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Revision 0

Borehole Summary Report for the Installation of Three Groundwater Wells in the 200-BP-5 Operable Unit, FY 2007

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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200-BP-5

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Document Type: RPT Program/Project: SGW

J. Fetters
Freestone Environmental Services, Inc.

Date Published
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APPROVAL PAGE

Title: Borehole Summary Report for the Installation of Three Groundwater Wells in the 200-BP-5 Operable Unit, FY 2007

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ACRONYMS

bgs	below ground surface
CCu	Cold Creek unit
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CSS	Colorado silica sand
FH	Fluor Hanford, Inc.
OD	outside diameter
OU	operable unit
RI/FS	remedial investigation/feasibility study
TD	total depth
WAC	*Washington Administrative Code*

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METRIC CONVERSION CHART

Into Metric Units		
If You Know	*Multiply By*	*To Get*
Length		
inches	25.4	millimeters
inches	2.54	Centimeters
feet	0.305	Meters
yards	0.914	Meters
miles	1.609	Kilometers
Area		
sq. inches	6.452	sq. centimeters
sq. feet	0.093	sq. meters
sq. yards	0.0836	sq. meters
sq. miles	2.6	sq. kilometers
Acres	0.405	Hectares
Mass (weight)		
Ounces	28.35	Grams
Pounds	0.454	Kilograms
Ton	0.907	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

This report presents field generated records and summarizes field activities during the drilling and construction of three wells, 299-E33-50 (C5195), 699-48-50B (C5196), and 699-50-56 (C5197). These wells will serve as groundwater monitoring wells for the 200-BP-5 groundwater Operable Unit (OU) to support 200-BP-5 OU Remedial Investigation/Feasibility Study (RI/FS). One well (C5195) was completed in the Rattlesnake Ridge interbed confined aquifer and is located in the north-central portion of the 200 East Area of the Hanford Site. Two wells (C5196 and C5197) were completed in the suprabasalt unconfined aquifer and are located in the 600 Area, directly north of the 200 East Area. During drilling activities, soil and groundwater samples were collected with the following objectives:

- Characterize soil and groundwater to support the 200-BP-5 OU RI/FS in accordance with *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA).
- Identify contaminants that may affect waste disposition.
- Confirm the well design (e.g., sieve analysis of aquifer sediments within the screened intervals will be performed).

Figure 1-1 presents the locations of the three monitoring wells included in this report along with key features of the area. A summary of the new wells is provided in Table 1-1.

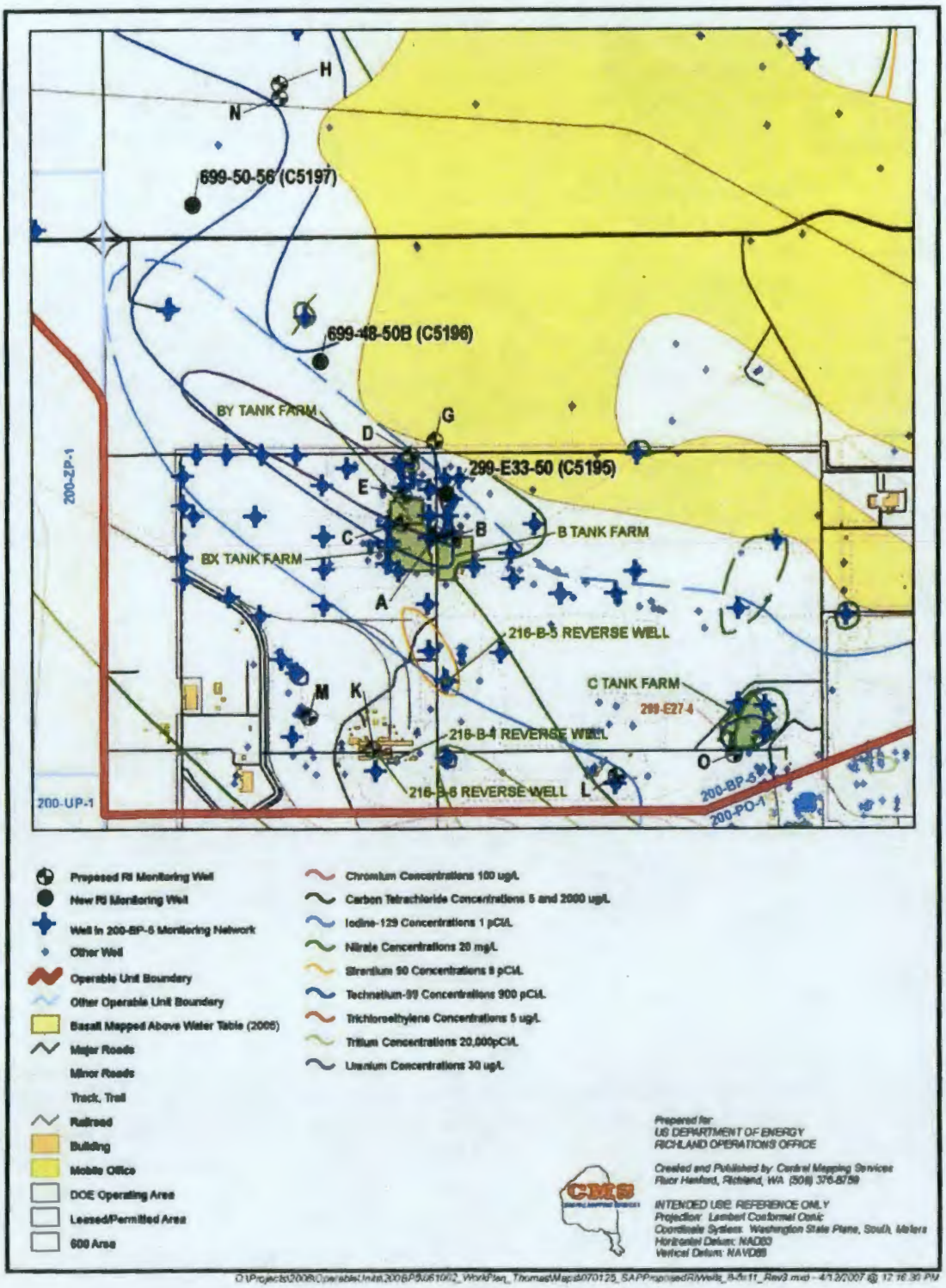
Table 1-1. Well Identification Numbers, Purpose, and Location.

Well ID	C5195	C5196	C5197
Well Name	299-E33-50	699-48-50B	699-50-56
Purpose of well	Confined Aquifer monitoring well	Unconfined Aquifer Monitoring Well	Unconfined Aquifer Monitoring Well
General Location	Within 200 East Area, near B/BX/BY Tank Farms	North of 200 East Area	North of 200 East Area (north side of Route 11A)

1.1 PURPOSE AND SCOPE

The purpose of this document is to compile and archive records, observations, and measurements associated with the drilling and construction of the three wells. This borehole summary report includes the field notes and forms prepared during the drilling and construction of the wells, well construction details, and well development data. Additional information described in the report includes subsurface geologic descriptions for each well, civil survey results, management of drilling-derived waste, and well acceptance. All drilling data are recorded in the English units in which they were measured. Well location data and drilling dates for the three wells is given in Table 5-1

Figure 1-1. Locations of New, Existing and Proposed Wells Associated with the 200-BP-5 Operable Unit Remedial Investigation.



The purpose for each well is summarized in the *Sampling and Analysis Plan for FY 2006 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study* (DOE/RL-2006-55) as follows:

- Well C5195 was installed south of well 299-E33-12 and will serve as a monitoring well for the confined aquifer within the Rattlesnake Ridge interbed. This well will establish if contamination measured in well 299-E33-12 is from an up gradient source or is traveling vertically downward through a faulty annular seal.

- Well C5196 was installed north of well 299-E33-26 and south of well 699-49-55A to resolve source unit origin of observed uranium groundwater contamination, to provide northern definition for the uranium plume, and to provide an additional measure of the basalt surface.

- Well C5197 was installed between wells 699-49-55A and 699-52-57 to resolve technetium-99 concentrations in the plume in this area so that concentration isopleths can be better defined. This well also helped to better define the location of an erosional channel in the basalt that may be a conduit for potential groundwater flow to the north.

The document supporting the well drilling and construction is the *Description of Work for Fiscal Year 2006 Installation of Three Wells 299-E33-50, 699-48-50B, and 699-50-56 at the 200-BP-5 Groundwater Operable Unit* (WMP-30726).

1.2 BACKGROUND

Beginning in the early 1940s and continuing for nearly five decades, large volumes of radioactive waste and non-radioactive dangerous wastes were stored and disposed of in various waste facilities located within the 200-BP-5 OU. Also, large volumes of process water were infiltrated utilizing cribs, trenches, and ponds. Liquid waste discharges to the vadose zone resulted in significant groundwater recharge which raised the water table and increased groundwater flow rates to the north and the southeast.

In 1989, the Hanford Site was listed on the National Priorities List pursuant to CERCLA, including the 200 East Area. To address CERCLA groundwater issues in the 200 East Area, the 200-BP-5 and 200-PO-1 groundwater OUs were established, which together cover the entire 200 East Area as well as land north, south and east. The 200-BP-5 OU includes groundwater generally (but perhaps not entirely) having a northward component of flow.

A number of documents describe historical waste disposal and impacts to the vadose zone and groundwater in the vicinity of 200-BP-5 OU. These documents were extensively reviewed during the 200-BP-5 OU RI/FS data quality objectives process. Pertinent information obtained during these reviews is summarized in the *Data Quality Objectives Summary Report in Support of the 200-BP-5 Groundwater Operable Unit Remedial Investigation/Feasibility Study Process* (WMP-28945). Approximately 92 existing monitoring wells comprise the 200-BP-5 OU groundwater monitoring network. Fifteen new groundwater wells were proposed to support the

200-BP-5 OU RI/FS. Wells C5195, C5196, and C5197 are the first of these 15 wells to be installed.

2.0 DRILLING, SAMPLING AND WELL CONSTRUCTION ACTIVITIES

This section summarizes the drilling, sampling and well construction activities associated with wells 299-E33-50 (C5195), 699-48-50B (C5196), and 699-50-56 (C5197). Well drilling, sampling and construction details common to all three wells are summarized in Section 2.1. Well-specific information is summarized in Section 2.2.

2.1 GENERAL INFORMATION

The following summarizes activities and information common to the three wells. The wells were constructed to Washington State standards detailed in *Washington Administrative Code* (WAC) 173-160 ("Minimum Standards for Construction and Maintenance of Wells"). Well construction activities were recorded and borehole geology was logged in accordance with Fluor Hanford, Inc. (FH) procedures: GRP-EE-02-14.1, "Drilling, Remediating, and Decommissioning Resource Protection Wells, and Geotechnical Soil Borings"; and GRP-EE-01-7.0 "Geologic Logging."

- **Drilling** – The boreholes were drilled using a cable tool drill rig and both drive barrel and hard tool methods. Wells C5196 and C5197 were drilled using 8.625-in. outside diameter (OD) by 8-in. inside diameter threaded casing to the total depth (TD) of each borehole. Well C5195 utilized 10.75-in. OD by 10-in. inside diameter welded casing to 234 ft below ground surface (bgs) and 8.625-in. OD by 8-in. inside diameter threaded casing from 234 ft bgs to the TD of 381 ft bgs. The reduction in casing size was required to properly seal and prevent intercommunication of the unconfined aquifer with the deeper Rattlesnake Ridge interbed confined aquifer. All temporary casing was removed during well construction.

- **Archive Lithologic Sampling** – Grab samples were collected from the drill cuttings of each well for geologic description and sample archive requirements. The samples were collected at 5-ft intervals and recognizable changes in lithology. Each archive sample was placed in a labeled pint jar and the sequential chip tray compartment. The jars and chip trays were delivered to the geologic sample archive storage building managed by Pacific Northwest National Laboratory. Digital photographs of each archive sample were taken in the field and used to construct a photographic log for each well. Borehole geologic logs and photographic logs for each well are presented in Appendices A through C.

- **Split-spoon sampling** – Split-spoon samples were collected from each of the three boreholes at predetermined depths and intervals. These samples are intended to support various chemical and physical soil analyses in support of the 200-BP-5 OU RI. These samples were collected using a 4-in. diameter split-spoon sampler containing four 6-in. long Lexan liners. The length of the split-spoon sampler is 2.5 ft (including shoe). The split-spoon was driven 2.5 ft or until refusal. Split-spoons used for chemical analysis were decontaminated prior to sample collection. See Section 2.2 for specific split-spoon

sample depths for each well. Split-spoon sample depths and *Hanford Environmental Information System* (HEIS) sample ID numbers are presented in Appendices A through C.

