-87.0': Gravelly Sand (gS) Poorly sorted w/ 75% m.-vc. ang. matic sand (70% basalt), 20% well-rounded med. pebbles to small cobbles (60% basalt) & 5% silt. Max cobble = 80 cm. Soil is moist w/ no rxn to HCl.	- GS @ 115' bgs
	Grab				- GS @ 117' bgs
	Grab				- GS @ 118.5' bgs

Reported By: Jake Horner | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Jake Horner | Date: 6-14-06 | Signature: L.D. Walker | Date: 8/3/06
End

A-6003-642 (03/03)

BOREHOLE LOG

Page 4 of 11 (12) Date: 6-15-06 - Start 7/10/06

Well ID: C4998 | Well Name: Entry Borehole #1 | Location: WTP Seismic Borehole #1

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120				~~87.0'~~ 88.0'-108': Sand (S) Mod. sorted with 90-95% v.dark gray (7.5YR, 2.75/1) weakly consolidated, slightly moist, slightly oxidized, ang. – sub-ang., f-vc (60-70% coarse) mafic sand (60-75% basalt) with ≤10% well-rounded to sub-rounded vf-c hetero-lithic pebbles (max = 2cm) & ≤5% silt. Mod. rxn with HCl. • 90' pebble fraction decreases to ≤5% • 100' dominant grain size decreases (m)	Cable tool drilling w/ hollow drive barrel
125				108'-116.5': Slightly Silty Sand (m)S Mod.-well sorted slightly moist & dark grayish brown (10YR, 4/2.5) with 85% to 95% m-vf sub-ang. sand (50% felsic, 50% mafic) with 5-15% silt. Max particle is 1mm. Weak rxn w/ HCl. • 110' silt is less homogeneous, concentrated in 1cm to 5cm clumps	
130				• 115' silt fraction decreases (≤10%)	
135				116.5'-118.5': Sand (S) V. well-sorted, v. dk gray (7.5YR, 3/1) & slightly moist w/ ~98% m-vf (~80% m) ang. to sub-ang. sand (~50% mafic & 50% felsic) with very sparse (~2%) vf pebbles (max = 3mm) & v. weak rxn w/ HCl.	
140				• Silt fraction increases to ~5% above a 3-4cm layer of highly weathered felsic sand (c-vc sand) @ ~118.5' bgs.	
145				118.5'-120' bgs: Silty Sand mS Mod. sorted f-vf sand (75%) with 25% silt. Sand is well-consolidated, has a mod. rxn w/ HCl & contains 4-6, 1-4cm layers of highly weathered lt. olive brown (2.5Y, 5/4) felsic sand (60-70% felsic). Thin layers contain ~60% S & ~40% M.	
150					
155					

Not used, see page #5

6-16-06

Reported By: Jake Horner | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: Jake Horner | Date: 6-16-06 | Signature: L.D. Walker | Date: 8-3-06

End

A-6003-642 (03/03)

BOREHOLE LOG

Page 5 of 11 (JB 7/10/06)
Date: 6-16-06 Start

Well ID: C4998 | Well Name: Entry Borehole #1 | Location: WTP Seismic Borehole #1
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120	Grab			120'-124': Sand (S)	Cable tool drilling with
				well-sorted, slightly moist, avg. =	hollow drive barrel,
				sub-angular f-m sand (50-60%	-120' Grab Sample (GS)
				felsic, 30-40% basalt) with <5%	
	Grab			silt, Max grain is coarse (S), Mod.	
				rxn w/ HCl	-GS @ 124' bgs
125				•122' silt fraction is increasing (~10%)	
				•122'-123.5' 2-3 layers (4-6cm)	
				with 20-30% silt	
				124'-126': Slightly Silty/Gravelly Sand (slS)	
	Grab			Poorly sorted, moist olive brown (2.5Y,	-GS @ 130' bgs
130				4/3) with ~65% vf-vc (80% m-c)	
				sub-ang. felsic sand (70% qtz+feldspar),	
				20% ang. vf-f pebbles (50% basalt,	
				50% felsic) & 15% silt. Weak rxn	-GS @ 134.5' bgs
	Grab			w/ HCl, max particle = 4cm (v. coarse)	
135				•~126' silt fraction decreases to ~5%	
				& avg. grain becomes m. coarse (80%)	
				126'-~133': Gravelly Sand (gS)	
				Same as above with 75% m-vc (S),	
				& 25% vf-f pebbles. Less consolidated	
140	Grab			& better sorted than above (mod. sort.)	-GS @ 140' bgs
				•127' soil is no longer moist (dry)	
				•130' sand (50% felsic, 50% basalt)	
				~133'-148': Sand (S)	
				well-sorted, dry, light gray vf-vc (S)	-GS @ 145' bgs
145	Grab			(80% coarse) (60-70% felsic)	
				Ang. to sub-ang. grains, max = 4 mm	
				vf-f ang. pebbles are present (10%)	
				No rxn with HCl & no silt.	
				•135' felsic fraction ~50%	-GS @ 150' bgs
150	Grab			•138' silt fraction increased to 2-3%	
				•144' Avg. grain size decreases (c-m)	
				& silt fraction increases to 5-10% (~147')	
				148' ~~@ 1495~~ 1495 Slightly Silty Sand (slS)	(m)S 148'-149.5' bgs
				well-sort, Mod. consolidated & lt. brownish gray	
155	Grab			(2.5Y, 6/2) with 80-90% vf-c (80% vf)	-GS @ 155' bgs
				sub-ang. felsic sand (75-85% felsic)	
				with 10-20% silt. Mod. rxn w/ HCl,	
				max grain = ½"-1mm	

Reported By: Jake Horner | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Jake Horner | Date: 6-19-06 End | Signature: L.D. Walker | Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 6a of 11 (13) 7/10/06
Date: 6-19-06 Start

Well ID: C 4998 | Well Name: Entry Borehole | Location: WTP Seismic Borehole #1

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
160	Grab			149.5'-157.0': Gravelly Sand (gS) Poorly sort & unconsolidated w/ 70-75% vf-vc (80% vc) ang. felsic sand (65-65% felsic, ~40% basalt), 25-30% vf-m ang. pebbles (~80% basalt) Max = 10cm (v. sparse). Weak rxn w/ HCl. Soil is dry.	Cable tool drilling w/ hollow core barrel -GS @ 160' bgs
165	Grab			•154' pebble fraction decreases (10-15%) •155.5'-156' silt fraction increases (~10%) •157' pebble fraction < 10%	-GS @ 165' bgs
170	Grab			157'-158.5': Sand (S) Poorly sorted with 90-95% vf-c (80% m-c) ang. Sand (60-70% felsic) with 5-10% vf-f ang.-sub-rounded pebbles (max = 1cm) No rxn with HCl, sediment is dry. •158' 5-10% (M) is encountered	-GS @ 170' bgs
175	Grab			158.5'-159.5': Slightly Silty Sand (M)S well-consolidated, mod sort. & lt. brownish gray (2.5Y, 6.5/2) with 85-95% vf-m (80% f) sand (70-80% felsic) w/ 5-10% lt. brown M. Max grain = ½-1mm, no rxn.	-GS @ 175' bgs -GS @ 180' bgs
180	Grab			159.5-162': Sandy Gravel (sG) Poorly sort. & unconsolidated with 60-70% well rounded vf-m pebbles (~70% basalt) 30-35% vf-vc ang. sand (55-75% felsic) with 5-10% lt. gray (2.5Y, 7/1) silt. Max particle = 10cm. Mod.-Strong rxn with HCl	-GS @ 185' bgs
185	Grab			162'-183': Silty Sandy Gravel (msG) V. Poorly sort. & unconsolidated w/ 70% well-rounded vf-vc (60-70% m) pebbles (80% basalt) with 15% vf-vc ang. Sand (50-70% felsic) & ~15% silt (lt. brownish gray, 2.5Y, 6.5/2) Max particle = 8-10cm, mod rxn with HCl •174' med. pebble fraction is less dom. & ~5-10% small cobbles are present. •Silt fraction decreases @ ~183' bgs (5-10%)	-GS @ 190' bgs -GS @ 195' bgs
190	Grab				
195	Grab				
				183'-220': Sandy Gravel (sG) Poorly sort. w/ 50-60% sub-rounded to sub-ang. pebbles (60-70% basalt), 15-20% sub-rounded to well-rounded s-m cobbles &	

Reported By: Jake Horner | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: Jake Horner | Date: 6-20-06 End | Signature: L.D. Walker | Date: 8/3/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 7 of 11 (12) 7/6/06
Date: 6-20-06 start

Well ID: C4998 | Well Name: Entry Borehole #1 | Location: WTP Seismic Borehole #1
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
200	Grab			183' - 220': SG cont. from page 6. Cobbles (60-70% basalt) with 15-20% m-vc sub-ang. sand (~50% basalt) with 5-10% silt. Max cobble = 15-20 cm. mod. rxn w/ HCl.	Cable tool drilling w/ hollow drive barrel 7 5/8" x 34" 202' - 210.5' 6 5/8" x 23" 210.5' - 425 (4/7-06)
205	Grab			• 205' - 212.5' Large basalt cobbles • 209.5' - 212.5' Boulders present (basalt) • 212.5' → Cobble size fraction decreases (15%-20% of bulk - 5-m cobbles)	-GS @ 200' bgs -GS @ 205' bgs
210	Grab			• 220' ≤ 10% cobbles (m (v. sparse) avg = 5)	-GS @ 210' bgs
	6-25-06			60% pebbles & 30-35% > m/ ~5% M.	
215	Grab			220' - 246': SG cont. Poorly sort. w/ 60-70% vf - vc (75% m/c) well-rounded - ang. pebbles (50-60% basalt 40-50% heterolithic), 30-35% vf - vc (20% vc) ang. - sub-ang. S (50% basalt, 50% hetero.)	-GS @ 215' bgs
220	Grab			Max particle = 10 cm (v. sparse). <5% M. • 230' - vc pebbles & 5-m cobbles are present. • 240' cobbles contain < 30% basalt, pebble fraction (50-60% basalt)	-GS @ 220' bgs
225	Grab				-GS @ 225' bgs
230	Grab				-GS @ 230' bgs
236	Grab				GS @ 235' bgs

Reported By: Jake Horner | Title: Geologist | Signature: Jake Horner | Date: 6-28-06
Reviewed By: L.D. Walker | Title: Geologist | Signature: LD Walker | Date: 8/3/06

End

A-6003-642 (03/03)

BOREHOLE LOG

Page 8 of 11 (12) 7/10/06
Date: 6-29-06 start

Well ID: C4998 | Well Name: Entry Borehole #1 | Location: WTP Seismic Borehole #1
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
240	Grab			246' - 259' : Gravelly Sand (gS) Mod-well-sort, w/ 60-80% m-vc(~20% m & 80% c/vc) ang. S(40-60% basalt, S in Sand is more felsic(~60%)) with 20-40% vf-f sub-ang. pebbles(~60% basalt) max = 2.8cm; no rxn w/ HCl.	Cable tool drilling w/ hollow drive barrel (6 5/8" OD x 23") -GS @ 240' bgs
245	Grab				-GS @ 245' bgs
	Grab			•247.5' - 2cm layer of dk. gray - v. dk. gray (2.5Y 3.5/1) silt (moist, no rxn w/ 1% HCl).	-GS @ 247' bgs
250	Grab			•252' m-f sand fraction increases (40-50% m-f & 50-60% c-vc) m-f sand (80-90% felsic) vc S & pebbles (50-60% basalt), weak rxn w/ HCl.	-GS @ 250' bgs
				259' - 266' : Sandy Gravel (sG) Mod sort. w/ 70-80% vf-c pebbles (60% m-c, sub-well rounded & 40% f-vc sub-rounded to ang.; 50-60% basalt, ~10% gneiss, 10% plutonic, 20% undifferentiated meta. Many grains slightly oxidized. Max grain = 3.4cm. Weak rxn w/ HCl.	-GS @ 255' bgs
255	Grab				
260	Grab			Moist - 266' - 267' : Sand (S) Well sort. w/ 80% f-vc (80% vc-c) ang. - sub-ang. S (~60% felsic), 20% f-vf sub-ang. pebbles (~60% basalt) Max = 1cm, mod. rxn HCl.	-GS @ 261' bgs
					-GS @ 266' bgs
265	Grab			267' - 268' : Sandy Gravel (sG) Poorly sort. w/ 40% vc sand - f. pebbles (ang. - sub-ang.; 50% metasiltstone, 50% m-vc sub-well rounded metasiltstone pebbles & ~15% vf ang. felsic sand. Mod rxn HCl, max = 1cm.	@ 6-29-06
270	Grab			•268' - 268.2' v. well sort. vf dark grayish brown (2.5Y, 4/2) felsic sand (80% qtz/felsics), Mod rxn w/ HCl, moist.	-GS @ 270' bgs
275	Grab			268' - 269.5' : Gravel (G) Mod sort. w/ 90% vf - m well-rounded - sub-ang. metasiltstone pebbles (f-vf pebbles ~50% basalt), 10% vc S.	-GS @ 275' bgs
		▽			DTW = 278.1' bgs 6-30-06

Reported By: Jake Horner | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Jake Horner | Date: 6-29-06 | Signature: L.D. Walker | Date: 8/3/06

End

A-6003-642 (03/03)

BOREHOLE LOG

Page 9 of 11 12 (OB 7/18/06 Start)
Date: 6-29-06

Well ID: C-4998 | Well Name: Entry Borehole #1 | Location: WTP Seismic Borehole #1
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
280	Grab			269.5'-310': Sandy Gravel (sG)	Cable tool drilling
				P. Sort. w/ ~70-80% vf-c heterolithic	with 6 5/8" x 23" Shelby
				pebbles (m-c pebbles - well rounded &	drive barrel & 8 5/8"
				vf-f pebbles - ang.-subang.) w/ 20-30%	temp. casing (2nd string)
				vf-vc (80% vc) sub-rounded - ang. lithic	9 5/8" OB 6-29-06
285	Grab			Lithic Sand (vf-f grains are more felsic	- GS @ 280' bgs
				(~60-80%)) & < 5% silt. Max = 5cm	- GS @ 285' bgs
				Mod rxn w/ HCl vc-c S (40-50% basalt)	
				• 273' → Driller noted harder Fm.	
				• 273' → 274' s-m cobbles, max = 15cm	
290	Grab			• 274' → still hard, c pebbles & sparse	- GS @ 290' bgs
				sa cobbles.	
				• 280.5' - 281' bgs Sand (s)	
				Well sort. w/ 90% m-c sub-ang S.	
				(60% felsic) lt. olive brown (2.5Y 5/6)	
295	Grab			10% well-rounded f-m pebbles.	- GS @ 295' bgs
				• 281' vc-f sand fraction of sG	
				decreases to < 5% f.-vc. S (40% basalt	
				vf-f (~80% qtz/felsic, <10% basalt)	
				• 308' small pocket of dark gray-dark	
300	Grab			grayish brown (2.5Y, 4/1.5) vf-f sub-rounded	- GS @ 300' bgs
				sand (~80% qtz, ~10% felsics, <10% basalt)	
				c-vc sand fraction ~ 40% basalt	
				310'-312': Sandy Gravel cont...	
				P. Sort w/ 60% well-rounded f pebbles to	- GS @ 305' bgs
305	Grab			m cobbles (heterolithic, ≤20% basalt), 40%	
				vf-c (80% m) sub-ang. dark gray-dark	
				gray-olive brown (2.5Y, 4/1.5) sand (60%	
				felsic, 20% mafic (basalt) f-m pebbles	
				ang.-sub-ang. Max = 15-20 cm, No rxn.	
310	Grab			• 310' sand heaving, had to add water	- GS @ 310' bgs
				• 318' weak-mod rxn w/ HCl &	
				very few cobbles (60-70% pebbles, 30-40%	
				sand). No recovery 312'-318' bgs	
315					
	Grab				- GS @ 318' bgs

Reported By: Jake Horner | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Jake Horner | Date: 7-5-06 | Signature: LD Walker | Date: 8/3/06

End

A-6003-642 (03/03)

BOREHOLE LOG

Page 10 of 11 12 (8) 3/10 log start
Date: 7-5-06

Well ID: C4998 | Well Name: Entry Borehole #1 | Location: WTP Seismic Borehole #1
Project: WTP Seismic Borehole Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
320	G.S.			~320' c Sand & f-m pebble fraction is ~40% basalt	Cable tool drilling with 6 5/8" x 2 ft hollow drive barrel & 8" @ 7-5-06 9 5/8" temp. casing.
325	G.S.			322'-323' : Sandy Gravel (sG) v. well- cons. & P. Sort. with ~60% f-vc well-rounded heterolithic pebbles (10-30% basalt), 30-35% sub-ang f-c (80-90% m) lt. olive brown (2.5Y, 5/4) sand (90% felsic/lt) w/ 5-10% silt. Max particle = 2.5", Weak rxn w/ HCl. consolidated, bimodal	Top of Ringold Fm is ~322' bgs. OTW = 280.3' bgs Switch to hard tools @ 323'
330	G.S.			323' 340' Gravelly sand (gS), 25% granules, 75% f-crs sand, poorly sorted, mostly angular grains, 50-60% basalt, 2.5Y4/2 (dk grayish brn), lgst clast = 5mm	Sample pulverized to mostly sand
335	G.S.				Fm not making mud - difficult to haul out. Hard, slow drilling
340	G.S.			340-345' sample bailed as well sorted f-m sand although driller says were in consolidated gravels	OTW = 283.4 7-6-06
345	G.S.			345-355' well consolidated sG w/ f-m pebble sized cuttings (non-fractured edges are well to sub-rounded) & f-m sand (~70% felsic) Max grain = 4-5 cm, very poorly sorted, pulverized.	
350	G.S.			2.5Y 5/2 (grayish brown)	OTW = 283.6' 7-7-06
355	G.S.			355-382 Silty sandy gravel (msG), 10-20% silt, 40% f-m crs sand, 40% granule to f-m pebble poorly sorted, G = mostly angular 30-40% basalt, S = 30-40% basalt, 2.5Y5/2 (grayish brown) lgst clast = 2cm, unbroken gravel clasts rounded to well rounded	Hole open 5'. Driller reports hole is predicting more mud now

Reported By: Jake Haener / Bruce Bjornstad | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Jake Haener / B Bjornstad | Date: 7-7-06 | Signature: L.D. Walker | Date: 8/3/06

End

A-6003-642 (03/03)

G.S. = grab sample

BOREHOLE LOG

Page 11 of 11 (2) 7/10/06
Date: 7-7-06 start

Well ID: C4998 | Well Name: Entry hole #1 | Location: WTP Seismic Borehole #1
Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
360	G.S.			Silty sandy gravel (msG), as above	
365	G.S.				
370	G.S.			Drilling slows - boulder?	Driller notes change in drilling at 370' bgs.
				370-375 sample ~50% mud, 40% sand, 10% gravel, 5Y5/3 (olive). Driller thinks still in gravels so high mud, low gravel due to pulverization	NFW = 287.3' 7-9-06
375	G.S.			375-380' 20% mud, 40% fn-crs sand, 40% granule gravel, v. poorly sorted, 5Y5/3 (olive), lgst clast ~5mm, G = 30-40% basalt, S = 10-20% mafic	Drilling rate increases
380	G.S.			rounded, w/hard basalt (3cm) pebble recovered from bailer in tact, weathering rind	All clasts angular
				380-385' 30% mud, 60% fn-crs sand, 10% granule gravel	Driven casing slowed at ~382'
385	G.S.			Washed sample: G = 70-80% basalt, S = 60-70% basalt, 5Y4/1 (dk gray), basalt grains nonvesicular	Color change. Drilling about the same
	G.S.				
390	G.S.			385-387.5 Washed sample ~90% basalt rock fragments, about 1/2 larger clasts vesicular	Drilling getting hard @ ~390'
				382-395' Basalt, vesicular, unweathered (upper 8' may be weathered?)	
395	G.S.			TD = 395' NB 7/10/06	
				8.12 NB 7/10/06	
					†Grab sample from 395-400'.

