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Pacific Northwest
National Laboratory
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U.S. Department of Energy

Borehole Summary Report for C4997 Rotary Drilling, WTP Seismic Boreholes Project, CY 2006

T. J. DiFebbo

February 2007

Prepared by Environmental Quality Management, 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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APPROVAL PAGE

Title: Borehole Summary Report for C4997 Rotary Drilling, WTP Seismic Boreholes Project, CY 2006

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Signature 1/4/07 Date

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APPENDICES

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ACRONYMS

bgs	below ground surface
DNFSB	Defense Nuclear Facilities Safety Board
FH	Fluor Hanford, Inc.
PNNL	Pacific Northwest National Laboratory
SAP	Sampling and Analysis Plan
TD	total depth
USACE	U.S. Army Corps of Engineers
WTP	Waste Treatment Plant
EQM	Environmental Quality Management
DOE	Department of Energy

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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	metric ton
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
metric ton	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

The following Final Geologic Borehole Report briefly describes the drilling of a single borehole at the Waste Treatment Plant (WTP) on the Hanford, Washington, U.S. Department of Energy (DOE) reservation. The location of the WTP is illustrated in Figure 1-1. The borehole was designated as "C4997", and was drilled to obtain seismic and lithologic data for the Pretreatment Facility and High-Level Waste Vitrification Plant in the WTP. Borehole C4997 was drilled and logged to a total depth of 1428 ft below ground surface (bgs) on October 8, 2006, and was located approximately 150 ft from a recently cored borehole, designated as "C4998". Pacific Northwest National Laboratory (PNNL) determined the locations for C4997, C4998, and other boreholes at the WTP in cooperation with the U.S. Army Corps of Engineers (USACE) Review Panel, and the Defense Nuclear Facilities Safety Board (DNFSB). The total depth of Borehole C4997 was also determined by PNNL.

The documents listed below were provided by Fluor Hanford (FH) and PNNL for conducting drilling activities and preparing this report. Additional supporting documents are referenced in those shown below. The information presented in this report is primarily based on the Sampling and Analysis Plan (SAP) listed below, and the geologic borehole logs in Appendices A and B.

- *Sampling and Analysis Plan, Waste Treatment Plant, Seismic Borehole Project* (PNNL-15848, Rev. 2)
- *Health and Safety Plan for the WTP Seismic Borehole Project* (Duratek Federal Services, Inc. for PNNL, Rev. 1).
- *Drilling Plan for the Waste Treatment Plant Seismic Test Borehole Project*; Gardner MG, KD Reynolds, and DE Skoglie; 2006; Duratek Federal Services, Richland, Washington (FS-RW-SWS-PN-005, Rev. 0)
- *Geologic Logging;* Groundwater Remediation Project Administrative Procedure, Fluor Hanford, Inc., Richland, Washington (GRP-EE-01-7.0, Rev. 1)

FH contracted with Environmental Quality Management, Inc. (EQM) to provide specific geologic services for the portion of Borehole C4997 that was drilled into basalt and interbed sediments underlying the Hanford and Ringold Formations. Personnel from an EQM subcontractor, Landau Associates (Landau), prepared geologic borehole logs, documented field activities, and collected grab samples from drill cuttings. The drilling contractors for Borehole C4997 were provided by FH and PNNL, and were not directed by EQM or Landau. Geophysical data were obtained from the borehole at various depth intervals by other FH and PNNL contractors.

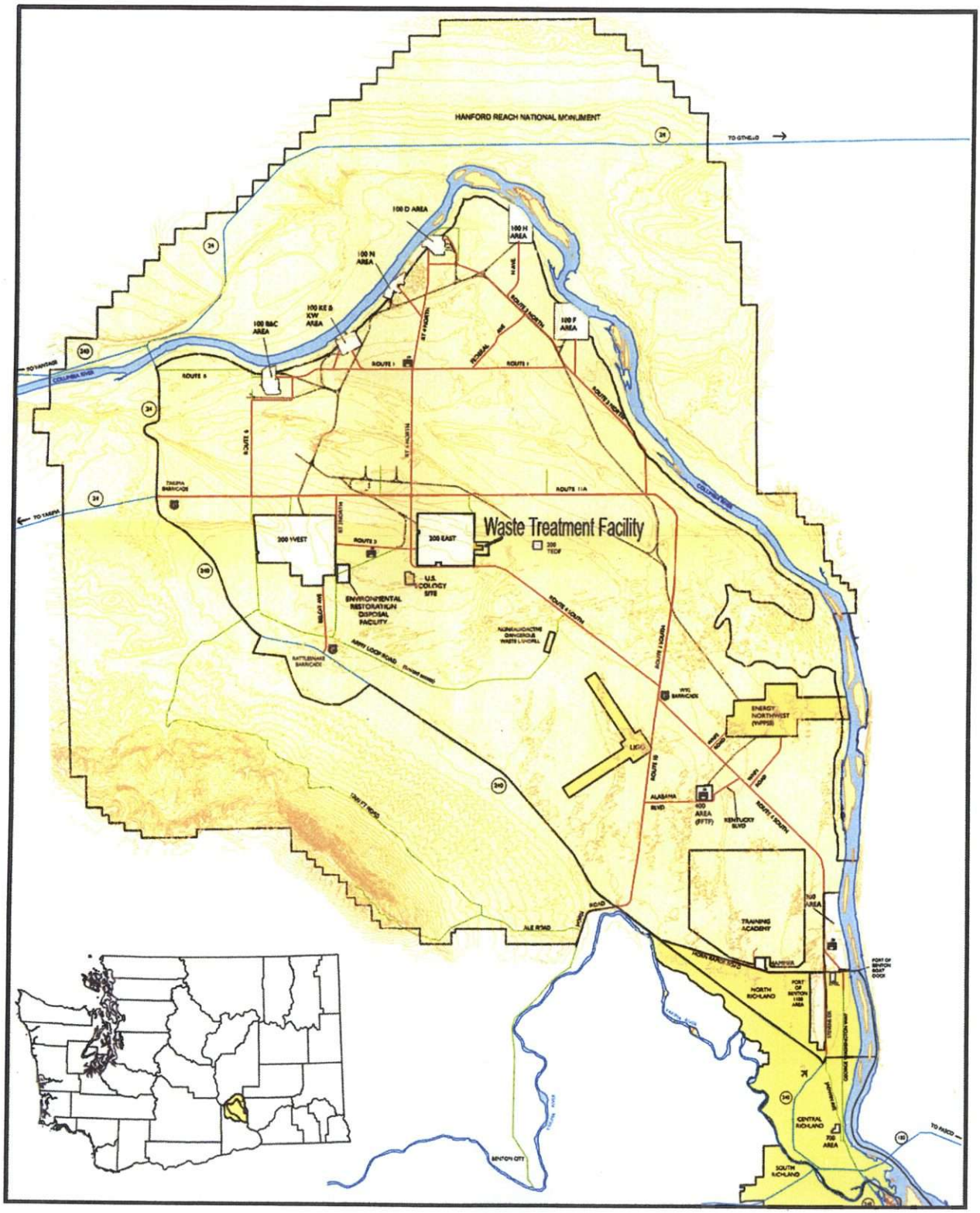
1.1 PURPOSE AND SCOPE

As requested by FH, the primary purpose of this document is to convey geologic borehole logs to FH and PNNL for the basalt and interbed sediments in Borehole C4997. The original signed geologic borehole logs for the Saddle Mountains Basalt Formation and upper Wanapum Basalt Formation were provided to FH on November 13, 2006.

Photocopies of the geologic borehole logs are included in Appendix A. The basalt and interbed sediment borehole logs were prepared on-site during drilling operations. Borehole logs for the overlying Hanford and Ringold Formations in Borehole C4997 were prepared by another contractor; photocopies were provided by FH, and are attached in Appendix B.

Drilling activities are documented by Landau on "Field Activity Reports – Daily Drilling" (daily activity reports). The daily activity reports can be viewed in the Hanford Well Information System (HWIS) Interface web page. FH provided both the geologic borehole log and daily activity report forms. Geophysical and other data from Borehole C4997 are not included in this report.

Figure 1-1. Waste Treatment Plant at Hanford, Washington.



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2.0 DRILLING ACTIVITIES

The *Sampling and Analysis Plan, Waste Treatment Plant, Seismic Borehole Project* (SAP) listed the four objectives shown below for drilling Borehole C4997 and other boreholes at the WTP.

- Identify geologic units below the WTP,
- Characterize sediments and basalt below the WTP,
- Provide core samples for dynamic laboratory testing, and
- Obtain shear wave, compressional wave, and other geophysical data.

The geologic logging and grab sampling conducted by Landau personnel was directed toward accomplishing the first two objectives for identifying and characterizing the basalt and interbed sediments of the Saddle Mountains Basalt Formation and the upper Wanapum Basalt Formation. The two objectives for obtaining core samples and geophysical data were the responsibility of other PNNL and FH contractors.

As shown on the map in Figure 2-1, Borehole C4997 was drilled near the Pretreatment Facility and High-Level Waste Vitrification Plant of the WTP. Borehole C4998 was drilled approximately 150 ft from C4997. The basalt and interbed sediments in Borehole C4998 were cored. Coring operations at C4998 were in progress when mud rotary drilling of the Elephant Mountain Member basalt began in Borehole C4997.

2.1 PROJECT MEETINGS

An initial project meeting for drilling the basalt and interbed sediments in Borehole C4997 was held on August 15, 2006 at EQM's office in Richland, Washington. PNNL and FH representatives described the general project scope of work, expected lithologies, and sampling plans to on-site geologists.

Daily meetings. site procedures, drilling operations, and security plans were discussed at an on-site project pre-job and safety meeting on August 21, 2006. EQM and Landau personnel were informed in the kickoff meeting that the "entry borehole" for C4997 was completed. Excavation permit requirements, end-of-shift forms, and other site procedures were discussed at an on-site quality assurance meeting on August 22, 2006.

2.2 DRILLING SUMMARY

A cable-tool rig began drilling the C4997 "entry borehole" on July 30, 2006, and ended on August 18, 2006 at a depth of 401 ft bgs. The "entry borehole" was drilled through the Hanford and Ringold Formations to a depth of 383 ft bgs where the top of basalt was encountered. The "entry borehole" was then drilled an additional 18 ft into the Elephant Mountain Member of the Saddle Mountains Basalt Formation.

Drilling continued on the C4997 borehole with a mud rotary rig on August 22, 2006 to a total depth of 1,428 ft bgs on October 8, 2006. Landau personnel prepared geologic borehole logs of the basalt and interbed sediments of the Saddle Mountains and upper

Wanapum Basalt Formations to a total depth of 1,428 ft bgs. Borehole C4997 was inadvertently deepened to 1,435.7 ft bgs on October 12, 2006 when the driller was attempting to drill-out cement at the bottom of the borehole. The driller error is noted on the October 12, 2006 Daily Field Report from Martin Gardner, Energy Solutions, and Thomas M. Brouns, WTP Seismic Boreholes Project Manager for PNNL. An emailed copy of the Daily Field Report is attached in Appendix D.

2.3 BASALT AND INTERBED SEDIMENT SAMPLING

Grab samples of basalt and interbed sediments were collected at a depth interval of five feet when sufficient drill cuttings were retrieved. PNNL provided glass pint jars, chip trays, and sand sample bags for the grab samples, and retained the samples that were collected by Landau. As directed by PNNL, a portion of each drill cutting sample was "washed", placed in a sand bag, and labeled. Drilling mud was washed from samples by placing them in a sieve and passing water over them. The unwashed portion of each sample was placed in a chip tray and a pint jar, and then labeled.

On September 12, 2006, PNNL requested on-site geologists to collect a larger quantity of washed samples from the upper 30 ft, middle, and lower 30 ft of each basalt member. As a result, additional sample quantities were collected from depths of 980, 1030, 1080, 1235, 1305, and 1370 ft bgs.

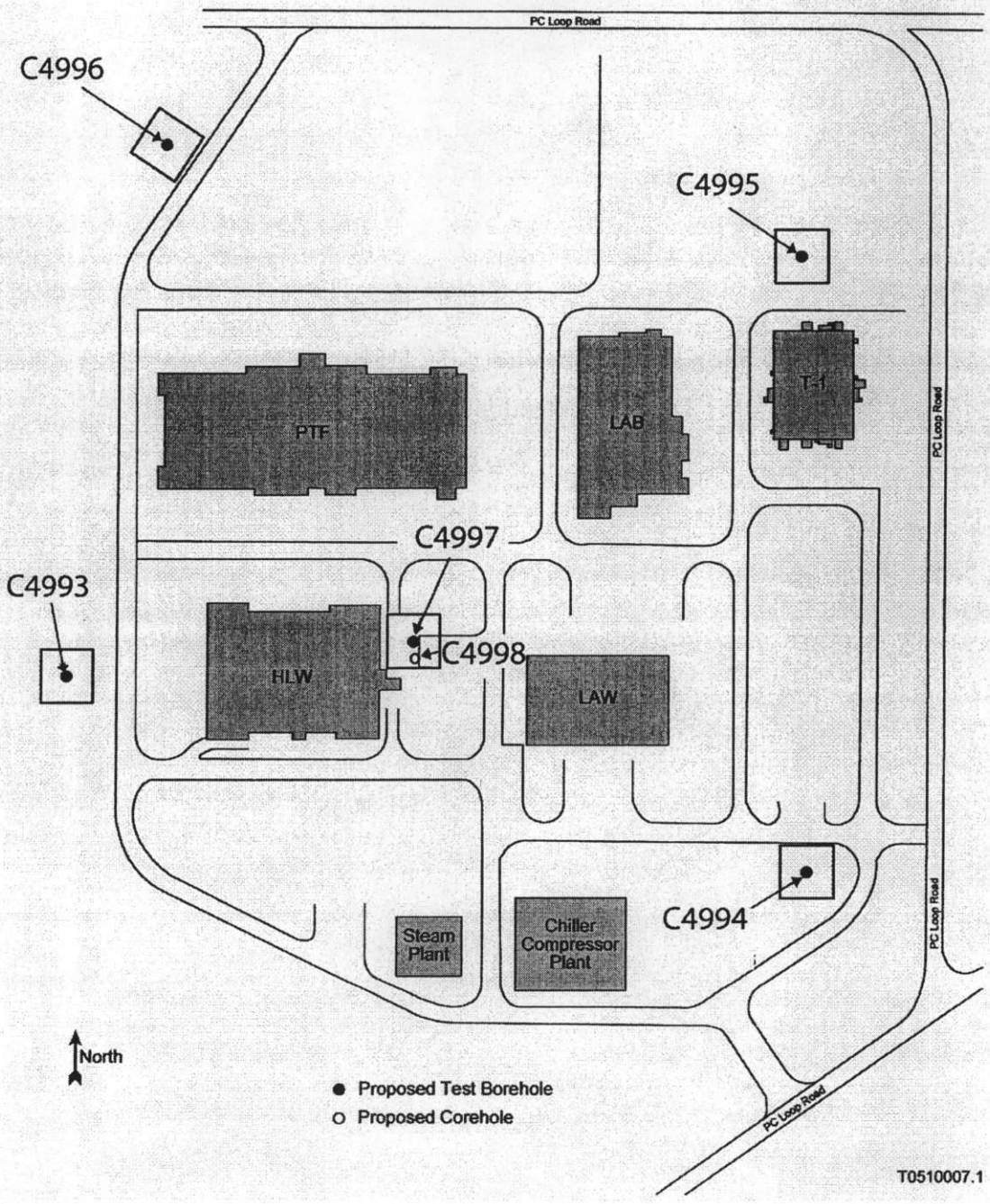
2.4 BOREHOLE GEOPHYSICAL LOGGING

As described in the SAP, one of the primary reasons for drilling C4997 and other boreholes at the WTP was the acquisition of shear wave, compressional wave, and other geophysical data. The SAP describes planned geophysical logging activities by Bruce Redpath of Redpath Geophysics and Dr. Kenneth Stokoe, II from the University of Texas-Austin. Drilling and geological logging were periodically suspended to allow for various downhole logging activities. Neither EQM nor Landau were responsible for any of the downhole logging operations.

2.5 RADIOLOGICAL FIELD SCREENING

Radiological control technicians surveyed radiation levels during drilling operations. The technicians informed on-site personnel that no ionizing radiation was detected above background levels at Borehole C4997.

Figure 2-1. Planned Drilling Locations at the Waste Treatment Plant, Hanford, Washington.