- **One-quart jar sampling** – Quart-size grab samples were collected at predetermined depths in addition to archive grab samples. Quart-sized grab samples are intended to support various geochemical and physical soil analyses in the development of modeling parameters for the 200-BP-5 OU RI/FS. Quart jar sampling depths and HEIS sample ID numbers are presented in Appendices A through C.

- **Geophysical Logging** – Each borehole was logged using S.M. Stoller Corporation's spectral gamma logging system and neutron moisture logging system. Gamma log data is useful in showing changes related to grain size, mineralogical makeup, and moisture content of the sediments encountered. The neutron moisture log can reveal moisture relationships between unit boundaries and grain size, assuming that fine grained sediments retain higher moisture content than coarse grained sediments. Because logging methods are limited to one string of casing, logging was conducted prior to sizing down temporary casing at well C5195 and again after TD was reached. Results of geophysical logging are presented in Appendices A through C.

- **Radiological Field Screening** – The drilling of each hole was classified as a low risk activity based on previous drilling and sampling activities. Based on this classification, morning and afternoon radiological surveys were conducted during drilling. A radiological control technician performed the radiological surveys using standard radiological field screening instruments. No radiological field measurements above background levels were reported.

- **Air Monitoring for Volatile Organic Chemicals** – Air quality monitoring was performed twice daily (morning and afternoon) to verify that the drillers' breathing zone remained free of volatile organic contamination. The breathing zone near the wellhead, the fresh drill cuttings, and geologic samples were surveyed for volatile organics using field-screening photoionization detector. No field measurements above background levels were reported by the industrial hygiene technician during the well drilling activities.

- **Well Construction Materials** – Each well was constructed using 4-in. nominal diameter, Type 304L stainless steel schedule 10 threaded casing. A Type 304L stainless steel continuous wire wrap well screen was utilized at each well. Screen size (slot size) and length varied depending on conditions in the interval to be screened. Each well screen was equipped with either a 3 ft long sump consisting of 4-in. diameter stainless steel casing with a stainless steel bottom cap or a 4-in. stainless steel bottom cap welded to the screen. Specific well construction materials are summarized in Section 2.2

- **Filter Pack and Backfill** – The primary filter pack surrounding the screen for each well consists of 20-40 (C5195) or 10-20 (C5196 and 5197) mesh Colorado silica sand (CSS). Specific well construction materials are summarized in Section 2.2

- **Annular Seal** - The annular seal for wells C5196 and C5197 consists of 0.25-in. bentonite pellets placed directly above the primary sand pack. The annular surface seal consisted of granular bentonite crumbles to approximately 10 ft bgs and Portland cement grout directly above the granular bentonite to ground surface. See Section 2.2.1.3 for specific details for the annular seal for well C5195.

- **Surface Completion** – The above ground stickup of the 4-in. diameter permanent casing is protected by 6-in. nominal diameter stainless steel casing embedded into a 6-in. thick, 4 ft by 4 ft concrete pad placed around the well. The wellhead is protected by 4-in. diameter by 3 ft tall steel posts at each corner of the cement pad.

2.2 WELL-SPECIFIC INFORMATION

This section summarizes the activities and information specific to each well location, such as sample depths, geologic observations and other unique well-specific activities.

2.2.1 Well 299-E33-50 (C5195)

Well 299-E33-50 (C5195) is located in the 200 East Area approximately 300 ft north of B Tank Farm and 50 ft east of Baltimore Street, at the coordinates and elevation presented in Table 5-1.

2.2.1.1 Drilling. Drilling of well 299-E33-50 was initiated on December 28, 2006 utilizing a cable-tool drill rig. Temporary 10.75-in. OD welded casing was advanced to the surface of the uppermost basalt surface (Elephant Mountain Basalt Member) located at 233.6 ft bgs using drive barrel methods. Drive-barrel drilling through the unsaturated zone was completed without the aid of drilling fluid. A nominal amount of water (approximately 2.5 gallons) was used to quench the top of the packer that was placed during welding to prevent welding slag from entering the borehole. The added water volume was removed within the first 2 or 3 ft of drilling after welding, thereby not impacting sampling results. Groundwater in the unconfined aquifer was first encountered at approximately 225 ft bgs on January 15, 2007.

Once the basalt surface was reached, a 10-in. tungsten carbide button bit was utilized to advance the borehole through the basalt to the surface of the Rattlesnake Ridge Interbed at 316.5 ft bgs.

Because well 299-E33-50 is intended to serve as a monitoring well for the confined aquifer within the Rattle Snake Ridge Interbed, it was imperative that a competent annular seal be placed across the Elephant Mountain Member basalt during drilling and in the final well construction. The annular seal was necessary to prevent intercommunication between the unconfined and the confined aquifers. Initially, sealing off the uppermost aquifer during drilling proved to be difficult for a couple of reasons:

- The temporary 10.75-in. casing was only advanced approximately 6-in. into the surface of the basalt which was less than ideal for setting a seal sufficient to prevent unconfined aquifer groundwater from leaking around the bottom of the casing shoe.

- The uppermost basalt appeared to be fractured with an apparent fracture zone (based on comments from driller) at approximately 240 ft bgs.

Initial attempts to seal off the uppermost aquifer with bentonite failed. This lead to a decision to advance the borehole 47 ft into the basalt (to 281 ft bgs) and place a cement/bentonite grout mixture into the borehole to a level approximately 12 ft above the bottom of the 10.75-in. casing. It was hopeful that placing cement to 281 ft would effectively seal off the upper fracture zones and also provide a robust seal around the casing shoe. The cement/bentonite grout was allowed to cure for 72 hours, at which time it was completely drilled out to 288.5 ft bgs with a 10-in. OD button bit. Drilling out the cement/bentonite grout seal (59-ft thick) was completed in approximately two hours. Water measurements collected shortly after drilling out the seal on February 9, 2007 indicated that water was still entering the borehole. When drilling resumed, February 13, 2007, quartz rich material was observed in the basalt cuttings suggesting that water was entering the borehole around the casing shoe. A downhole camera was lowered into the borehole to visually determine the source of water entering the borehole. Upon visual inspection, water could be seen cascading into the borehole from under the shoe and from fractures in the upper portion of the basalt. Due to the failure of the initial cement/bentonite grout seal, a decision was made to pressure grout the borehole.

The borehole was advanced to 299 ft bgs, at which time neat cement was pressure grouted into the borehole with the aid of a packer from 299 ft to 217 ft bgs on February 16, 2007. The grout plant reached a maximum pressure of 17 psi. Neat cement was allowed to cure for 72 hours, at which time it was re-drilled with a 10-in. OD button bit. The neat cement grout seal cured much harder than the pervious seal. Redrilling of the second seal took approximately 2 days to complete. While drilling out the cured grout, periodic water levels measurements were collected to verify that groundwater was not entering the borehole. Once it was determined that the neat cement grout seal had sufficiently sealed the upper portion of the basalt and unconfined aquifer, the borehole was advanced to the contact between the Elephant Mountain Basalt and the Rattlesnake Ridge Interbed at 316.5 ft bgs. One drive barrel sample of interbed sediments was collected to confirm the interbed contact. Five, 5-gallon buckets of 0.375-in. coated bentonite pellets were then added to the bottom of the borehole to seal off the penetration into the interbed and approximately 200 gallons of bentonite slurry was placed from the top of the bentonite pellets to above the original static water level of 225 ft bgs. Once the bentonite plug and bentonite slurry were set, the borehole was ready for setting the temporary 8-in. casing.

A 7-in. hard tool was used to advance the temporary 8-in. casing through the Rattlesnake Ridge Interbed, to the Pomona Basalt encountered at a depth of 375.5 ft bgs. Drilling reached a TD of 381 ft bgs (5.5 into the Pomona Basalt) on March 8, 2007.

2.2.1.2 Sampling. Continuous split-spoon samples were collected from six intervals within the unsaturated zone including; 0 to 6 ft bgs, 60 to 85 ft bgs, 105 to 120 ft bgs, 160 to 170 ft bgs, 185 to 195 ft bgs, and 217.5 to 227.5 ft bgs. Samples collected in the first two intervals (0 to 6 ft bgs and 60 to 85 ft bgs) were collected every 2 ft and the in the remaining four intervals, sample collection occurred every 2.5 ft. Split-spoon intervals were chosen to align with low permeability zones using stratigraphic information from nearby wells. Of the 36 samples

collected, five samples were analyzed for physical properties. The remaining unused samples were retained for potential future analysis.

A total of three split-spoon samples were collected from within the Rattlesnake Ridge interbed Split-spoon samples were collected at three intervals; 1.5 to 4 ft, 24.5 to 27 ft, and 50 to 52.2 ft below the upper Elephant Mountain Member basalt and Rattlesnake Ridge interbed contact. The intervals were chosen to align with higher permeability zones based on nearby well log information from well 299-E33-12. The split-spoons were equipped with four, 6-in. long Lexan liners to allow segregation of the split-spoon sample after collection. The split-spoon sample liners were capped, taped, and labeled according to internal FH procedures

Quart sized grab samples were collected every 2.5 ft beginning at 60 ft to 277 ft bgs. Of the 67 samples collected, 28 were analyzed for Tier 1 contaminant transport model development. The remaining samples were retained for possible analysis in the future.

Groundwater samples were collected using a submersible 5 HP pump. One groundwater sample was collected in the unconfined aquifer and three in the confined aquifer. Water samples collection depths in the confined aquifer roughly corresponded with split-spoon sample depths, with samples being collected at the top, middle, and bottom of the interbed. Due to the silt/clay nature of the interbed, samples were collected where the borehole could produce the most water. Samples in the confined aquifer were collected with approximately 5 ft of open hole.

Sampling depths and associated HEIS sample ID numbers are included in Appendix A.

2.2.1.3 Well Construction

Well completion information for well 299-E33-50 (C5195) is summarized in Table 2-1.

Table 2-1. Well Construction Summary. (2 sheets)

Well Construction Materials	Well Name / ID		
	299-E33-50 / C5195	699-48-50 / C5196	699-50-56 / C5197
Total Depth Drilled (ft bgs)	381	215.2	164.1
Water Level (ft bgs)	224.64 (3-26-07)	208.14 (11-29-06)	151.39 (12-11-06)
Permanent 4-in. Diameter screen and casing			
Top of Screen (ft bgs)	316.1	204.2	151.2
Bottom of Screen (ft bgs)	331.1	214.5	161.2
Screen Length (ft)	15	10.3	10
Screen Size	10 (0.010")	20 (0.020")	20 (.020")
Sump (ft)	3	NA	2.9
Top of Casing (ft ags)	2	2.1	1.9
Top of 6-in. protective casing	3	2.1	2.37
Annular Seal			
Surface Seal (ft bgs)	0-10.0	0-10.7	0-10.0
Granular Bentonite Seal (ft bgs)	10.0-219.1	10.7-193.9	10.0-137.9

Table 2-1. Well Construction Summary. (2 sheets)

Well Construction Materials	Well Name / ID		
	299-E33-50 / C5195	699-48-50 / C5196	699-50-56 / C5197
3/8-in. Bentonite Pellet Seal (ft bgs)	219.1-229.9	NA	NA
Portland Cement seal (ft bgs)	229.9-307.5	NA	NA
3/8-in. Bentonite Pellet Seal (ft bgs)	307.5-309.6	193.9-199.6	137.9-143.1
Primary Filter Pack			
Primary Filter Pack	309.6-336.6 (20-40 CSS)	199.9-215.2 (10-20 CSS)	143.9-164.5 (10-20 CSS)
Over Drilled Portion Fill			
3/8-in. Bentonite Pellet Seal (ft bgs)	336.6-343.7	NA	NA
Fill	343.7-364.2	NA	NA
3/8-in. Bentonite Pellet Seal (ft bgs)	364.2-381.0	NA	NA

Notes:
ags = above ground surface
bgs = below ground surface
CSS = Colorado silica sand
NA = not applicable

The 3 ft stainless steel sump was placed from 334.1 to 331.1 ft bgs and a 15 ft 10-slot screen was placed 331.6 to 316.1 ft bgs. The 4-inch OD permanent casing was placed from 316.1 ft bgs to 2 ft above ground surface. A 6-in. diameter stainless steel protective casing was placed to 3 ft above ground surface.