Reported By: Bruce Bjornstad / Jake Horner / J. Fowler | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Bruce Bjornstad, Jake Horner, J. Fowler | Date: 7-10-06 | Signature: L.D. Walker | Date: 8/3/06

End

A-6003-642 (03/03)

BOREHOLE LOG

Page 12 of 12
Date: 7/10/06 - start.

Well ID: C4998 | Well Name: Entry B.H. # 1 | Location: WTP Seismic Borehole # 1

Project: WTP Seismic Boreholes Project | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
400	G.S.			395' – 401.5': Basalt, Vesicular	Casing @ 384.5' bgs.
	G.S.				Hard-tool drill w/
	~~G.S.~~ (NB) 7/10/06				cable tool rig.
				T.D. = 401.5' bgs (Entry Borehole)	- Grab sample from 400 ~~404~~ 401.5' (NB) 7/10/06 7/11/06 (RB)
405				* Core hole will continue below this point.	

Reported By: N. Bowles | Reviewed By: L. D. Walker

Title: Geologist | Title: Geologist

Signature: | Date: 7-10-06 | Signature: | Date: 8/3/06

End

A-6003-642 (03/03)

APPENDIX E

CHIP TRAY PHOTOGRAPHS (C4993)

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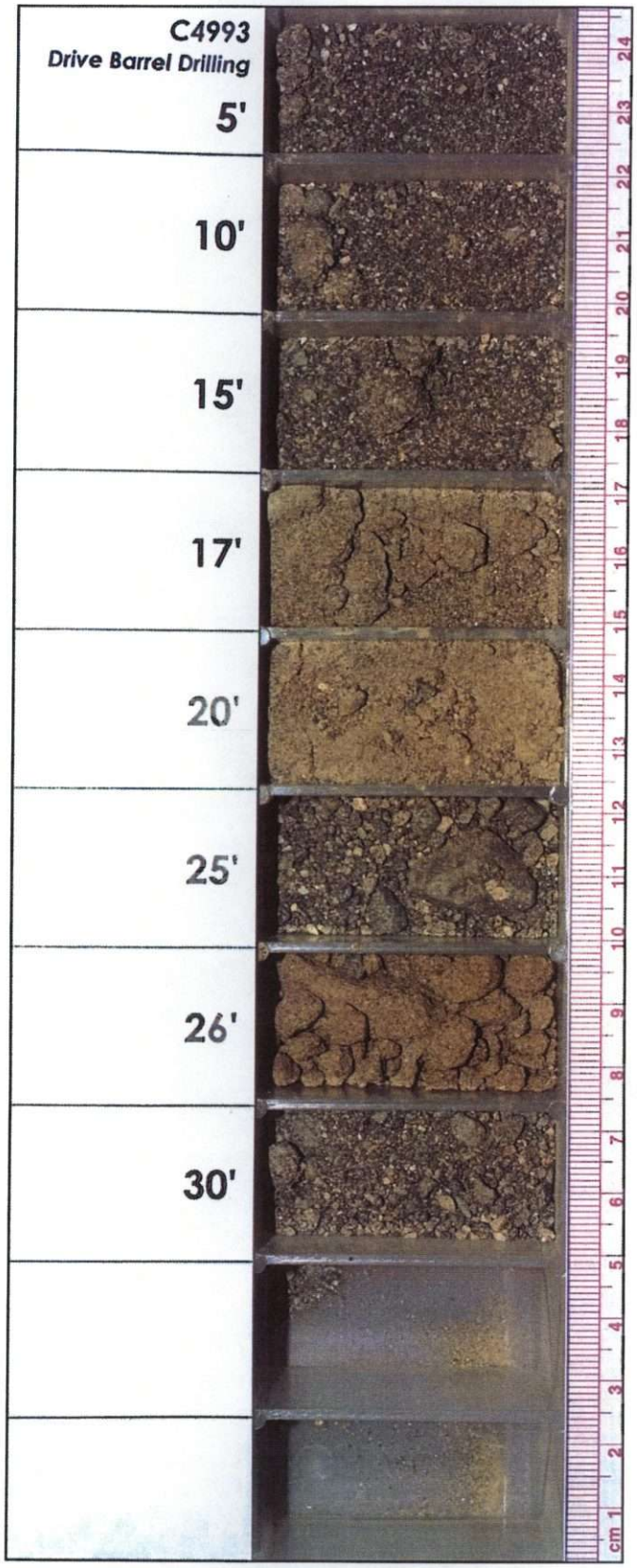
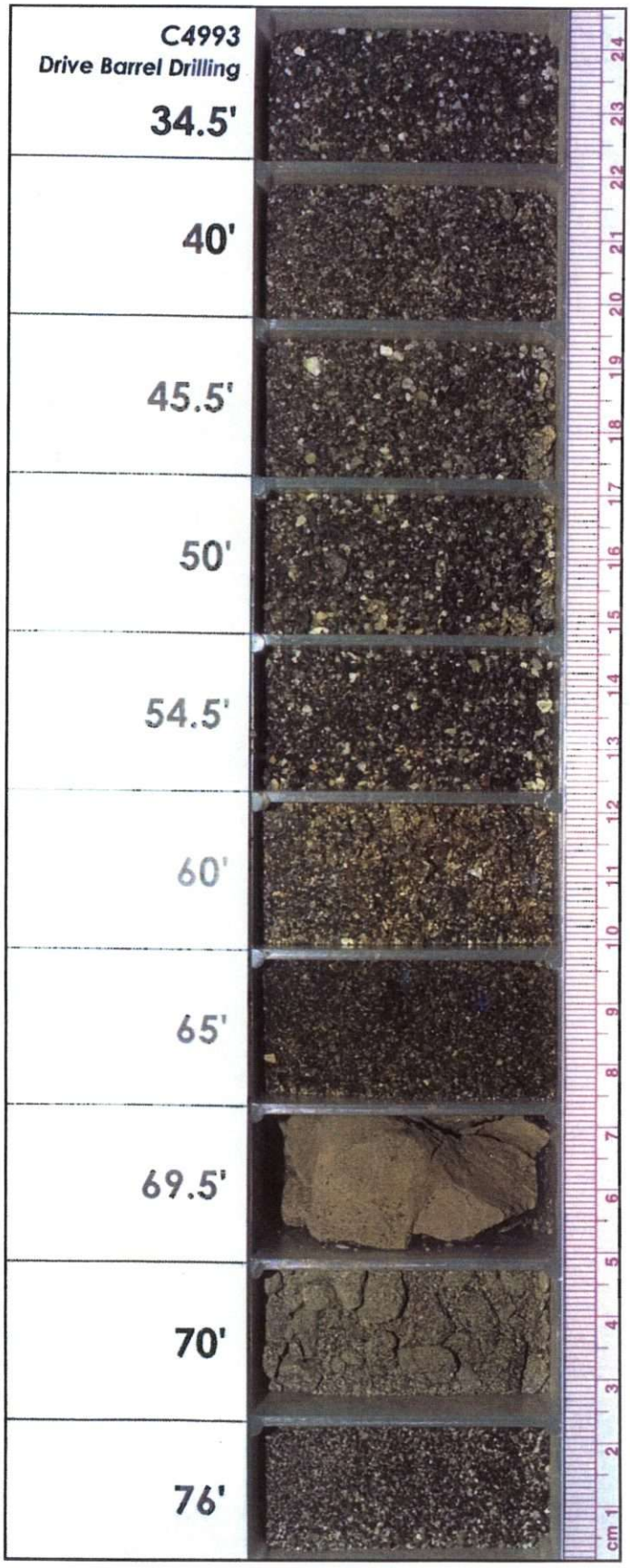
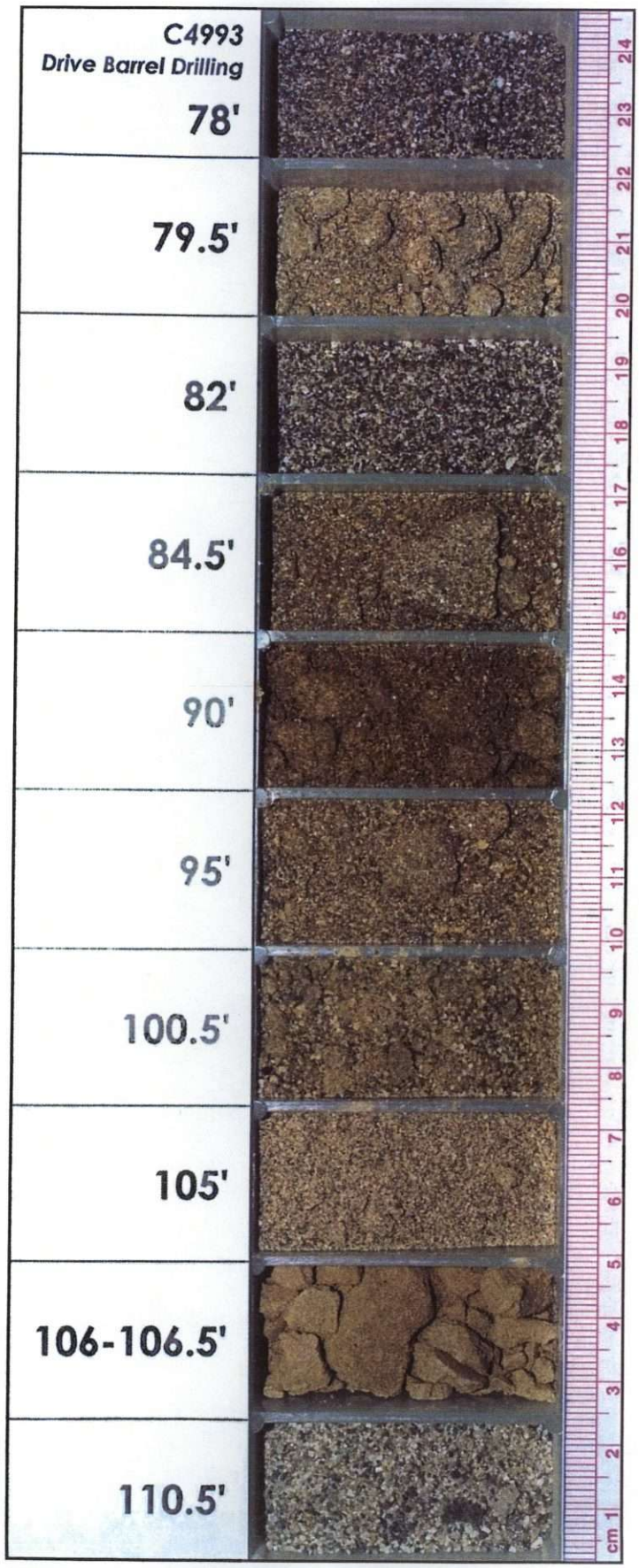
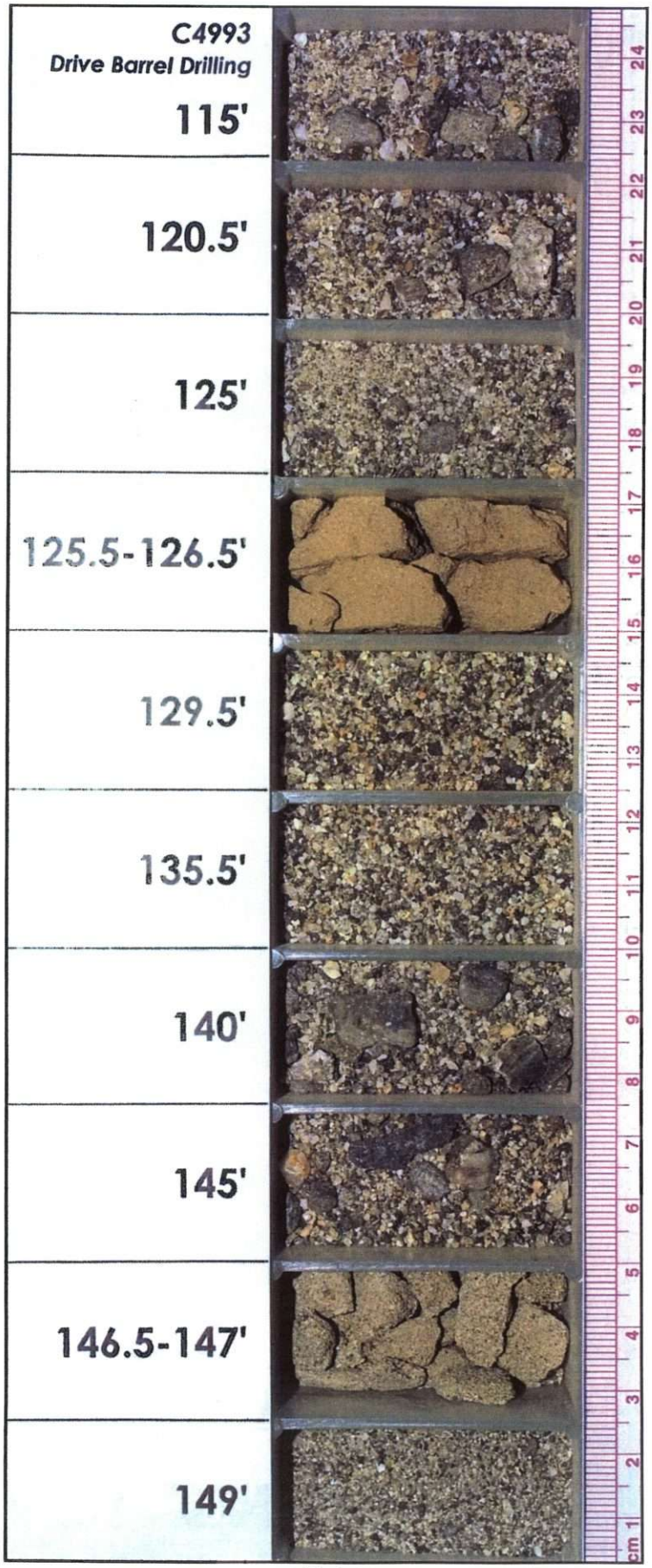
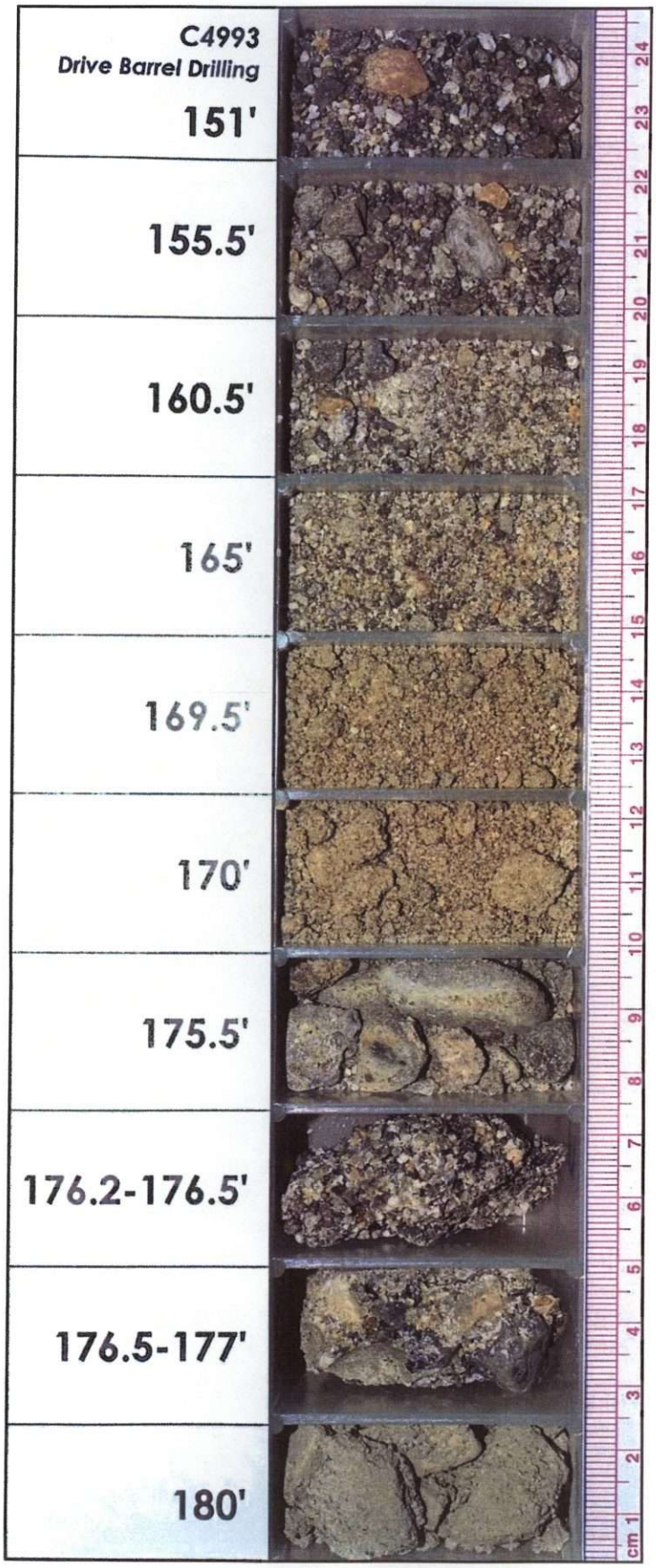
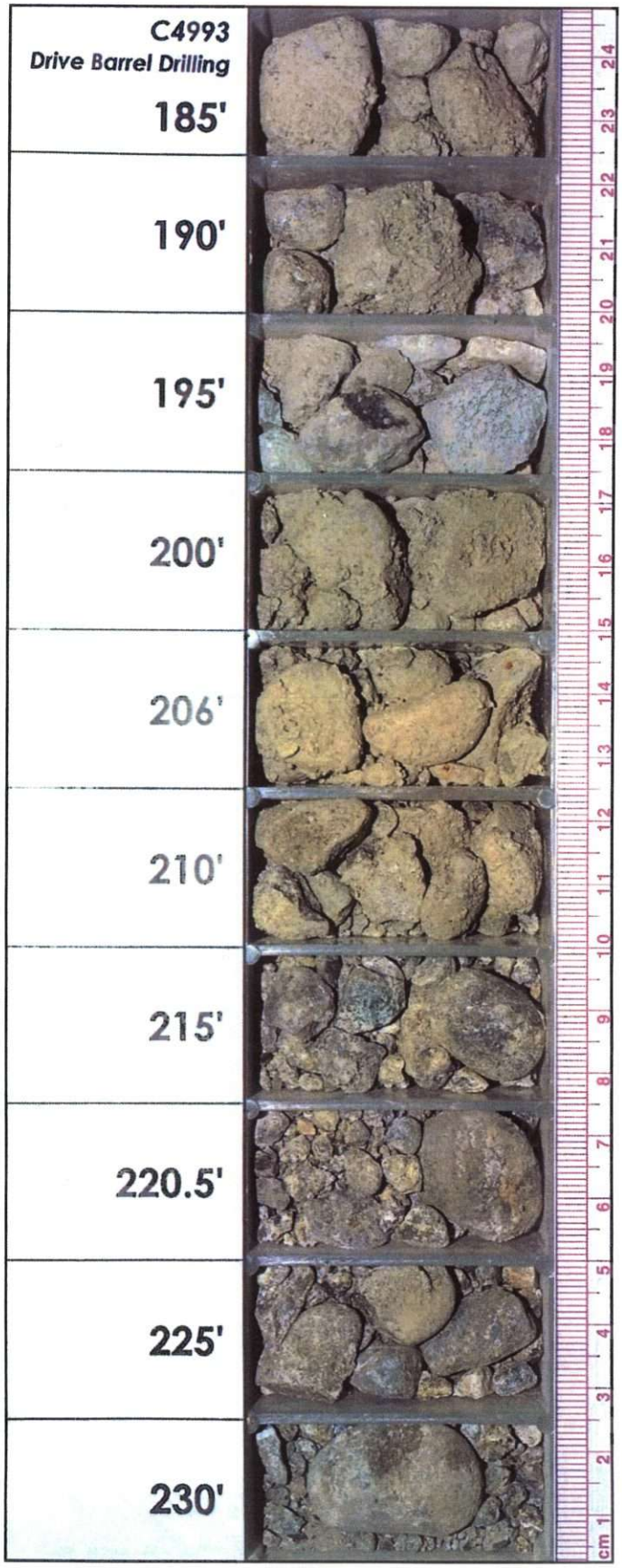