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3.0 BOREHOLE GEOLOGY

Borehole C4997 was drilled through the Hanford and Ringold Formations overburden, and the Saddle Mountains Basalt Formation, into the Priest Rapids Member of the upper Wanapum Basalt Formation. The total depth of C4997 was 1,428 ft bgs when geologic logging was completed on October 8, 2006. As explained below, the driller deepened the borehole to 1,435.7 ft bgs on October 12, 2006.

3.1 OVERBURDEN SEDIMENT DRILLING

The overburden sediments in Borehole C4997 consisted of the silt, sand, and gravel of the Hanford and Ringold Formations. An entry borehole was drilled with a cable tool rig through the overburden sediments, and then extended 18 ft into the uppermost basalt to a final depth of approximately 401 ft bgs. The top of the Elephant Mountain Member basalt was encountered at a depth of approximately 383 ft bgs. The geologic logs for the entry borehole are attached in Appendix B.

"Drill cutting returns" to ground surface were enhanced by adding potable water to the entry borehole. It was impossible to identify when groundwater was initially encountered due to the addition of water to the entry borehole. The geologic borehole logs in Appendix B indicate that groundwater samples were collected at depth intervals of 279.5 to 280.4 ft , 303 ft, and 364.5 to 367.6 ft bgs. The geologic borehole logs also indicate that split-spoon samples were collected for dynamic testing.

3.2 BASALT AND INTERBED SEDIMENT DRILLING

The top of the uppermost basalt, Elephant Mountain Member, was encountered in the entry borehole at a depth of 383 ft bgs. The top of the lithologic units listed below were identified at the indicated depths on the geologic borehole logs in Appendix A.

Saddle Mountains Basalt Formation

- Elephant Mountain Member basalt 383 ft bgs
- Rattlesnake Ridge Interbed 495 ft bgs
- Pomona Member basalt 537 ft bgs
- Selah Interbed 737 ft bgs
- Esquatzel Member basalt 760.5 ft bgs
- Cold Creek Interbed 855.5 ft bgs
- Umatilla Member basalt 950.4 ft bgs
- Mabton Interbed 1109 ft bgs

Wanapum Basalt Group

- Priest Rapids Member basalt 1205.5 ft bgs

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4.0 REFERENCES

Sampling and Analysis Plan, Waste Treatment Plant, Seismic Borehole Project (PNNL-15848, Rev. 2)

Health and Safety Plan for the WTP Seismic Borehole Project (Duratek Federal Services, Inc., Rev. 1).

Drilling Plan for the Waste Treatment Plant Seismic Test Borehole Project; Gardner MG, KD Reynolds, and DE Skoglie; 2006; Duratek Federal Services, Richland, Washington (FS-RW-SWS-PN-005, Rev. 0)

Geologic Logging; Groundwater Remediation Project Administrative Procedure, Fluor Hanford, Inc., Richland, Washington (GRP-EE-01-7.0, Rev. 1)

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APPENDIX A

PHOTOCOPIED Geological Borhole Logs for Saddle Moutains Basalt formation and Upper wanapum basalt formation in borehole c4997

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METHOD: GRP-EE-01-7.0

BOREHOLE LOG

Page 1 of 28
Date: 8-22-06

Well ID: C4997	Well Name: WTP Seismic	Location: WTP-Center	
Project: WTP-Seismic Borehole		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
365					Depth of Casing 383' 9 5/8 OD
					Cement @ 367-368 (Plug @ 315)
367					Drill Mud Rotary 7 7/8 Bit
					Open Hole
					Drill w/Sodium Bicarb
370				Cement Slury	
375					
380					
383					
385					
390				Some Basalt Chip in Cement Possible Cave in During Backfill (Below Casing)	
3-22-06 DW 395 ~~400~~					
400				Basalt @ 400 Black	Change to Quick Gout (Prep) Wash out NaBi Check loose circ. @ 403 Add Grout-Quickgel
405					

Reported By: Doann Hamilton	Reviewed By: L.D. Walker	
Title: Geologist	Title: Geologist	
Signature: Doan Ham	Date: 8-22-06	Signature: LD Walker	Date: 9/29/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 28
Date: 8-22-06

Well ID: C4997 | Well Name: NA | Location: WTP-CENTER

Project: WTP-SEISMIC BOREHOLE | 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)
405	~~GRAB~~	NA		SAME BASALT CHIPS WET BLUISH BLACK	Mud Rotary
				DRY BLUE GRAY GLEY2 5B	7 7/8" carbide bit
				GLEY2 5/1B 2.5	
410	GRAB			Same Basalt Chips	
				Wet: Gley2 2.5/5PB Bluish-black	
				Dry: Gley2 2.5/5B Bluish-black	
415	GRAB			No change	Driller noted fractures @ 416' bgs. Very hard & very slow drilling. Driller noted fractures @ 416.7' bgs
420	GRAB			SAME BASALT CHIPS	
				WET: GLEY2 3/5B V. DARK BLUISH GREY	
				DRY: GLEY2 5/5B BLUISH GREY	
425	GRAB			SAME BASALT CHIPS	
				WET: GLEY2 2.5/5B BLUISH-BLACK	
				DRY: GLEY2 5/10B BLUISH-GREY	
				D.M.N.	Driller says fmtn more fractured @ 429.5' bgs
430	GRAB			~~Bat~~ Basalt chips	
				Wet: Gley2 2.5/10G greenish-black	
				Dry: Gley2 5/5B bluish gray	8-24-06
				(Elephant Mountain member)	
				Dry- Gley 2 4/5B	
435	GRAB			wet Gley2 3/5BG V. dark greenish gray	1030 HR 435'
				60% Basalt; 40% gray (salt pepper) fracture fill (friable	435–437' = 1.33'/hr
				with thumb nail pressure) weak HCl reactive - fracture	penetration rate
				fill) ↖ appears to be residual drill mud reactivity not fracture fill	← High pH 12.0 ~ drill mud sampled @ 438 feet. mud tender thinks residual concrete.
440	GRAB			Wet Gley2 3/10G V. dark greenish gray	1340 @ 440'
				70% Basalt; 30% gray (salt pepper) fracture fill	Add water @ 440' ~1 gal/minute
				(friable) None HCL reaction	in preparation for QUIK TROL
445					additive to increase visc. of mud from 32 → 38

Reported By: DAWN HAMILTON / David Nelson / Brian Christensen | Reviewed By: L.D. Walker

Title: GEOLOGIST | Title: Geologist

Signature: [signatures] Date: 8-22-06 + 8-23-06 + 8/24/06 | Signature: [signature] | Date: 9/29/06

9-23-06

A-6003-642 (03/03)

BOREHOLE LOG			Page 3 of 28 Date: 8-24-06
Well ID: C4997	Well Name: NA	Location: WTP-Center	
Project: WTP-Seismic Borehole		Reference Measuring Point: Ground Surface	

Depth (Ft.)	Sample Type No.	Sample HCL/M 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
445	Grab			wet Gley 2 25/10G - greenish black 60% Basalt 40% gray (salt&pepper) fracture fill (fracture fill - friable) None HCL Reaction	445 @ 1628 hr. Mud Rotary 7 7/8" bit
450	Grab			wet Gley 1 2.5/N - greenish black 50% Basalt - 40% gray (salt&pepper) fracture fill (fracture fill friable) None HCL Reaction	450 @ 1840 hr, BEC
455	grab			RRR BASALT CHIPS dark greenish gray Dry: GLEY 1 4/5GY melanocratic 60% pyroxenes amphiboles - 40% Ca-feldspar No HCL reaction WET: 2.5/10GY greenish black	
460'	grab			BASALT CHIPS dark greenish gray Dry: GLEY 1 4/10 GY / WET: 2.5/10GY greenish black 60% pyroxenes amphiboles 40% Ca-feldspar No HCL reaction	@463' Quik-Trol LV & 1 bag QuikGel added (8/25/06 Day Shift begin)
465'	Grab			BEC wet-Gley 1 2.5/N - greenish black 40% Basalt & 60% gray (salt&pepper) fracture fill (friable) Elephant Mountain member No HCL reaction	465' @ 0825 BEC Sample Rate drilling: 1.30'/hr. from 465-470 interval
470	Grab			wet-Gley 1 2.5/10Y - greenish black 50% basalt & 50% gray (salt&pepper) fracture fill (friable) Drilling - numerous fractures indicated by driller at 472 ft to 475 run	@470' @ 1158 hr BEC sample @471' rough drilling likely fractured rock 1245 hr. Driller adjusted (lowered) rotation & down pressure rate
475	Grab			wet - Gley 1 3/5G very dark greenish gray; basalt & BEC 60% basalt & 40% gray (salt & pepper) fracture fill (friable) @ 1652 hrs	1430 hr, smooth drilling @ 472.5 feet
480	Grab			RRR BASALT CHIPS Wet: GLEY 1 2.5/10GY greenish black 50% dark pyroxenes 50% Ca-feldspar No HCL reaction	Light Drill chatter 489.2-489.8

Reported By: Brian Christiansen / Ryan Reich	Reviewed By: L.D. Walker
Title: Geologist	Title: Geologist
Signature: [signature] Ryan Reich 8/25/06 Date:	Signature: [signature] Date: 9/29/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 4 of 28
Date: 8/26/06

Well ID: C4997	Well Name: NA	Location: WTP - Center
Project: WTP Seismic Borehole		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)
485	Grab			~~AR~~ Basalt Chips	Mud Rotary
				Wet: GLEY1 2.5/5GY greenish black	7 7/8" carbide bit
				60% dark pyroxene 40% Ca feldspar	Light drill chatter 486'
				No HCl Reaction	
					Light drill chatter 487'
490				~~BC~~	488' rough drill action,
490.5	Grab			wet: Gley 2 3/10B very dark bluish gray	fractures
				80% basalt 20% fracture fill light green	Sample 490.5 @ 0750
				and reddish yellow palagonite (flow	
				bottom Elephant Mountain member?)	493.5' drilling rough
					0859
495	Grab			wet Gley 1 6/10Y greenish gray	@0930
				claystone to siltstone	
				(Rattlesnake Ridge Interbed)	
500	Grab			wet 10YR 5/4 yellowish brn	500' rough drilling
				siltstone with wellsorted medium	Sample @0955
				sandstone interbed	(501' to 503' basalt
					clasts? Some water loss 11 ghr
505	Grab			wet 10YR 5/4 yellowish brown	driller added "N-Seal" 1210 hrs
				siltstone? (poor recovery)	for formation sealing)
				abundant basalt chips	Drilling smooth to 503'
					509' added "N-Seal" 1220 hr
					to control mud loss.
510	Grab			wet 10YR 7/2 light gray	@1250 - 510' sample
				siltstone (poor recovery) abundant	
				basalt chips	smooth drilling 510 - 515'
515	Grab			wet 5Y 7.5/1 light gray -	@1305' - 515' sample
				siltstone	smooth drilling
					510 to 515 to 520'
520	Grab			wet 5Y 6/1 gray	@1325 - 520' sample
				siltstone	
					smooth drilling 520 to
					mud loss added
					"N-seal" 1405 hr

Reported By: Ryan Reich	Reviewed By: L.D. Walker
Title: Geologist	Title: Geologist
Signature: [signature] Date: 1/4/06	Signature: [signature] Date: 10/25/06

A-6003-642 (03/03)

BOREHOLE LOG			Page 5 of 28 Date: 8/26/06
Well ID: C4997	Well Name: NA	Location: WTP - Center	
Project: WTP Seismic Borehole		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
					Mud Rotary
525	Grab			wet 5Y 6.5/1 gray siltstone	@1412 525' sample
					Drilling smooth 525' to 530'
530	grab			wet 5Y 6/1 gray siltstone & fine sandstone; well sorted	@1424 530' sample Drilling smooth 530 to 535'
535	Grab			wet 10YR 5/8 & 6/8 yellowish brown & brownish yellow sandstone; medium; well sorted. (TOP Pomona Member) @537'	@1430 535' sample Drilling rough @ 535.5'
				few basalt fragment in cuttings weathered	Drilling relatively smooth
				wet 2.5Y 5/3 (siltstone)	
540	Grab			wet 2.5Y 6/3 (basalt) 20% basalt & 80% weathered flow top siltstone	1520 hr sample 540' Drilling relatively smooth
				Drill cuttings increasing in basalt % wet 2.5Y 6/4 (siltstone)	
545	Grab			wet Gley 2 3/10B very dark bluish gray 20% basalt & 80% weathered flow top siltstone	1530 hr Sample @ 545' Drilling relatively smooth
				wet 2.5Y 7/6 (siltstone)	
550	Grab			wet Gley 2 2.5/10B bluish black 60% basalt & 40% weathered flow top siltstone	1550 hr sample @ 550' Drilling relatively smooth
				wet 2.5Y 7/8 (siltstone)	
555	Grab			wet Gley 2 3/10B very dark bluish gray 60% basalt & 40% weathered flow top siltstone	1610 hr sample @ 555' Drilling relatively smooth
				wet 10YR 7/6 yellow (siltstone)	
560	Grab			wet Gley 2 3/5PB very dark bluish gray 70% basalt & 30% flow top siltstone	1635 hr sample @ 560' Drilling smooth

Reported By: Brian Christianson		Reviewed By: L.D. Walker	
Title: Geologist		Title: Geologist	
Signature: [signature]	Date: 8/26/06	Signature: [signature]	Date: 9/29/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 6 of 28
Date: 8/26/06

Well ID: C4997	Well Name: NA	Location: WTP-Center
Project: WTP-Seismic Borehole		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)
565				2.5Y 7/6 yellow (Siltstone	1705hr Sample@565'
				wet Gley1 2.5/10Y greenish black	- Gyro test 8/26 night shift
				90% basalt & siltstone 10%	- Geophysic Vs & Vc
					test 8/27/06 1520 to 1805hr
				RR	- Concrete tagged 8/28 1310
				Basalt chips Pomona flow top	@ 244' 3"
570	Grab			wet: GLEY2 3/5GY very dark greenish gray	
				70% dark angular grains, some w/ vesicles	569'-573' (4'/15 min)
				30% leucocratic grains w/ ~~dark phenocrysts~~ & silt stone	traces of cement
				RR 8/29/06	& bentonite
				Basalt chips Pomona flow top	
575	Grab			Wet: GLEY2 3/5GY v dark greenish gray	traces of cement
				70% dark angular grains, some w/ vesicles	& bentonite
				30% leucocratic grains w/ ~~dark phenocrysts~~ RR 8/29/06	
				& silt stone or precipitate w/ light	HCL reaction
				Basalt chips Pomona flow top	
580	Grab			wet: GLEY1 3/10GY v. dark greenish gray	
				70% dark angular grains	
				30% light grains - silt stone or precipitate	w/ HCL reaction
					Lost Drill Mud - Pull
585	GRAB			BASALT CHIPS GLEY2 2.5/5B BLUISH BLACK WET	Casing & Recement
				80% DARK & SOME W/ WHITE ~~COATED~~ DH 8-31-06	TOOK SAMPLE FROM MUD PIT
				COATING SOME RED BROWN DK + BLACK	STILL HAVE LCM OUT SHAKER
				20% LIGHT (COATING/LOOSE FRAG ~~NO~~ HCL REACT)	NO CUTTINGS
				DRY -> GLEY2 4/5B DK BLUISH GREY DH 8-31-06 MED REACTION	
590	GRAB			SAME BASALT CHIPS	STILL SAMPLE FROM MUD PIT
				~~90%~~ DH 95% BLACK / DK RED BROWN & CHIPS	
				5% LIGHTER COLOR CHIPS	
595	GRAB			SAME BASALT CHIPS	FROM MUD TANK
				70% DARK BLACK SOME DK RED BROWN CHIPS	
				30% LIGHT WHITE SPOTTED BLACK	
				DMN	2057 collect sample
600	GRAB			Basalt chips (Wet: Greenish-black Gley2 2.5/5BG	Driller noted 2" thick
				dry: Bluish-grey Gley2 5/5B)	fractured @ 600.18' bgs then
				80% dark grey-green-black grains & chips	smooth action (possible platy
				20% light grey & light brownish-red chips (HCL rxn)	fracturing). Mid flow?