The over-drilled portion of the borehole was filled with 0.375-in. coated bentonite pellets from 381 ft to 364.2 ft bgs and 10-20 mesh CSS from 364.2 to 343.7 ft bgs. A 0.375-in. coated bentonite pellet seal was placed from 343.7 to 336.6 ft bgs. The primary filter pack (20-40 CSS) was placed from 336.6 to 309.6 ft bgs. Above the primary filter pack a 0.375-in. coated bentonite pellet seal was placed 309.6 to 307.5 ft bgs. Portland cement was placed through the Elephant Mountain Basalt from 307.5 to 229.9 ft bgs. Coated bentonite pellets were placed directly above the Portland cement from 229.9 to 219.1 ft bgs. Granular bentonite was placed from 219.1 to 10 ft bgs. The surface seal is comprised of Portland cement from 10 ft bgs to ground surface.

Following well construction, well development was performed with a 5 HP submersible pump over a two day period. The pump intake was set in the lower portion of the screen at approximately 326 ft bgs. Development was completed on March 29, 2007. Well development was performed in accordance with GRP-EE-01-6.3 ("Well Development and Testing").

2.2.2 Well 699-48-50B (C5196)

Well 699-48-50B (C5196) is located approximately 900 ft north of the 200 East Area fence line near the intersection of Route 4 and 12. Surveyed coordinates and elevation are presented in Table 5-1

2.2.2.1 Drilling. Drilling of well 699-48-50B was initiated on October 25, 2006 using drive barrel methods to advance the borehole to the surface of the Elephant Mountain Basalt (209.5 ft bgs) by drive barrel method. The borehole was advanced to the total drill depth of 215.2 ft bgs (5.7 ft into the top of the basalt) on November 15, 2006, utilizing a 7-in. OD hard tool. Drilling through the unsaturated zone was performed without the aid of drilling fluid (water).

Saturated soils were first encountered approximately 207 ft bgs on November 2, 2006. The water level was first measured at 207.96 ft bgs on November 14, 2006.

2.2.2.2 Sampling. Split-spoon samples were collected from within the unsaturated and saturated zones of well C5196. A total of four split-spoon samples were attempted, though only three obtained sample recovery: the final split-spoon attempt encountered basalt therefore no sample recovery was achieved. The two samples collected from within the unsaturated zone were from 193.5 to 196 ft bgs and 198.5 to 201 ft bgs. These samples were analyzed for physical parameters. One sample was collected with in the saturated zone from 207 to 209.4 ft bgs. This sample was analyzed for various target contaminants, and selected physical parameters (particle-size distribution, bulk density, and moisture content).

Quart-sized grab samples were collected from the unsaturated zone every 2.5 ft starting at 186 ft bgs to the basalt surface. Selected samples were analyzed for constituents and soil properties for use in contaminant transport model development. Remaining samples were retained by Pacific Northwest National Laboratory for possible future analysis.

Groundwater samples at well C5196 were collected after the well was completed due to the shallow aquifer. Once the well was completed, a variable speed pump was utilized for collection of groundwater samples. The pump intake was set at 211.93 ft bgs and the flow rate was set at approximately 1 gpm.

Sampling depths and associated HEIS sample ID numbers are included in Appendix B.

2.2.2.3 Well Construction. A summary of the well completion for well 699-48-50B (C5196) is described in Table 2-1.

A 10-ft 20-slot screen with bottom cap was placed from 214.5 to 204.2 ft bgs and the 4-inch OD permanent casing from 204.2 ft bgs 2.1 ft above ground surface. The typical 3 ft sump design was not used for well C5196 due to the shallow aquifer. The 6-in. diameter stainless steel protective casing was placed 2.1 ft above ground surface.

The primary filter pack (10-20 CSS) was placed from 215.4 to 199.6 ft bgs. A 0.25-in. bentonite pellet seal was placed from 199.6 to 193.9 ft bgs. Directly above the pellet seal, granular bentonite was placed from 193.9 to 10.7 ft bgs. A surface seal composed of Portland cement was placed from 10.7 ft bgs to ground surface.

Well development was performed following construction of the well with the pump set at 156.5 ft bgs and 81.8 ft bgs. Well development was completed on September 13, 2006 and was

performed in accordance with GRP-EE-01-6.3. Results of the well development are summarized in Section 4.0.

2.2.3 Well 699-50-56 (C5197)

Well 699-50-56 (C5197) is located approximately 0.5 mi. east of Route 4 and 200 yards north of Route 11, at the coordinates and elevation presented in Table 5-1.

2.2.3.1 Drilling. Drilling was initiated on October 15, 2007 drive barrel methods to advance the borehole to the top of the Elephant Mountain Basalt at 161 ft bgs. Drilling through the unsaturated zone was performed without the aid of drilling fluid (water). The borehole was advanced to the total drill depth of 164.5 ft bgs (3.1 ft into the top of the Basalt) on November 30, 2006, utilizing a 7-in. hard tool. Groundwater was first encountered approximately 151.20 ft bgs on November 21, 2006.

2.2.3.2 Sampling. Three split-spoon samples were collected in the saturated zone over the interval 151 to 158.5 ft bgs. Three split-spoon sample attempts were necessary at the first sample interval (151 to 153.5 ft bgs) in order to obtain sufficient sample volume. Of the three split-spoon samples collected, one sample was analyzed for physical parameters and the others analyzed for constituents and soil properties for use in contaminant transport model development. The remaining sample material was retained for possible future analysis.

Quart-sized grab samples were collected every 2.5 ft over the interval 131 ft to the 151 ft bgs (groundwater surface). Of the eight quart-sized samples collected, three were analyzed for constituents and soil properties for use in contaminant transport model development. The remaining unused samples were retained for possible future analysis.

One groundwater sample was collected once the basalt surface was reached. A variable speed submersible pump was utilized for the sample collection. The groundwater sample was collected with the pump intake set at 159 ft bgs and no open borehole.

Sampling depths and associated HEIS sample ID numbers are included in Appendix C.

2.2.3.3 Well Construction. Well completion information for well 699-50-56 (C5197) is summarized in Table 2-1.

A 3 ft sump was placed from 164.1 to 161.2 ft bgs. The 10 ft 20 slot screen was placed from 161.4 to 151.2 ft bgs with the 4-in. OD permanent casing placed from 151.2 ft bgs to 1.9 ft above ground surface. A 6-in. diameter stainless steel protective casing was placed to 3.37 ft above ground surface.

The primary filter pack (10-20 CSS) was placed from 164.5.4 to 143.1 ft bgs. A 0.25-in. bentonite pellet seal was placed from 143.1 to 137.9 ft bgs. Directly above the pellet seal, granular bentonite was placed from 137.9 to 10 ft bgs. A surface seal composed of Portland cement was placed from 10 ft bgs to ground surface.

Following construction of the well C5197, well development was performed with the pump placed in the middle of the screen interval at 158.8 ft bgs. Well development was completed on December 15, 2006. Well development was performed in accordance with GRP-EE-01-6.3.

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3.0 GEOLOGY OF 200-BP-5 OPERABLE UNIT

The following section summarizes the general geology in the area surrounding the three new monitoring wells.

3.1 STRATIGRAPHIC SETTING

The stratigraphy of this portion of the 200-BP-5 OU consists of unconsolidated sedimentary deposits that overlie the older Columbia River Basalt Group flood basalts and associated sedimentary interbeds. The principal stratigraphic units of the Hanford Site including the two uppermost basalt flows, from youngest to oldest, are:

- Holocene surficial deposits (fill and eolian deposits)
- Hanford formation
- Cold Creek unit (CCU)
- Ringold Formation
- Elephant Mountain Member basalt (Columbia River Basalt Group)
- Rattlesnake Ridge interbed (Ellensburg formation)
- Pomona Member basalt (Columbia River Basalt Group)

All these stratigraphic units except the Ringold Formation were present at the three borehole locations. Holocene deposits of the Hanford Site typically include eolian (windblown) sands as well as construction backfill which typically consist of poorly sorted gravelly sands or sandy gravels of local Hanford formation origin. Although excavation backfill material can be substantial beneath the tank farms (locally up to 32 ft beneath the B/BX/BY Tank Farms), this disruption did not appear to extend deeper than 5 ft bgs at any of the three subject well sites.

The Hanford formation is the result of sediment deposition associated with glaciofluvial sediments deposited by cataclysmic floods from glacial Lake Missoula, pluvial Lake Bonneville, and other ice-margin dammed lakes (PNNL-13024, *RCRA Groundwater Monitoring Plan for Single-Shell Tank Waste Management Area C at the Hanford Site*). The Hanford formation is divided into three facies: (1) gravel-dominated facies, (2) sand dominated facies, and (3) silt-dominated facies (WHC-SD-EN-TI-012, *Geologic Setting of the200 East Area: An Update*). In the area of Waste Management Area B/BX/BY, the Hanford formation has been subdivided into an upper gravelly unit (H1), a sand-dominated unit (H2), and a lower gravel-dominated unit (H3) (RPP-23748, *Geology, Hydrogeology, Geochemistry, and Mineralogy Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*). These units are described below (listed youngest to oldest):

- H1: The upper gravel-dominated Hanford formation H1 unit consists of mostly sandy gravel to silty sandy gravel, with lesser amounts of gravelly sand. Thin (0.5 ft) silt layers are locally present within this sequence. The gravels are multi-lithologic but generally contain a high percentage of basalt. The finer fraction has been described as mostly very coarse to coarse sand with as much as 5% to 7% silt. The samples generally display no cementation or obvious sedimentary structure.

- H2: The sand-dominated Hanford formation H2 unit consists of a sand-dominated sequence. The H2 unit is predominantly poorly to well-sorted, medium- to coarse-grained sand with some silt layers (HNF-5507, *Subsurface Conditions Description of the B-BX-BY Waste Management Area*). The upper portion of the H2 unit has generally larger-grain size and has occasional matrix-supported pebbles in a coarse sand matrix. With depth, the medium to coarse sand becomes more frequently interstratified with layers of fine- to medium-grained sand. Distinctive is the "salt and pepper" appearance of the sand imparted by the approximately equal concentrations of dark-colored basalt and light-colored quartz and feldspar.

- H3: The lower gravel-dominated Hanford formation H3 unit is an open-framework gravel to interstratified gravel and sand with local silt and/or clay horizons. The H3 unit overlies basalt bedrock or the CCU and/or the Ringold Formation in the OU. Where the H3 unit directly overlies gravels of the CCU, the contact between these units can be difficult to distinguish and is therefore described as Hanford formation lower gravel/CCU undifferentiated (RPP-23748).

The CCU or the Hanford formation lower gravel/CCU undifferentiated (RPP-23748) sediments underlie the Hanford formation in the vicinity of the three new wells. The CCU represents sediments deposited between the late Pliocene and early Pleistocene.

The CCU has been described to include up to two separate facies. A sequence of sandy gravel to gravelly sand occurs beneath a thick (approximately 30 ft) silt-dominated facies. These two facies are found directly above the top of upper-most basalt unit or directly above the Ringold Formation. The gravel sequence represents either cataclysmic flood deposits or ancestral Columbia River deposits. It is thought that the silt rich facies may represent over bank flood plain alluvium from the ancestral Columbia River or eolian loess (HNF-5507). Where the silt unit is absent, the gravel sequence is indistinguishable from similar-appearing facies of the overlying Hanford formation H3 unit described below, and it is referred to as the Hanford formation lower gravel/CCU undifferentiated or "H3/CCU undifferentiated" (HNF-5507). The two uppermost members of the Miocene Saddle Mountain Basalts, the Elephant Mountain Member basalt and the Pomona Member basalt, and the intervening Rattlesnake Ridge interbed. All three units were encountered during the drilling of C5195.

The Elephant Mountain Member of the Columbia River Basalt Group is composed of two basalt flows and is the uppermost basalt unit beneath the 200-BP-5 OU. The Elephant Mountain Member has a total thickness of approximately 66 to 82 ft in the 200 East Area.

The Rattlesnake Ridge interbed is a sedimentary unit (part of the Ellensburg Formation) which overlies the Pomona Member and underlies the Elephant Mountain Member basalt. This unit is composed of fine tuffaceous sands, silts, and clays. The Rattlesnake Ridge interbed consists primarily of air-fall and fluvially reworked fine-grained siliciclastic material, as well as micaceous-arkosic sands derived from the Rocky Mountain terrain (RHO 1978, *Geology of Gable Mountain – Gable Butte Area*).