C4993
Drive Barrel Drilling
5'
10'
15'
17'
20'
25'
26'
30'


C4993
Drive Barrel Drilling
34.5'
40'
45.5'
50'
54.5'
60'
65'
69.5'
70'
76'
cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


C4993
Drive Barrel Drilling
78'
79.5'
82'
84.5'
90'
95'
100.5'
105'
106-106.5'
110.5'
cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


C4993
Drive Barrel Drilling
115'
120.5'
125'
125.5-126.5'
129.5'
135.5'
140'
145'
146.5-147'
149'


C4993
Drive Barrel Drilling
151'
155.5'
160.5'
165'
169.5'
170'
175.5'
176.2-176.5'
176.5-177'
180'
cm 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24


C4993
Drive Barrel Drilling
185'
190'
195'
200'
206'
210'
215'
220.5'
225'
230'
cm 1
2
3
4
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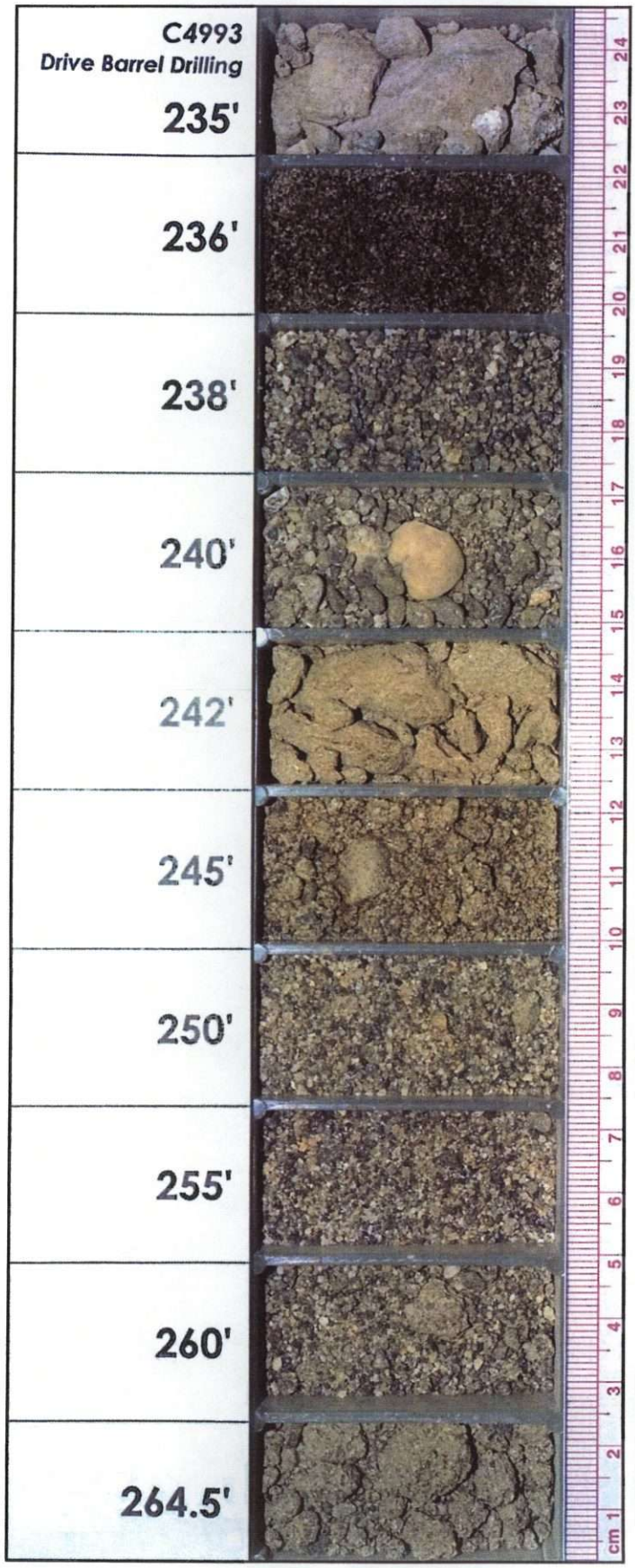
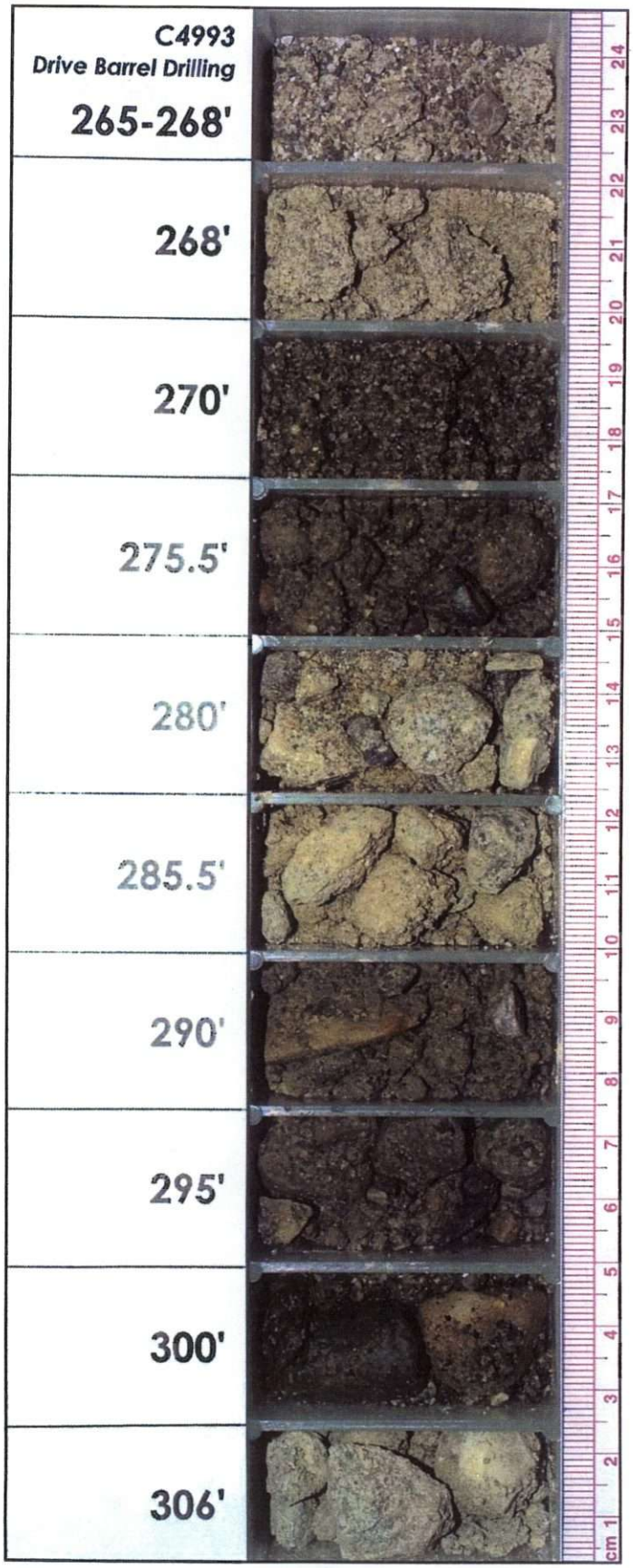
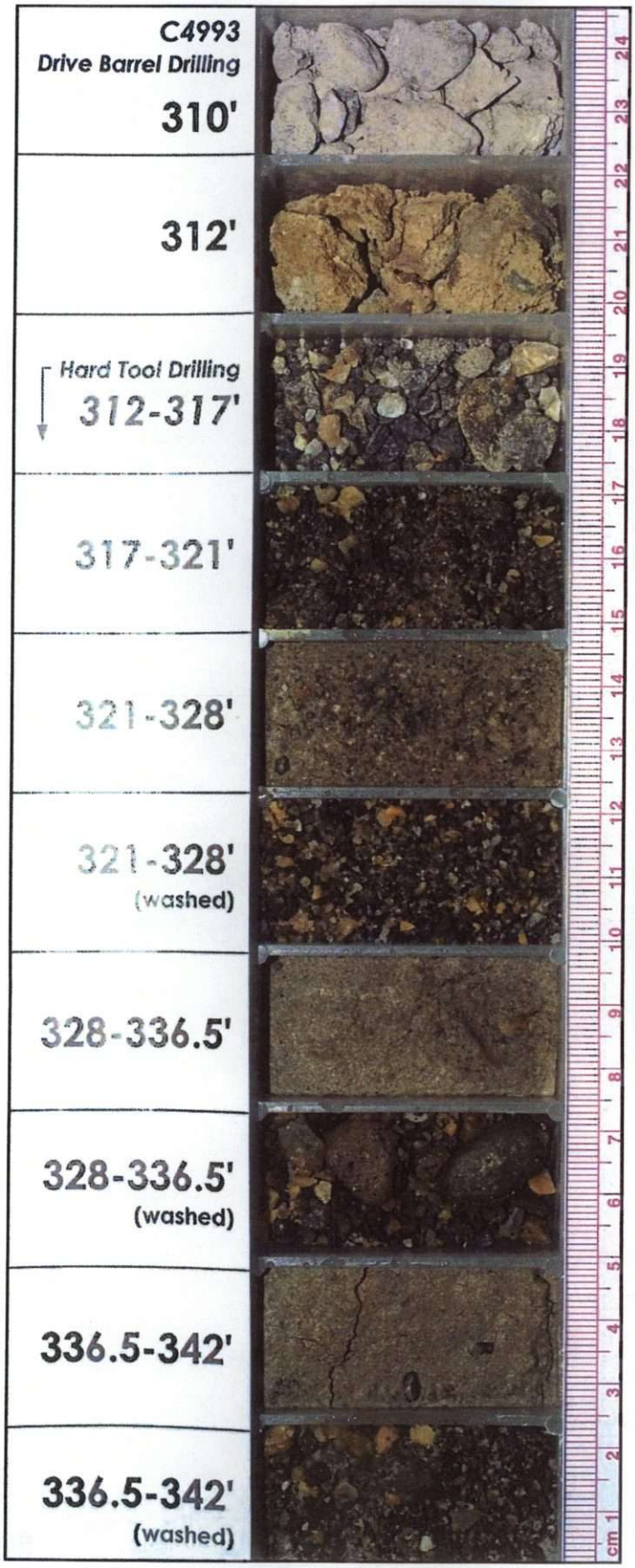
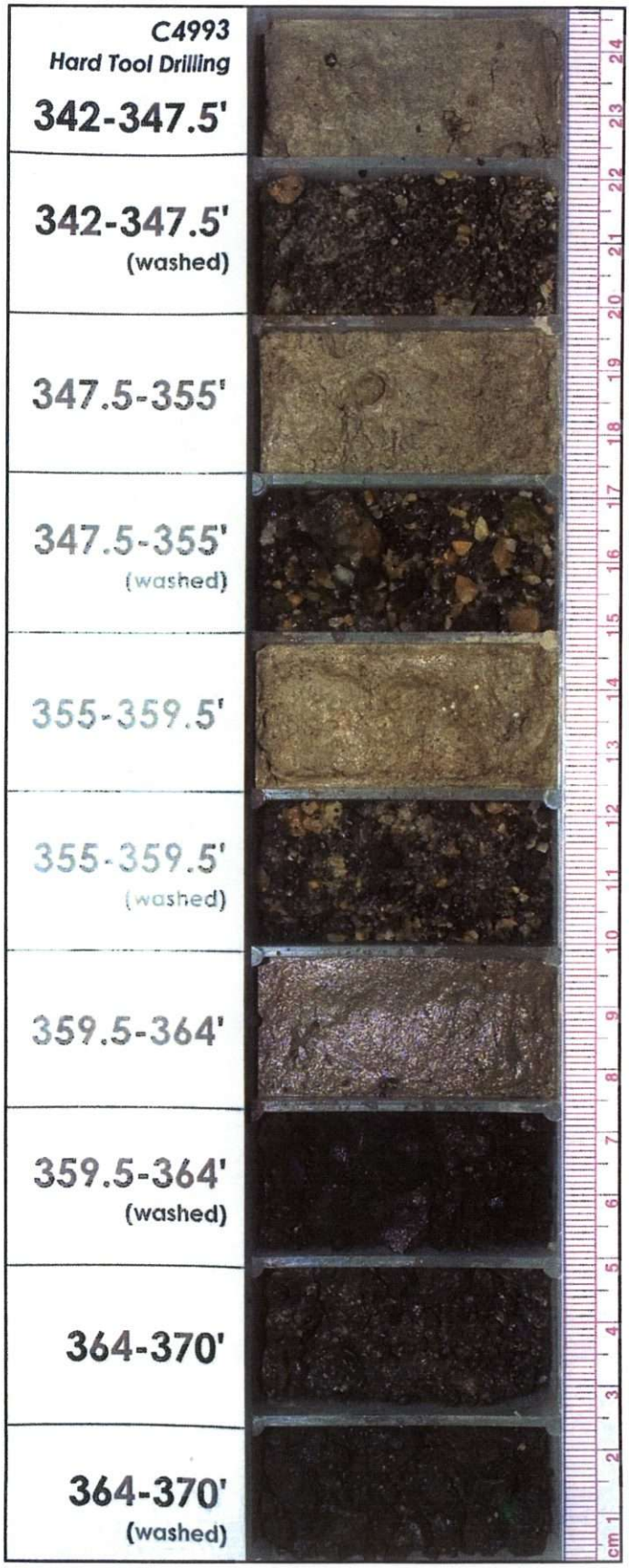
15
16
17
18
19
20
21
22
23
24


C4993
Drive Barrel Drilling
235'
236'
238'
240'
242'
245'
250'
255'
260'
264.5'


C4993
Drive Barrel Drilling
265-268'
268'
270'
275.5'
280'
285.5'
290'
295'
300'
306'
cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


C4993
Drive Barrel Drilling
310'
312'
Hard Tool Drilling
312-317'
317-321'
321-328'
321-328'
(washed)
328-336.5'
328-336.5'
(washed)
336.5-342'
336.5-342'
(washed)


C4993
Hard Tool Drilling
342-347.5'
342-347.5'
(washed)
347.5-355'
347.5-355'
(washed)
355-359.5'
355-359.5'
(washed)
359.5-364'
359.5-364'
(washed)
364-370'
364-370'
(washed)


C4993
Hard Tool Drilling
370-377.5'
370-377.5'
(washed)
377.5-383.5'
377.5-383.5'
(washed)

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APPENDIX F

CHIP TRAY PHOTOGRAPHS (C4996)