Right margin: @583 8-29-06 DH 8-31-06

Reported By: Brian Chris Hanson / Ryan Reich / Dawn Hammond	Reviewed By: L.D. Walker
Title: Geologist David Nelson	Title: Geologist
Signature: [signatures] Date:	Signature: [signature] Date: 9/29/06

Don Hammond 8-29-06 8-31-06 Ryan Reich 8/29/06 David M. Nelson 8/31/06

A-6003-642 (03/03)

BOREHOLE LOG		Page 1 of 28 Date: 9/1/06
Well ID: C4997	Well Name: NA	Location: WTP Central
Project: WTP Seismic Borehole	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	
				DMN	Driller notes fracture @ 604.6'	
605	GRAB	NA		Basalt chips	Mud Rotary	
				Wet: Greenish black; Gley2 2.5/10G	7 7/8" carbide bit	
				Dry: Dk. greenish-gray; Gley2 4/5BG	Driller notes fracture @ 608.1'	
				80% dark chips; some dark red-brown		
				20% light chips; apparent vesicles, no HCL rxn	Driller notes fracture @ 609.3'	
610	GRAB			No change @ 610'; but some LCM in sample		
					Driller notes harder drilling	
					between 610.5' and 611' bgs.	
					Driller adds weight @ 611.3' bgs	
615	GRAB			Same Basalt Chip Wet: Gley2 2.5/10B Bluish-Black	Fracture @ 612.5' bgs	DAYSHIFT 9-1-06 DH
				70% Dark Chips Black some Red Brown		
				30% Light White Speck Black + Some White		
				No HCL Reaction		
620	GRAB			Same ~~@~~ As 615 (DH 9-1-06)		
					Added LCM	
625	GRAB			Same ~~@~~ As 620 W/LCM In Chips (DH 9-1-06)		
					From 628.5	
					To 629 Coarse Cutting	
					Drilling Pick Up	
630	GRAB			Same As 625 – No LCM	Collect From Mud Pit	
					To Avoid LCM	
635	GRAB			Same Basalt Chips	From Mud Pit	
				85% Dark Black & Some Red Brown		
				15% Light White Speck Black (No HCL rxn)		
640	GRAB			DMN ~~Trace~~ DMN	Fracture @ 639.4' to 639.6'	Nightshift 9/1-2/06 DMN
				Basalt chips ~~trace~~ LCM in chips		
				Wet: Greenish-black; Gley2 2.5/5BG		
				Dry: V. dark greenish gray; Gley2 3/5BG		

Reported By: David Nelson / Duann Hamilton		Reviewed By: L. D. Walker	
Title: Geologist / Geologist		Title: Geologist	
Signature: David M. Nelson	Date: 9/1/06	Signature: LD Walker	Date: 9/29/06
Duann Hamilton	-9/2/06		

A-6003-642 (03/03)

BOREHOLE LOG

Page 8 of 28
Date: 9/2/06

Well ID: C4997 | Well Name: | Location: WTP Central

Project: WTP Seismic Borehole | 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)
				DMN	
645	GRAB			Basalt Chips: trace LCM in chips	
				No change from 640'	
				100% Basalt (dark)	
				DMW	
650	GRAB			Basalt chips: No LCM	
				No change from 640' & 645'	
				DMN	
655	GRAB			Basalt Chips	
				Wet: Greenish-black Gley2 2.5/10G	
				Dry: Dk. Greenish grey Gley2 4/10GBG DMN	
660	GRAB			BASALT CHIPS	COLLECTED FROM MUDPIT
				WET: BLUISH BLACK GLEY2 2.5/5B	
				DRY: DK BLUISH GREY GLEY2 4/10B	
				90% DARK BLACK TRACE Rd BROWN CHIPS	
				10% LIGHT WHITE SPEC BLACK	
665	GRAB			SAME AS 660	COLLECT FROM MUDPIT
670	GRAB			SAME AS 665	COLLECT FROM MUDPIT
675	GRAB			SAME AS 670	COLLECT FROM MUDPIT
				DMN	
680	GRAB			Basalt Chips (90% black, 10% white)	
				Wet: Greenish black; Gley2 2.5/10G	
				Dry: Dark greenish gray: Gley2 4/5BG	
				Dark chips w/ trace pyrite, White no HCl rxn	

9-2-06 DAY SHIFT DH

9/2/06 Night shift

Reported By: DAWN HAMILTON | Reviewed By: L.D. Walker

Title: GEOLOGIST | Title: Geologist

Signature: [signature] / [signature] Date: 9-2-06 9/3/06 | Signature: [signature] | Date: 10/25/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 9 of 28
Date: 9/3/06

Well ID: C4997	Well Name: NA	Location: WTP Control	
Project: WTP Seismic Borehole		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
685	GRAB			DMN Basalt chips Wet: Greenish-black; Gley2 2.5/10 BG Dry: Dark greenish gray; Gley2 4/5B 85% dark chips, 15% light chips (no HCl rxn)	Mud Rotary 7 7/8" carbide bit
690	GRAB			DMN No change from 685'	
695	GRAB			DMN No change from 690' & 685'	Day shift 9/3/06
700	Grab			wet: Gley 2 3/10BG - very dark greenish gray 80% basalt & 20% gray fracture fill? Non-Hcl reactive Fractures 703 to 704.5'	
705	Grab			wet: Gley 2 3/5BG very dark greenish gray. 70% basalt, 30% gray with trace gray green fracture fill chips. Non-HCL reactive	704.3' Tough drilling [illegible]
710	Grab			wet: Gley 1 3/N very dark gray 70% basalt & 30% gray fracture fill Non-Hcl reactive	
715	Grab			wet: Gley 2 4/8 5B - bluish black 85% basalt & 15% fracture fill gray & trace bluish green; non Hcl reactive	
720	Grab			Basalt Chips (Pomona) Wet: GLEY1 3/5G very dark greenish gray 70% dark 30% light	

Reported By: David Nelson / Brian Christiansen / Ryan Rick		Reviewed By: L.D. Walker	
Title: Geologist		Title: Geologist	
Signature: David M. Nelson	Date: 9/3/06	Signature: LD Walker	Date: 9/29/06

Brian Christiansen 9/3/06
Ryan Rick 9/3/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 10 of 28
Date: 9/3/06

Well ID: C4997	Well Name: NA	Location: WTP - Central Boring #1
Project: WTP Seismic Borehole		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)
725'	Grab	NA		Basalt Chips (Pomona)	Mud Rotary
				Wet: GLEY1 3/10GY very dark greenish gray	7 7/8" carbide bit
				70% dark 30% light Ca-feldspar	
				Basalt chips	
730'	Grab			Wet: GLEY1 4/10GY dark greenish gray	
				60% dark 40% light	
				No HCl reaction	
				Pomona Member	
735'	Grab			Basalt chips	
				Wet: GLEY1 3/10GY	
				60% dark 40% light	light drill chatter
				No HCl reaction	at 737.0'
				Interbed Selah	
740'	Grab			Basalt Chips w/ SILT/CLAY	
				Wet: GLEY1 4/5G dark greenish gray	
745'	Grab			Silt with sand Interbed	very thick mud
				Wet: GLEY2 5/5GY greenish gray	loss of fluids
					poor sample recovery
				wet = 2.5Y 6/1 light greenish gray &	
750'	Grab			wet = 2.5YR 6/3 light reddish brown	
				Silt with clay	
755'	Grab			wet = 5YR 5/6 yellowish red	
				silty fine sandstone @ 30%; &	
				wet - Gley 2 5/5B	
				siltstone @ 70%	
				(Bottom Selah Interbed)	760.5' rough drilling
760	Grab			wet = Gley1 5/10Y greenish gray	
				siltstone with fine sand	
				(Esquatzel member)	smooth harder @ 764

Reported By: Ryan Reich / Brian Christians		Reviewed By: L.D. Walker	
Title: Geologist		Title: Geologist	
Signature:	Date: 9/4/06	Signature: [signature]	Date: 9/28/06

[signature] Ryan Reich 9/4/06

A-6003-642 (03/03)

[redacted]

BOREHOLE LOG

Page 11 of 28
Date: 9/4/06

Well ID: C4997 | Well Name: NA | Location: WTP Central Boring #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)
765	Grab			wet: Gley 2 2.5/5PB bluish black basalt 95% & 5% very dark greenish gray fracture fill · vesicular (Esquatzel Member)	767 drilling rough to 769'
770	Grab			wet: gley 2 2.5/5PB bluish black basalt vesicular 98% wet gley 1 6/5GY 5/5G greenish gray fracture & vesicular fill	Mud Rotary 7 7/8" carbide bit
775	Grab			wet: gley 1 3/10Y very dark greenish gray basalt some vesicular & trace greenish gray fractured vesicular fill (wet: gley 1 6/5G)	
780'	Grab			RR Basalt chips Wet: GLEY2 2.5/5G greenish black 80% dark 20% light trace of grains from amygdules (chlorite?) dark pyroxenes in Ca-feldspar & silica groundmass; No HCL reaction	
785'	Grab			Basalt chips 3/5G v. dark greenish gray Wet: 70% dark grains 30% light grains LW 9-29-06 No HCL reaction	
790'	Grab			Basalt chips wet: GLEY1 3/10GY v. dark greenish gray 70% dark 30% light	9-8-06 START 791
795	GRAB			BASALT CHIPS WET: V. DK GREENISH GREY GLEY2 3/10BG 60% LIGHT 40% DARK NO HCL REACTION	COLLECT OUT MUD PIT SHIFT CHANGE
800	GRAB			BASALT CHIPS WET: DARK BLUISH GREY GLEY 2 4/10BG 60% LIGHT 40% DARK APHANITIC NO HCL REACTION	

Reported By: Don [illegible] / Chris Hanson / Ryan Reich / Christine Kimmel
Title: Geologist
Signature: [illegible] Date: 9/4/06

Reviewed By: L. D. Walker
Title: Geologist
Signature: LD Walker Date: 9/29/06

A-6003-642 (03/03)

Ryan Reich 9/5/06
Don [illegible] 9-8-06
Christine Kimmel 9-8-06

[redacted]

BOREHOLE LOG

Page 12 of 28
Date: 9/9/06 & 9/10/06

Well ID: C4997 | Well Name: N/A | Location: WTP CENTRAL BORING
Project: WTP SEISMIC BOREHOLE PROJECT | Reference Measuring Point: GROUND SURFACE

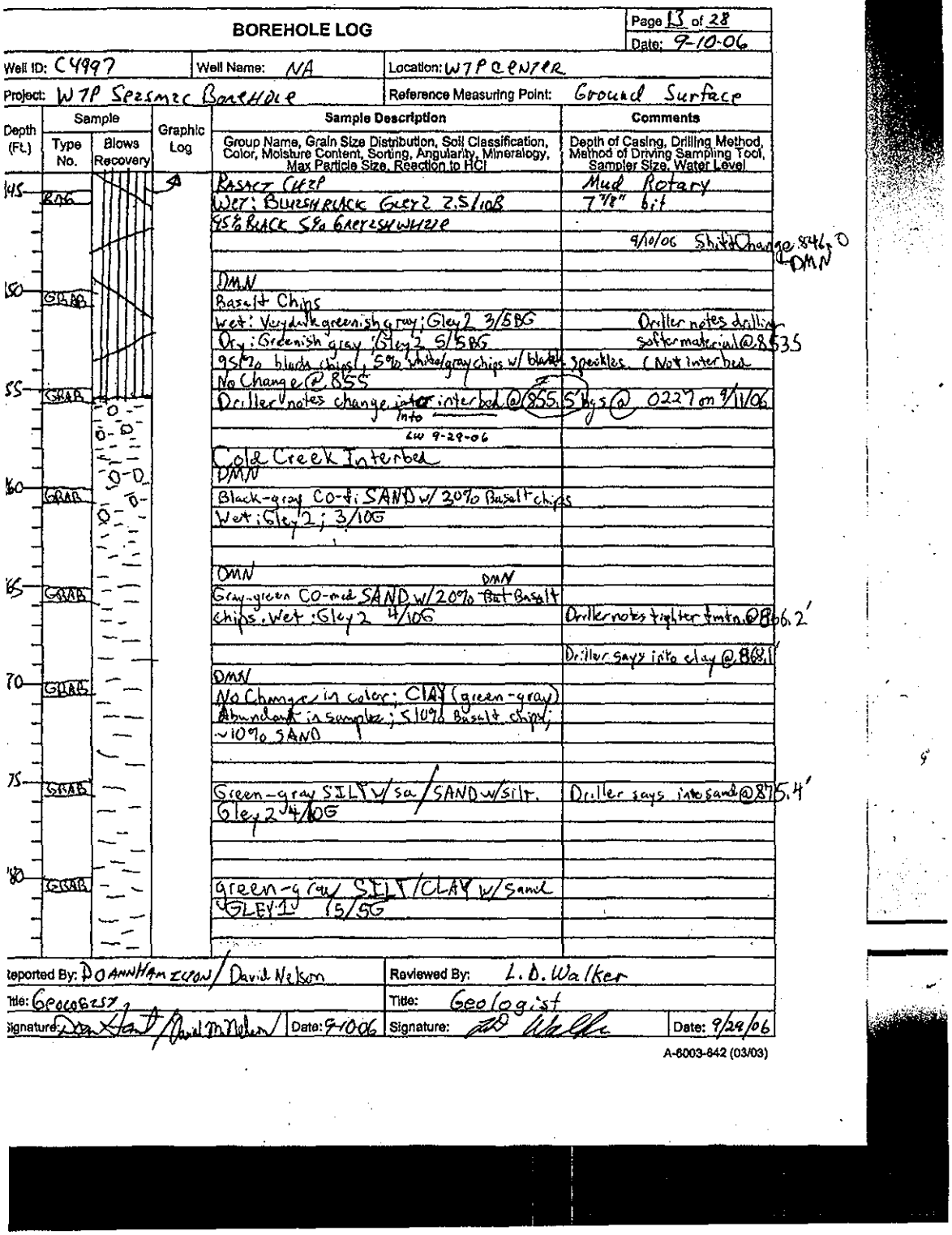
Depth (Ft.)	Sample Type No.	Sample Blows/6in Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Drilling Sampling Tool, Sampler Size, Water Level
805	GRAB			BASALT CHIPS WET: VERY DK BLUISH GREY: GREY 2 3/10BG, APHANITIC 60% DARK 40% LIGHT NO HCL REACTION	Mud Rotary 7 7/8" carbide bit
810	GRAB			BASALT CHIPS (FALOT Cement) WET: BLUISH BLACK / DRY: DK BLUISH GREY GLEY 2 2.5/10B / GLEY 2 4/10B 70% DARK 30% WHITE	
815	GRAB			BASALT CHIPS - SAME COLOR, LESS WHITE 80% DARK 20% WHITE	
820	GRAB			SAME BASALT CHIPS 95% BLACK 5% WHITE	
825	GRAB			BASALT CHIPS WET: BLUISH BLACK (GREY 2 3/10B) 95% BLACK 5% WHITE APHANITIC	828.2': ADD DRILL ROD ADJUST GEOLINE
830	GRAB			BASALT CHIPS WET: BLUISH BLACK (GREY 2 3/10B) 95-98% BLACK 5-3% GREY FELDSPAR CRYSTALS (OCCAS) NO HCL REACTION	SMOOTH DRILLING ACTION - FORMATION NOT PRODUCING MUCH WATER
835	GRAB			BASALT CHIPS BLUISH BLACK (GREY 2 3/10B) INCREASE IN FELDSPAR	
840	GRAB			BASALT CHIPS BLUISH BLACK GLEY 2 2.5/10B - WET 95% BLACK 5% WHITE & BLACK	

Reported By: CHRIS KENNEL / DOANN HAMILTON
Title: GEOLOGIST
Signature: Christine Kennel / DoAnn Hamilton
Date: 9/9/06

Reviewed By: L.D. Walker
Title: Geologist
Signature: L.D. Walker
Date: 9/29/06

A-6003-842 (03/03)

[redacted]



BOREHOLE LOG

Page 13 of 28
Date: 9-10-06

Well ID: C4997 | Well Name: NA | Location: W7P CENTER
Project: W7P Seismic Borehole | 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
145	RAB6			Basalt Chips Wet: Blueish Black GLEY2 2.5/10B 95% Black 5% Greenish White	Mud Rotary 7 7/8" bit 9/10/06 Shift Change 846.0 DMN
150	GRAB			DMN Basalt Chips Wet: Very dk greenish gray; GLEY2 3/5BG Dry: Greenish gray; GLEY2 5/5BG 95% blacks chips, 5% white/gray chips w/ black speckles (Not interbed No Change @ 855	Driller notes drilling softer material @ 853.5
155	GRAB			Driller notes change into interbed @ 855.5 bgs @ 0227 on 9/11/06 CW 9-29-06 Cold Creek Interbed DMN Black-gray CO-f SAND w/ 20% Basalt chips Wet: GLEY2 3/10G	
160	GRAB			DMN Gray-green CO-med SAND w/ 20% Basalt chips. Wet: GLEY2 4/10G	DMN Driller notes tighter frm to @ 866.2'
165	GRAB			DMN No Change in color; CLAY (green-gray) Abundant in sample; 5-10% Basalt chips; ~10% SAND	Driller says into clay @ 868.1'
170	GRAB			Green-gray SILTY sa / SAND w/ silt. GLEY2 4/10G	Driller says into sand @ 875.4'
175	GRAB			green-gray SILT / CLAY w/ sand GLEY1 5/5G	
180	GRAB				