The Pomona Member is the older (lower) of the two basalt units encountered during drilling and consists of a single basalt flow. It is one of the most extensive of the Saddle Mountain Basalts, ranging in thickness from 164 to 197 ft.

3.2 BOREHOLE GEOLOGY

This section describes the general geologic characteristics observed during the drilling of boreholes for wells 299-E33-50 (C5195), 699-48-50B (C5196), and 699-50-56 (C5197). Geologic logs were prepared in accordance with FH procedure GRP-EE-01-7.0 and are included in Appendix A through C.

3.2.1 Borehole 299-E33-50 (C5195)

All five major stratigraphic units were encountered while drilling borehole C5195; Hanford formation, CCU, Elephant Mountain Member basalt, Rattlesnake Ridge interbed, and the Pomona Member basalt. The top of the Elephant Mountain Member basalt was reached at 233.6 ft bgs and the unit has an apparent thickness here of 83 ft. The Rattlesnake Ridge interbed was encountered from 316.5 ft to 375.5 ft bgs for an apparent thickness of 59 ft. The vadose zone at C5195 is approximately 225-ft thick and the unconfined aquifer is approximately 8.6-ft thick.

3.2.1.1 Hanford formation, H1 and H2). The two upper facies of the Hanford formation (H1 and H2) were identified. The H1 unit at C5195 is a silty gravel identified from 4 to 15 ft bgs. The H2 unit is predominately a sand unit which was identified from 11 to 187.5 ft bgs with two distinct 1-ft thick silt layers present at 63 to 64 ft bgs and 164 to 165 ft bgs.

3.2.1.2 Undifferentiated Hanford formation, H3/Cold Creek Unit. The undifferentiated Hanford formation/CCU consisted of silty to sandy gravels found from 187.5 to 233.6 ft bgs (the top surface of the Elephant Mountain Basalt). According to HNF-5507, there are two facies of the Hanford formation/CCU mapped in the area of C5195. At this borehole, however, the upper fine-grained silt dominated facies appears to be absent. Where this silt layer is missing, the lower sandy gravel dominated layer of the CCU can generally not be distinguished from the similar appearing lower gravel-dominated Hanford formation H3 unit.

3.2.1.3 Elephant Mountain Basalt Member. The Elephant Mountain Member basalt is the uppermost basalt member in the project area. At borehole C5195, this basalt was encountered from 233.6 to 316.5 ft bgs and has an apparent thickness of 82.9 ft. Cuttings in the upper portion of the flow show abundant red/reddish brown oxidized surfaces and vesicles. Cuttings from the bottom of this unit showed reddish-brown surfaces indicating the flow bottom is either fractured or brecciated.

3.2.1.4 Rattlesnake Ridge Interbed. The Rattlesnake Ridge interbed was encountered from 316.5 to 375.5 ft bgs, showing an apparent thickness of 59 ft. The upper portions of the interbed sediments (316.5 to 320.0 ft bgs) are dark greenish gray with small veins of yellowish clay present. Samples exhibit a slight glassy appearance indicating that sediments were baked by the

overlying basalt flow. Sand is medium to fine, mostly fine. The sand grains in the samples were approximately 30% basalt and 70% felsic. Angularity of the sand grains was sub angular to angular. Silt is brown to yellowish brown. The interbed sediments exhibited no reaction with hydrochloric acid.

3.2.1.5 Pomona Basalt Member. The Pomona Member basalt was encountered from 375.5 to TD at 381 ft bgs on March 8, 2007. The borehole was advanced 5.5 ft into the upper portion of the flow. Cuttings surfaces were oxidized, possibly indicating a brecciated nature of the flow top. Vesicles were present in the basalt cuttings.

More detailed descriptions of C5195 findings are included in the borehole and photographic logs presented in Appendix A.

3.2.2 Borehole 699-48-50B (C5196)

Three stratigraphic units are encountered in borehole 699-48-50B; the Hanford formation, CCU, and the Elephant Mountain Member basalt. The Hanford H1 was encountered from 5 to 42 ft bgs. The Hanford H2 sand dominated unit was encountered from 45 to 190 ft bgs. The top of the Elephant Mountain Member basalt was encountered at 209.5 ft bgs on November 2, 2006. The vadose zone in this area is approximately 208-ft thick and the unconfined aquifer is approximately 1.5-ft thick, however, there is disagreement about whether this water is groundwater or water added during drilling. Zones of increased moisture were noted in silty horizons in the lower vadose zone.

3.2.2.1 Hanford formation (H1 and H2). The two upper facies of the Hanford formation (H1 and H2) were identified at borehole C5196. The H1 unit at this borehole is composed of silty sandy gravel to sandy gravel identified from ground surface to 45 ft bgs. The H1 unit shows no cementation and weak or no reaction to hydrochloric acid. The H2 unit is a "salt and pepper" sand dominated unit identified from 45 to 195 ft bgs. Three silt layers were encountered in the H2 unit at the following depths: 53 to 54, 135 to 137, and 140 to 144 ft bgs. The silt layers are compacted, brown to dark grayish brown and react strongly with hydrochloric acid.

3.2.2.2 Undifferentiated Hanford formation/Cold Creek unit. The sediments encountered near the bottom of C5196 resemble those of the CCU found in borehole C5197, though each facies (i.e., silt dominated and gravel dominated) are thinner. Although sediments appear similar, they could not be differentiated from upper Hanford formation.

The undifferentiated Hanford formation/CCU is found form 195 ft to the surface of the Elephant Mountain Basalt (209.5 ft bgs) and made up of a 12-ft thick silt layer and a 2.5-ft thick sandy gravel layer. Silt in this unit ranges from olive brown to dark bluish gray and reacts strongly with hydrochloric acid. Sandy gravel directly underlies the silt.

3.2.2.3 Elephant Mountain Basalt. The top surface of the Elephant Mountain Member basalt was encountered at a depth of 209.5 ft bgs at C5196. Drilling was terminated 5.6 ft into the basalt at 215.2 ft bgs.

More detailed descriptions of C5196 findings are included in the borehole and photographic logs presented in Appendix B.

3.2.3 Borehole 699-50-56 (C5197)

Three stratigraphic units were encountered in borehole 699-50-56; Hanford formation, the CCU, and the Elephant Mountain Member basalt. The top of the Elephant Mountain Basalt was reached at a depth of 161 ft bgs. The vadose zone in this area is approximately 151.2-ft thick and the unconfined aquifer is approximately 9.8-ft thick. Zones of increased moisture were noted at depths of approximately 104 to 132 ft bgs and were associated with silt-rich sediments. The H3 unit appears to be missing at C5197.

3.2.3.1 Hanford formation (H1 and H2). The upper two facies of the Hanford formation (H1 and H2) were identified at borehole C5197. The H1 unit consists of silty sandy gravel to sandy gravel from 3 to 48 ft bgs. This unit shows no cementation and a weak to no reaction with hydrochloric acid. The predominantly sand dominated unit, H2, was identified from 48 to 103 ft bgs. This unit is composed of gravelly sand to sand with one silt layer found from 71 to 74 ft bgs. This unit shows no cementation and a variable reaction to hydrochloric acid (stronger reactions occur in finer grained sediments).

3.2.3.2 Cold Creek Unit. The two facies of the CCU were encountered in borehole 699-50-56, an upper thick silt rich facies and a lower sandy gravel facies. The approximately 32-ft thick, silt rich interval is found between 103 and 135 ft bgs and can be divided in to two beds. The upper portion (103 to 123 ft bgs) consists of brownish gray to grayish brown silt and fine to very fine sands that react strongly with hydrochloric acid.

The lower portion of silt facies (123 to 135 ft bgs) contains no sand and is dense in nature. The sediment color varies dramatically from olive brown (123 to 125 ft bgs and 132 to 135 ft bgs) to dark greenish gray (125 to 132 ft bgs). Orange to red mottling is present in this lower portion, helping to support this unit as a possible buried paleosol. Reaction to hydrochloric acid is very weak to weak.

The lower sandy gravel facies of the CCU is found from 135 ft bgs to the surface of the Elephant Mountain basalt at 161 ft bgs. This facies is distinguishable from the lower Hanford H3 unit due to the above silt layer and is predominantly sandy gravel. This unit shows no cementation and a very weak to no reaction with hydrochloric acid.

3.2.3.3 Elephant Mountain Basalt. The Elephant Mountain Member basalt is the uppermost basalt member in the project area. At borehole C5197, this basalt was encountered at 161 ft bgs. Drilling was terminated 3.1 ft into the basalt at 164.1 ft bgs.

More detailed descriptions of C5197 findings are included in the borehole and photographic logs presented in Appendix C.

3.3 HYDROGEOLOGY

The vadose zone in the project location is composed of a thin layer backfill material and unconsolidated sands and gravels of the Hanford formation. The unconfined aquifer beneath the project area is also contained within the Hanford formation sediments directly overlying the upper-most basalt unit. The unconfined aquifer thickness in the vicinity of well C5195 is about 8.5 ft, less than 1.5 ft at C5196, and approximately 9.5 ft at well C5197.

The uppermost confined aquifer is contained within the Rattlesnake Ridge interbed was the target aquifer for well C5195. The static water level of the confined aquifer is approximately 0.5 ft higher than that of the unconfined aquifer.

4.0 WELL DEVELOPMENT

Each of the three wells was developed by surging within the well screen after exposing the sand-packed screen. After well and wellhead completion work was finalized, a temporary 5 HP submersible pump was placed in each well and pumped until physical water quality parameters (conductivity, pH and temperature) stabilized and turbidity declined to less than 5 nephelometric turbidity unit. During these development pumping tests, the water level in the pumping well was monitored using a pressure transducer. Plots of drawdown and recovery data for each of these tests are included in Appendices A through C. A summary of the final field water quality data is summarized in Table 4-1.

Table 4-1. Well Development Data Summary.

Well Name/ Well ID	Static Water Level (ft bgs)	Date	Intake Depth (ft bgs)	Pumping Duration (minutes)	Final Turbidity (NTU)	Final Conductivity (µS/cm)	Final Temp (°C)	Average Flow Rate (gpm)	Final Drawdown (ft)	Total Gallons Pumped
299-E33-50 /C5195	224.92	3/28/07 3/29/07	325.59 326.34	123 159	2.15	0.440 0.281	23.4 21.1	4.8 3.0	40.2 >41.0	1067
699-48-50B /C5196	207.98	12/4/06	211.93	617	1.4	0.555	16.3	1.25	2.70	690
699-50-56 /C5197	154.35	12/15/06	161.2	60	2.13	0.620	15.8	11.5	0.09	690

Notes:
bgs = below ground surface
L = lower
U = upper
NTU = nephelometric turbidity unit

5.0 CIVIL SURVEY

The well locations were surveyed in accordance with GRP-EE-01-1.6 ("Survey Requirements and Techniques"). Vertical survey data were recorded using *North American Vertical Datum of 1988* (NAVD88) and the horizontal coordinates were recorded using the Washington State Plane (South Zone) *North American Datum of 1983* (NAD83), with the 1991 adjustment for horizontal coordinates. Surveyed locations of the boreholes are presented in Table 5-1 and the reports are located in Appendices A through C.

Table 5-1. Well Location Summary.

Well Name	Well ID	Washington State Ecology ID	Drilling Dates		Northing[a] (m)	Easting[a] (m)	Ground Surface Elevation[b] (Brass Cap) (m)	Total Depth (ft bgs)
			Start	Finish				
299-E33-50	C5195		12/28/06	3/29/07	137599.30	573773.61	190.742	381.0
699-48-50B	C5196		10/25/06	12/5/06	138044.28	573334.48	185.562	215.2
699-50-56	C5197		10/15/06	12-15-06	138841.55	572748.21	168.178	164.1

Notes:

[a] Northing and easting coordinates are based on Washington State Plane Coordinates North American Datum of 1983 (NAD83) rounded to 1 m.

[b] North American Vertical Datum of 1988 (NAVD88) values rounded to 0.001 m.

bgs = below ground surface.