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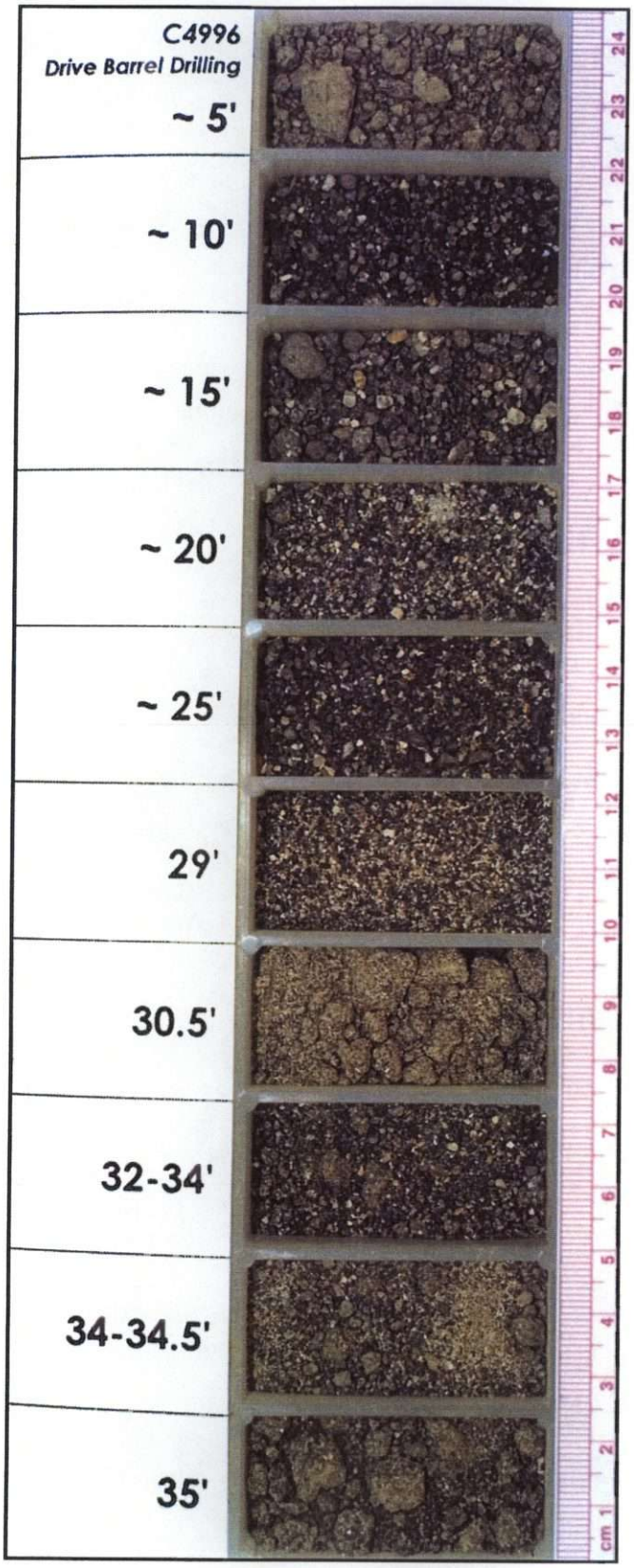
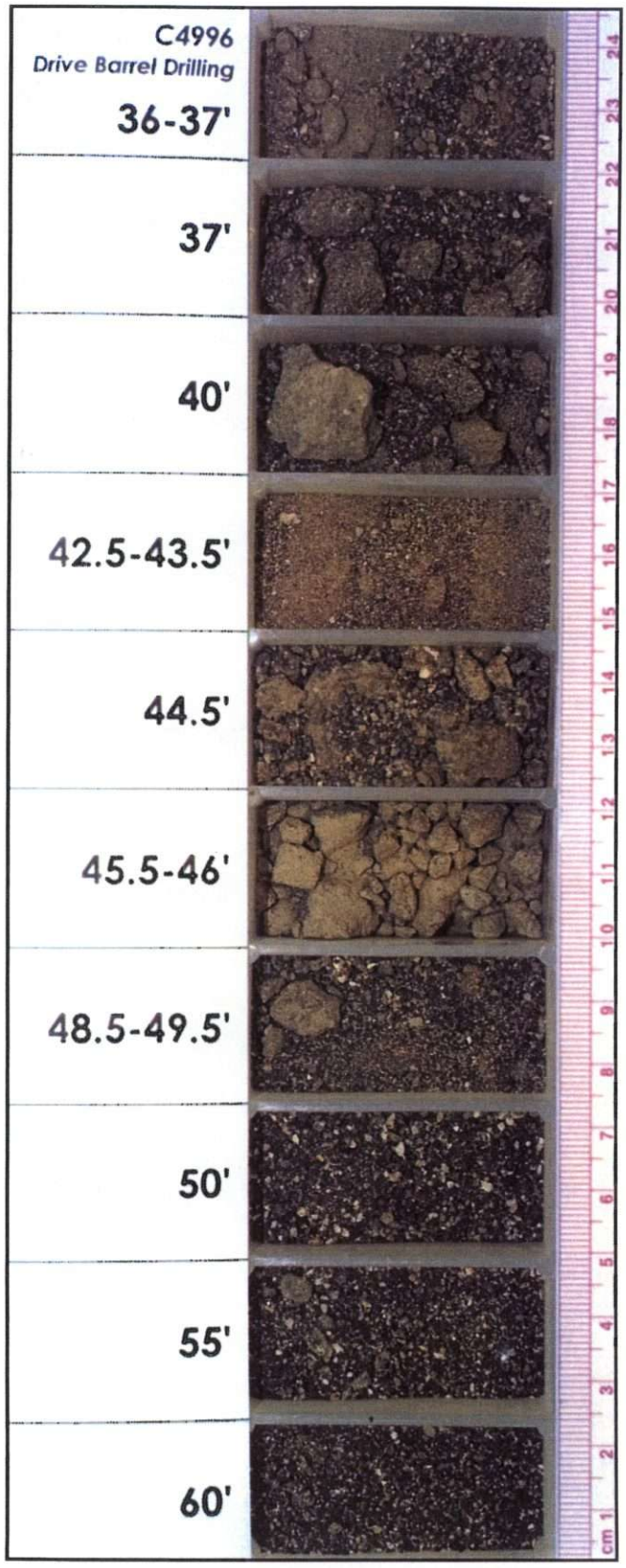
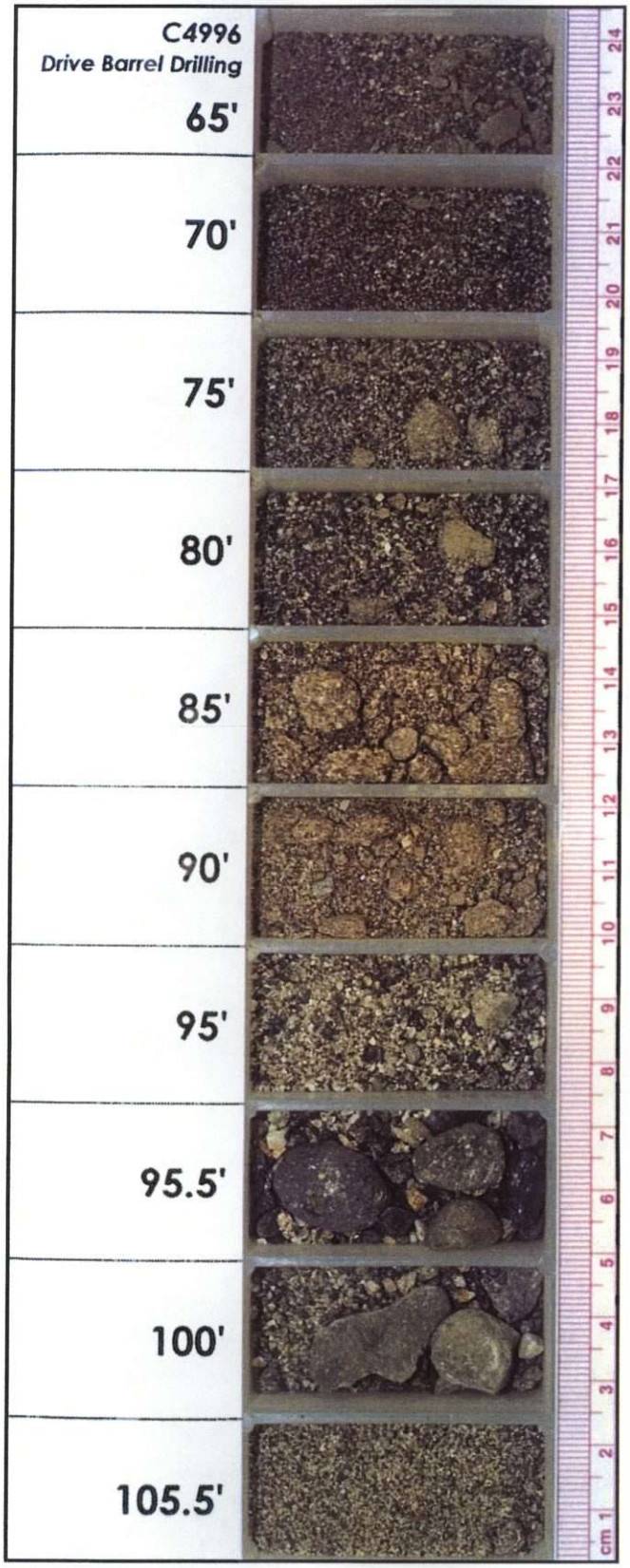
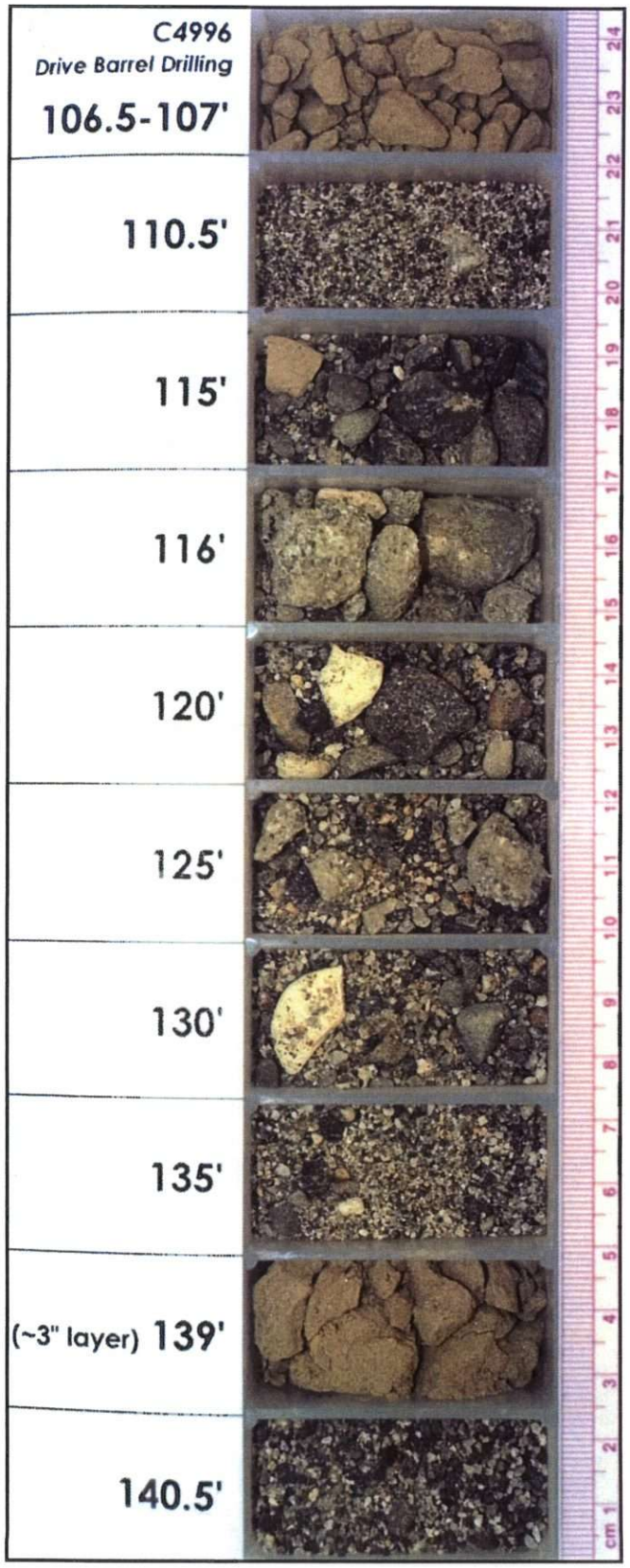
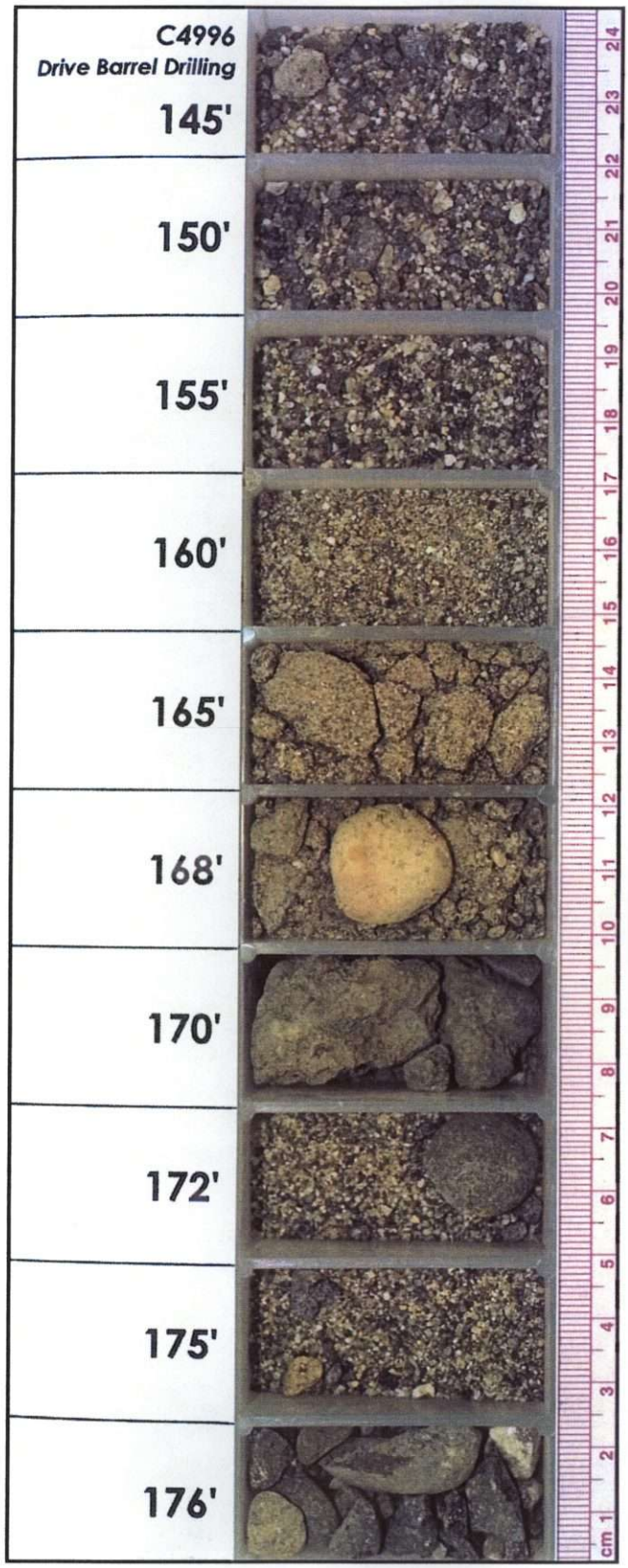
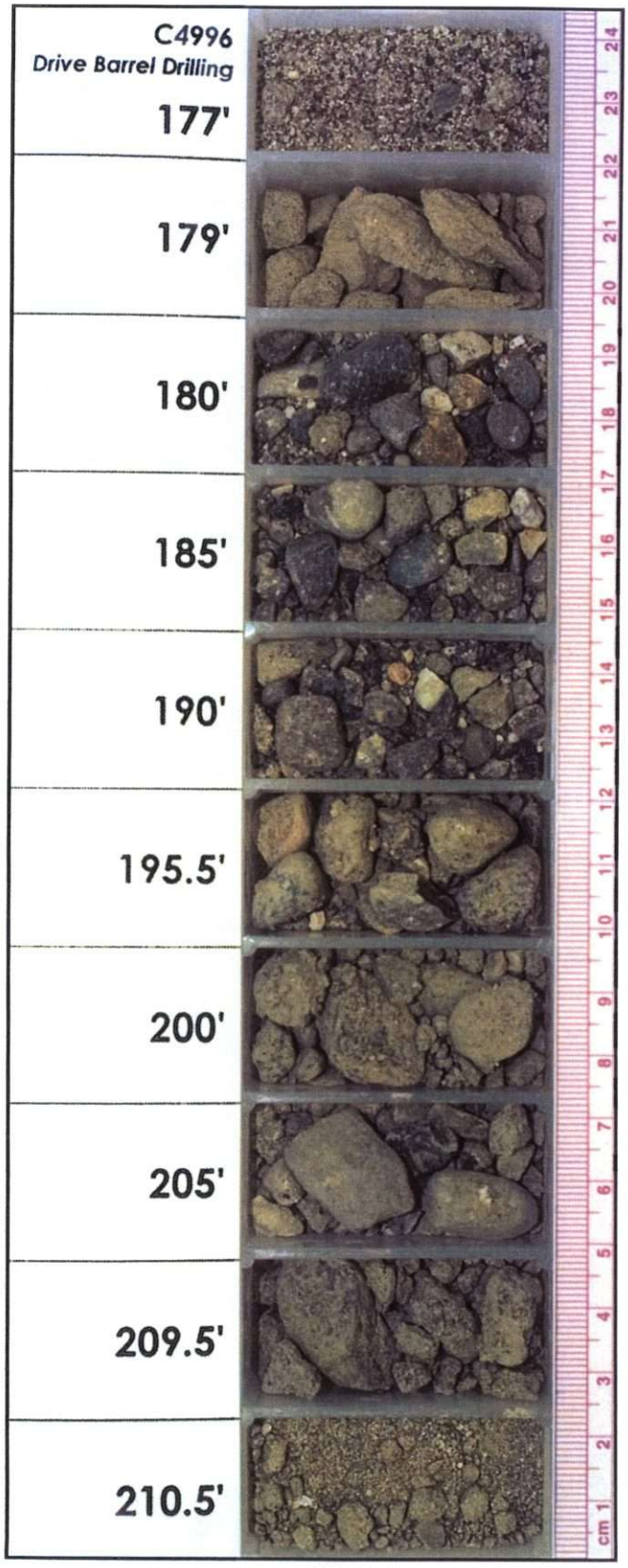

C4996
Drive Barrel Drilling
~ 5'
~ 10'
~ 15'
~ 20'
~ 25'
29'
30.5'
32-34'
34-34.5'
35'

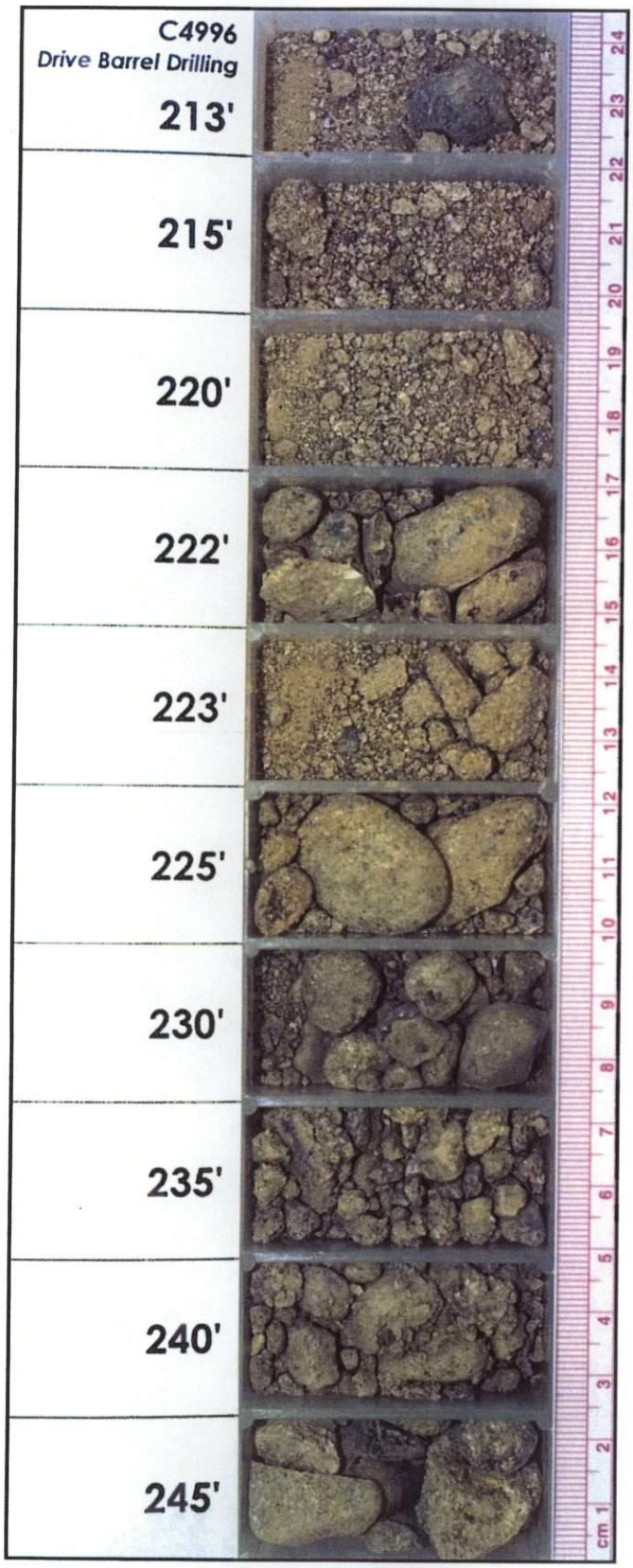

C4996
Drive Barrel Drilling
36-37'
37'
40'
42.5-43.5'
44.5'
45.5-46'
48.5-49.5'
50'
55'
60'