Reported By: DOANNHAM ZORN / David Nelson | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Doan Hart / David M Nelson | Date: 9-10-06 | Signature: L.D. Walker | Date: 9/29/06

A-6003-642 (03/03)

BOREHOLE LOG			Page 14 of 28 Date: 9/11/06
Well ID: C4997	Well Name: NA	Location: Central WTP	
Project: WTP Seismic Borehole		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
885	GRAB			Greenish-gray to dark gray sa SILT w/ <5% Basalt chips Gley 1; 2.5/N Greenish-Black (Wet)	Mud Rotary 7 7/8" carbide bit
890	GRAB			No change	
895	GRAB			GREEN, BROWN & CLEAR SANDS MIX 2N W/ ALOT BASALT CHIP	
900	GRAB			Same	
905	GRAB			MULTCOLOR SAND SIZE ≈10% QUARTZ W/CLAY ALOT OF ORGANIC - BURNT WOOD W/BASALT CHIP MILD REACT HCL	DRILLING INTO CLAY START 950
910	GRAB			DK GREENISH GREY GLEY 1 4/10GY CLAY W/MULTCOLOR SAND + SOME ORGANIC & BASALT CHIPS MOD REACT HCL	
915	GRAB			GRAYISH GREEN GLEY 1 4/5G CLAY TRACE SAND MOD REACT HCL	
920	GRAB			SAME BUT BLOCKY	

Shift change

Reported By: David Nelson / DOANN HAMILTON		Reviewed By: L.D. Walker	
Title: Geologist		Title: Geologist	
Signature: David M. Nelson / Doann Hamilton	Date: 9-11-06	Signature: [signature]	Date: 9/29/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 15 of 28
Date: 9-1-06

Well ID: C4997	Well Name: NA	Location: CENTER - WTP	
Project: WTP Seismic Borehole		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)
925	GRAB			GRAYISH GREEN GLEY 1 4/6G CLAY BLOCKY MED REACT HCL	Mud Rotary 7 7/8" carbide bit
930	GRAB			SAME	
935	GRAB			V. DK GREENISH GREY GLEY 1 3/5GY CLAY MED REACT HCL	SLEW PAST 940 & 945 TO FAST TO SAMPLE. DECREASE SAND? KEEP ... & HAD TO PICK UP SPEED — ALL CLAY
940	NR				
945	NR				
950	GRAB			SAME CLAY — MOST LIKELY FROM 935-950 MED REACT HCL	950.4 HIT BASALT UMATILLA MEMBER ID FROM C4998
955	GRAB			BASALT WET → BLUISH BLACK GLEY 2 2.5/10B 90% BLACK 10% DK GREY SPECK.	
960	GRAB			SAME BASALT CHIPS WET → BLUISH BLACK GLEY 2 2.5/5PB 100% BLACK	

Reported By: DAWN HAMILTON		Reviewed By: L. D. Walker	
Title: GEOLOGIST		Title: Geologist	
Signature: [signature]	Date: 9-1-06	Signature: [signature]	Date: 9/29/06

A-6003-642 (03/03)

LANDAU ASSOCIATES

October 13, 2006

EQM Inc.
1777 Terminal Dr.
Richland, WA 99352

Attn: Ms. Mitzi Miller

RE: LETTER OF AUTHENTICITY
BOREHOLE C4997, LOG PAGE 16
WTP SEISMIC STUDY PROJECT

Dear Ms. Miller

As you requested, this letter confirms authenticity of the data provided on page 16 of the boring log for Borehole C4997 of the WTP Seismic Study Project at the Hanford site. The two field Geologists who oversaw the drilling of the boring for the target interval specified on page 16 (965 to 1005 ft below ground surface) have review the data and indicate as signatories to this letter, that the data presented on page 16 is a fair and accurate accounting of the observed drill cuttings and that no alterations have been performed. A copy of page 16 is attached for your reference.

If you have any questions related to the contents of this letter, please feel free to contact Christine Kimmel, Landau Associates' Project Manager at (425)778-0907.

LANDAU ASSOCIATES, INC.

David M. Nelson
Staff Geologist

Doann M. Hamilton
Staff Geologist

Christine B. Kimmel, L.G.
Senior Project Geologist
CBK/

10/13/06 \\Edmdata\projects\017\001\WTP\R\Log 16 authenticity_ltr.doc

ENVIRONMENTAL | GEOTECHNICAL | NATURAL RESOURCES

SEATTLE
130 2nd Avenue South
Edmonds, WA 98020
1 (800) 552-5957 f: (425) 778-6409

SPOKANE
10 North Post St., Suite 218
Spokane, WA 99201
(509) 327-9737 f: (509) 327-9691

TACOMA
950 Pacific Avenue, Suite 515
Tacoma, WA 98402
(253) 926-2493 f: (253) 926-2531

PORTLAND
7800 SW Durham Road, Suite 500
Tigard, OR 97224
(503) 443-6010 f: (503) 443-6119

BOREHOLE LOG Page 16 of 28 Date: 9-11-06

Well ID: C4997 | Well Name: NA | Location: CENTER - WTP

Project: WTP - Seismic Bore Hole | 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
965	GRAB			DMN Basalt Chips (80% dark, 20% white-gray) Wet: Greenish black; Gley2 2.5/10G Dry: Dark bluish gray; Gley2 4/5B No HCL rxn	Gyro survey run 1.0° inclination @ borehole.
970	GRAB			BASALT CHIPS WET: BLUISH BLACK GLEY2 2.5/5PB 100% BLACK OR DK CHIPS	SHOE CHANGE 9-12-06
975	GRAB			SAME BASALT CHIPS WET: BLUISH BLACK GLEY2 2.5/5PB 100% BLACK OR DK CHIPS	
980	GRAB			SAME BASALT CHIPS WET: BLUISH BLACK GLEY2 2.5/5PB 100% BLACK OR DK CHIPS	STOP 9-12-06 FOR GEOPHYS Geophys (Acoustic Televiewer and Vs/Vp) logged from 785' to 977' - DMN 9-12-06 9-18-06 START UP @ 981'
985	GRAB			BASALT CHIPS WET: BLUISH BLACK GLEY2 2.5/5B 100% BLACK OR DARK COLOR DRY: DARK GREENISH GREY GLEY2 4/10BG	9-19-06 Sh. Pt change, 9/19/06
990	GRAB			DMN Basalt Chips (Grout) 90% dark, 10% light chips (plus bentonite) chips in sample; Wet: V. Dark greenish gray Gley2 3/10BG; Dry: Dk. bluish gray Gley2 4/5B	Drill action: Hard & Slow Drill rate: ~ 0.3 ft/hr No HCL rxn on basalt
995	GRAB			DMN Basalt chips (80%), grout chips (15-18%), Cold creek interbed chips (2-5%). Wet: V. dk. greenish-gray Gley2 3/10G. Dry: DK. greenish gray - Gley2 4/10BG	Same drill action Drill rate ~ 0.85 ft/hr No HCL rxn on basalt.
1000	GRAB			BASALT CHIPS WET: BLUISH BLACK GLEY2 2.5/5PB DRY: DARK GREENISH GREY GLEY2 4/10BG 90% BLACK OR DARK COLOR 10% LIGHTER WHITE SPECK BLACK	SHOE CHANGE DRILL CONSISTANT @ 1003.2 FEET UP TO 2.0'/hr

Reported By: David Nelson / DOANN HAMPTON | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: David M. Nelson | Date: 9/11/06 | Signature: L.D. Walker | Date: 10/25/06

Doan Hamp 9/12/06 9-18-06 9-19-06

A-6003-642 (03/03)

[redacted]

BOREHOLE LOG Page 17 of 28 Date: 9-20-06

Well ID: C4997 Well Name: NA Location: CENTER - W7P

Project: W7P Seismic Borehole 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
1005	GRAB			BASALT CHIPS	
				WET: BLUISH BLACK GLEY2 2.5/5PB	LOST MUD IN RESERVE
				DRY: DARK GREENISH GREY GLEY2 4/10B6	& HOLE (NOT ACC.)
				85% BLACK & DARK CHIPS (10% VESSECULAR)	ADDED LCM
				15% LITE WHITE W/BLACK SPECKS	
1010	GRAB			BASALT CHIPS	
				WET: BLUISH BLACK GLEY2 2.5/5B	
				DRY: DARK ~~BLUISH~~ GREY GLEY2 4/10B6 ~~GREENISH GRY~~ SAME DK PLATY	
				80% BLACK & DARK / ~~15~~ 20% WHITE W/BLACK	Shift change 0700 DMN on site
1015	GRAB			DMN	
				Basalt Chips (95% black or dk grey) w/ ~~rust~~ 15% colored vesicles; 5% grout chip; trace Cold Creek	Drill rate ≈ 2.25'/hr ATS
				Wet: V. DK. bluish gray; GLEY2 3/5B	Driller says 5mtn fractured
				Dry: V. DK. bluish gray; GLEY2 3/10B	
1020	GRAB			DMN	
				Basalt Chips (Same as @ 1015)	Drill rate ≈ 2.5'/hr ATS
				Small chips. Moderate - poor recovery.	Driller says 5mtn fractured
1025	GRAB			DMN	
				Basalt chips (same as @ 1015 & 1020)	Drill rate 2.2'/hr ATS
				Small chips. Moderate to poor recovery.	Drill action: hard material very DMN
					Drillers call Grd @ 1028.1'
1030	GRAB			DMN	
				Basalt chips (same as 1015, 1020 & 1025) 90%	Drill rate 1.4'/hr ATS
				Grout chips 10%; trace Cold Creek interbed	Drill Action: Very hard
				chips. Only 5% of basalt chips show rust-color	
				Small chips. Moderate to poor recovery	
1035	GRAB			BASALT CHIPS	BIT GOING-V. SMALL CHIPS
				WET: BLUISH BLACK GLEY2 2.5/5PB	RATE 2.1 ft/hr & 0.6 ft/hr
				DRY: V. DARK BLUISH GRY GLEY2 3/10B	DH 9-20-06
				84% DARK OR BLACK, 15% WHITE W/BLACK	PUT MORE WEIGHT ON BIT
				1% RUST SMALL CHIPS	CHECK OUT CUTTING INCREASE
1040	GRAB			BASALT CHIPS	SPEED CUTS GOOD PASSAGE 9-21-06
				WET: BLUISH BLACK GLEY2 2.5/5PB	MUD VESCOSITY NOT RIGHT
				DRY: V. DARK BLUISH GREY GLEY2 3/5B	TOO MUCH UP CHIPS 1.1 ft/hr
				99% BLACK OR DARK (10% VESSECULAR)	10% FRACTURE ZONE
				1% LIGHT SOME DARK & PLATY V. SMALL CHIPS	VESECULAR

Reported By: Donna Hamecker / David Nelson Reviewed By: L. D. Walker

Title: Geologist / Geologist Title: Geologist

Signature: Donna Hamecker / David M. Nelson Date: 9-20-06 Signature: L. D. Walker Date: 10/25/06

A-6003-642 (03/03)

[redacted]

BOREHOLE LOG Page 18 of 28 Date: 9-21-06

Well ID: C4997 Well Name: NA Location: WTP-Center

Project: WTP Seismic Borehole 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
1045	GRAB			BASALT CHIPS WET: BLUISH BLACK ~~GREY~~ GLEY2 2.5/5PB 99% BLACK OR DARK 1% LT GRAY	Gyro Survey run @ 1046.1' Inclination = 1°
1050	GRAB			DMN ~~-colored~~ Basalt Chips (98% black-gray; 2% ~~rust colored~~) Wet: Gley2 2.5/5B Bluish-black Dry: Gley2 3/5B V. Dk. bluish-gray Abundant grout chips	DMN Drill rate @ 1.3'/hr
1055	GRAB			DMN Basalt Chips (99% dark gray-gray); 1% grout chips Wet: Gley2 2.5/5B Bluish-black Dry: Gley2 3/5B V. Dark bluish-gray Some grout chips	Drill rate @ 2'/hr
1060	GRAB			BASALT CHIPS - 100% DARK BLACK WET: BLUISH BLACK GLEY2 2.5/5PB DRY: V. DARK BLUISH GREY GLEY2 3/5B	1.8 ft/hr SWITCH DMN
1065	GRAB			BASALT CHIPS - 100% DARK BLACK WET: BLUISH BLACK GLEY2 2.5/5PB DRY: V. DARK BLUISH GREY GLEY 2 3/5B	2.4 ft/hr
1070	GRAB			BASALT CHIPS - 100% DARK 1% MnO_2 WET: BLUISH BLACK GLEY2 2.5/5PB DRY: V. DARK BLUISH GREY GLEY2 3/5B	DRILL SLOW RATE AFTER ROD ADD ON NOW 1.0 ft/hr 9-22
1075	GRAB			BASALT CHIPS - 100% DARK 1% MnO_2 1% RUST WET: BLUISH BLACK GLEY 2 2.5/5PB DRY: V. DARK BLUISH GREY GLEY2 3/5B	DRILL RE ADJUST RATE ACCURATE TRACES RUN AVERAGE 1.7 ft/hr
1080	GRAB			DMN Basalt Chips (100% Dark gray to gray-blue); 10% grout chips Wet: Gley2 2.5/10B - Bluish black Dry:	Very Distraction; Smooth/hard @ 1079.1' to 1080.0 Drill rate 1.2'/hr

Reported By: D. DMN / Hamerson / David Nelson Reviewed By: L.D. Walker

Title: Geologist / Geologists Title: Geologist

Signature: Don Hamerson / David M. Nelson Date: 9-21-06 / 9-22-06 Signature: LD Walker Date: 10/25/06

A-6003-842 (03/03)

[redacted]

BOREHOLE LOG

Page 19 of 28
Date: 9-22-06

Well ID: C4997 | Well Name: NA | Location: WTP-Center

Project: WTP-Seismic Borehole | 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
				DMN	
1085	GRAB			Basalt Chips (50% blue gray, 50% gray)	Drill action: smooth & hard
				Wet: Gley 2 2.5/5B Bluish-black	Drill rate: 1.6 ft/hr
				Dry: Gley 2 4/5PB Dark bluish-gray	Fractured @ 1088.0-1088.7
				Trace grout chips	Recirculate @ 1088.7'
				BASALT CHIPS 100% DARK 1% RUST 1% BLUE GREY	PULL RODS BACK 160'
1090	GRAB			WET: BLUISH-BLACK GLEY 2 2.5/5B	CLEAN OUT HOLE SLOWLY BACK
				DRY: V. DARK BLUISH GREY GLEY 2 3/5B	TO 1090
					Start up @ 0.8 ft/hr
1095	GRAB			1038 HR sample collected Green gray chip	1000 HR @ 1095 feet
				Basalt chips 98% 2% Trace Cement?	
				wet: Gley 2 2.5/5B bluish black	
				Dry: Gley 2 3/10B very dark bluish gray	
1100	Grab			Basalt chip 95% 5% Grey cement Green gray	1222 hrs sample collected
				wet: Gley 2 3/5B very dark bluish grey	stone
				Dry: Gley 2 4/10B dark bluish grey	
				1405 hrs @ 1105 feet	
1105	Grab			Basalt chips 90% 10% cement Green gray cement	
				wet Gley 2 2.5/10B bluish black	Drill action got
				Dry Gley 2 3/10B very dark bluish grey	smooth @ 1108 ft
				Contact Mabton Interbed 1108 to 1109'	1109 becoming harder
				Basalt 1110 feet @ 1800 hour	1109 feet
1110	Grab			wet: Gley 2 2.5/5B bluish black	
				Dry:	
				80% Basalt - 20% gray cement? Siltstone	
				trace green siltstone	
				SILT STONE	
1115	Grab			Wet: GLEY 1 4/5G dark greenish gray (Silt Stone)	
				40% siltstone chips 60% basalt cuttings	
					~1115-1120' rate decrease ~10'/hr
					controlled by formation
1120	Grab			SILT STONE	
				wet: GLEY 1 4/5G dark greenish gray	
				30% siltstone cuttings 60% basalt cuttings	basalt slough

Reported By: David Nelson / Doann Hamilton / Brian Christensen / Ryun Reich | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: David M. Nelson, Doann Hamilton | Date: 9/22/06 | Signature: LD Walker | Date: 10/25/06