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6.0 WASTE MANAGEMENT

Waste generated during drilling and construction of the three monitoring wells was managed using the strategy documented in the *Waste Control Plan for the 200-BP-5 Operable Unit, DOE/RL-2003-30, Rev. 1.* Wastes include drill cuttings, purgewater, decontamination waste, and miscellaneous waste. The interim action waste management plan established the requirements for managing and disposing waste associated with the interim actions as stipulated in the 1996 interim remedial action Record of Decision (EPA et al. 1996, *Declaration of the Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units at the Hanford Site [Interim Remedial Actions]*) and the 1999 Record of Decision amendment (EPA et al. 1999, *U.S. Department of Energy Hanford Site – 100 Area Benton County, Washington Amended Record of Decision Summary and Responsiveness Summary [100-HR-3 Operable Unit]*). A data quality objective summary report (WMP-28945) was prepared to define waste characterization and disposal requirements using historical analytical data and process knowledge.

6.1 VADOSE ZONE CUTTINGS

With the exception of well C5195, all drill cuttings (i.e., soils) from above the historically high water table (197 ft bgs at well C5196 and 144 ft bgs at well C5197) were stockpiled on plastic sheeting near the point of generation. Since field radiological and chemical vapor surveying did not detect any contamination during the drilling operation, all drill cuttings were later spread on the ground near the well after well completion. Drill cuttings from well C5195 were contained in 55-gallon drums starting at ground surface due to its proximity to soil contamination area 200-E-121.

6.2 SATURATED ZONE CUTTINGS

All drill cuttings and purgewater were contained in 55-gallon drums once the historically high water table was encountered. Free liquids from the contained soil slurries were decanted by pumping to a purge water truck and managed as purgewater (Section 6.3). As a result of the field radiological and chemical vapor surveys not detecting contamination during drilling, the drummed drill cuttings were determined to be compliant with data quality objective requirements (WMP-28945). All drummed drill cuttings (after decanting) were returned to the ground near the point of generation.

6.3 PURGEWATER

Purgewater was generated during the drilling below the water table and during the well construction activities. All purgewater was contained on site in a purgewater truck and at the completion of the well construction activities, was transported to the Purgewater Storage and Treatment Facility. Specific waste storage, handling, and transport requirements were documented in the Waste Packaging/Labeling Instruction Sheet. Purgewater management was performed at the direction of FH.

7.0 WELL ACCEPTANCE

Well acceptance is the final step in the well construction process and represents confirmation of meeting requirements of the work scope. Well acceptance also serves as the contractual completion of the finished product.

The acceptance process involved representatives from the drilling contractor (Blue Star Enterprises North West), FH and Freestone Environmental Services, Inc. conducting a detailed inspection of the well site and a review of the well drilling and completion documentation. Final well acceptance was documented by completion of a checklist and signatures from representatives of the drilling contractor and FH.

The walk down for all wells, C5196 and C5197 was conducted on January 2, 2007 and April 19, 2007 for well C5195. Representatives from FH, Blue Star Enterprises North West and Freestone Environmental Services, Inc. were in attendance for the walk down each well. Surveillance QA-SURV-GRP-SURV-05-245 was issued documenting the acceptance of these three wells.

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8.0 REFERENCES

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APPENDIX A

WELL DOCUMENTATION FOR 299-E33-50 (C5195)

Borehole Log

Photographic Log

Well Summary Sheet

Well Construction Summary Report

Well Development and Testing Data

Well Survey

Sample Depths and HEIS #s

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BOREHOLE LOG

Page 1 of 10
Date: 12/28/06

Well ID: C5195
Well Name: ~~299-E33-34~~ 299-E33-50
Location: 100 yd N of Tank Farm 50' East Centerline st
Project: 200-BP-5 RI/FS
Reference Measuring Point: Ground

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 Rig 134
0		split spoon		2' Sand(s): F, A, 80% Qtz, 20% basalt, moist, no Rxn HCl, 2.5y 4/3 olive brown	10 3/4" welded casing. Drive Barrel Method
2	grab	split spoon		4' - Silty Gravel (mG) 50% gvl 40% silt 10% sand. gvl: 8cm-2mm (sc-VFP) 50% Qtz 50% basalt, R-SR	0-2' S/S HCl S#5 B1LWY8 B1LV27, B1LWY8-MB, B1LX01(FB)
4	grab	split spoon		Sand: VC-VF, A, 50% Qtz, 50% basalt, A; Silt: moist (slightly) 10YR 5/3, brown, str Rxn HCl	2-4' S/S HCl S#3 B1LX02(FB) B1LWY6, B1LWY9-MB, B1LWY9
5					
6	grab			6' - Same lithology as above w/ slight increase in gravel	4-6' S/S HCl S#3; B1LX03, B1LX00 B1LX00-MB, B1LWY7
8				10' - Silty Gravel (mG) 60% gvl 20% sand 20% Silt; gvl: 10cm-2mm (sc-VFP), R-SR, 50% basalt, 50% Qtz; vc-VF, 50% Qtz 50% basalt, A; Silt: Dry, 10YR 5/2 grayish brown, mod Rxn HCl.	6' - gvls up to 15cm
10	grab				
11	grab			11' - Silty Sand (ms) 50% sand 50% silt; Sand: 60% Qtz, 40% basalt, A, vc-VF; Silt: Slightly moist, str Rxn HCl, 10YR 5/2 grayish brown	
15	grab			15' Sand (s) 90% Qtz 10% basalt, m-F, A, slightly moist, 10YR 5/2 grayish brown, wk Rxn HCl	15' noticable Mica content
20	grab			20' - Slightly Silty Sand (ms) 80% sand 20% silt; Sand: 90% Qtz 10% basalt, A-SA, vc-VF; Silt: Slightly Moist, 10YR 6/3, Pale brown, mod Rxn HCl	
23	grab			23' Sand (s) moist 2.5y 5/3 lt olive brown 90% Qtz 10% basalt, str Rxn HCl	
25	grab			25' Sand (s) vc-VF 60% Qtz 40% basalt, A-SA, moist, 2.5Y 4/2, Dk grayish brown mod Rxn HCl	26' Decreasing moisture
30	grab			30' Sand (s) 90% sand 10% gvl; gvl < 1cm (mP-VFP) "pea sized" A-SA, basalt, sand; slightly moist, 10YR 5/2 grayish brown, vc-VF, 60% Qtz, 40% basalt, A, v str Rxn HCl	
35	grab			35' - Sand (s) vc-VF, 60% Qtz 40% basalt A, Slightly moist, mod Rxn HCl, 10YR 5/2 grayish brown	

Reported By: Jeff Fetters
Title: geologist
Signature: Jeff Fetters
Date: 12/28/06

Reviewed By: L.D. Walker
Title: Geologist
Signature: L.D. Walker
Date: 4/11/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 10
Date: 1/2/06

Well ID: C5195
Well Name: ~~299-E33-224~~ 299-E33-50
Location: 100 yds W of Tank Farm, 50' East Baltimore St
Project: 200-BP-5 C/IS
Reference Measuring Point: ground

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	grab				Cable Tool, 10 3/4"
				40' Same lithology as above	Casing, Drive barrel
				44' Sand decreasing in grain size	
45	grab			45' Sand (s) C-VF, 80% qtz 20% basalt, A, Slightly Moist, str Rxn HCl, 10YR 5/2 grayish Brown	
50	grab			50' Sand (s) 90% snd 10% gvl: lcm-2mm (mp-VFP), 90% basalt, 10% qtz, SA-SR Snd: VC-VF 70% qtz 30% basalt, A, Slightly Moist, 10YR 5/2 grayish brown, wk Rxn HCl	53' basalt gravels not Present
55	grab			55' Sand (s) 70% qtz 30% basalt, VC-F, A, Slightly Moist, 10YR 4/2 Dk grayish brown, Mod Rxn HCl	
59	grab			59' Sand (s) VF 80% qtz 20% Basalt, A, Slightly Moist, 10YR 5/3 brown, str Rxn HCl.	60-62' S/S # B1L9T6
60	grab	S/S		60' Same lithology as above	60' Quart grab # B1L9F1
62	grab			63' Silt (m), Moist 10YR 4/3 brown, str Rxn HCl	62-64' S/S # B1L9T7
63	grab	S/S		64' Sand (s), VC-VF, A, 60% qtz 40% basalt Moist, 10YR 4/2 Dk grayish brown, Mod Rxn HCl	62' Quart # B1L9F2
64	grab			65' Gravelly sand (gs) 80% snd 20% gvl: gvl: lcm-2mm (mp-VFP) 50% basalt 50% qtz SA-SR, Snd: C-F, 70% qtz 30% basalt, A, Moist, 10YR 4/2 Dk grayish brown, Mod Rxn HCl	64-66' S/S # B1L9T8
65	grab	S/S		70' Same lithology as above	64' Quart grab # B1L9F3
66	grab			74' Sand (s) 90% snd 10% gvl: gvl: 5mm-2mm (FP-VFP) 90% basalt 10% qtz, A-SA; Snd: VC-F, 60% qtz 40% basalt, A, Moist, 10YR 4/2 Dk grayish brown, Mod Rxn HCl	66-68 S/S # B1L9T9
		S/S			66' Quart grab # B1L9F4
68	grab				68-70' S/S # B1L9V0
		S/S			68' Quart grab # B1L9F5
70	grab				70-72' S/S # B1L9V1
		S/S			70' Quart grab # B1L9F6
72	grab				72-74' S/S # B1L9V2
		S/S			72' Quart grab # B1L9F7
74	grab				74-76' S/S He's # B1L9V3
75	grab	S/S			74' Quart grab # B1L9F8
76	grab				76-78' S/S # B1L9V4
		S/S			76' Quart grab # B1L9F9
78	grab				78-80 S/S # B1LX26
		S/S			78' Quart grab # B1LX27

Reported By: Jeff Fetters
Title: geologist
Signature: [signature] Date: 1/4/06

Reviewed By: L. D. Walker
Title: Geologist
Signature: [signature] Date: 4/11/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 10
Date: 1/9/06 07 sm

Well ID: C5195
Well Name: ~~299-E50-224~~ 299-E33-50
Location: 100 yd N of B Tank Farm, 50' E Baltimore St.
Project: 200-BP5 ?/?
Reference Measuring Point: ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
80	grab	S/S		80' sand (s) c-F, 60% qtz, 40% basalt,	80-82' S/S # BILX28
		S/S		Slightly Moist, 10YR 4/2 DK grayish brown,	80' quart grab # BILX29
				A, Med Rxn HCl	82.5-85 S/S # BIL9V5,
82.5	grab				BILBK7 (Dup)
		S/S			82.5' quart grab # BIL9H
				85' Silty sand (mS) 80% sand 20% silt; sand	84' sand becoming
85	grab			VC-VF, A, 90% qtz 70% basalt; silt: Dry,	Finer grained
				2.5y 5/1 gray, str Rxn HCl	85' quart grab # BIL9H1
87.5	grab				87.5' grab # BIL9H0
					90' grab # BIL9H3
				90' Silty sand (mS) 60% sand 40% silt; sand	
90	grab			C-VF, 60% qtz 40% basalt, A; silt: slightly	
				moist, 2.5Y 6/2 lt brownish gray, str	
92.5	grab			Rxn HCl	92.5 grab # BIL9H4
				92' sand (s) same lithology as above	
95	grab			10% silt content, 10YR 5/2 grayish	95 grab # BIL9H5
				brown, Med Rxn HCl	
				95' same lithology as above w/ ↑	
97.5				F-VF sand content	97.5 grab # BIL9H6
				98' sand (s) 60% qtz 40% basalt, c-F,	
100	grab			Moist, vwk Rxn HCl, 10YR 4/2, DK	100' grab # BIL9H7
101	grab			grayish brown, A	101' fine sand
				101' sand (s) 70% qtz 30% basalt, vc-VF,	102' grab # BIL9H8
102.5	grab			Slightly Moist, 10YR 5/2 grayish brown,	
103	grab			Med Rxn HCl, A, <5% basalt pebbles	
				103' gravelly sand (gS) 90% sand 10% gvl: gvl:	105-107.5 S/S # BIL9V6
105	grab			80% basalt 20% qtz, 1cm-2mm (mp-VFP) A,	105' grab # BIL9H9
		S/S		Sand: vc-m, A, 70% qtz 30% basalt, Slightly	107.5-110' S/S # BIL9V7
107.5	grab			Moist, 10YR 4/2 DK grayish brown, vwk	107.5' grab # BIL9J0
		S/S		Rxn HCl	110-112.5' S/S # BIL9V8
				105' (sand) (s) vc-VF, slightly moist 2.5y	110' grab # BIL9J1
110	grab			5/2 grayish brown, wk Rxn HCl, 70%	
		S/S		qtz 30% basalt	112.5-115 S/S # BIL9V9
112	grab			110' sand (s) - as above	112.5 grab # BIL9J2
112.5	grab				
		S/S			
115	grab				
		S/S		115' sand (s) - 95% sand, 5% silt, trace	115' grab # BIL9J3
				gravel - sand vfs-vcs, predom. MS-CS -	115-117.5 S/S # BIL9W0
		S/S		2.5Y 5/2 grayish brown, no rxn HCl, dry	