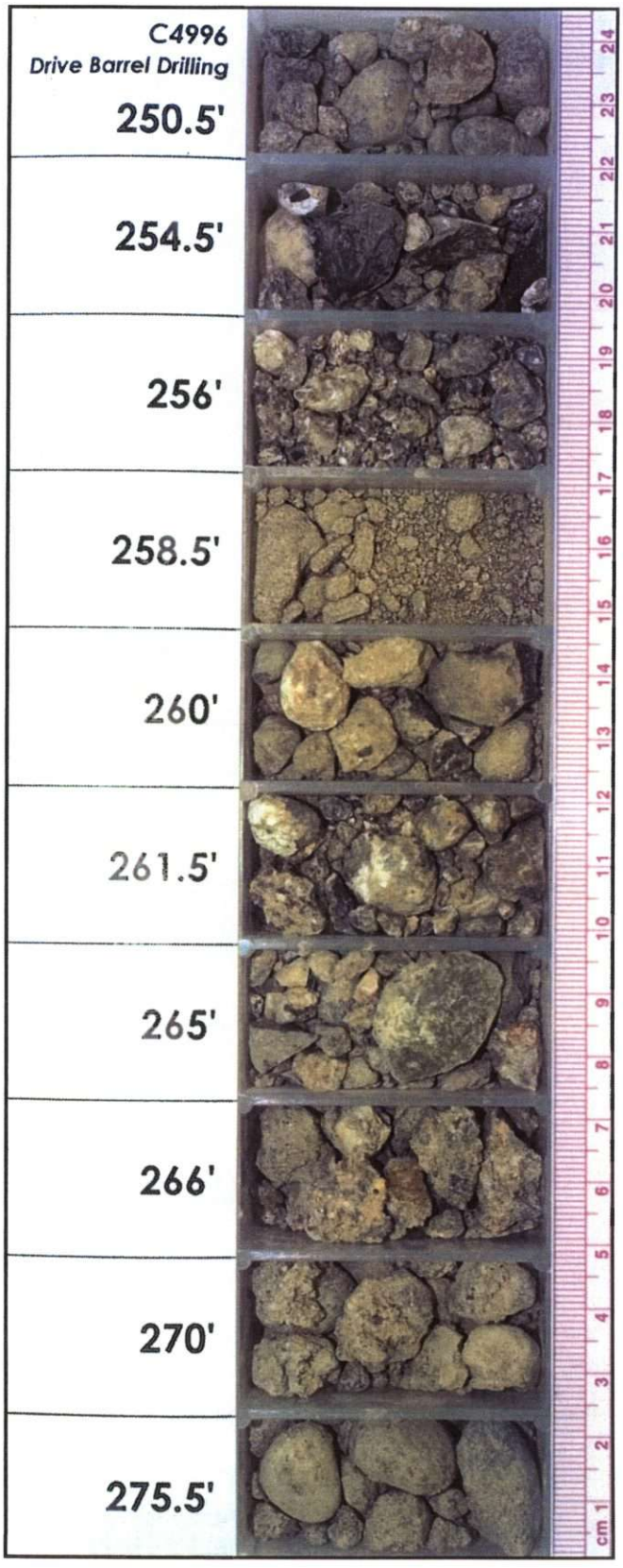

C4996
Drive Barrel Drilling
65'
70'
75'
80'
85'
90'
95'
95.5'
100'
105.5'

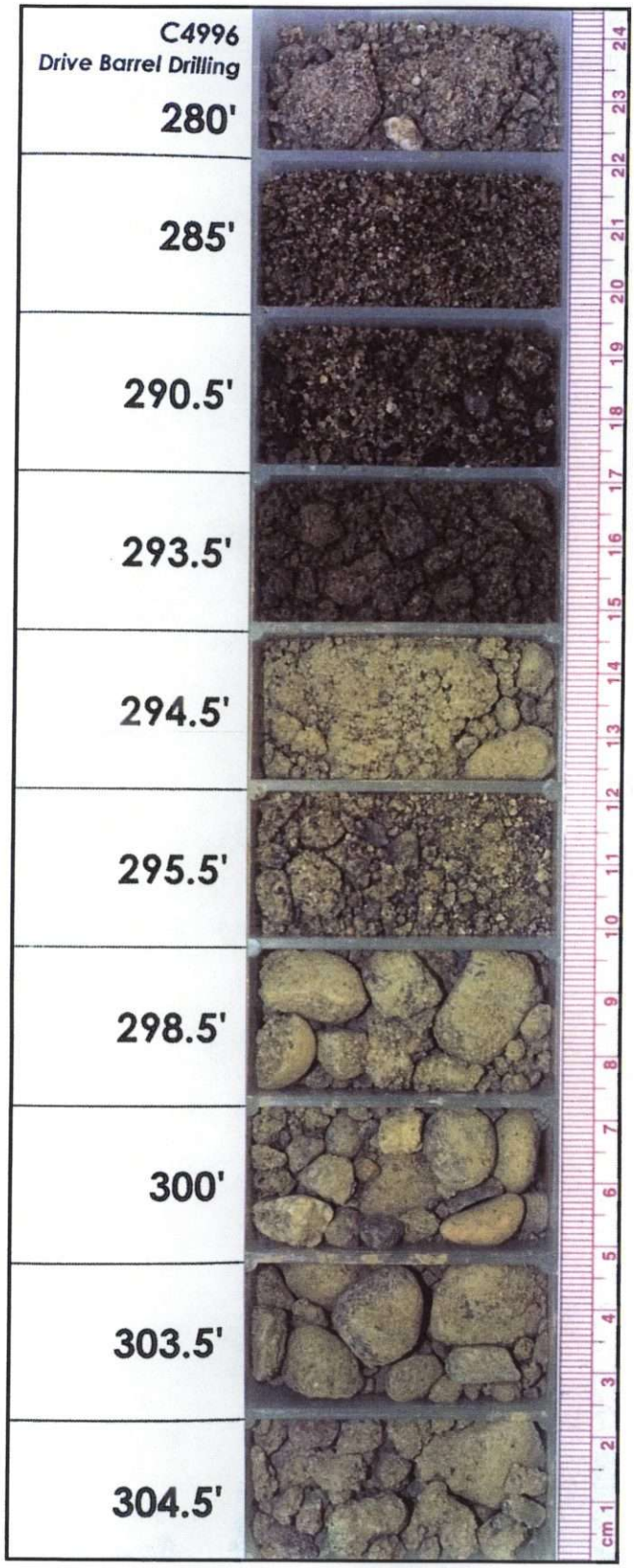

C4996
Drive Barrel Drilling
106.5-107'
110.5'
115'
116'
120'
125'
130'
135'
(~3" layer) 139'
140.5'

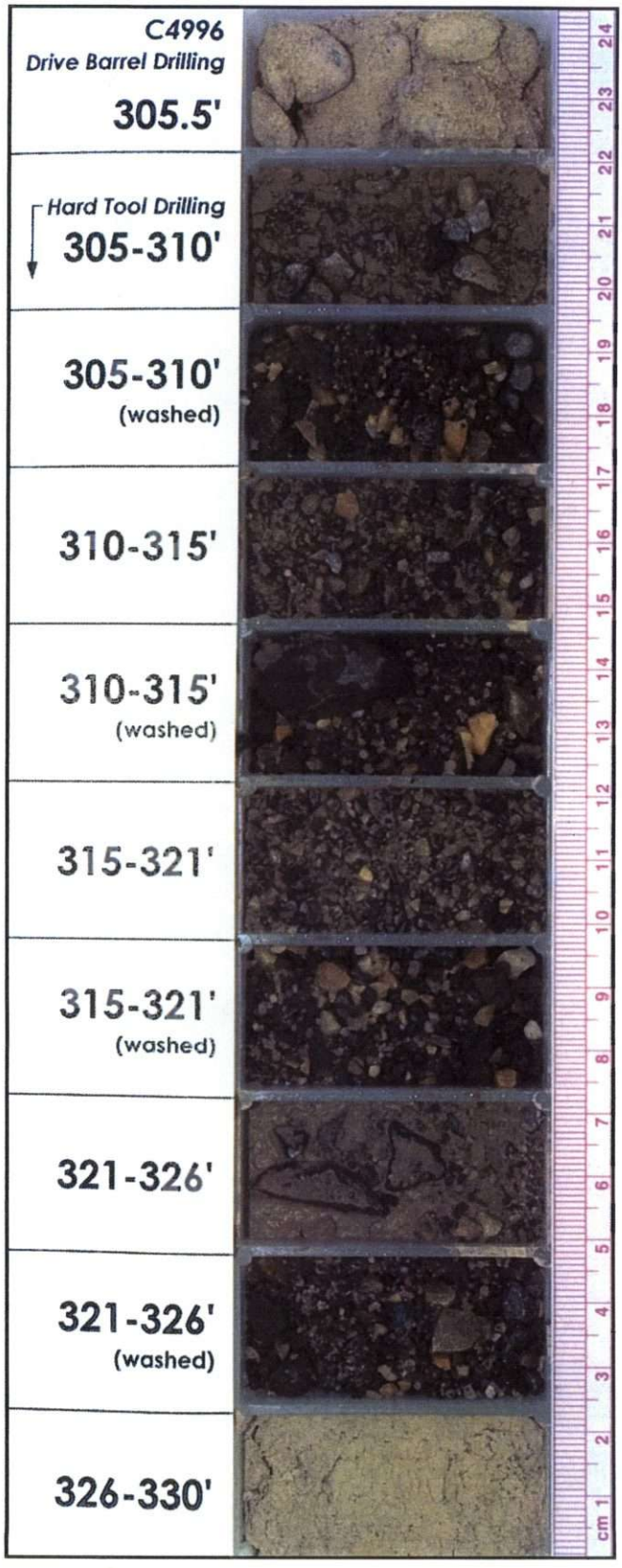

C4996
Drive Barrel Drilling
145'
150'
155'
160'
165'
168'
170'
172'
175'
176'
cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

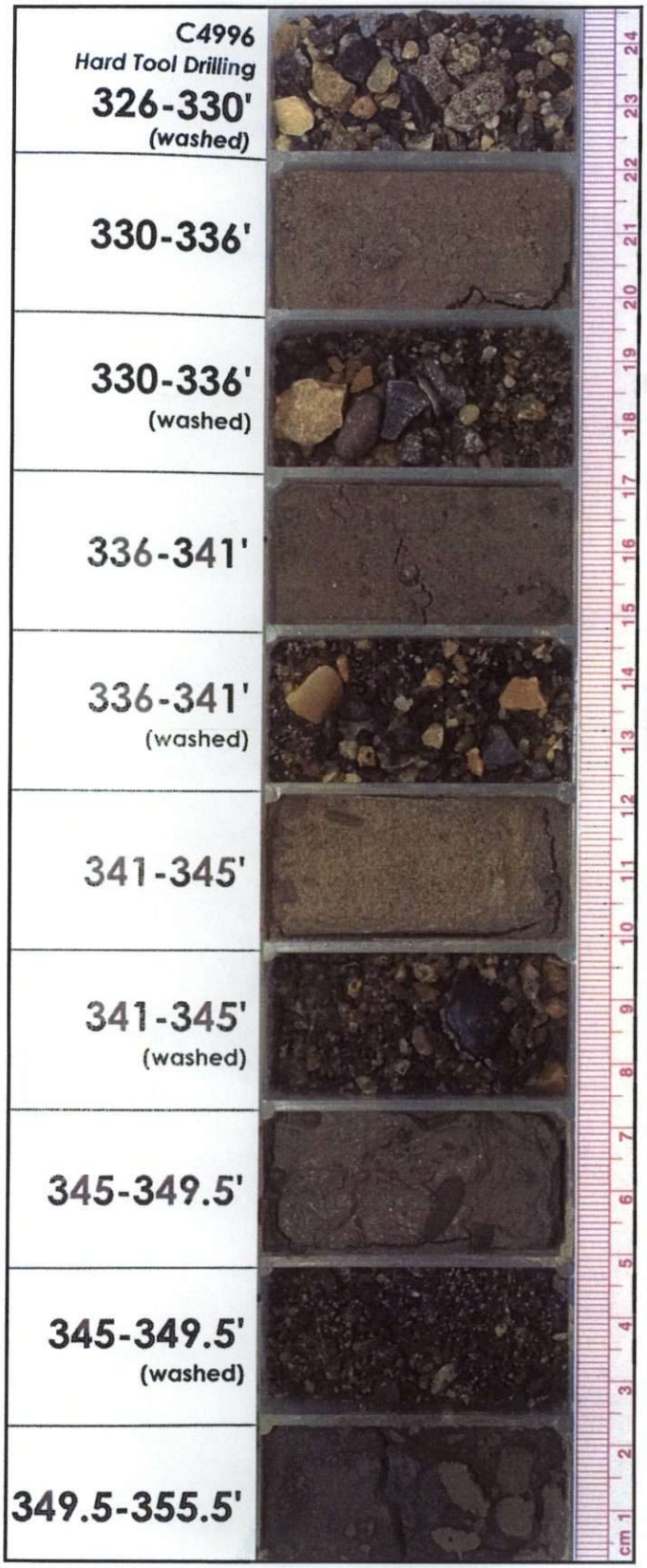

C4996
Drive Barrel Drilling
177'
179'
180'
185'
190'
195.5'
200'
205'
209.5'
210.5'


C4996
Drive Barrel Drilling
213'
215'
220'
222'
223'
225'
230'
235'
240'
245'
cm 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24


C4996
Drive Barrel Drilling
250.5'
254.5'
256'
258.5'
260'
261.5'
265'
266'
270'
275.5'


C4996
Drive Barrel Drilling
280'
285'
290.5'
293.5'
294.5'
295.5'
298.5'
300'
303.5'
304.5'
cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


C4996
Drive Barrel Drilling
305.5'
Hard Tool Drilling
305-310'
305-310'
(washed)
310-315'
310-315'
(washed)
315-321'
315-321'
(washed)
321-326'
321-326'
(washed)
326-330'

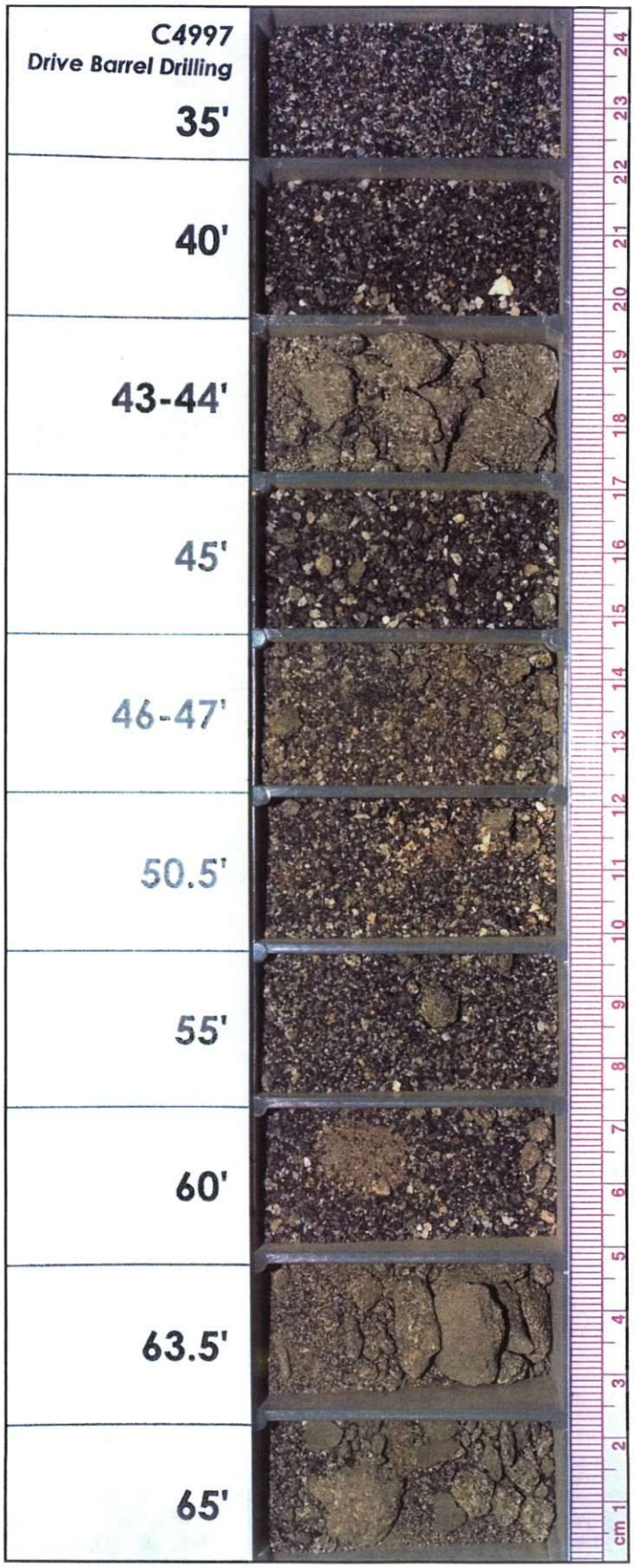

C4996
Hard Tool Drilling
326-330'
(washed)
330-336'
330-336'
(washed)
336-341'
336-341'
(washed)
341-345'
341-345'
(washed)
345-349.5'
345-349.5'
(washed)
349.5-355.5'
cm 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

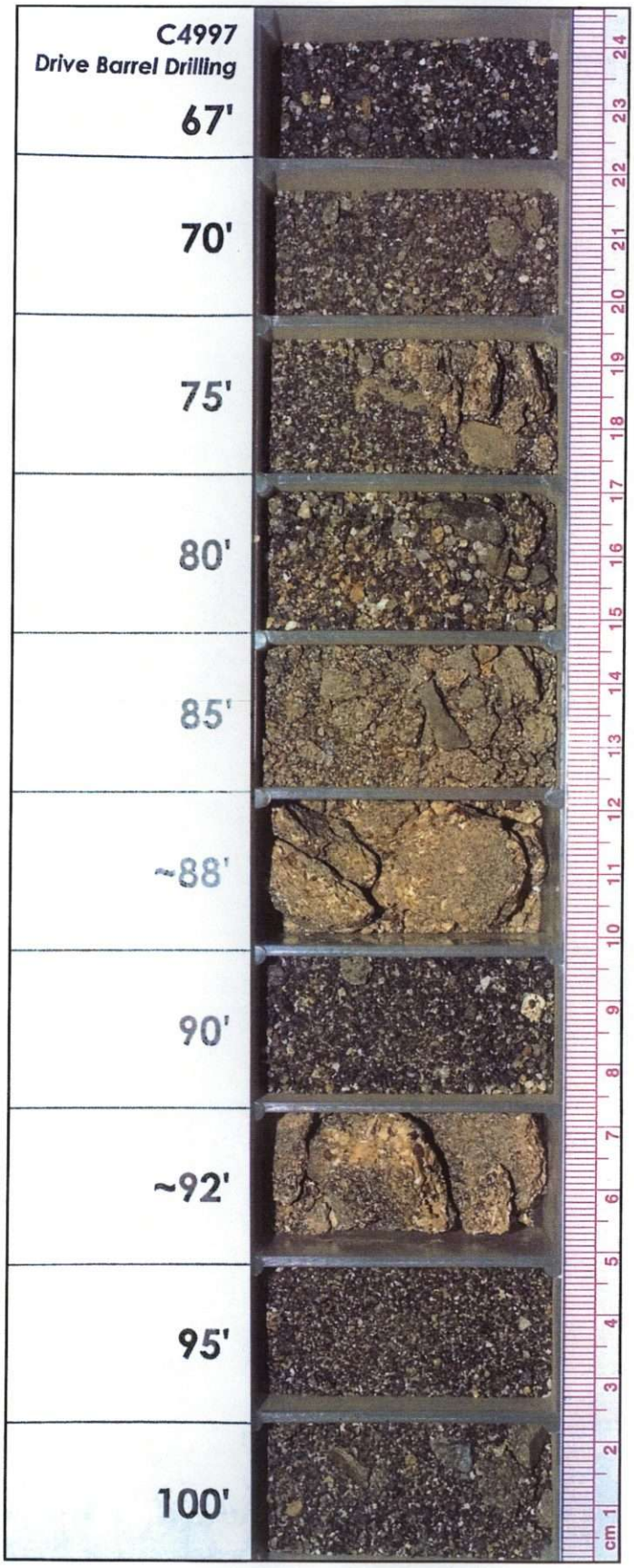

C4996
Hard Tool Drilling
349.5-355.5'
(washed)
358-360'
358-360'
(washed)
360-365'
360-365'
(washed)
365-369'
365-369'
(washed)