Brian Christensen 9-23-06
Ryun Reich 9/23/06
9/23/06

9-23-06 BEC

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 9/23/06

Well ID: C4997 | Well Name: NA | Location: Central WTP
Project: WTP Seismic Borehole | 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
1125	Grab			SILT STONE Wet: GLEY1 4/5GY dark greenish gray (Siltstone fragments) 40% Siltstone cuttings 60% basalt	basalt sloughs At 1128': Stopped drilling to do AIR circulation
1130	Grab			SILT/CLAY STONE Wet: GLEY1 4/5GY dark greenish gray ~30% basalt	(Siltstone fragments) basalt sloughs
1135	Grab			SILT/CLAY STONE Wet: GLEY1 4/10GY dark greenish gray ~ 20% basalt	drill rate accelerated at ~1138'
1140	Grab			Fine SAND Wet: GLEY1 6/10GY greenish gray Well RR Well sorted, very fine Quartzose, micaceous	
1145	Grab			Fine SAND Wet: GLEY1 6/10GY greenish gray Well sorted, very fine Quartzose, micaceous	
1150	Grab			60% sand 30% basalt & 10% cement Fine sand: well sorted, Quartzose Wet: 5BG 5/5GY green/gray	Rec'd 9/27/06
1155	Grab			Fine SAND 30% sand; 50% basalt; 10% cement wet: GLEY1 6/10GY greenish gray well sorted, Quartzose.	
1160	Grab			Fine SAND Wet: GLEY1 5/5GY greenish gray 40% Sand 30% cement 20% basalt Well Sorted, Quartzose, micaceous	cuttings

Reported By: Ryan Reich | Reviewed By: L.D. Walker
Title: Geol. | Title: Geologist
Signature: Ryan Reich | Date: 9/27/06 | Signature: L.D. Walker | Date: 10/25/06

A-6003-642 (03/03)

[redacted]

BOREHOLE LOG

Page 21 of 28
Date: 9/28/06

Well ID: C4997 | Well Name: NA | Location: WTP Central

Project: WTP Seismic Borehole | 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
1165	GRAB			DMN	Drill action: soft & slow
				~~Fi me~~ Fine to medium SAND (30%)	Drill rate: 6'/hr
				Wet: Gley1 5/5GY greenish gray	New Mud in borehole to
				Dry: NA	flush out detergent & cut
				40% Basalt chips (slough) & 30% cement (slough)	tings.
1170	GRAB			DMN Fine ~~SAND~~ SAND (60%)	
				Wet: Gley1 5/10GY Greenish Gray	Drill action: soft
				Dry: NA	Drill rate: 8'/hr
				30% Basalt Chips, 20% cement (Slough)	
1175	GRAB			Fine to medium SAND (50%)	Drill action: soft
				Wet: Gley1 5/10GY Greenish Gray	Drill rate: 7.1'/hr
				Dry: NA	
				30% Basalt chips (slough), 20% cement (Slough)	
1180	GRAB			Fine to medium SAND (25%)	Drill action: soft
				Wet Gley 1 3/5G very dark greenish gray	Drill rate: 7.6'/hr
				Dry: NA	
				10% Basalt chips (Slough), 5% cement (Slough)	
1185	GRAB			Fine to medium SAND (15%)	Drill action: soft
				Wet: Gley 2.5/5G Greenish black	Drill rate 7.6'/hr
				75% Basalt chip slough w/cement chips	Suds coming from borehole
				& bentonite. Abundant suds in sample.	but no detergent added.
1190					LOST ROD DOWN HOLE
					NEED FISH OUT
1195					
1200					

9/28/06 Day Shift

9.28.06 NITE DH

VOID THIS SHEET
LDW 10-25-06

UNTIL FISH TOOL OUT
ONCE FISH DEPTH @ 1162
ID TRUE BIT DEPTH ROD SPUN OFF + THEY ADDED
SO WHEN ROD THE ROD WENT IN HOLE SO TOOL LENGTH
BASED COLLECTED SAMPLE 1180, 1185
@ 1165, 1170, 1175, 1180, 1185, 72 UP NOT REPRESENT
DH 9-30-06

Reported By: David Nelson / DOAN Hancy		Reviewed By: L.D. Walker	
Title: Geologist		Title: Geologist	
Signature: [signature]	Date: 9/28/29 06	Signature: [signature]	Date: 10/25/06

A-6003-642 (03/03)

BOREHOLE LOG		Page 22 of 28 Date: 9-30-06
Well ID: C4997	Well Name: NA	Location: WTP - CENTER
Project: WTP SEISMIC BORE HOLE		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
1165	GRAB	JARS LABEL W/ #-2		V. POOR RECOVERY 1% SAND GRANULAR	SLOW DRILL DUE TO
				REST BASALT + CONCRETE + SOME CLAY	PIECE METAL BOTTOM
					OF HOLE FROM RODS
					BREAKAGE
1170	GRAB			V. POOR RECOVERY 1% SAND GRANULAR	-LOST METAL INTO CLAYS
				REST CONCRETE + BASALT TRACE CLAY	HAVE TO RAISE + LOWER
					BIT TO CLEAR UP
				CLAY W/ BASALT CHIP	
1175	GRAB			DARK GREENISH GRAY; GLEY1 4/5G - WET	
				DMN	
1180	GRAB			Clay w/ Basalt chips (50%/50%)	
				Wet: Gley1 5/5G greenish gray	
				Dry: ~~NA~~ DMN Gley1 6/5GY Greenish Gray	
				Trace wood debris from drill support truck	
					Drill Action: Soft
1185	GRAB			Clay (60%) w/ Basalt chips (40%)	Drill rate 11.2'/hr
				Wet: Gley1: 5/5G greenish gray	Drill rate decreases
				Dry: Gley1 6/5GY greenish gray	to 3'/hr from 1186 to 1189 (Sand?)
				Trace wood debris from drill support truck	Driller says clay @ 1189
					Driller says sticky clay 1190'
1190	GRAB			Clay (fine-medium sandy CLAY) 70% with	Drill action: soft / sticky
				Basalt chips (30%). Sand is quartzose (med)	Drill rate: 2.6'/hr
				Wet: Gley1 5/5G greenish gray	Bit raised & lowered to clear.
				Dry: Gley1 6/5G greenish gray	Driller says out of clay @ 1194'
				Trace wood debris from drill support truck	
1195	GRAB			Silty, clayey fine to coarse SAND; Quartzose (80%)	Drill rate 3.6'/hr
				Basalt chips (20%); Trace wood debris from drill truck	Driller says back in clay @ 1196'
				Wet: Gley 1 4/10GY Dark greenish gray	Bit raised & lowered to clear clays
				Dry: Gley 1 7/10Y Light greenish gray	Driller says alternating between
					(clays & silt) ~~&~~ sand layers.
1200	GRAB			Silty fine-medium SAND (%); Basalt chips ( )	Drill action: soft
				Wet: Gley1 4/5G Dark greenish gray	Drill rate: 3.5'/hr
				Dry: Gley1 7/10Y Light greenish gray	
				Quartzose sand	

Reported By: DAWN HAMILTON / David Nelson	Reviewed By: L.D. Walker
Title: GEOLOGIST	Title: Geologist
Signature: [signature] / [signature] Date: 9-30-06	Signature: [signature] Date: 10/25/06

9/30/06

Day shift 9/30/06

A-6003-642 (03/03)

[redacted]

BOREHOLE LOG

Page 23 of 28
Date: 9/30/06

Well ID: C4997 | Well Name: NA | Location: WTP Central
Project: WTP Seismic Borehole | 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
1205	GRAB			Fine to coarse SAND with silt and basalt chips	
				Wet: Gley1 4/5G dark greenish gray	Mabton-Priest Rapids
				Dry: Gley1 6/10GY greenish gray	contact @ top of DMN 1205.5'
				Contact w/ Priest Rapids Basalt Member	
1210	GRAB			Basalt Chips (grey to black) 90% 10% Mabton	Drill action: Smooth
				Wet: Gley2 3.5/10G greenish black	Drill rate: 4'/hr
				Dry:	
1215	GRAB			BASALT CHIPS GREY & WHITE & BLACK	RATE 1.5 ft/hr
				WET: BLUISH BLACK GLEY2 2.5/5PB	
				DRY: DK GREENISH GREY GLEY2 4/10BG	LOOSENED MUD
1220	GRAB			BASALT CHIPS: BLACK & GREY & WHITE	RATE 1.8 ft/hr
				WET: BLUISH BLACK GLEY2 2.5/5PB	
				DRY: DK GREENISH GREY GLEY2 4/10BG	STILL LOOSENED MUD
1225	GRAB			BASALT CHIPS: BLACK & GREY & WHITE	RATE 4.0 ft/hr
				WET: BLUISH BLACK GLEY2 2.5/5PB	
				DRY: DK GREENISH GREY GLEY2 4/10BG	
1230	GRAB			BASALT CHIPS: BLACK & GREY & WHITE	INCREASE VISCOS, OF MUD
				Some CHIPS PLATELIKE TRACE MW	
				WET: BLUISH BLACK GLEY2 2.5/5PB	RATE 1.2 ft/hr
				DRY: DK GREENISH GREY GLEY2 4/10BG	
1235	GRAB			BASALT CHIPS: BLACK & GREY & WHITE	CHIPS ARE LARGER
				Some CHIPS PLATELIKE MORE ENCLOSE	DUE TO ENCLOSE
				WET: BLUISH BLACK GLEY2 2.5/5PB	VISCOSITY OF MUD
				DRY: DK GREENISH GREY GLEY2 4/10BG	RATE 3.1 ft/hr
1240	GRAB			BASALT CHIPS: BLACK GREY & WHITE	
				ENCLOSE PLATELIKE CHIPS	
				WET: BLUISH BLACK GLEY2 2.5/5PB	
				DRY: DK GREENISH GREY GLEY2 4/10BG	

Reported By: David Nelson / DOANN Hamza | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: David M. Nelson 10-20-06 | Signature: L.D. Walker Date: 10/25/06
DOANN Hamza 10/1/06

A-6003-842 (03/03)

BOREHOLE LOG

Page 24 of 28
Date: 10-1-06

Well ID: C4997 | Well Name: NA | Location: WTP CENTER
Project: WTP SEISMIC BOREHOLE | 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)	
1245	GRAB			DMN DMN		Day Shift 10/1/06
				BASALT CHIPS (95%); Translucent phenocrysts (10-(5%) (Possibly zeolite)	Driller says fractured	
					Drill action: slightly rough	
				Wet: Gley 2 2.5/5B Bluish black	Drill rate: 3.4'/hr	
				Dry: Gley 2 3/5 B Very dark bluish gray		
1250	GRAB			DMN		SHIFT CHANGE
				BASALT CHIPS (50%); MABTON clay & sand (50%)	Pull ROP for GEOPHYSICS	
				Wet: Gley 2 4/5BG Dark greenish gray	Drill action: smooth 10/4/06	Day shift
				Dry, Gley 2 5/10BG Greenish gray	Drill rate: 1.41 ft/hr	
				Fine-grained chips w/ large (2mm) Mabton chips		
1255	GRAB			BASALT Chips (90%); grout (10%) Small chips	Drill action; Smooth & slow	
				Wet: 2.5/10 BG Greenish black Gley 2	Drill rate: 2.9'/hr	
				Dry: Gley 2 3/10 BG Very dark greenish gray		
				100% black to dark gray		
1260	GRAB			BASALT Chips (80%); grout chips (20%)	Drill action: smooth & slow	
				Wet: 2.5/10 BG Greenish black	Drill rate: 2.6'/hr	
				Dry: 3/10 BG Gley 2 Very dark greenish gray		
				100% basalt is black - dark gray		
1265	GRAB			BASALT Chips (85%); grout chips (15%)	Drill action: smooth	
				Wet: Gley 2 2.5/10BG Greenish black	Drill rate: 4.1'/hr	
				Dry: 3/10 BG Gley 2 Very dark greenish gray		
				100% basalt chips black to dark gray		
1270	Grab			BASALT Chips	rate = 1.0'/hr	
				Wet: GLEY1 3/10GY v. dark greenish gray	trace of cement	
				Dry: GLEY1 4/5G dark greenish gray	trace of quartz sand	
				basalt is 70% dark, 30% light		
1275	Grab			BASALT Chips	rate = 1.7'/hr	
				Wet: GLEY1 3/5G v. dark greenish gray	trace of quartz sand	
				Dry: GLEY1 4/5G dark greenish gray	trace of Siltstone	
				basalt is 80% dark, 20% light		
1280	Grab			BASALT Chips w/ dark green Siltstone	trace of coal chips from ~1279-1282 (low grade)	
				Wet: GLEY1 3/5G v. dark greenish gray		
				Dry: GLEY1 4/5G dark greenish gray		
				basalt is 70% dark, 30% light		

Reported By: David Nelson, Ryan Reich | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: David M. Nelson | Date: 10/5/06 | Signature: [signature] | Date: 10/25/06

Ryan Reich 10/5/06

A-6003-642 (03/03)

25 10-25-06

BOREHOLE LOG

Page 25 28
Date: 10/5/06

Well ID: C4997 | Well Name: NA | Location: WTP Center
Project: WTP Seismic Borehole | 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
1285	Grab			BASALT Chips Wet: GLEY1 3/10GY V. dark greenish gray Dry: GLEY1 4/5GY dark greenish gray Basalt is 80% dark, 20% light with occassional coal fragments	trace of dark greenish gray siltstone (<10%)
1290	Grab			Basalt chips Wet: GLEY1 3/10GY V. dark greenish gray Dry: GLEY1 4/5GY dark greenish gray With occasional coal fragments	trace of dark greenish gray siltstone (<5%)
1295	GRAB			BASALT CHIPS WITH DARK GREEN SILTSTONE (<5%) WET: GREY 1 2.5/10GY DRY: GREY 1 3/N BASALT IS 80% DARK, 20% LIGHT Increase in coal fragments (<5%)	DRILL ACTION SMOOTH/SLOW 2.5 FT/HR
1300	GRAB			BASALT CHIPS WITH DARK GREEN CHIPS (OLIVINE?) WET: GREY 2 3/10BG NO HCL REACTION DRY: GREY 1 4/N Occ. coal fragments	DRILL RATE 5.8 FT/HR
1305	GRAB			BASALT CHIPS (85%) WITH DARK GREEN CHIPS (15%) (<5% SILTSTONE, 10% OLIVINE & SECONDARY MINERALIZATION. BASALT IS FINED GRAINED WET: GREY 1 3/10Y DRY: GREY 2 5/10B	SLOW SMOOTH DRILL ACTION DRILL RATE 2.2 FT/HR
1310	GRAB			BASALT CHIPS (80%) DARK GREEN CHIPS (5%) GRAY CHIPS (5%) BASALT IS FINED GRAINED NO HCL REACTION GREEN CHIPS WET: GREY 2 3/5BG DRY: GREY 2 3/10G	10-25-06
1315	GRAB			BASALT CHIPS (80% DARK, 20% LIGHT) FINE GRAINED, NO HCL REACTION WET: GREY 2 3/9BG DRY:	SMOOTH DRILL ACTION
1320	Grab			BASALT Chips Wet: GLEY1 3/5GY V dark green-ish gray Dry: GLEY1 5/10GY dark greenish gray 80% dark 20% light, No HCL Reaction	Smooth drilling at 2.9/hr.