Reported By: Jeff Fetters / Steve Airhart
Title: geologist / Geologist
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Date: 1-8-07

Reviewed By: L.D. Walker
Title: Geologist
Signature: [signature]
Date: 4/11/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 4 of 10
Date: 1-8-07

Well ID: C5195
Well Name: ~~299-E30-224~~ 299-E33-50
Location: 100yd N Bleak Farm, 50' East Baltimore St.
Project: 200-BP-5 RI/FS
Reference Measuring Point: Ground Surface

Depth (FL)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120	S/S			120' Sand (s) - as above, note	117.5' grab # BIL9J4
	GRAB			occasional silt nodule. Also note	117.5-120' SS # BIL9W1
				$CaCO_3$-rich stringers - 1-2", compacted.	
	GRAB				120' grab # BIL9J5
				125' Sand (s) - as above, weak rxn	122.5' grab # BIL9J6
125	GRAB			HCl, dry.	125' grab # BIL9J7
					127.5' grab # BIL9J8
				~~127~~ 127.5' Sand as above - see FRR	130.0' grab # BIL9J9
	GRAB			re: > soil moisture (not representative)	
				130' Sand (s) - as above, slight > HCl	
130	GRAB			rxn - weak-to-moderate, dry.	
				132.5' Sand (s) - as above - slight >	
	GRAB			VFP-FP gravel.	132.5' grab # BIL9K0
				135' Sand (s) - as above - decrease	135' grab # BIL9K1
135	GRAB			coarse fraction, predom FS-MS - mod.	
				rxn. HCl.	
140	grab			140' Sand(s) C-VF Predom M-VF, no Rxn	140' grab # BIL9K3
				HCl. Slightly moist, 2.5y 5/2 grayish brown	
				70% qtz 30% basalt	
142.5	grab			142.5' increased FS - silt %	142.5' grab # BIL9K4
145	grab			145' Same lithology as above	145' grab # BIL9K5
147.5	grab			147.5' same lithology as above w/ ↑	147.5' grab # BIL9K6
				VC-C Sand fraction <5% silt	
150	grab			150' Sand (s) F-VF, 80% qtz, 20% basalt,	150' grab # BIL9K7
				A-SA, Slightly moist, 2.5y 5/2 grayish	
				brown, STR Rxn HCl	
152.5	grab			152.5 Slight increase in moisture	152.5 grab # BIL9K8
155	grab			155' Sand (s) F-VF, increasing fine	155' grab # BIL9K9
				fraction, 90% qtz + 10% basalt, slightly	
				moist, 2.5y 5/3 lt. olive brown, STR Rxn	
157.5	grab			HCl	157.5 grab # BIL9L0

Reported By: Steve Airhart / Jeff Fetters
Title: Geologist / geologist
Signature: [signature] Date: 1/9/07

Reviewed By: L.D. Walker
Title: Geologist
Signature: [signature] Date: 4/11/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 5 of 10
Date: 1/15/07

Well ID: C5195
Well Name: 299-E33-50
Location: Boyd N 8 Tank Farm, 58' East Baltimore St.
Project: 200-BP-5 RI/FS
Reference Measuring Point: ground

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
160	grab	5/5		160' Sand (s) same lithology as above	160-162.5' s/s # B1L9W2
				w/ increase M-C sand %, mod Rxn HCl	160' grab # B1L9L1
					162.5-165' s/s # B1L9W3
162.5	grab	5/5		163.5 silt (ms), moist, 2.5y 5/3 lt. olive	162.5' grab # B1L9L2
163.5	grab			brown, mod Rxn HCl	
165	grab	5/5		165' Sand (s) 70% gr 30% basalt, VC-VF	165-167.5' s/s # B1L9W4
				Predom F-C, A-SA, slightly moist, 2.5y 5/2	165' grab # B1L9L3
				grayish brown, wk Rxn HCl	165-167.5 s/s # ~~B1L9W5~~ B1L9W8
167.5	grab	5/5		167.5' same as above, decreasing F-VF	167.5-170' s/s # B1L9W5
				sand, 2.5y 4/2 Dk grayish brown	167.5' grab # B1L9L4
170	grab			170' Silty sand (ms) 80% sand 20% silt; sand: 70%	170' grab # B1L9L5
171	grab			gr 30% basalt, VC-VF Predom M-VF, A-SA; silt	171' ↑ sand % ↓ silt
				slightly moist, 10YR 5/3 brown mod Rxn HCl	172.5 grab # B1L9L6
172.5	grab			171' sand (s) 60% gr 40% basalt, VC-F Predom	
				VC-C, A, Dry-slightly moist, wk Rxn	
				HCl 2.5 4/1 Dk gray	175' grab # B1L9L7
175	grab			172.5' Same lithology as above ↑ F-VF sand	x ≈ 1/10 gal 1/20 cobbles
				175' sand (s) same lithology as above; gvl	during welding & Packer
177.5	grab			10% basalt, R-SR, 2cm-2mm (cP-VFP)	Removal
				180 gravelly silty sand (gms) 80% sand, 15% silt	177.5' grab # B1L9L8
				5% gvl; gvl: 1cm-2mm (MR-VFP), SA-SR basalt; sand	180' grab # B1L9L9
180	grab			VC-VF Predom M-VF, 70% gr, 30% basalt, A; silt	182.5 grab # B1L9M0
				Dry, 2.5y 5/2 grayish brown, mod Rxn HCl	
182.5	grab			182.5' same lithology as above, w/ ↓ Fines	
				2.5y 5/2 lt olive gray	
185	grab			185' Sand (s) 70% sand 5% gvl 5% silt; gvl: 95%	185-187.5' s/s # B1L9W6
		5/5		basalt 10% gr, 2cm-2mm (cP-VFP) A-R; sand:	185' grab # B1L9M1
				VC-VF, A, 70% gr 30% basalt; silt: Dry 10YR	
187.5	grab			5/2 grayish brown, wk Rxn HCl	187.5-190' s/s # B1L9W7
		5/5		187.5' silty sand, gvl (msG); gvl: 50% basalt 50%	187.5' grab # B1L9M2
190	grab			gr, R-SR, 2mm-8cm; sand: 70% gr 30% basalt	190-192.5' s/s # B1L9W8
		5/5		A-SA, VC-VF, silt: moist, 2.5y 4/3 olive brown	190' grab # B1L9M3
				no Rxn HCl	191' ↑ sand ↓ silt
192.5	grab			190' silty sandy gravel (msG) 70% gvl 15% sand 15%	192.5-195' s/s # B1L9W9
		5/5		silt; gvl 8cm-2mm, 60% gr 40% basalt, R-SR, sand:	192.5' grab # B1L9M4
195	grab			80% gr 20% basalt, A-SA, VC-VF Predom M-VF;	195' grab # B1L9M5
				silt: Dry 2.5y 5/1 gray, wk Rxn HCl	
				195 Same as above gr % to 70%	197' cobbles ↑ to 18cm
197.5	grab			basalt to 30%	197.5' grab # B1L9M6
				197.5 same lithology as above ↑ silt %	

Reported By: Jeff Fetters
Title: geologist
Signature: [signature] Date: 1/12/07

Reviewed By: L.D. Walker
Title: Geologist
Signature: [signature] Date: 4/11/07

A-6003-642 (03/03)

BOREHOLE LOG

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Date: 1/12/07

Well ID: C5195 | Well Name: 299-E33-50 | Location: 100yd N of B Tank Farm, 50' East Baltimore St

Project: 200-BP-5 RI/FS | Reference Measuring Point: ground

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
200	grab			200'-Silty sandy Gravel (MSG) 50% gvl 30% Silt, 20% Sand gvl: 7cm-2mm (sc-vFP), R-SR, 60% 2/2 40% basalt; Sand: VC-VF Predom M-VF, 80% 2/2 20% basalt, A-SA, Silty/Dry, 10YR 3/2 grayish brown, mod Rxn HCl	200' grab# ~~BIL9M7~~ 7F1/12 BIL9m7
202.5	grab			202.5' increased gvls < 5cm in size	200' Suspect larger cobbles UP to 17cm; 202.5' grab# BIL9M8
205	grab			205' Same lithology as above, 10YR 4/2 Dk grayish brown, no Rxn HCl	205' grab# BIL9m9
207.5	grab			207.5' same lithology as above	207.5' grab# BIL9N0
210	grab			210: Same as above	210' grab# BIL9N1
212.5	grab			212.5'- Same as above	212.5' grab# BIL9N2
215	grab			215' Silty Gravel (SG) 80% gvl, 15% silt, 5% sand: gvl: 10cm-2mm (sc-vFP) predom <3cm 50% basalt 50% 2/2, R-SR, Sand: VC-C, 50% basalt, 50% 2/2, A; Silt: wet 10YR 4/3 Brown, no Rxn HCl	215' grab # BIL9N3 moisture in sample due to H_2O added durring welding
217.5	grab	3/3		217.5'-Silty sandy Gravel (MSG), Same as 212.5' Sample, no Rxn HCl	217.5' grab# BIL9N4; 217.5'-220' s/s # BIL9X0
220	grab	3/3		220'- Silty Sandy Gravel (MSG), Same lithology as above	220-222.5' s/s # BIL9X1; 220' grab# BIL9N5; 222.5' cobbles to 15cm
222.5	grab	3/3			222.5-225' s/s# BIL9X2; 222.5' grab # BIL9N6
225	grab	3/3		225' Sandy Gravel (SG), 90% gvl 10% sand; gvl: 8cm-2mm (sc-VFP) suspect larger, 80% 2/2, 20% basalt, R-SR; Sand: VC-F Predom VC, A, 60% 2/2 40% basalt, wet 10YR 4/1 Dk gray, no Rxn hcl	225-227.5' s/s # BIL9X3; 225' grab# BIL9N7
227.5	grab	3/3			227.5-230' s/s # BIL9X4; 227.5' grab# BIL9N8
230	grab	3/3		230' Same lithology as above, increase in med sand Fraction	230-232.5' s/s # BIL9X5; 230' grab # BIL9N9; 232.5'-233.6 s/s# BIL9X6
232.5	grab	3/3		233' Sandy Gravel (SG) 80% gvl, 15% sand 5% silt; gvl: 8cm-2mm (sc-VFP) suspect larger, 50% basalt, 50% 2/2, R-SR; Sand: VC-M Predom VC, 50% basalt 50% 2/2, A-SA; Silt: wet, 10YR 4/3 Dk gray, no Rxn HCl	232' grab# BIL9P0
233	grab			233.6'- Basalt, Elephant Mtn Member Aphanitic, gray 125/N Blocky, 80% basalt, 40% 2/2 fines	Drilling w/ 10" hard tool @ 233' bgs; Drilling w/ 10" button bit @ 236' bgs
233.6					
235	grab				

Reported By: Jeff Fetters | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: Jeff Fetters | Date: 1/12/07 | Signature: L.D. Walker | Date: 4/11/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 7 of 10
Date: 1/18/07

Well ID: C5195 | Well Name: 299-E33-50 | Location: 100 yd N B tank farm, 50' E Battlement St.
Project: 200-BP-5 R.I/FS | Reference Measuring Point: Ground

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				240' Basalt Same as above, 20% zzt/others/Soil or "Paper" material	Cable Tool Method 10 3/4" casing, 10" bottom BLF
245	grab			245' Basalt same as above, 10% zzt/others.	
250	grab			250' Basalt Same as above, no change	253' (pump intake): water sample HEIS# B1MC07
255	grab			253' Basalt, 15% other materials (zzt/others), glassy, 2 grey 3/1 very dark greenish grey	15% others may indicate poor seal, or maybe stuff fell down casing was pulled back?
260	grab			260' Basalt, Same as above, noticable increase in cuttings w/ rounded edges both basalt and non basalt material	
265	grab			265' basalt same as above	
270	grab			270' basalt, increase on fines lith: same as above	
275	grab			275' same as above	

Reported By: Erika Rincon / Jeff Fetters
Title: geologist / geologist
Signature: Erika R / [signature] Date: 2-2-07

Reviewed By: L.D. Walker
Title: Geologist
Signature: [signature] Date: 4/11/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 8 of 10

Date: 2-2-07

Well ID: C5195 | Well Name: 299-E33-50 | Location: Yoyd N of Bton's Farm / 50' E of Baltimore St.