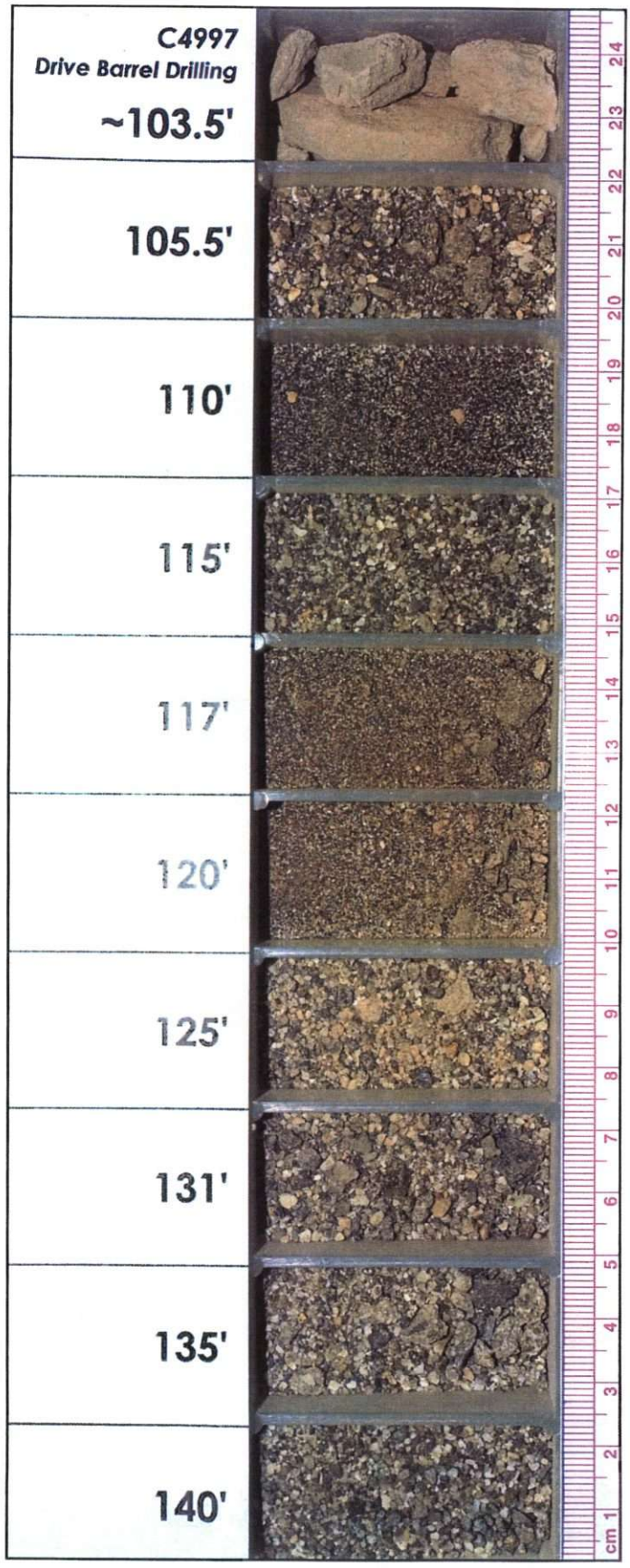
APPENDIX G

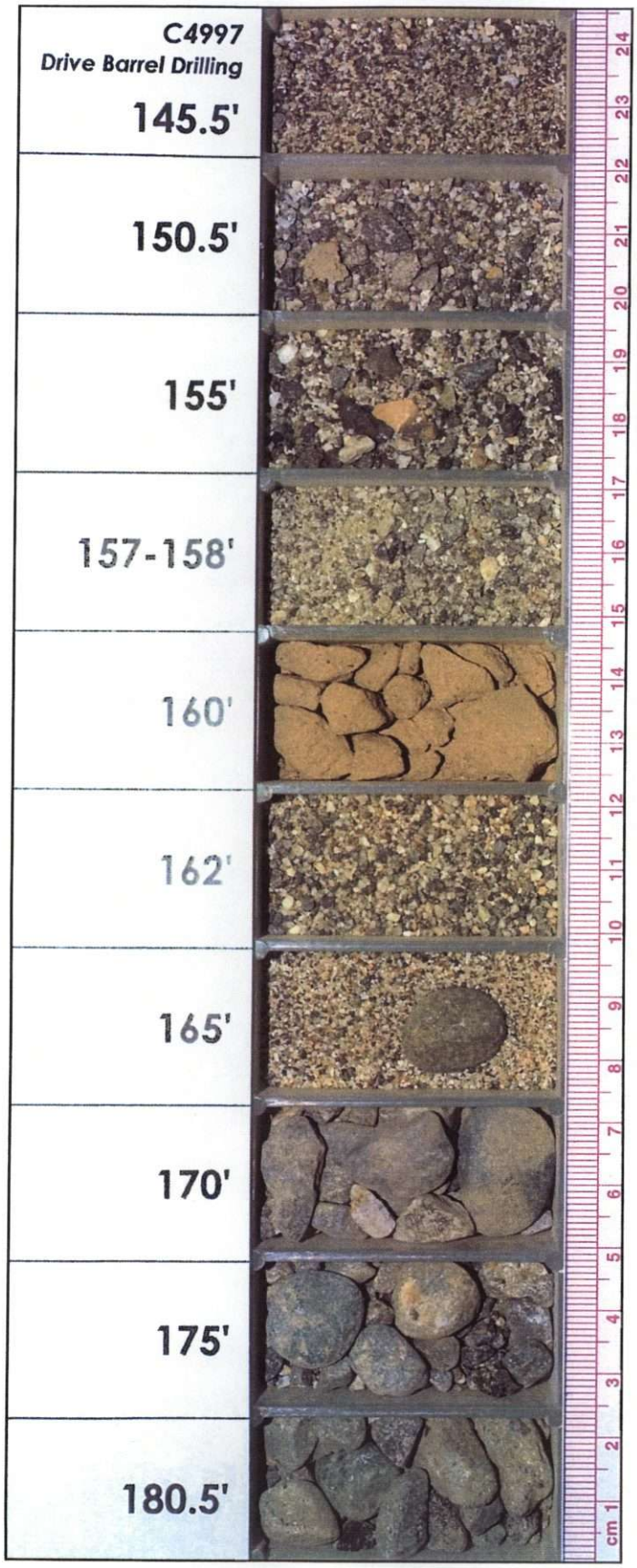
CHIP TRAY PHOTOGRAPHS (C4997)


C4997
Drive Barrel Drilling
5'
10'
15'
~16.8-17'
17'
20'
25.5'
~26.5'
30.5'
~33.5'


C4997
Drive Barrel Drilling
35'
40'
43-44'
45'
46-47'
50.5'
55'
60'
63.5'
65'


C4997
Drive Barrel Drilling
67'
70'
75'
80'
85'
~88'
90'
~92'
95'
100'
cm 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24


C4997
Drive Barrel Drilling
~103.5'
105.5'
110'
115'
117'
120'
125'
131'
135'
140'
cm 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24


C4997
Drive Barrel Drilling
145.5'
150.5'
155'
157-158'
160'
162'
165'
170'
175'
180.5'
cm 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
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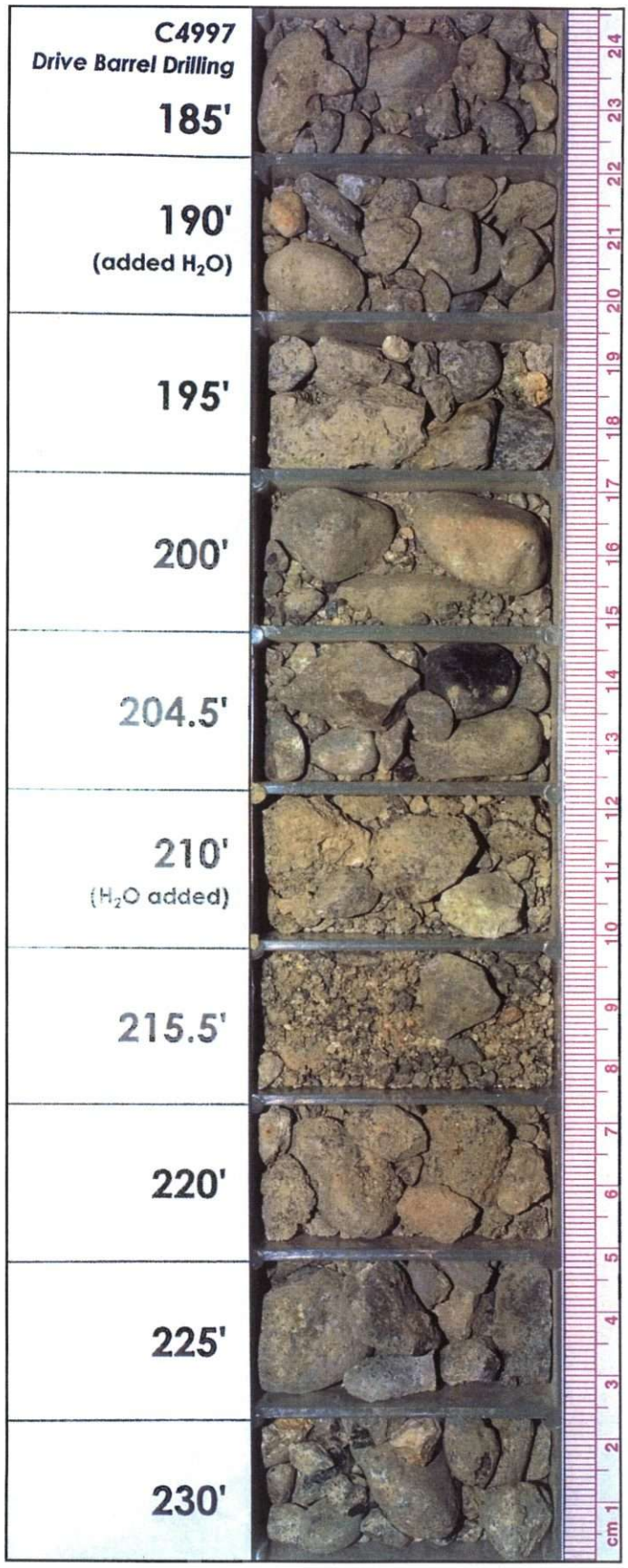
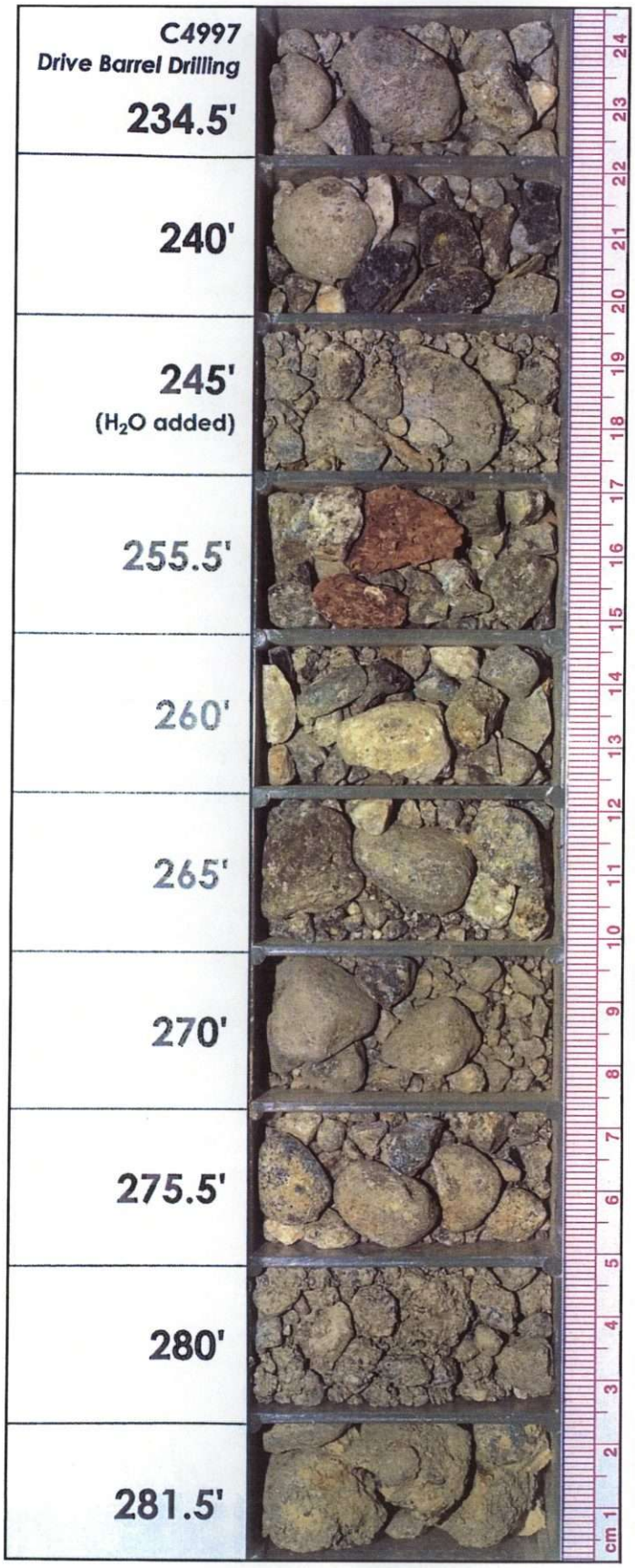
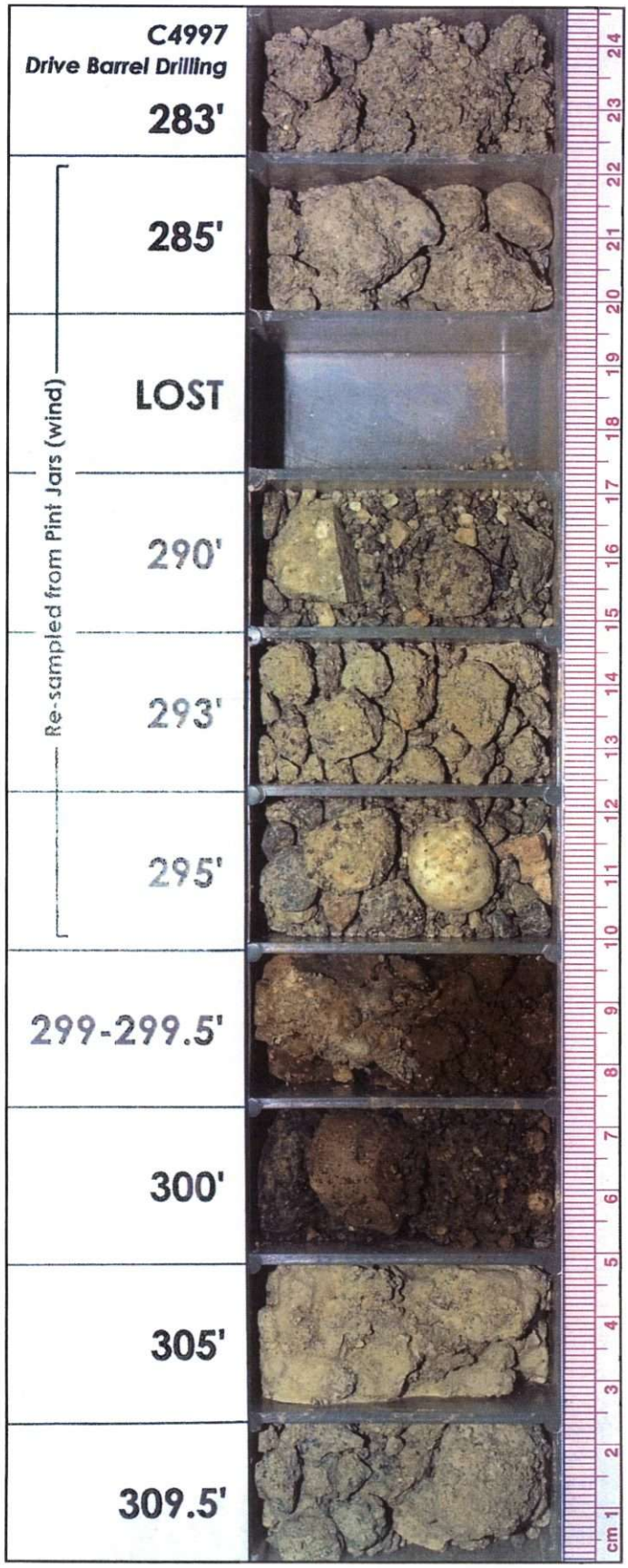
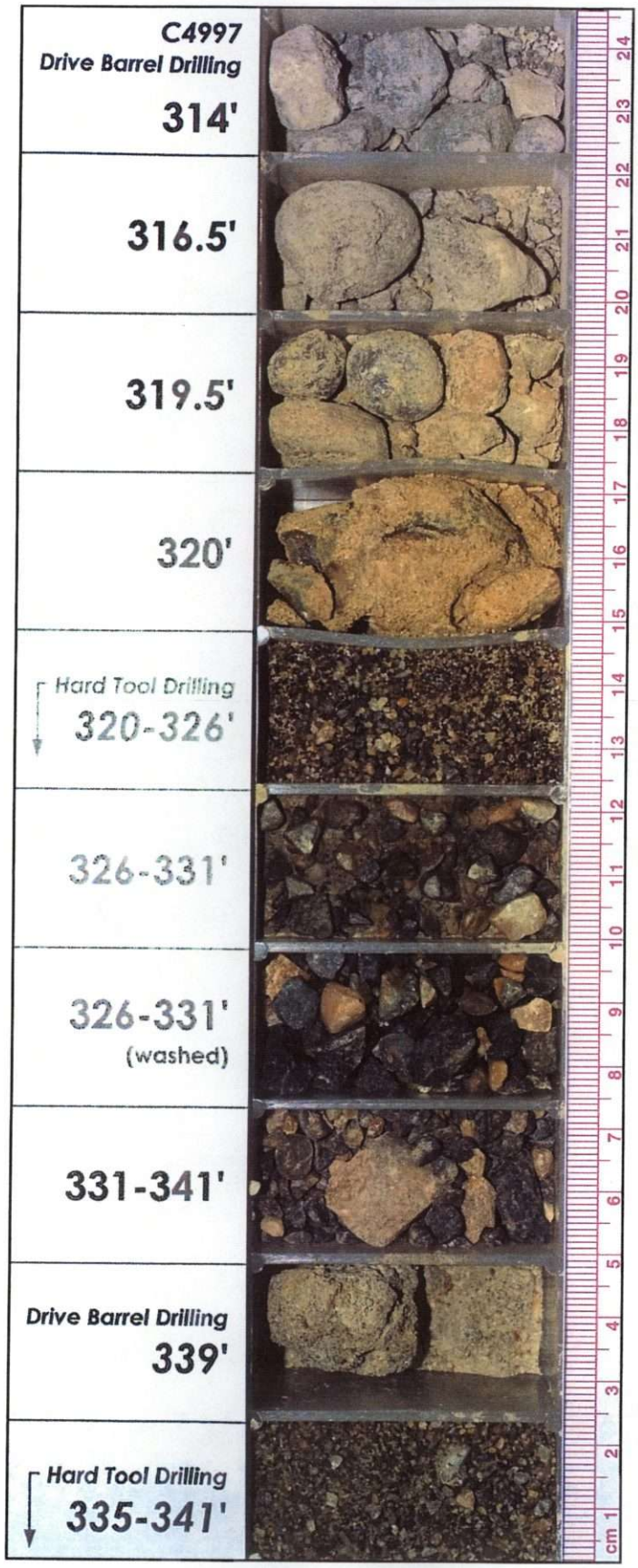
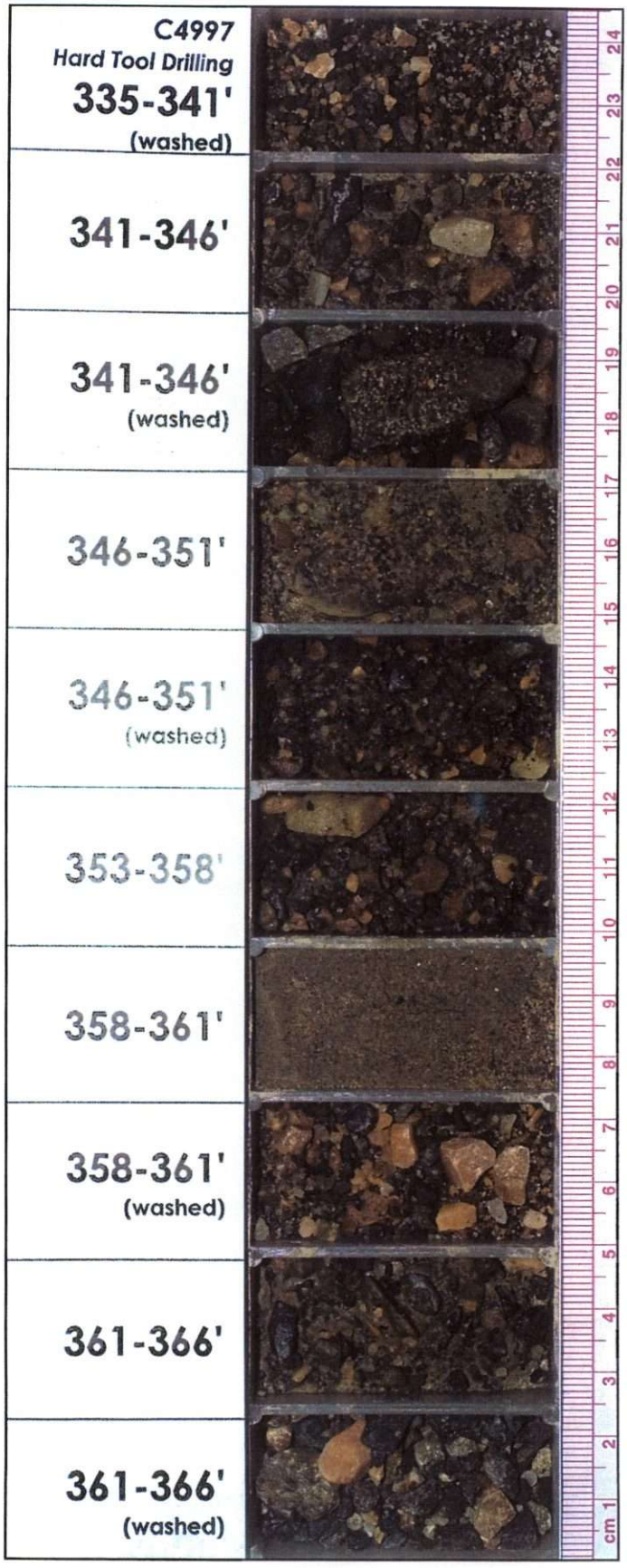
24