Reported By: Ryan Reich / Christie Kimmel | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Ryan Reich 10/5/06 Christie Kimmel | Date: 10/5/06 | Signature: L.D. Walker | Date: 10/25/06

A-6003-642 (03/03)

BOREHOLE LOG Page 26 of 28 Date: 10/5/06

Well ID: C4997 Well Name: NA Location: WTP Center

Project: WTP Seismic Borehole 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
1325'	Grab			BASALT Chips Wet: GLEY1 3/5GY v. dark greenish gray Dry: GLEY1 5/10GY dark greenish gray 80% dark 20% light No HCl Rxn	Smooth drilling at 2.9'/hr.
1330'	Grab			BASALT Chips Wet: GLEY1 3/10GY v. dark greenish gray Dry: GLEY1 4/5GY dark greenish gray 70% dark 30% light No HCl Rxn	rate = 2.5'/hr
1335'	Grab			BASALT Chips Wet: GLEY1 3/10GY v. dark greenish gray Dry: GLEY1 4/5GY dark greenish gray 80% dark 20% light	rate = 2.5'/hr
1340'	Grab			BASALT Chips Wet: GLEY1 3/10Y v. dark greenish gray Dry: GLEY1 4/10GY dark greenish gray 70% dark 30% light	trace of greenish gray siltstone V. light chatter at 1343'-1344'
1345	GRAB			BASALT CHIPS (70% DARK 30% LIGHT) WITH TRACE (<5%) DARK GREEN SILTSTONE WET: GREY 1 3/10Y DRY: GREY 1 4/10GY	
1350	GRAB			BASALT CHIPS (70% DARK 30% LIGHT) WITH TRACE (10%) DARK GREEN SILTSTONE WET: GREY 1 3/10Y DRY: GREY 1 4/10GY	SLOW SMOOTH DRILL ACTION
1355	Grab			BASALT Chips Wet: GLEY1 3/10Y v. dark greenish gray Dry: GLEY1 4/10GY dark greenish gray 70% light dark 30% dark light, No HCl Rxn	
1360	Grab			BASALT Chips Wet: GLEY1 3/10Y v. dark greenish gray Dry: GLEY1 4/10GY dark greenish gray 70% light dark 30% light, No HCl Rxn	

Reported By: Ryan Reich / Christine Kimmel Reviewed By: L.D. Walker

Title: Geologist Title: Geologist

Signature: Christine Kimmel Date: 10/7/06 Signature: L.D. Walker Date: 10/25/06

Ryan Reich 10/7/06

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 10/8/06

Well ID: C4997 | Well Name: NA | Location: WTP CENTER
Project: WTP SEISMIC BOREHOLE | 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
1365	GRAB			BASALT CHIPS (60% DARK 40% LIGHT) WITH DK GREEN CHIPS AND SOME SECONDARY MINERALIZATION. BASALT IS FINE GRAINED WET: GLEY2 3/5B DRY: GLEY2 4/5B NO HCL RXN	1364.4' BGS - DRILL RATE INCREASED, ACTION BECOMES ROUGH 1365.2' DRILLER REPORTS DECREASE IN DRILL RATE, ROUGH ACTION
1370	GRAB			BASALT CHIPS (95-98% BLACK) SMALL - LARGE CHIPS, FRIABLE CHIPS, CONTAINS BLACK CLAY WET: GLEY2 2.5/5PB DRY: GLEY2 3/5PB	-1369.5 SOFT DRILL -1371 HARD DRILL -1374.5 SOFT DRILL
1375	GRAB			BASALT CHIPS WITH BLACK CLAY (95-98% BLACK), CHIPS ARE FRIABLE WET: GLEY2 2.5/5PB DRY: GLEY2 3/5PB	-1376.2 HARD DRILL ACTION
1380	Grab			~~End of flow top @ 1379~~ DMN 10/25/06 per RAR BASALT chips Wet: GLEY1 3/5G V. dark greenish gray Dry: GLEY1 4/10GY dark greenish gray 90% dark 10% light, No HCl Rxn	Smooth drilling, trace of quartz from vesicle filling
1385	Grab			BASALT chips Wet: GLEY1 3/5G V. dark greenish gray Dry: GLEY1 4/10GY dark greenish gray 90% dark 20% light No HCl Rxn	Smooth drilling, trace of ~~smoky~~ quartz (opal) from vesicle filling rate = ~~[illegible]~~'/hr End of flow top = 1389 DMN per RAR
1390	Grab			BASALT chips Wet: GLEY1 3/5G V. dark greenish gray Dry: GLEY1 4/10GY dark greenish gray 90% dark 10% light	rate = 27'/hr Smooth drilling
1395	Grab			BASALT chips Wet: GLEY1 3/10GY V. dark greenish gray Dry: GLEY1 4/10GY dark greenish gray 90% dark 10% light	rate = 2.8'/hr
1400	Grab			BASALT chips Wet: GLEY1 3/10GY V. dark greenish gray Dry: GLEY1 4/10GY dark greenish gray 90% dark 10% light	rate = 3.2'/hr Driller notes fractures at ~1404'

Reported By: Christine Kimmel | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Christine Kimmel Date: 10/8/06 | Signature: L.D. Walker Date: 10/25/06
Ryan Roberts 10/8/06

A-6003-642 (03/03)

[redacted]

BOREHOLE LOG — Page 28 of 28 — Date: 10/8/06

Well ID: C4997 | Well Name: NA | Location: WTP Center
Project: WTP Seismic Borehole | 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
1405	~~Grab~~			BASALT chips Wet: GLEY1 3/10GY v. dark greenish gray Dry: GLEY1 4/10GY dark greenish gray 90% dark 10% light	rate = 2.1'/hr.
1410	GRAB			BASALT chips Wet: GLEY1 v. dark greenish gray Dry: GLEY1 dark greenish gray 90% dark 10% light No HCl Rxn	10/8/06 Dayshift DMN
1415	GRAB			BASALT CHIPS (85%) w/green clay chips (15%) Wet: Gley2 2.5/10BG Greenish black Dry: Gley1 3/5GY Very dark greenish gray Quartz-filled vesicles	rate = 1.6'/hr Action: smooth
1420	GRAB			BASALT CHIPS (85%) w/green clay chips (15%) Wet: Gley2 2.5/10BG; Quartz-filled vesicles Dry: 3/5GY Gley1 very dark greenish gray Black to dark green clay with basalt chips (Possible interbed) from 1421.8-1424.4'	Flow bottom? Rosalia? Drill rate: 1.3/hr Drill action: smooth Driller notes fractures at 1420.5'-1421.5' Driller notes much softer material between 1421.8 & 1424.4'. Back into basalt at 1424.4'.
1425	GRAB			BASALT CHIPS (98%) w/dense green clay Wet: Gley1 2.5/N Black; Vesicles unfilled	
1430				Bottom of Hole	⊗ NOTE: After geologist released from drillsite, the driller advanced the borehole past 1428' while drilling out cement. Final TD = 1435.7' LDW 10/25/06
1435				1428 DH 10-8-06	

Reported By: Ryan Reich/David Nelson/Don Hunt | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Ryan Reich | Date: 10/8/06 | Signature: LD Walker | Date: 10/25/06
David M. Nelson
Don Hunt

A-6003-642 (03/03)

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APPENDIX B

Photocopied Geological Borehole logs for Hanford and Ringold formations in borehole c4997

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BOREHOLE LOG

Page 1 of 13
Date: 7/30/06 – Start 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
					Cable Tool drilling w/ 6" hollow drive barrel.
0				0 – 16.8': Sand (S) fill material (non-native), well compacted, slight moisture, v. sparse gravels (1" to max ~1") subrd., ~8% silt, >90% v. fn to med. sand, mod. HCl Rxn, lt. brn to grayish color.	Note: V. poor lighting conditions for examining soils (0' → 5' bgs)
5	Grab			→ @ 7': increase in moisture, compaction. Also, increase silt cont. to ~10%, color: dk. brn (5Y4/2), mod to strong HCl Rxn.	G.S. @ 5' bgs.
10	Grab				G.S. @ 10' bgs.
				~16.8'-17' - 2" layer of ang. to sub-ang. S (~80% felsic, 20% basalt), ol. brn (2.5Y4/3), weakly cons., sl. moist, no HCl rxn	
15	Grab			17' – 63': Sand (S), Native. Wellsort. m-vc ang. S (~80% basalt) Dk gray to black, nd HCl rxn, max = 2mm 7-31-06 No silt, 80% med-vc S.	G.S. @ 15' bgs. Split spoon 20.6-23.1' 20.6-21.1'; 25 blows; Bulk 867 21.1-21.6'; 36 blows; Bulk 868 21.6-22.1'; 40 blows; Bulk 869 22.1-22.6'; 45 blows; Bulk 870
				-18' grain size decrease to ~70% m -20' grain size increases back to 70% c	
20	Grab			→ @ ~26.5' bgs: v. thin (2") layer of w.s., v.f.-m.S, 80% felsic, brn., v. similar to lenses from 16.8 to 17'.	20.6-23.5; Bulk; G.S. @ 20' bgs G.S. @ 25.5' bgs 7/31/06
	Split Spoon	192 blows 100%+rec		→ @ 35.5' bgs: Same as above (v. thin, 2", vf. ms), No HCl Rxn	
25	Grab			→ @ ~36.5' bgs: Slightly v. sparse gravel to max size 2" subrd. to subang., <5%, (v. fine to fine pebble) 7/31/06	
				→ @ ~37.5' v. sparse (<5%) gravel to max 6" (lg. cobble) rd. to subrd, continuing	G.S. @ 30.5' bgs (PSD Particle Size analysis) Sample @ 30.5' bgs.
30	Split Spoon	100% Rec 156 Blows (10/29/45/39/33)			Split Spoon sample from 30.1' to 32.1' bgs A: 31.6-32.1', 39 Bl. #B1K871 B: 31.1-31.6', 45 Bl. #B1K872 C: 30.6-31.1', 29 Bl. #B1K873 D: 30.1-31.1', 108 Bl. #B1K874
35	G.S.			7/31/06 P.2 Note: Water → Slight 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 - Start; 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. 39.8-40 Split Spoon	100% Rec 30 Blows (20/15/15/63/84)		(Cont'd) Sand from 7' → to ± 44' bgs (SS) 7/31/06	Cable-Tool drilling w/ hollow drive barrel.
				→ @ ~43' bgs: v.fn to c-se Sand (80% v. fn to fn, 20% md. to 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).	G.S. @ 40' bgs P.S. @ 40' bgs. Split-Spoon Sample from 39.4' → 41.4' bgs. A: 40.9'-41.4'; 6 BL, B1K875 B: 40.4-40.9'; 6 BL, B1K876 C: 39.9-40.4'; 6 BL, B1K877 D: 39.4-39.9'; 20 BL, B1K878 *D is all slough
45	G.S.			→ @ 49' bgs: Cont. w/ S sim. to above 43'. Max Gr to 1/2" (md. pebble), v. sparse.	G.S. @ 45' bgs
50	G.S. 49.5-50 Split Spoon	100% Rec 30 Blows (9/38/58/69/134)		→ @ 46' bgs: return to S, sim. to 43'-44', w/ 60% Felsic to 47' bgs. 70% (SS) 8/1/06	G.S. @ 50.5' bgs & P.S. @ 50.5' bgs Split-Spoon Sample from 50.2' - 52.2' bgs. A: 51.7'-52.2'; 6 BL; B1K879
55	G.S.			→ @ 47': Return to 80% basalt Sand, Mod. Sorted, fn to v. c-se, sub ang. to sub rd., v. wk to No HCl Rxn., <5% silt.	B: 51.2-51.7'; 5 BL; B1K880 C: 50.7-51.2'; 3 BL; B1K881 D: 50.2-50.7'; 9 BL; B1K882 *D has ~0.3' of slough.
60	G.S. & P.S. Split Spoon 59.8-60	294 blows 100% rec. (29/25, 60, 55, 134)		→ @ 54': Trace in Basalt cont. to ~ 80%, md. to v-c-se.	G.S. @ 55' bgs! G.S. @ 60' bgs
65	Gravels Split Spoon 64.8-65	(SS) 8/1-06		→ @ 55' return to same as 47-54' (70% basalt, fn. to v. c-se sand).	Split spoon sample 60.3'-62.8' A: 61.8-62.3'; 5 BL; B1K883
				·57' silt fraction inc. to ≤ 10% S is weakly cons. in small zones w/ higher silt concentrations.	B: 61.3-61.8; 6 BL; B1K884 C: 60.8-61.3; 5 BL; B1K885 D: 60.3-60.8; 20 BL; B1K886
70	Gravels Split-spoon 69.8-72.5	100% rec 328 blows (9,28,65, 117, (SS) 8-1-06 (9, 20, 36, 52, 11))		63'-64': Slightly Silty Sand (m) S Mod. sort weakly cons. w/ 85% S: m-v.c ang, 60% felsic, 40% basalt & 15% M: grayish brn (2.5Y, 4.5/2, wk 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; 52 BL; B1K887 B: 70.8-71.3; 36 BL; B1K888
75	G.S.			64'-66.5': Sand (S) dk grayish brn (2.5Y 4/2, 5/1.5, moist) Mod.-poorly sort, loose S: vf-vc (80% m-c) ang. >70% basalt (no silt)	C: 70.3-70.8; 20 BL; B1K889 G.S. @ 70' bgs D: 69.8-70.3; 9 BL; B1K890 Bulk (~70-72.5): B1K856
				66.5' - silt fraction inc. to ≤ 10%, inc. moisture, sl. oxidized, weak soil development Dk. brn (2.5Y, 4/4, moist)	G.S. @ 75' bgs

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

Title: Geologist | Title: Geologist

Signature: [signature] Date: 8/1/06 | Signature: [signature] Date: 8/23/06

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 8-1-06-Start / 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. / P.S. Split-Spoon / Bulk	100% Rec		66.5'-103.5: Sand (S)	Cable tool drilling w/
		287 Blows		Well-sort, loose S: vf-vc (90% vc) v. ang.	hollow drive barrel
		(23/49/55/		~75% basalt, minor silt (<2%), many oxid.	G.S. @ 80' bgs.
		121/39)		grains, no HCl rxn, v. dk gray (5Y 3/1, dry)	P.S. @ 80' bgs.
				69' silt fraction → to ≤10%. v. sparse	Split-Spoon from (NB 8/1/06)
85	G.S.			pebbles, max = 5 cm. Grayish brn (2.5Y 4.8/2) dry	from 79.7' to 81.7' bgs.
				strong HCl rxn.	G.S. @ 85' bgs.
				72.5' silt fraction <5% 1-2 cm layers	
				~~[illegible]~~ (NB 8-1-06) concentrated with m & mod. oxidized	
				lt. yellowish brn (2.5Y 6/4, sl. moist)	
90	G.S. / P.S. Split-Spoon / Bulk	100% Rec		77' 98% S, ang. 75% basalt, sl. oxid. 1% M	G.S @ 90' bgs.
		245 blows		no HCl rxn, v. sparse pebbles (1-4 cm) dk gray	P.S @ 90' bgs.
		(17/30/43/		84' bgs: ~90% v. fn to md. S w/ ~	Split-Spoon sample
		48/107)		5% cse & v. sparse pebbles to	from 89.6'-91.6' bgs
				max 1 cm. <5% silt. moist,	A: 91.1-91.6'; 48 bl.; B1K895
95	G.S.			well to mod. sorted. v. compacted,	B: 90.6-91.1; 43 bl.; B1K896
				v. wk. HCl Rxn. lt. gry/brown	C: 90.1-90.6; 30 bl.; B1K897
				(2.5Y 4/2), 60% felsic, to ~85.5'	D: 89.6-90.1; 17 bl.; B1K898 (NB 8/1/06)
				→ @ 85.5': Return to ~75% basalt.	100% Rec. 245 Blows total.
				(sim. to that from 72.5-77')	Bulk "5-gal bucket" sample
100	G.S. / P.S. Split-Spoon / Bulk	100% Rec		weathered/oxidized grains increase,	from 89.6-91.6' bgs
		244 Blows		80% fine to md. S, ~15% cse.	HEIS# B1K8F7
		(14/24/51/		to v. cse S., v. sparse v. fn. pebbles	split-spoon sample (NB 8/1/06)
		63/92)		(to max 3 mm). <5% silt + 1%	from 79.7' to 81.7' bgs
				v. fn. s. Note: Hole staying	A: 81.2-81.7; 121 bl.; B1K891
105	G.S.			open v. well & casing driving harder.	B: 80.7-81.2; 55 bl.; B1K892
				→ @ 88' v. thin (<1") layer	C: 80.2-80.7; 49 bl.; B1K893
				of highly oxidized sand lam-	D: 79.7-80.2; 23 bl.; B1K894
				inations w/ yellow & orange	100% Rec./287 Blows tot.
				grains. Mod. to strong HCl Rxn.	Bulk "5-gal-Bucket"
110	G.S./P.S. Split-Spoon / Bulk	100% rec.		~~90%~~ (NB 8/1/06) ~<10% silt.	Sample from 79.7-81.7' bgs
		289 blows		→ @ 88.5': v. sparse cobbles to	HEIS# B1K8F6
		(10, 27, 41,		max 6", rd. ~1" (NB 8/1/06)	G.S. @ 95' bgs.
		102, 104)		→ @ ~92': v. thin (~~~2"~~) layer of	G.S. @ 100' bgs.
				well consolidated, oxidized	P.S. @ 100' bgs (NCO)
115	G.S.			& discolored sand w/ lt. yellow	Split-Spoon sample
				to orange grains (v. similar to	from 99.7 to 101.7' bgs,
				that @ 88', <10% silt.	100% recovery, 244
				→ @ 94': same as 92' & 88' (~2").	blows total
				p.4 →	cont'd p.4 →