Project: 200-BP-5 RI/FS | 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 Method,
280	grab			280' basalt - same as previous	10 3/4" Casing, 10"
				increase in fines	button bit.
					283' Drill Rate ↓
285	grab			285' - Basalt, same as above <5%	
				qtz/others, 20% cement content	
290	grab			290' - Basalt, same as above <10%	
				cement content	291' DR ↑
293	grab			293' - Basalt same as above, <5%	
				cement content, Increasing qtz/	
295	grab			others, qtz/others showing rounded	
				edges <10%	296' slight increase
				295' - Same as above	in qtz/others
299	grab			299' - Basalt, same as above	
300	grab				300' DR ↓
305	grab			305' Basalt, same as above, <5%	305' hard drilling
				cement content, trace qtz/others	
310	grab			310' - Basalt same as above, slight	
				increase in qtz/others, <5%	
					312.5' fractured basalt
				315' - Basalt - Same as above, increase in	
				qtz/others, basalt cuttings showing rust	
				colored oxidization	
315	grab			316.5' silt(m) 30% silt 20% sand/basalt: sand: 100%	Drive barrel ↓ 315' -
316.5	grab			312.5 (c-m, A Glassy Vitrification?; silt/clay	322' bgs
				Moist gley 2.5/1, dk greenish gray, small nodules/	S/S 318'-320.5' bgs
319.5		SS		of clay 10 YR 7/6 yellow, no Rxn HCl	

Reported By: Erika Runian / Jeff Fetters | Reviewed By: L. D. Walker

Title: geologist | Title: Geologist

Signature: [signature] Date: 3/1/07 | Signature: [signature] Date: 4/11/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 9 of 10
Date: 3/1/07

Well ID: C5195 | Well Name: 299-E33-50 | Location: 100 yds N B tank Farm, 50' E Baltimore St.

Project: 200-BP-5 RI/FS | Reference Measuring Point: Ground

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
320	grab	s/s		320' Silty sand (ms) 80% sand 20% silt	318-320.5' s/s sample
320.5				Sand: 90% qtz/others 10% basalt VF-M, SA-SR, Silt: Moist, 2.5y 4/2 olive, no Rxn HCl	Heist #3: BIL8J8, BIL9P6, BIL9P7, BIL9P8, BIL9P9, BIL9P0, BIL8C9
					8" hard tool installed
325	grab			325' Same as above, slight increase in silt fraction, 2.5y 5/3 olive, wet	325' water sample, DTB= 325, casing at 315.56' bgs BIL8C2, BIL8D7, BIL8K9
330	grab			330' Sandy Silt (SM) 30% silt/clay 20% sand Sand: 90% qtz/others, 10% basalt, VF-F, SA-A; Silt: wet, no Rxn HCl, 10yr 5/2 grayish brown	330' Some clay on hard tool
					DR ↓
335	grab			335' - Same lithology as above	335' - hard tool caked w/ clay
					Casing driving hard
340	grab			340' Same lithology as above, slight increase in silt/clay fraction, 7.5y 5/2 Brown	
341		s/s			341-343.5' s/s sample
343.5	grab			343.5' - gravelly sandy silt (gsM) 70% silt/clay, 25% sand, 5% gvl; Gvl: 2mm-3mm (VFP), SA-SR qtz; Sand: C-VF 90% qtz 10% basalt, SA-SR, Silt: 10yr 4/3 brown, moist, no Rxn HCl, Clumps of lighter, 10yr 7/3 very pale brown, clay present	Heist #4: BIL9E1, BIL9E2, BIL9E3, BIL9E4, BIL9E5, BIL9T2, BIL9T3, BIL9T4
345	grab			345' - Sand (S) 90% sand 10% silt/clay; Sand: 80% qtz/others, 20% basalt, C-VF, SA-SR; Silt: moist, 10yr 4/3 brown, no Rxn HCl	345' - Rust Red mottling in sands, sample collected w/ DTB
349.5	Hydrosample				349.5' water sample, DTB = 349.5', casing at 345.53' bgs
350	grab			351-355' - ~~Silty Sand (SM)~~ sandy silt (SM) 40% 60% silt/clay; Sand C-VF, 60% qtz 40% basalt, A-SR, qtz = ↑ Rounding; Silt: wet 10yr 5/2 brown, no Rxn HCl	Heist #5: BIL8J9, BIL8L0, BIL8L3, 350' Same as above
355				358' - Decreasing sand content, 20% sand 80% silt/clay	358' - increasing clay on hard tool, Driller states borehole is swelling shut
358					

Reported By: Jess Fetters | Reviewed By: L. D. Walker

Title: Geologist | Title: Geologist

Signature: [signature] Date: 3/6/07 | Signature: [signature] Date: 4/11/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 10 of 10
Date: 3/6/07

Well ID: C5195 | Well Name: 299-E33-50 | Location: 100 yd n B Tank Farm, 50' E Baltimore St.

Project: 200-BP-5 RI/FS | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
360	grab			360 Silt/clay (M) 80% silt/clay 20% Sand; Sand M-VF, A-SR, 60% Qtz 40% basalt; Silt; wet 10YR 5/3 brown, no Rxn HCl	5/3 362.4-364.2' bgs, Heis#s BILBK1, BILBK6, BILBK7, BILBK8, BILBK9, BILBT0, BILBD1
362.4		5/3			
364.2 365	grab			365' Silty Sand (gmS) 80% sand 20% silt; sand: M-VF, Predom VF, SR-SA, Qtz, <5% basalt. moist, 2.5Y 5/4 tan olive brown; Silt: 2.5Y 6/4 lt. yellowish brown, moist, no Rxn HCl	365' Sample collected w/ Drive barrel
370	grab			370'- Same lithology as above ≤10% gvl 70% sand, 20% silt; gvls 2mm-4mm Qtz, A, ↑ Csand fraction	
375	grab			375'-gravelly silty sand (gmS) 30% gvl 50% sand 20% silt: gvl 50% basalt 50% Qtz/others, A, 1.5cm-2mm (mp-VFP); Sand: 60% basalt 40% Qtz/others, A, VF-VC Predom F-VF; Silt: wet, 10YR 4/3 brown, no Rxn HCl	375' basalt cuttings Snow Reddish oxidized surfaces, few vesicles possible flow top
375.5				375.5' - Basalt, Pomona basalt, Reddish brown/Rust Red oxidized surfaces few vesicles present	
377.8	H_2O Sample				377.8' water sample
380	grab			380' - Basalt Same lithology as above	O+B = 377.8' bgs, casing depth = 371.2' bgs Heis#s BILBK2, BILBK3, BILBL4, BILBL5
381	grab			381' - Basalt Same lithology as above, no vesicles present.	381.0' = TD

Reported By: Jeff Fetters | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: [signature] | Date: 3/8/07 | Signature: [signature] | Date: 4/11/07

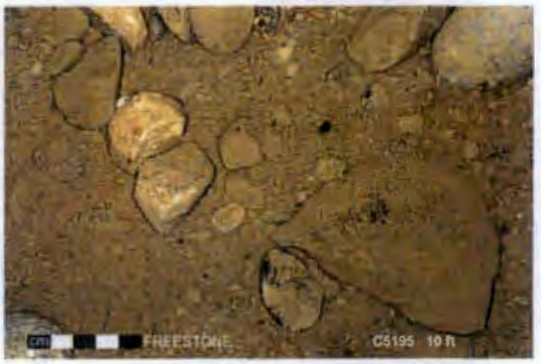
A-6003-642 (03/03)