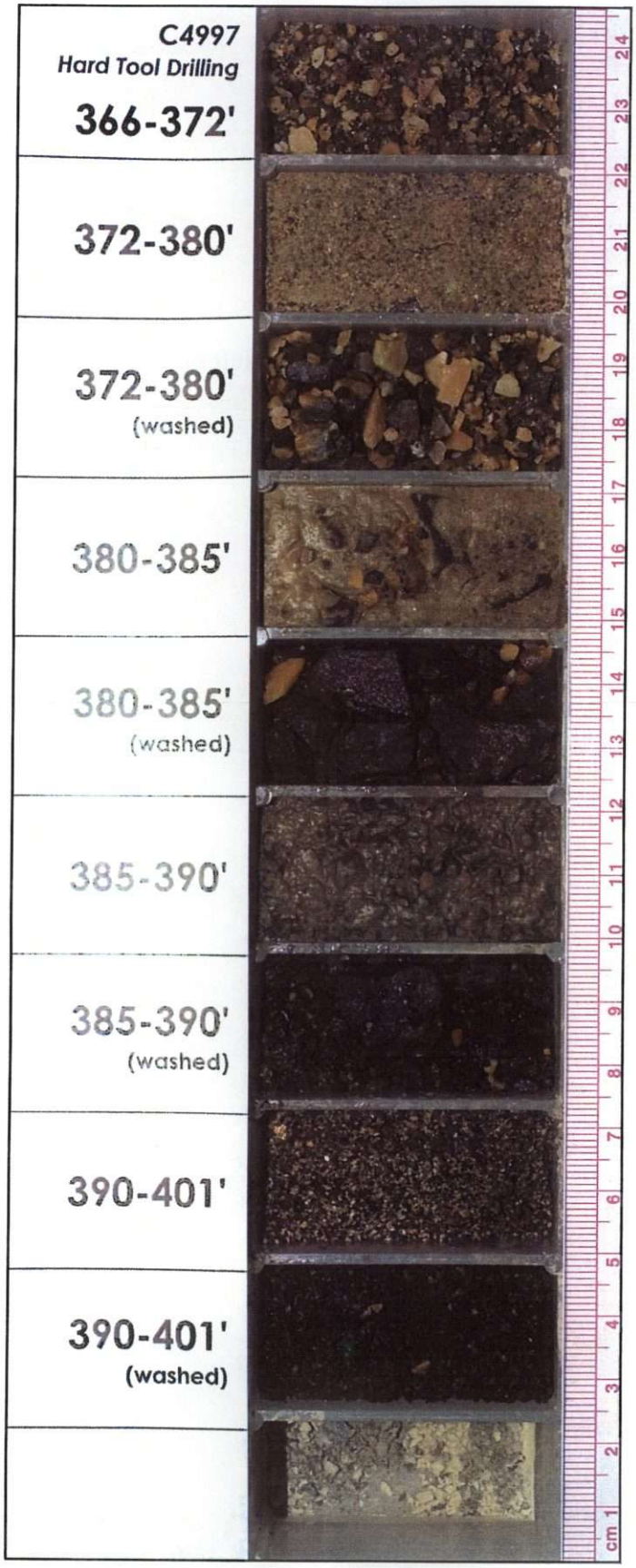

C4997
Drive Barrel Drilling
185'
190'
(added H_2O)
195'
200'
204.5'
210'
(H_2O added)
215.5'
220'
225'
230'
cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


C4997
Drive Barrel Drilling
234.5'
240'
245'
(H2O added)
255.5'
260'
265'
270'
275.5'
280'
281.5'
cm 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24


C4997
Drive Barrel Drilling
283'
285'
LOST
290'
293'
295'
299-299.5'
300'
305'
309.5'
Re-sampled from Pint Jars (wind)
cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


C4997
Drive Barrel Drilling
314'
316.5'
319.5'
320'
Hard Tool Drilling
320-326'
326-331'
326-331'
(washed)
331-341'
Drive Barrel Drilling
339'
Hard Tool Drilling
335-341'
cm 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24


C4997
Hard Tool Drilling
335-341'
(washed)
341-346'
341-346'
(washed)
346-351'
346-351'
(washed)
353-358'
358-361'
358-361'
(washed)
361-366'
361-366'
(washed)
cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


C4997
Hard Tool Drilling
366-372'
372-380'
372-380'
(washed)
380-385'
380-385'
(washed)
385-390'
385-390'
(washed)
390-401'
390-401'
(washed)
cm 1
2
3
4
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APPENDIX H

CHIP TRAY PHOTOGRAPHS (C4998)

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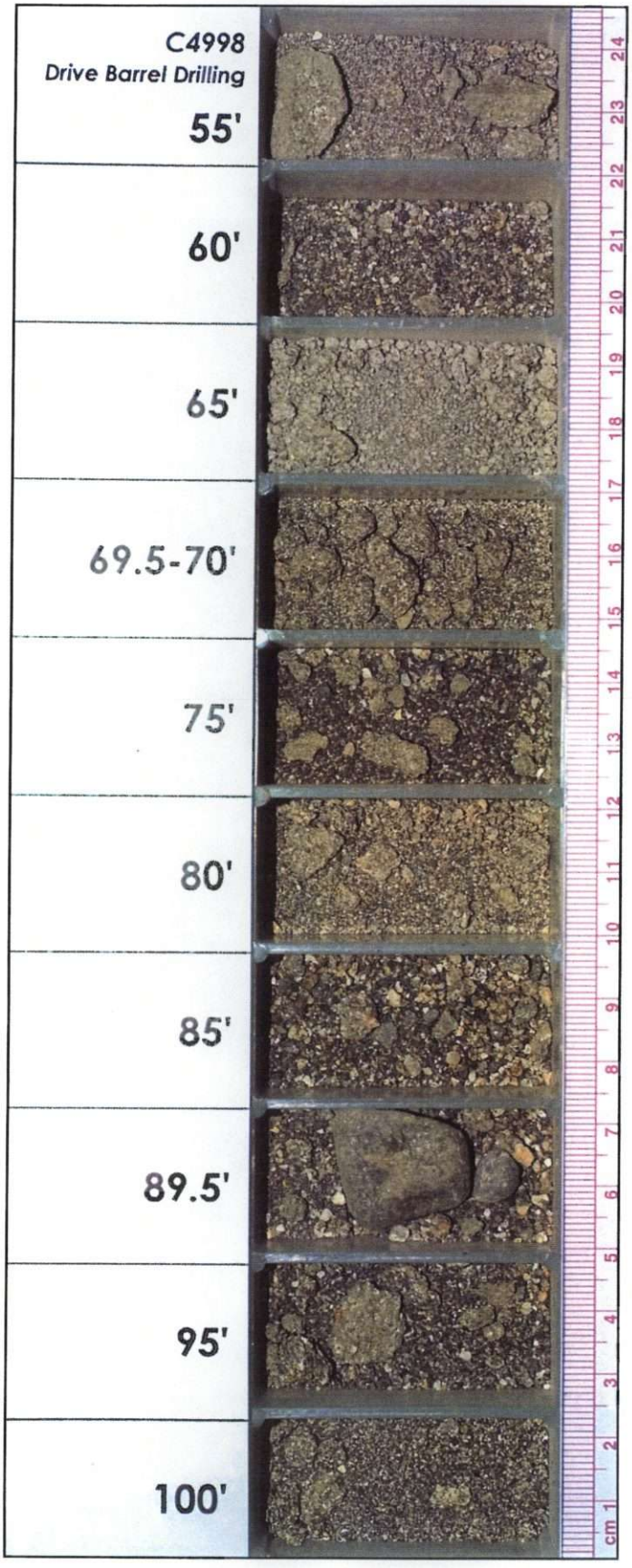
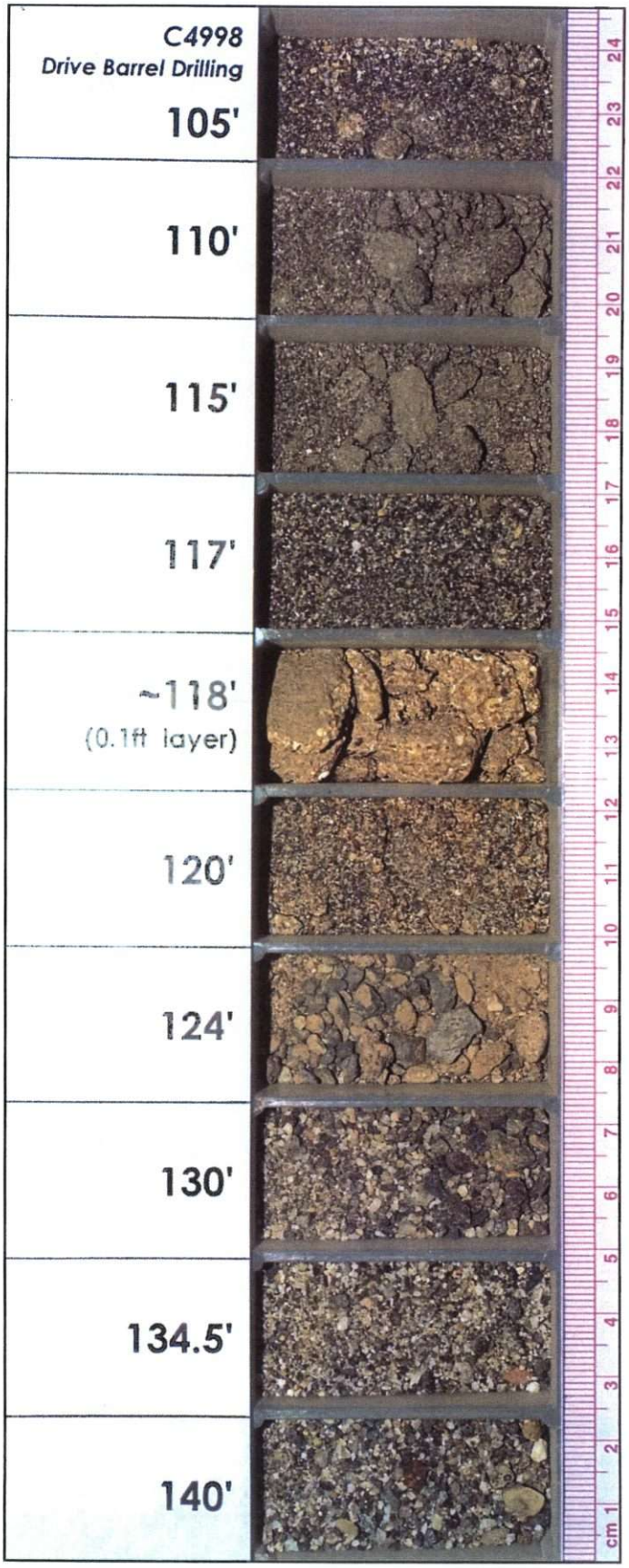
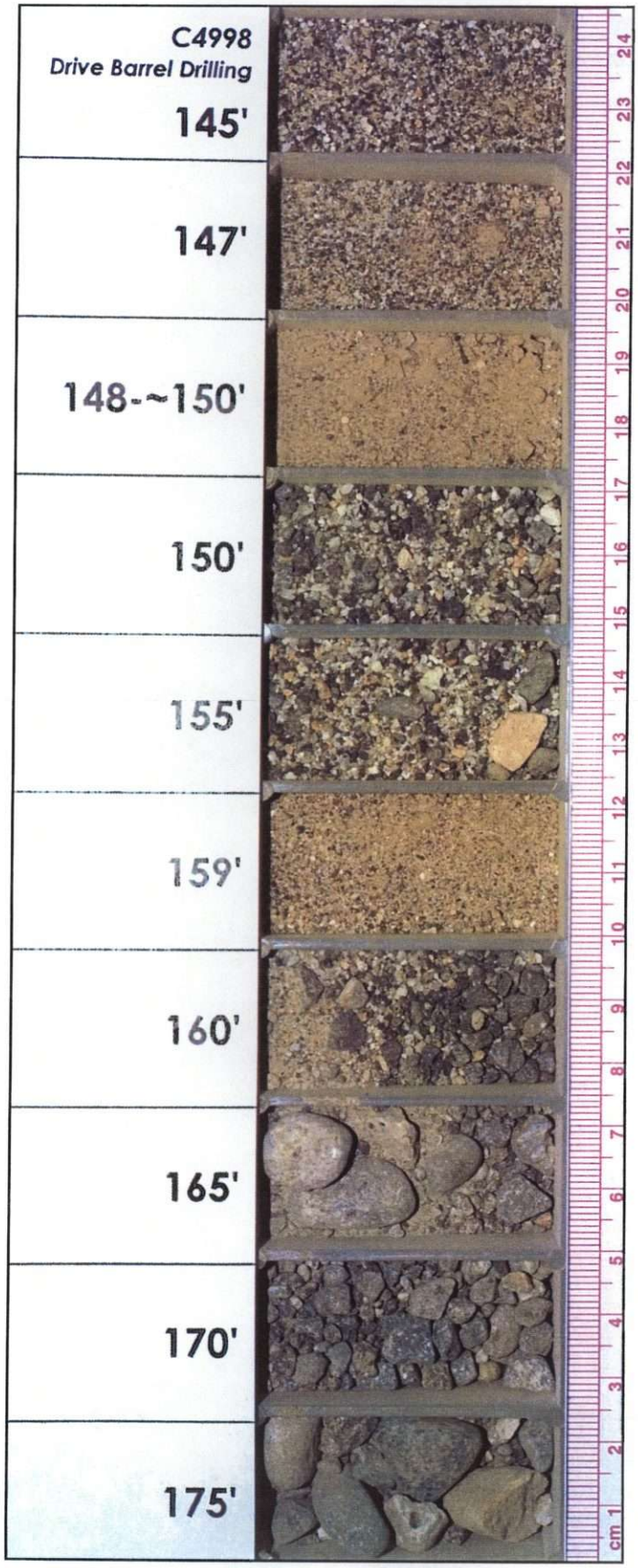
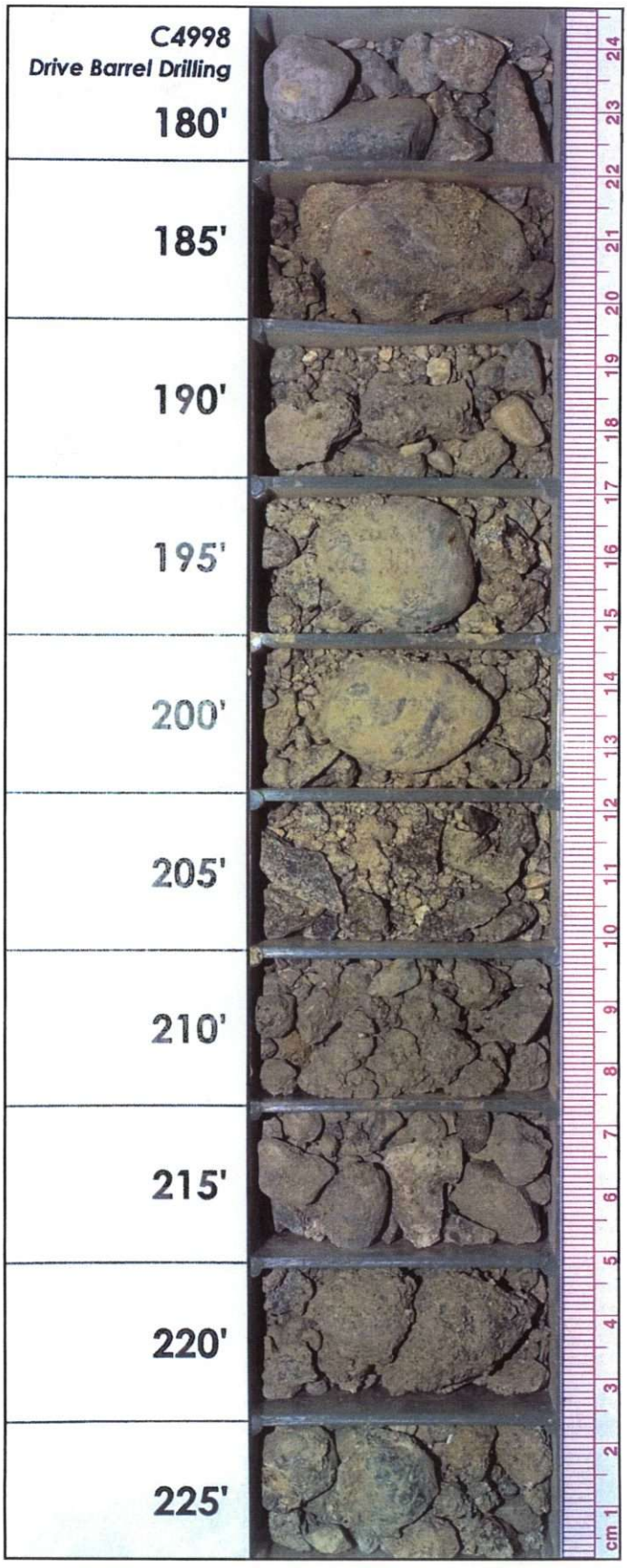
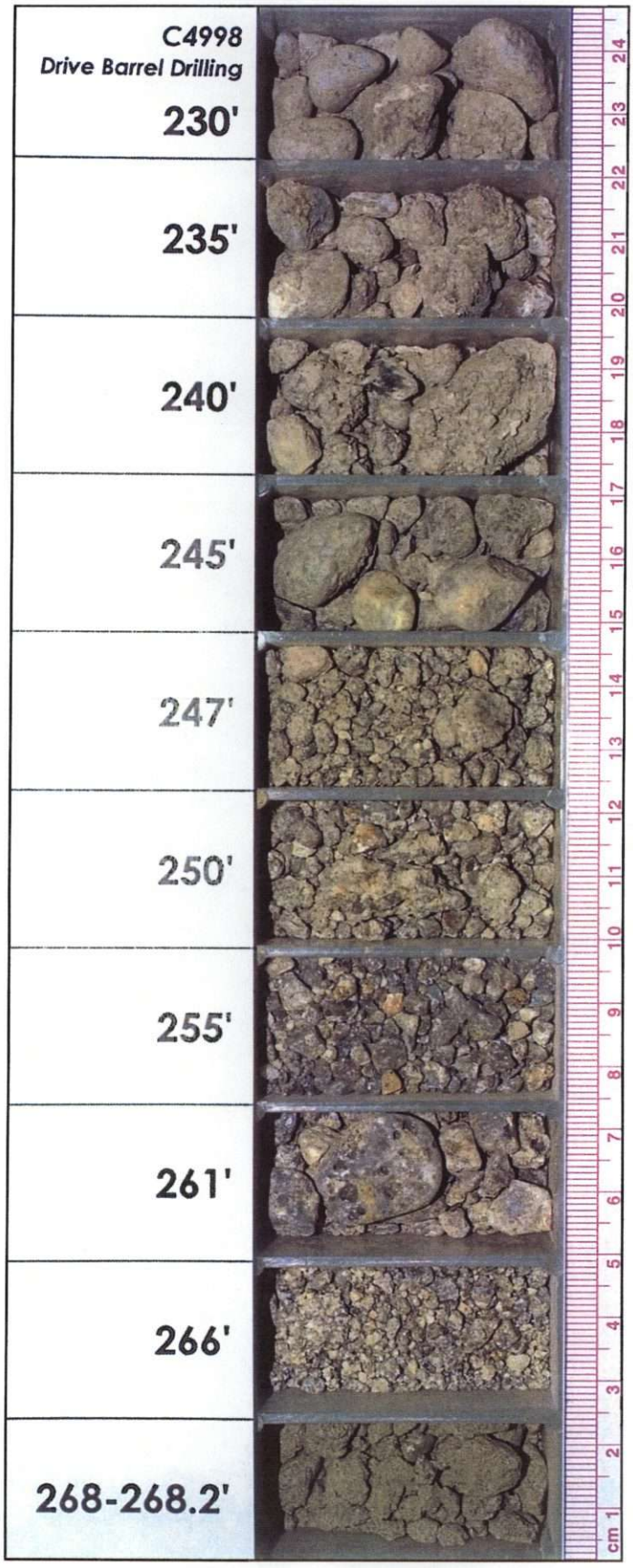
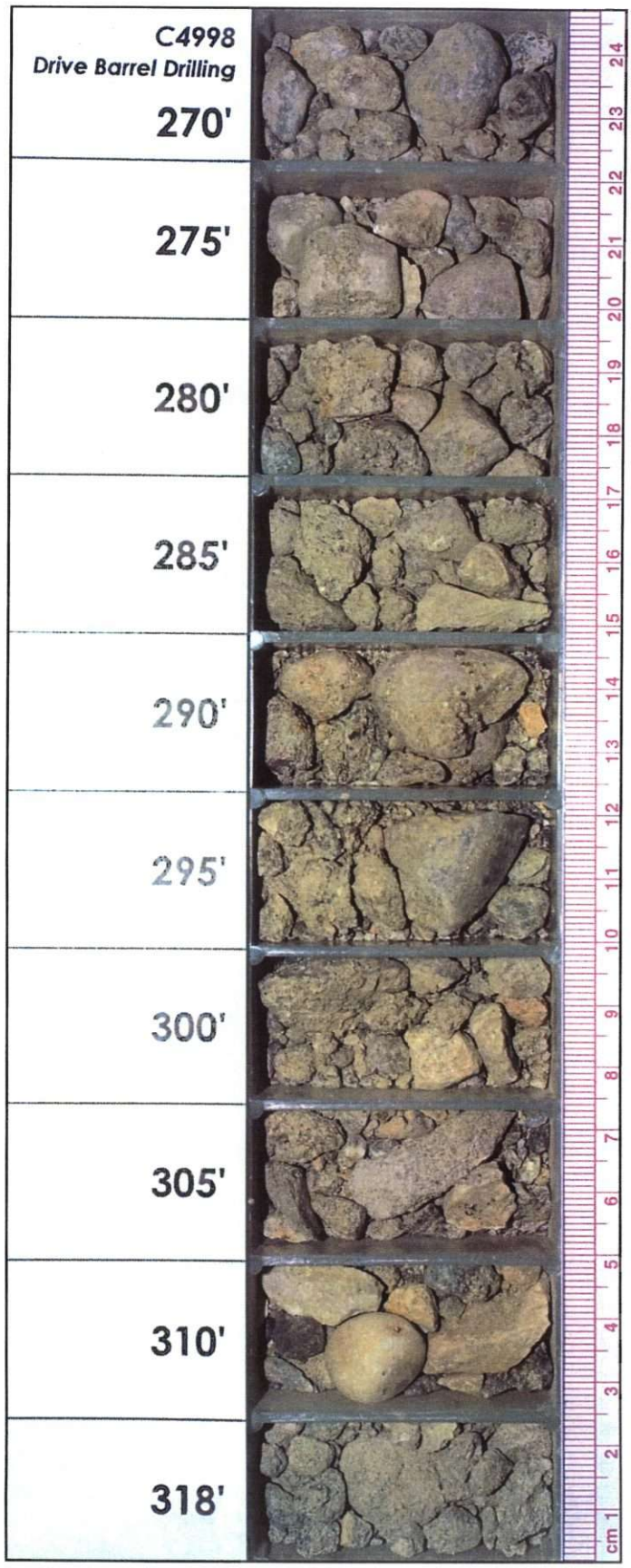