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

Title: Geologist | Title: Geologist

Signature: [signature] | Date: 8-2-06 | 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
100			not used @ 8-2-06		Cable-Tool drilling
				→ 95': con't w/ ~75% basalt	w/ hollow drive barrel.
				S, w/ weathered/oxidized grains,	Continuation of
				v. similar to that described @	Split-Spoon info:
				85.5'.	A: 101.2 – 101.7; 63 Bl.; B1K899
				→ @ ~103.5': thin (up to 2"	B: 100.7 – 101.2; 51 Bl.; B1K880
				thick max) layer of silt (M)	C: 100.2 – 100.7; 24 Bl.; B1K881
				<5% v. fine sand, 95% M,	D: 99.7 – 100.2; 14 Bl.; B1K882
				non-plastic, moist, v. comp-	Bulk "5-gal. Bucket" sample
				-acted, strong to v. strong	from 99.7 – 101.7' bgs
				HCl reaction, lt brn (5Y 5/3)	HEIS # B1K8F8
				v. well sorted.	G.S. @ 105.5' bgs
				103.5 → 124.5 Sand (S)	G.S./P.S. @ 110' bgs
				Mod. sorted, v. slight moisture,	split spoon 109.5' – 111.5'
				>90% v. fn. to md S, w/ sparse	289 blows 100% rec.
				crs to v. crs grains, subang., 50–60%	A: 111 – 111.5; B1K8B3; 180 blows
				felsic / 40 to 50% basalt, overall	B: 110.5 – 111; B1K8B4; 78 "
				color: lt. gr/brn (5Y 5/2), <10%	C: 110 – 110.5; B1K8B5; 37 "
				silt, v. wk HCl Rxn, fairly	D: 109.5 – 110; B1K8B6; 10 "
				well consolidated, some clumps	Bulk: ~~110~~ 109.5 – 112'; B1K8H0
				of oxidized/discolored silty sand	G.S. @ 115' bgs
				to max ~2 to 3 mm.	
				→ @ 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 dk grayish brn (2.5Y 4/2, moist)	
				40% basalt 60% felsic. No Δ 117–124.5'	

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

Title: Geologist | Title: Geologist

Signature: [signature] / [signature] | Date: 8-2-06 | Signature: [signature] | Date: 8/23/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 5 of 13
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/
	Split Spoon ↓ Bulk	100% rec.		Mod sort unconsolidated S with 90% f-vc	hollow drive barrel.
		232 blows		(>80% c/vc) ang. S (60% felsic 40% basalt)	G.S./P.S. @ 120' bgs
		(15,35,44,		& <5% M & <5% vf ang. pebbles Max	Split-spoon 120.6'-123.1' @ 8-2-06
		41,92)		grain = 3 mm, no HCl rxn. lt gray (2.5Y,	A: 123.1-122.6; 185bl.; 41bl.; B1K8B7
125	G.S.			5.5/2, sl. moist)	B: 121.6-122.1; 99bl.; 44bl.; B1K8B8
				·127' no silt ~45-50% basalt <10%	C: 121.1-121.6; 57bl.; 35bl.; B1K8B9
				vf-f ang. pebbles (~70% basalt). Normal	D: 120.6-121.1; ; 15bl.; B1K8C0
				grading from 124.5' down, changing to	Bulk: 120.6-123.1; B1K8H1
				gS @ ~127.5' bgs.	G.S. @ 125' bgs
130				127.5'-135': Gravelly Sand (gS)	G.S./P.S. @ 131' bgs
	G.S./P.S.			Same as above, with ~70% c-vc	Split-spoon 131'-133.6'
	Split Spoon ↓ Bulk	100% rec.		S & ~30% vf-f ang. pebbles	A: 132.5-133; 35bl.; B1K8C1
		209 blows		·129' small cobbles present (sparse)	B: 132-132.5; 64bl.; B1K8C2
		(20,31,64,		8-2-06	C: 131.5-132; 31bl.; B1K8C3
135	G.S.	35,59)		·130' pebble fraction dec. <10% (S).	D: 131-131.5; 20bl.; B1K8C4
				147.5 8/2/06	Bulk: 130.2-132.7'; B1K8H2
				135' → 147.5: Sand (S) Same as	G.S. @ 135' bgs
				above (127.5-135') w/ <10% G,	
				highly unconsolidated (hole caving in).	G.S. & P.S. (N/C) @ 140' bgs
140	G.S./P.S.			→ 144.5': v.fn. to v.cse S (80%	Split-Spoon Sample
	Split-Spoon Bulk	100% Rec.		v.fn. to fine / 20% cse to v.cse); inc.	from 139.7'-141.7' bgs.
		(164 Blows		in felsic cont. to 60 to 70% felsic,	A: 141.2-141.7'; 31Bl.; B1K8H3
		(8/18/29/		mod. consolidation, weathered/oxid.	B: 140.7-141.2'; 29Bl.; B1K8H4
		31/78)		w/ lt. yellowish brn to orange grains	C: 140.2-140.7'; 18Bl.; B1K8H5
145	G.S.			found in clumps, poor sorting,	D: 139.7-140.2'; 8 Bl.; B1K8H6
				overall coloring: lt. yellowish brown (2.5Y 5/4), No to v.wk. HCl 8/3/06	100% recovery, 164 Blows.
				Rxn except on clumps of weath/	Bulk "5-gal. Bucket" sample
				oxid. grains → mod. to Strong Rxn.	from 139.7-141.7' bgs.
				147.5 → 149.5': slightly silty Sand (mS)	HEIS # B1K8H7
150	G.S./P.S.			~85-90% vf. to md. S, ~80% felsic,	G.S. @ 145.5' bgs.
	Split-Spoon Bulk	100% Rec.		sub ang. ~10-15% silt. lt gray/brn	G.S. & P.S. (N/C) @ 150.5' bgs
		185 Blows		(5Y 5/2). Mod consolidation/well	Split-Spoon Sample
		(8/13/34/		sorted, mod. HCl Rxn.	from 150.1-152.1' bgs
		45/85)		149.5-154': Sand (S)	A: 151.6-152.1'; 45Bl.; B1K8H8
155	G.S.			>90% S: (v.fn. to v.cse) sub-	B: 151.1-151.6'; 34Bl.; B1K8H9
				ang. (~60 to 70% basalt). <10%	C: 150.6-151.1'; 13Bl.; B1K8J0
				G: v.fn to fn pebbles w/ v.sparse	D: 150.1-150.6'; 8Bl.; B1K8J1
				max size to 1/2" (md. pebbles). → P.6	100% Recovery, 185 Blows total.
					→ P.6

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

Title: Geologist | Title: Geologist

Signature: John Horner / [signature] 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: 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
160	GS/PS Split Spoon / Bulk	100% Rec. 210 Blows (6/15/30/48/102)
165	G.S.	
170	GS/PS Split Spoon ↓ / Bulk	~73% rec. 161 blows (8,19,20,47,67)
175	G.S.	
180	GS/PS Split-Spoon / Bulk	64% Rec. 244 Blows (8/26/81/56/73)
185	G.S.	~~%~~ (initials) 8/8/06
190	GS/PS Split Spoon / Bulk	95% Rec. 421 Blows (21/72/81/122/125)
195	G.S.	

Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)

cont'd from 149.5': mod. sorted, unconsolidated, dry, v. wk to no HCl Rxn.
→ @ 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% vfn to fn, 75% md. to v.cse.) otherwise same as 149.5 – 154'.

157 – 158': Silty Sand (mS) ~60% S, v.fn to md, 70 to 80% felsic w/ v. sparse cse to v.cse grains subang. ~35% silt lt. brn/~~gray~~ (2.5Y 7/2). <5% G (to fine pebble); v. dry & consolidated strong to v. strong HCl Rxn.

158 – 159.5: Sand (S) v. similar to mS from 157 – 158' w/out silt cont. (~5% silt)

159.5 – 160': Silt (m) ~95% m, non plastic, lt. brn/ ~~gray~~ (2.5Y 6/3), v. slight moisture, well sorted & highly consolidated w/ strong HCl Rxn. <5% vfn. S. 100% felsic.

160 – 166': Silty Sand (mS) (v. similar to mS from 157 – 158' w/ increased felsic content 80 + 85%, and no fn, max v.cse S.) → G.S. @ 165' bgs

166' – 187': Silty Sandy Gravel (msG) P. sort, unconsolidated, clast supported w/ >60% sub-rnd-rnd vf-vc pebbles (70% basalt) >30% vf-vc ang S (50% basalt, 50% felsic) + <20% lt gray silt (10YR 6.8/1, dry). Max = 5cm, strong HCl rxn.
·168' sparse cobbles up to 10cm

Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)

Cable-Tool drilling w/ hollow drive barrel.
Bulk "5-gal. Bucket" sample from 150.1 – 152.1' bgs HEIS# B1K8J2
G.S. @ 155' bgs.
G.S. & P.S (NCO) @ 160' bgs.
Split-Spoon sample from 159.5 – 161.5' bgs
A: 161'-161.5'; 48 Bl.; B1K853
B: 160.5'-161.'; 30 Bl.; B1K854
C: 160.'-160.5'; 15 Bl.; B1K855
D: 159.5'-160.'; 6 Bl.; B1K8L0
100% Recovery, 210 Blows total
Bulk "5-gal. Bucket" Sample from 159.5 – 161.5' bgs. HEIS# B1K8L1 (~~gray~~ initials 8/8/06)
G.S. @ 165' bgs
-168' adding H_2O to improve rec.
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; 8 bl.; B1K8L4; 95%
D: Ø% rec
Bucket: 170'-172.5; B1K8L6
G.S. @ 175' bgs
G.S. & P.S (NCO) @ 180.5' bgs.
Split-Spoon Sample from 180.1 – 182.1' bgs:
A: 181.6-182.1; 56 Bl., 80% R; B1K8L7
B: 181.1-181.6; 81 Bl., 100% R; B1K8L8
C: 180.6-181.1; 56 Bl. 75% R.; B1K8L9. (initials 8/8/06)
~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.

Reported By: N. Bowles / J. Horner | Reviewed By: L. D. Walker
Title: Geologist | Title: Geologist
Signature: [signature] / John Horner | Date: End 8-4-06 (~~8-3-06~~, initials 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 (25, 45, 55, 55, 80)		·174 silt fraction ≥10%, 30% S, 60% G	Cable-tool drilling w/
				·175 silt fraction 20%, 20% S, 60% G	hollow drive barrel
				large cobbles present max = 20cm	
				→179': silt down to ~10% to 15%.	Note: Began adding water
				→183': G size decreases to 10cm max (sm cobbles).	@~188.5' bgs.
205	G.S.			→187' G size increases to ~8" max	for cuttings retrieval.
				& silt down to ~5% ⇒ sG	
				187'–198': Sandy Gravel (sG)	G.S. & P.S (NCO) @ 190.' bgs
				~75% G, (~75% v.fn. to v.cse	Split-Spoon Sample
				pebbles, ~25% sm. to lg. cobbles	From 189.7–191.7' bgs
210	G.S./P.S. Split-Spoon	100% rec. 278 blows (4)61/63/65/58)		to max size ~8"), subrd. to	A: 191.2–191.7; 122Bl.; B1K8M2 90% R.
				sub ang., w/ sparse rd. cobbles;	B: 190.7–191.2; 81Bl.; B1K8M3 100% R.
				~60% basalt.	C: 190.2–190.7; 72Bl.; B1K8M4 100% R.
				~20% S (90% md. to cse.,	D: 189.7–190.2; 21Bl.; B1K8M5 90% R.
				<10% v. fn to fn.) sub ang. to	95% Rec., 421 Tot. Blows/4 shoes.
215	G.S.			ang., ~60% basalt	Bulk "5-gal. Bucket" Sample
				~5% silt. Overall: poorly	from 189.7–191.7' bgs,
				sorted, clast supported, w/	HEIS# B1K8M6
				v.wk. to mod HCl Rxn. (Moisture	split-spoon 199.7–202.2
				unknown due to added H2O w/ drilling,	lined: 199.7'–201.7'
220	G.S./P.S. Split-Spoon	100% Rec 464 Blows (39/112/118/146/49)		although, likely dry).	A: 201.2–201.7; 55 blows; 50%; B1K8M…
				·195 – : lg. cobbles & boulders	B: 200.7–201.2; 55 blows; 100%; B1K8M…
				max = 30cm	C: 200.2–200.7; 45 blows; 100%; B1K8M…
				·198' M fract. inc. to ~10%–15%	D: 199.7–200.2; 25 blows; 90%; B1K8 N…
				198'–206': Silty Sandy Gravel	Bulk: 200–202.5; [illegible] B1K8N1
225	G.S.			Same as above with up to 20% M	GS/P.S. @ 200' bgs
				lt. brownish gray (2.5Y 6/2, dry)	G.S. @ 204.5' bgs
				·204' 50%–60% vf–vc pebbles (no cobbles)	* Began adding H2O
				w/ 25% S (vf–vc) & 25% lt. brownish gray M.	@~206' (8/6/06).
	Bulk Sample			→@206' reduction in silt content <10%	G.S. & P.S (NCO) @ 210' bgs.
230	GS/P.S.			206' → : Sandy Gravel (sG)	Split-Spoon Sample from
				~75% lg. (~50% v.fn. to v.cse pebbles,	209.4–211.4' bgs
				~40% sm. to lg. subang/subrd. cobbles,	100% Rec., 278 tot. Blows
				<10% sub ang. to ang. (due to drilling)	A: 210.9–211.4; 65Bl., 100% R.; B1K8N2
				boulders (Basalt)) 60 to 70% Basalt	B: 210.4–210.9; 63Bl., 100% R.; B1K8N3
235	G.S.			Overall Po–G. (40%) Max = ~12".	C: 209.9–210.4; 61Bl., 100% R.; B1K8N4
				~20% md. to v. cse. Sand (w/ ~10%	D: 209.4–209.9; 31Bl., 100% R.; B1K8N5
				v.fine to fine). subang. & ang., ~60% basalt	F.) Bulk "5-gal. Bucket"
				<5% silt. overall, poorly sorted,	Sample from 209.4–211.4' bgs.
				clast supported. v. sim. to 187–198' w/ Boulders.	HEIS# B1K8N6

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

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

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 8/6/06 - Start; 8/10/06 - Finish

Well ID: C4997 | Well Name: Enty 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				(cont'd S/G from 206':	Cable-Tool drilling
	GS./P.S.	100% rec.		→ @ 208': Increase silt (m) to <10%.	w/ hollow drive barrel.
	SG/	274 BC		→ @ 212': Increase sand cont. to	G.S. @ 215.5' bgs.
	bulk	(94/156/		~40%, same general dist. & desc.,	G.S. & P.S (NCO) @ 220' bgs
		224/274)		Decrease Gravel cont. to ~50%,	Split-Spoon Sample from
				similar to above, silt @ <10%	219.6 → 221.6' bgs
245	G.S.			Also, No more boulders.	A: 221.1 - 221.6; 196Bl.; B1K8N7
				→ @ 214': Boulders return (v. sparse)	B: 220.6 - 221.1; 118Bl.; B1K8N8
				max size ~ 14"	C: 220.1 - 220.6; 112Bl.; B1K8N9
				→ @ 215': Significant decrease in	D: 219.6 - 220.1; 39Bl.; B1K8P0
250	GS/P.S. Split Spoon bulk	100% Rec. 499 Blows (78/119/126/137/39)		overall grain size: ~40% G, [illegible]	All liners 100%, 464 Blows Tot.
				(80% v.fine to v(se. pebbles, <20%	G.S. @ 225' bgs
				sm. to lg cobbles) ~50% S (80%	Drive barrel sample from
				(se to v(se, <20% v. fine to md),	228.2' - 230.2' bgs : B1K8P6
				<10% silt.	G.S. / P.S. @ 230' bgs
255	G.S.			·224' G fraction increased to ~60-70%	G.S. @ 234.5' bgs
				·230' G is >90% pebbles & 10% small cobbles	G.S. @ 240' bgs,
				·233' large cobbles are present (~10%)	P.S. @ 240' bgs.
				m-f S fraction increases (~60% felsic)	Split spoon from 240 - 242.5'
				grains are sl. oxidized. Dk grayish brn.	(BC = 274)(rec = 100%)
260	GS/P.S. Split Spoon	100% rec. 440 blows (30,75,100,100,135)		(2.5Y, 4/2) no HCl rxn. (70% G 30% S).	Drive barrel sample
				·235' M fraction inc. to ~10%	(242.5 - 243'), B1K8R1
				·240' (70% G, 25% S, 5% M). Gravel	G.S. @ 245' bgs.
				sub. rnd - ang., v. poor sort., basalt (trace	G.S & P.S. @ 250' bgs.
	@ 8-9-06			quartzite), dry, granule - mod. cobble (2-60 mm).	Split-Spoon Sample from
265				Sand f (80%) - crse (20%), sl. damp - dry.	250 - 252' bgs :
				70/30 maf/fel, well sort, 10YR 4/2 d. grayish brown,	A: 251.5 - 252; 157 Bl., B1K8R2
				Silt % low - trace, no HCl to test,	B: 251 - 251.5; 126 Bl., B1K8R3
				dry, loose.	C: 250.5 - 251; 115 Bl., B1K8R4
				·245' (65% G, 35% S). Gravel ang - sub. rnd,	D: 250 - 250.5; 78 Bl., B1K8R5
270	GS/P.S. Split-Spoon	100% rec. (18,48,66,73,124)		basalt, quartzite, quartz, v. poor sort, granule -	All 100% Rec., 495 Tot. Blows
				sm. cobble (2-30mm); Sand crse (50%) - v. crse	Bulk "5-gal. Bucket" Sample
				(50%), 90 maf/10 fel, mod. sort, 10YR 3/1 v.d. gray,	from 250 - 252' bgs; HEIS
				no rxn to HCl. [H2O ADDED FOR SPOIL RECOVERY]	# B1K8R6.
				·248' (65% G, 30% S, 5% M). silt	G.S. @ 255.5' bgs.
275	G.S.			matrix conglomerates observed - small &	G.S. & P.S. @ 260' bgs
				easy to break apart, silt % increases,	- added water @ 263' bgs
				wet due to H2O added earlier.	W.L. = 277.45' bgs (8/9/06)
		WL ▽		→ @ 253': silt content reduces <5%, from conglomerate,	8/9/06
				Sand to ~40%, Gravel to ~55%	Clast supported

A - B1K8P7
B - B1K8P8
C - B1K8P9
D - B1K8R0

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

Title: Geologist | Title: Geologist

Signature: [signatures] | Date: 8/10/06 | Signature: [signature] | Date: 8/23/06

A-6003-642 (03/03)

BOREHOLE LOG

Page 9 of 13
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 / Bulk	100% Rec 586 Blows (69/132/ 205/146/39)		·255.5' sG cont. w/ v. poorly sort., clast	Cable tool drilling w/
				supported & uncons. with 70% G; sub-rnd to	hollow drive barrel.
				well-rnd m-vc pebbles (60% basalt) ang-subang.	
	Trit.			vf-m pebbles (80% basalt) & 25% S: ang.	Split-Spoon: 259.7-262.2'
				vf-vc (vf-f is 60-70% felsic, m-vc is 60-70%	440 Total blows, A-D 100% rec.
285	G.S.			basalt), M is ~5%, dk grayish brn (2.5Y	A: 261.2-261.7; 100bl.; B1K8R7
				4/1.5, sl. moist), brown color is dominated by	B: 260.7-261.2; 100bl.; B1K8R8
				sl. oxid. finer grained felsics. Max = 6cm	C: 260.2-260.7; 75bl.; B1K8R9
				v. wk HCl rxn.	D: 259.7-260.2; 30bl.; B1K9D8
				·257-259' grad. inc. in vf-m S & M	Bulk sample: 260-262.5; B1K9D9
290				fraction. @ 259' 60% G (vf-c pebbles, 70% m	G.S./P.S. @ 270' bgs
	Trit / G.S. / P.S.	0% rec		30-35% S (60-70% m-vc w/ felsics (70%) & 30-40%	G.S. @ 265' bgs
	Split-Spoon	260 blows		m-vc mafic dom.) w/ 5-10% M	
		(56/49/59/55) 120		·266' weakly consolidated, many oxidized	*added ~3 gal. H2O @ 263' bgs
	Split-Spoon / Bulk			grains, clay/silt coating on pebbles. Not	@ 8-9-06
295		100% Rec		Natural moisture (sl. moist) present dk grayish brn (2.5	Split-Spoon: 269.4'-272' bgs
		225 Blows		Y 5/2). Avg pebble = 1cm. fine S has 2-3%	339 total blows, 100% rec. (A-D)
		(15/34/49/		pyrite ~70% qtz. Coarse pebbles (petrolithic	A: 270.9-271.4; 73bl; B1K9F0
		58/69)		crs. S & fn. pebbles ≥75% basalt	B: 270.4-270.9; 66bl; B1K9F1
	G.S.			·269' M fraction increases (>10% mod.)	C: 269.9-270.4; 48bl; B1K9F2
300	Trit / G.S.	90% Rec		·between 270 & 272' M fract. reduced to ≤10%	D: 269.4-269.9; 15bl; B1K9F3
	Split-Spoon / Bulk	159 Blows		→ @ 275' bgs: Showing signs of	Bulk: 270-272.5 bgs; B1K9F4
		(26/62/15		natural moisture, likely capillary	G.S. @ 275.5' bgs.
G.W. sample	Trit.	20/36)		Fringe above water table.	G.S., P.S. & Tritium Samples
				→ @ 279': cuttings are saturated	@ 280.0' bgs.
305	G.S.			→ @ 281.5': v. thin (<1.5") of silty	Split-Spoon Sample
				sandy Gravel (msG) containing	from ~280.0' → 282.0' bgs
				silty/clay stringers w/ ~~ ~~ (8/10/06)	100% Recovery, 586 Blows
				plasticity & lt. yellowish brn (2.5Y	A: 146 Bl.; B: 205 Bl.;
				(2.5Y 5/4), saturated/wet. (8/10/06)	C: 132 Bl.; D: 64 Bl.
310	GS/BS/Trit			→ @ 283' (282.5 – 283.5' bgs):	HEIS #s B1K9B8, B1K9B9
	Split-Spoon	97% rec. 416 blows (61, 24, 26, / 95, 241)		~1' of well sorted slightly silty Sand	B1K9C0, & B1K9C1.
				((m)S). ~15% silt, ~~ ~80%	Bulk "5-gal. Bucket" sample
	Trit.			med. to v. cse sand, sub ang. to (8/10/06)	from 280-282' bgs,
	G.S.			ang. ~60% felsic; <5% v. fn. to	HEIS # B1K9F5
315				fn. pebbles (G), sub-ang. to ang.	Tritium Sample @ 283' bgs.
	G.S.			Overall coloring is lt. brn. (8/10/06)	Ground water (G.W.) Samples
				(2.5Y 4/2), saturated/wet.	collected from 279.5' – 280.4' bgs
				·283'-286': heaving S w/ sparse (5-10%) pebbles	HEIS #s: B1K996 & B1K997.
				10% 15% of S is m-f (70% felsic)	G.S. @ 285' bgs (packed w/ drive barrel)

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

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 8-10-06 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)
			Not used (JB) 8/11/06	286'-288.5': Gravelly Sand (gS)	Cable tool drilling
				Unconsolidated, matrix supported & mod.-well	with hollow drive
				sorting w/ 80-90% ang S: 90% m-c (50% basalt	barrel
				50% felsic) & 10-20% pebbles: vc-f ang	
				70% basalt; m-vc well-rounded <40%	Trit./G.S./P.S. @ 291'
				basalt & <2% M. Max = 6cm, no HCl rxn	Split-spoon 291-293.5'
				S size & pebble fraction inc. w/ depth	260 Tot. blows Ø% rec.
				• 288.5' G fraction >30%	(rock plugged the s/s shoe)
				288.5'-319': Sandy Gravel (sG)	
				Same as above w/ >30% pebbles	Trit./G.S./P.S. @ 293' bgs
				• 292' G/S = 50/50 G (80% felsic, 20%	Split-Spoon Sample
				basalt) m (<5%) f-vc S, no m-vc S	From 292.6'-294.6' bgs
				(Note: Chip tray sample from 288.5' (NB 8/10/06)	100% Rec., 225 Blows Tot.
				bgs lost due to high wind gust at	A: 294.1-294.6'; 58 Bl., B1K9M8
				site overturning chip tray. All	B: 293.6-294.1'; 49 Bl., B1K9M9
				other samples recovered from	C: 293.1-293.6'; 34 Bl., B1K9NØ
				Pint jar samples (285, 290, 293, 295))	D: 292.6-293.1'; 15 Bl., B1K9N1
				→ @ 299 → 299.5' bgs: Silty Gravel (mG)	Bulk "5-gal. Bucket" Sample
				Isolated layer of mG, v. poorly	from 292.6 → 294.6' bgs
				sorted, clast supported w/ max	HEIS # B1K9N2
				G = ~4" (sm. cobble), sub rd. to	Tritium & G.S. @ 295' bgs.
				sub ang; ~60% G, ~35% silt;	G.S. @ 299-299.5' bgs.
				3 distinct types of silt: ① v. weathy	Trit./G.S./P.S. @ 300' bgs.
				oxid. reddish brn (10YR 4/4) w/ ~15%	Split Spoon from 300 to
				v. fn-md S mixed in, low plasticity	302' bgs. 90% Rec., 159 Blows Tot.
				② lt. yellowish brn (2.5Y 5/4) w/ <5%	A: 20 Blows, 50% Rec.; B: 15 Blows,
				v. fn sand, nonplastic. ③ lt. grey,	100% Rec.; C: 62 Blows, 100% Rec.;
				(GLEY 1 7/10Y), ~10% v. fn. S, low	D: 26 Blows, 100% Rec..
				plasticity. Return to SG below	HEIS #s: B1K9C6, 7, 8, 9 &
				299.5' bgs. Also, All silts: no HCl Rxn	Dups = B1K9C2, 3, 4, 5
				→ @ 300': increase in silt to	Bulk "5-gal. Bucket" Sample
				~10%. Ending @ ~300.5' bgs	from 300. -302' bgs,
				→ @ 305': Max G. to ~4" (sm.	HEIS # B1K9F6
				cobble). Sand cont. decrease	Tritium Sample @ 303' bgs
				to <10% ⇒ G (not sG),	G.W. Samples Collected
				Silt @ ~10%, G @ ~80%.	From 303.0' bgs (discrete)
				Return to SG @ ~306'	HEIS #s: B1K9BØ,
				• 308' ~70% G, 25% S, 5% M. Sand is	B1K9B1 & Dups: B1K9B2,
				segregated w/ 40% m-vc w/ 40% basalt & 60% (8-11-06)	B1K9B3
				well-sorted pockets of fn. felsic S (>90% felsic)	G.S. @ 305' bgs.

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

Title: Geologist | Title: Geologist

Signature: [signatures] Date: 8-10-06, 8/11/06 | Signature: [signature] Date: 8/23/06

A-6003-642 (03/03)

BOREHOLE LOG

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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)
320	G.S.			•310' sG cont. w/ no silt, 60-70% G (+ ang pebbles ~60% basalt; m-vc pebbles & sm. cobbles ~40% basalt) 30-40% m-vc S (40-50% basalt)	Cable tool drilling w/ hollow drive barrel
				•316' improved sorting w/ 70% well-sorted f-vc pebbles (>60% c-vc) w/ 30-40% basalt throughout: 30% vf-vc S: 50% vf-m felsic (70%) & 50% m-vc with only 30-40% basalt. Color Δ's f/ dk. gray (2.5Y, 4/1) @ 314' to grayish brn / lt. olive brn (2.5Y, 5/2.5) @ 316' bgs.	G.S./RS./Trit. @ 309.5' bgs; Split-spoon 310.5-313.1 (416 blows); A: 312-312.5; 95 bl.; B1K9N3; B: 311.5-312; 36 bl.; B1K9N4; C: 311-311.5; 24 bl.; B1K9N5; D: 310.5-311; 11 bl.; B1K9N6; D-90% rec. A-C 100% rec.
325	G.S.			•318' chroma decreases to 1.5 (lt. gray brn)	Bulk: 310.5-313: B1K9N7
330	G.S.			319'-358': Ringold Unit A sG Well-sorted (bimodal), clast supported cons. with >75% G: m-vc (≤50% vc) sub-well rounded pebbles (heterolithic, ≤20% basalt abundant qtzite) & ≤25% S: f-m (>80% m) sub-ang. lt. olive brn. (2.5Y, 6.25/4) >90% felsic. Max= 5cm, no HCl rxn.	Tritium sample @ 313' bgs; G.S. @ 314' bgs; G.S. @ 316.5' bgs; G.S. @ 319.5' bgs
335	G.S./RS/Trit.; Split-Spoon	680 blows (59, 56, 115, 160, 290)		•320' well consolidated w/ increase in silt fraction (>5%)	Switch to "Hard-Tool" drilling @ 320' bgs.
340	G.S.	8/15/06		→*@ 327.5-328: thin zone of easier drilling (drillstring dropped ~6" quickly). •339' small clumps of matrix (2-4cm) in bulk sample show no change. The sample was collected by drive barrel on 4th attempt & was mixed. Bulk color is grayish brn (2.5Y, 5/1.5) undisturbed clumps are still lt. ol. brn.	G.S. @ 326' (320'-326'); G.S. @ 331' (326-331'); G.S./RS./Trit. @ 335' bgs; Split-spoon 336.8-338.8' (339.2 w/ shoe) ~680 blows; *Could not open ss sampler. taken/scooped out from bottom. B1K9D0, B1K9D1, B1K9D2 (A,B,C); (Bulk) Bucket: B1K9F7: 337-339'
345	G.S.			→ @ 335-341: Hard tool cuttings prim. Sand (>95%) ⇒ not representative of formation in this zone, v. thin mud (watery) ⇒ v. low silt content.	Split spoon (B1K5B4; B1K9B5); *Note: Mark on cable indicated GS/Trit/RS. @ 335. Tag on bottom = 336.8' bgs.
350	G.S./Trit; Bulk in Sample Trit.			→ @ 341-346: Cont. w/ SG. Inc. in silt content to ~5% (+/-) mud thickening slightly & cuttings suspending more.	HEIS #s for work sample w/ open-hole 334.5'-339' bgs
355	G.S.			• Drilling rate increased to ~1ft/5min from 356'-341' bgs	W.L. = 278.0' bgs on 8/15/06; G.S. @ 341' (335-341' bgs); G.S. @ 346' (341-346' bgs).
				•351-352.5' very similar to sample @ 339' bgs with small cobbles present Max = 10 cm	G.S./Trit. @ 351 (346-351')

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

Title: Geologist | Title: Geologist

Signature: [signature] / [signature] Date: 8-16-06 | 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, 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				(Cont'd SG from 319'):	Hard-tool drilling w/
	G.S.			→ @ 358 → 361': Inc. in Sand &	Cable tool rig
				Silt cont. ⇒	
				358' → 383.': silty sandy Gravel (msG)	Bulk/drive barrel sample
				Same as above w/ silt content	@ 351'-352.5' bgs
365				increased to ~15%. Sand to	(poor recovery, matrix
	Trit G.S.	50% Rec.		~45%. (Hard-Tool drilling mud	is likely underrepresented)
	Split-Spoon	(145 Blows)		thickening significantly).	HEIS # B1K9F8
		(39/35/71)		→ @ 361 → 366': Sand cont. decrease	P.S. @ 351-352.5 (drive barrel)
G.W. Sample				to 25%. Silt inc. to 20% (much	Trit @ 353' bgs (bailer)
370				thicker mud developing.).	G.S. @ 358' (353'-358')
				→ @ ... 8/17/06	G.S. @ 361' (358'-361')
	G.S./Trit				G.S. & Trit. (NOD) @
					366' (361'-366').
					Split-Spoon sample from
375					365.6'-367.1' bgs.
					50% Rec., 145 Blows
					(39/35/71) HEIS #s:
					B1KC05, B1KC06,
				→ @ 380-385: Increased basalt	B1KC07, B1KC08.
380	G.S. Trit			cont. w/ weathered flow top	Bulk "5-gal. Bucket" Sample
	Bulk	P.S.		vesicular fragment ⇒ Top of	from 365.6 → 367.6' bgs
				Basalt likely @ 383' bgs	1/2 full, HEIS # B1K868
				(casing refusal @ 383.3' bgs)	P.S. from 365.6-367.6' bgs.
					Ground-water (G.W.) sample
385	G.S. Trit.			383' → 401': Basalt, vesicular,	from 364.5' bgs to
				likely weathered to 391' bgs	367.6' bgs. HEIS #s:
				(upper 8'), unweathered	B1K873, B1K874.
				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 380-382' 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] / [signature] Date: 8-18-06 end	Signature: [signature] Date: 8/23/06

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 8-18-06 sht

Well ID: C4997 | Well Name: Entry Bh #3 | Location: WTP Seismic Boreholes #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	↓			Basalt: 383' - 401' bgs	Hard rock drilling with cable tool rig.
				Total Entry Borehole Depth = 401' bgs	
					Ca.S. @ 401' bgs (380' - 401')
405					
410					
415					
420					
425					
430					
435					

Reported By: J. Harmer
Title: Geologist
Signature: [signature] Date: 8-6-06 End

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

A-6003-642 (03/03)

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