C4998
Drive Barrel Drilling
55'
60'
65'
69.5-70'
75'
80'
85'
89.5'
95'
100'
cm 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

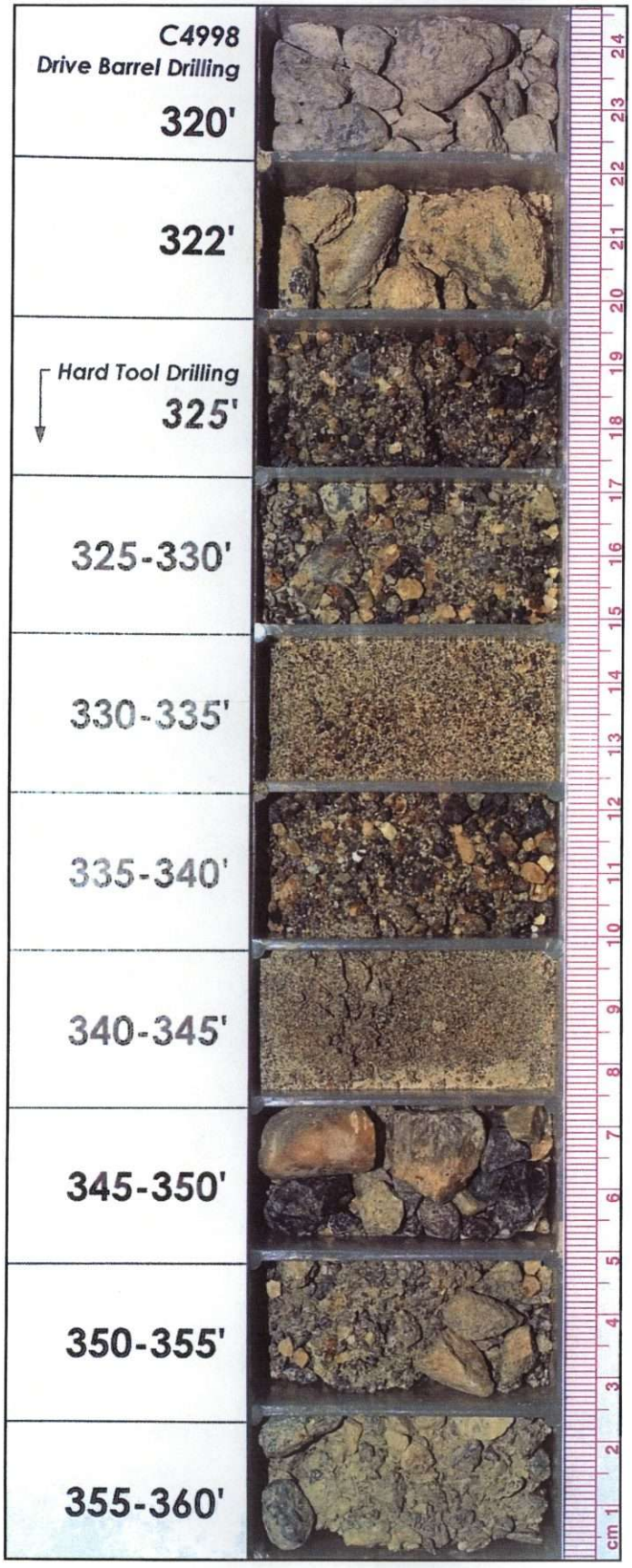

C4998
Drive Barrel Drilling
105'
110'
115'
117'
~118'
(0.1ft layer)
120'
124'
130'
134.5'
140'
cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

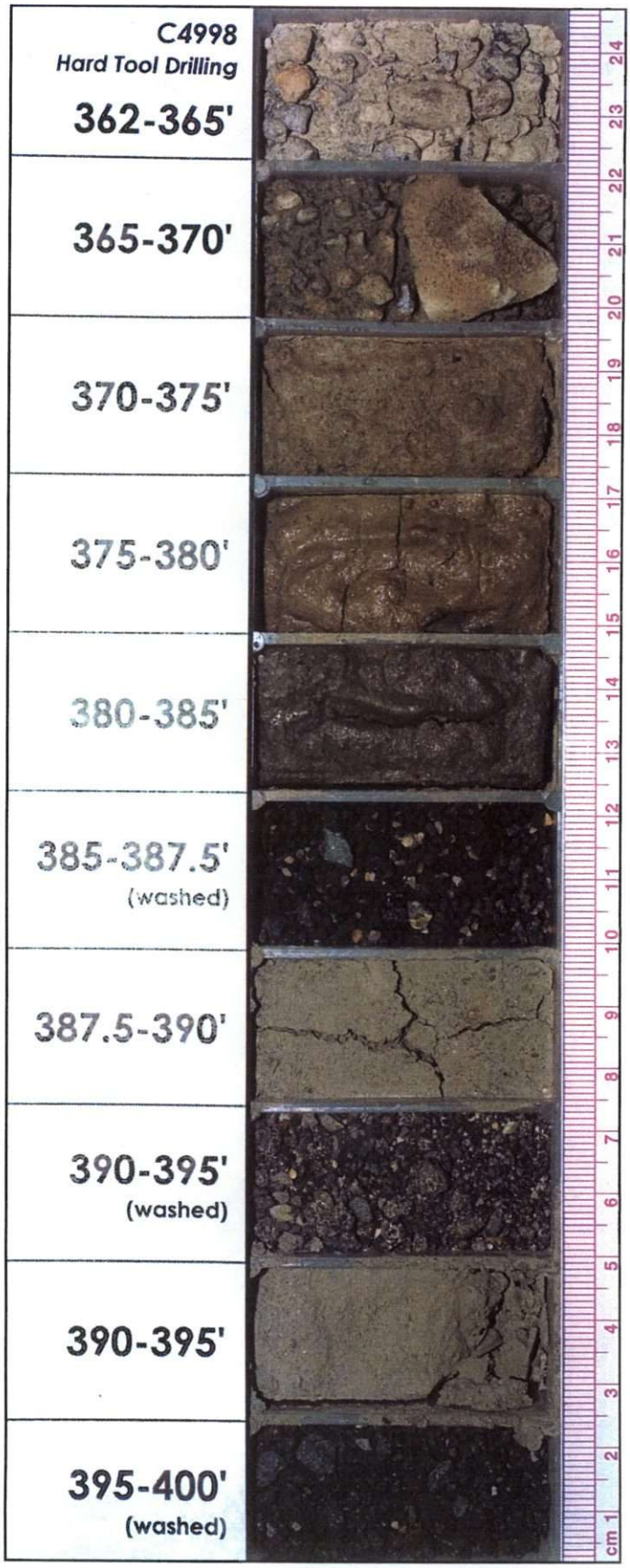

C4998
Drive Barrel Drilling
145'
147'
148-~150'
150'
155'
159'
160'
165'
170'
175'

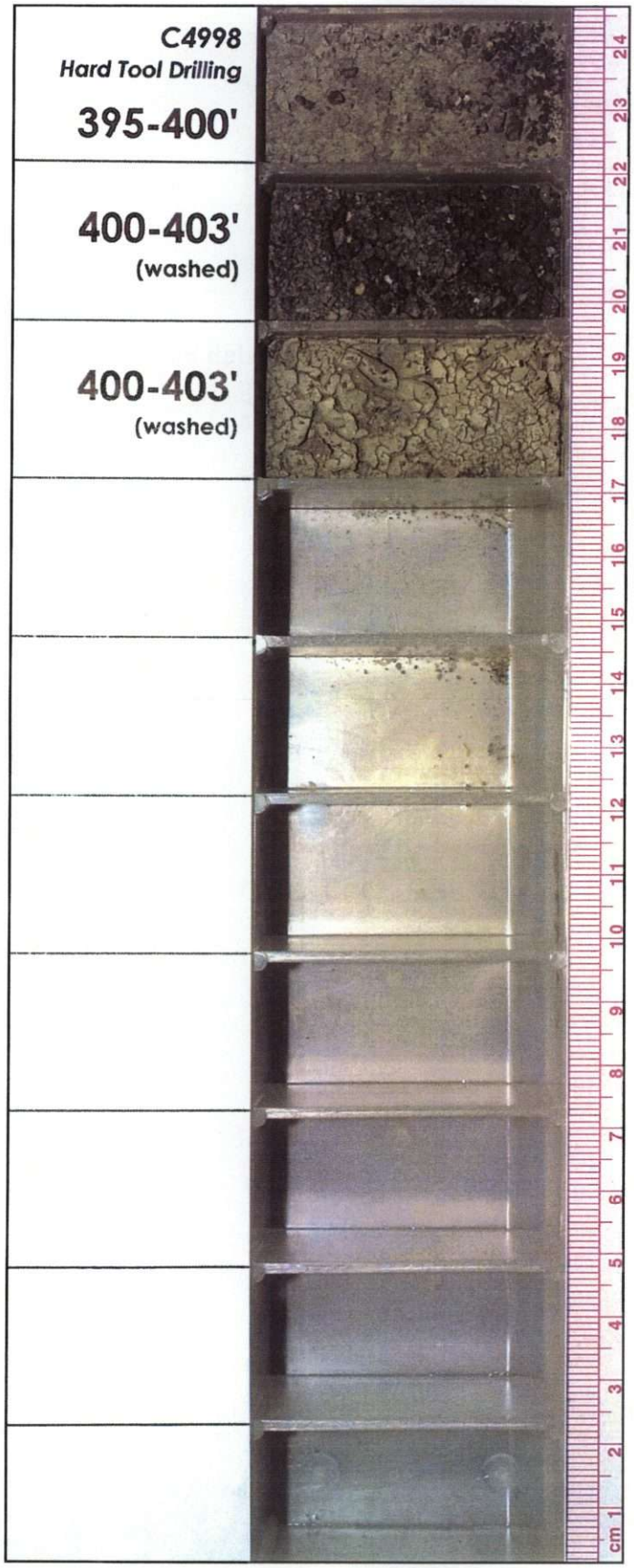

C4998
Drive Barrel Drilling
180'
185'
190'
195'
200'
205'
210'
215'
220'
225'
cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


C4998
Drive Barrel Drilling
230'
235'
240'
245'
247'
250'
255'
261'
266'
268-268.2'
cm 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24


C4998
Drive Barrel Drilling
270'
275'
280'
285'
290'
295'
300'
305'
310'
318'
cm 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24


C4998
Drive Barrel Drilling
320'
322'
Hard Tool Drilling
325'
325-330'
330-335'
335-340'
340-345'
345-350'
350-355'
355-360'
cm 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24


C4998
Hard Tool Drilling
362-365'
365-370'
370-375'
375-380'
380-385'
385-387.5'
(washed)
387.5-390'
390-395'
(washed)
390-395'
395-400'
(washed)
cm 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24


C4998
Hard Tool Drilling
395-400'
400-403'
(washed)
400-403'
(washed)
cm 1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
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17
18
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