Well C5195

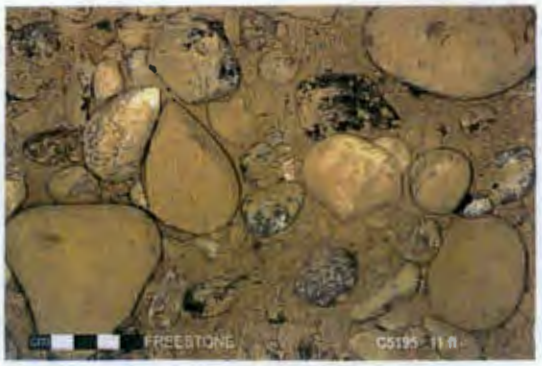
2 ft

4 ft

6 ft



10 ft



11 ft

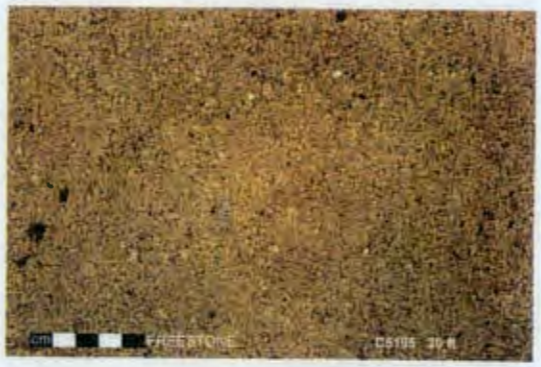
15 ft

Well C5195

20 ft

23 ft

25 ft

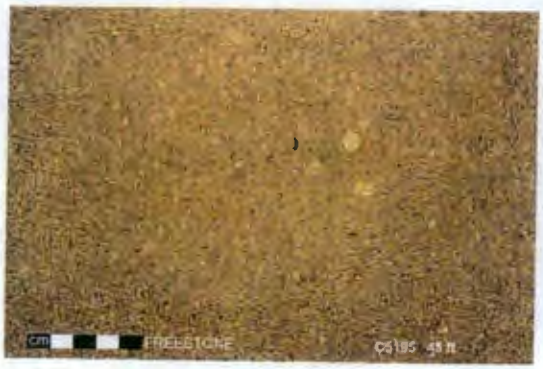


30 ft

35 ft

40 ft

Well C5195



45 ft

50 ft

55 ft

59 ft

60 ft

63 ft

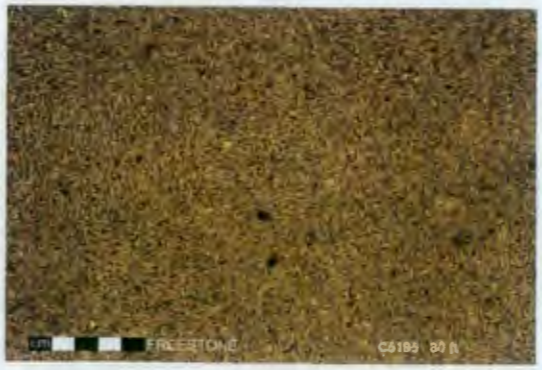
Well C5195

64 ft

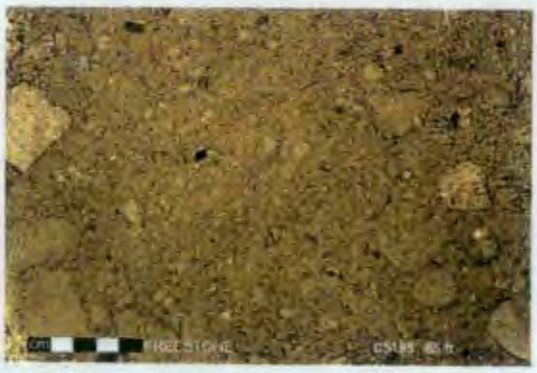
65 ft

70 ft

75 ft



80 ft

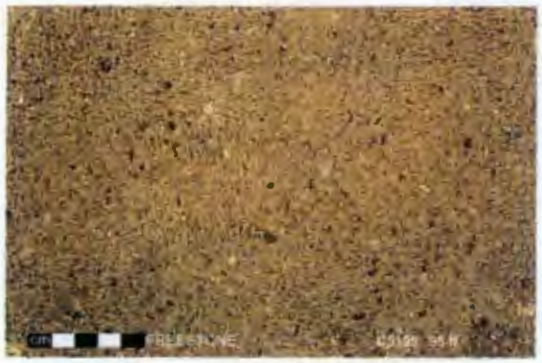


85 ft

Well C5195

90 ft

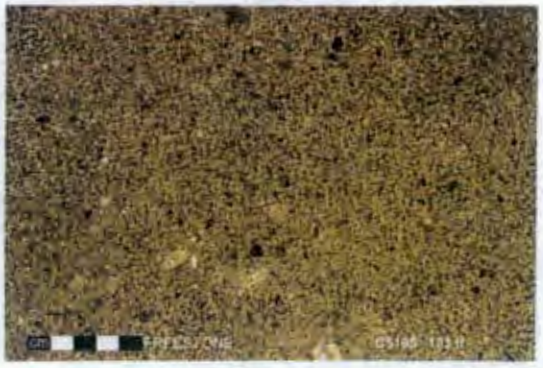
92 ft



95 ft

100 ft

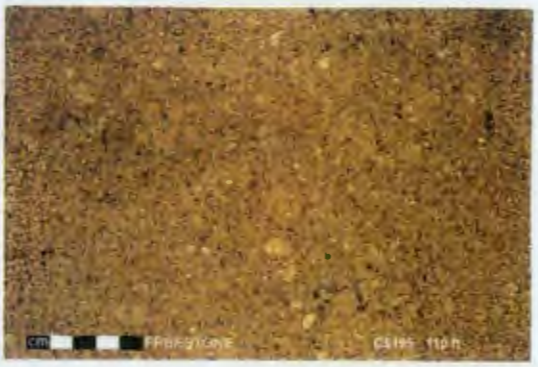
101 ft



103 ft

Well C5195

105 ft



110 ft

112 ft

115 ft

120 ft

125 ft

Well C5195

130 ft

135 ft

140 ft

143 ft

145 ft

150 ft

Well C5195

155 ft

160 ft

164 ft

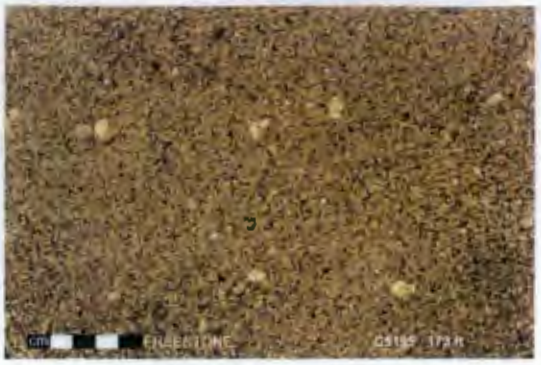
165 ft

167 ft

170 ft

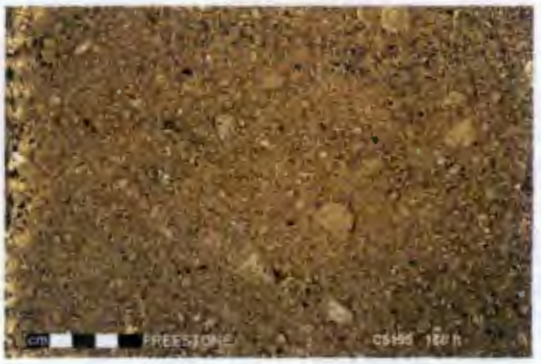
Well C5195

171 ft

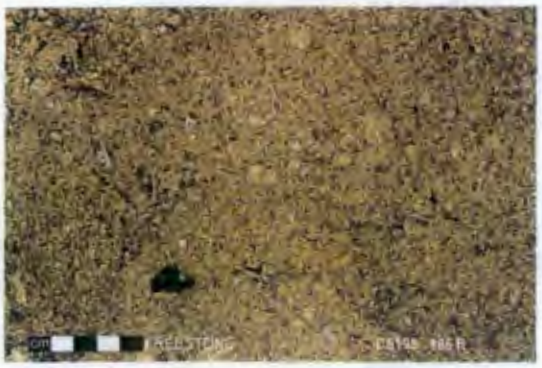


173 ft

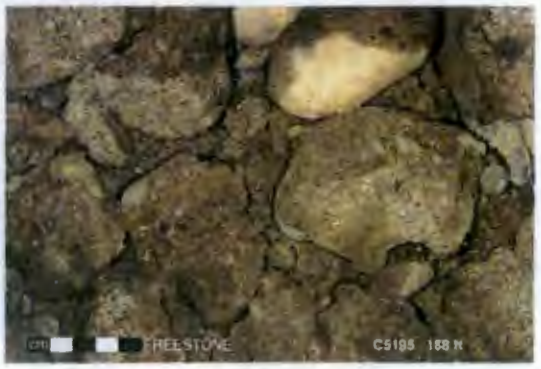
175 ft



180 ft

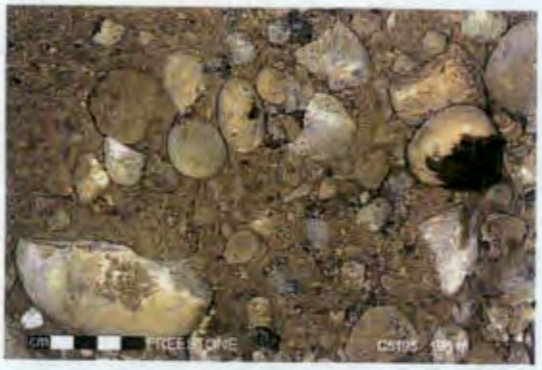


185 ft



188 ft

Well C5195

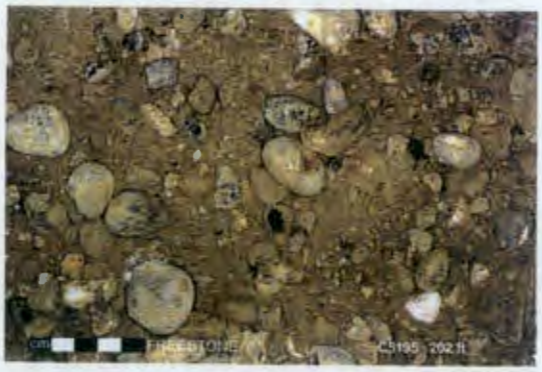


190 ft

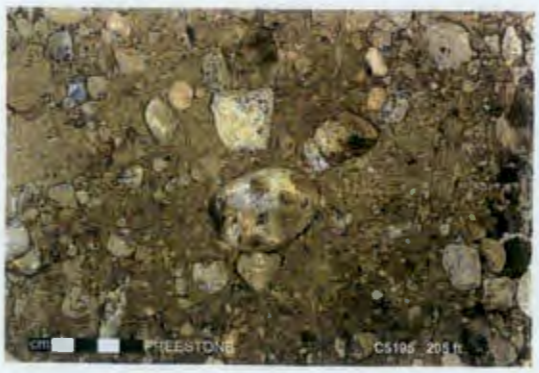
195 ft

198 ft

200 ft



202 ft



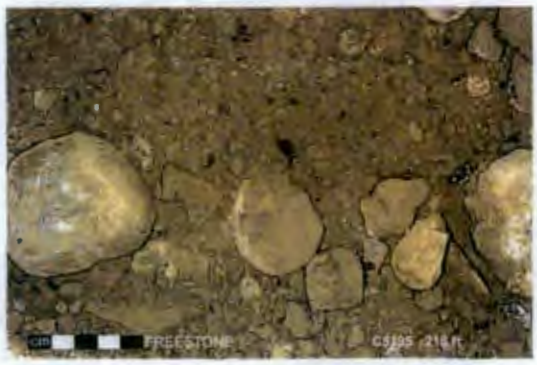
205 ft

Well C5195

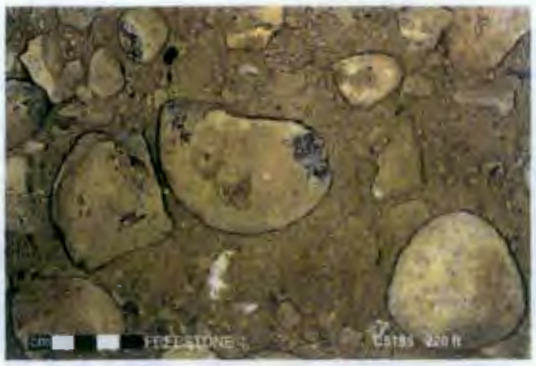
208 ft

210 ft

215 ft



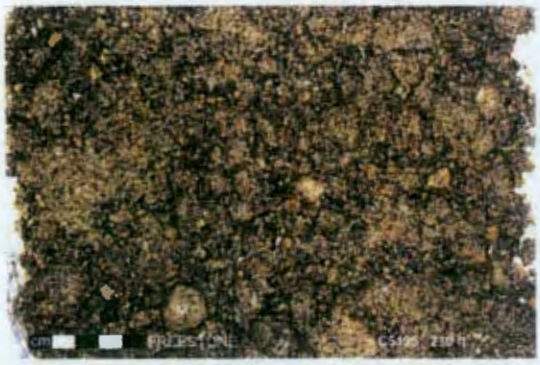
218 ft



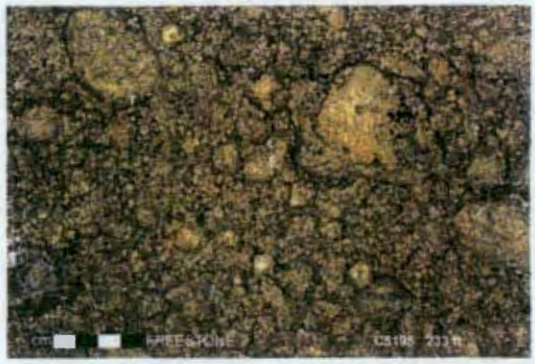
220 ft

225 ft

Well C5195



230 ft



233 ft

235 ft

240 ft

245 ft

250 ft

Well C5195

255 ft

260 ft

265 ft

270 ft

275 ft

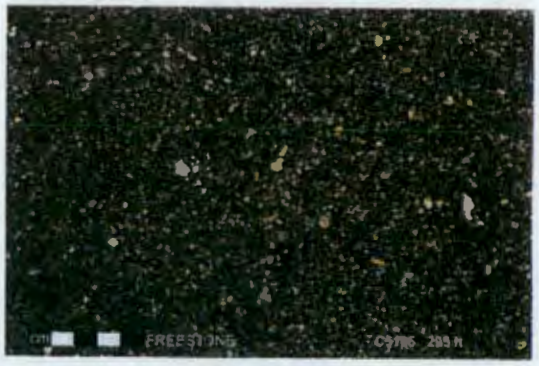
280 ft

Well C5195

285 ft

290 ft

293 ft



295 ft

299 ft

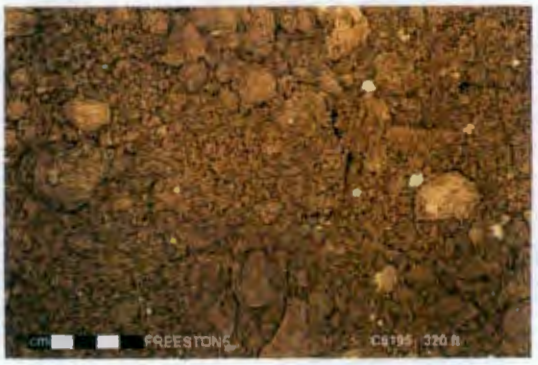
305 ft

Well C5195

310 ft

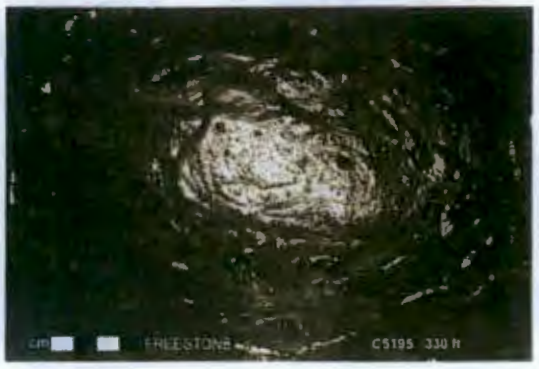
315 ft

316 ft



320 ft

325 ft

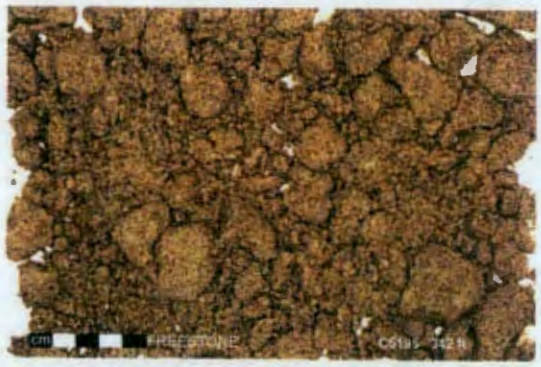


330 ft

Well C5195

335 ft

340 ft



342 ft

345 ft

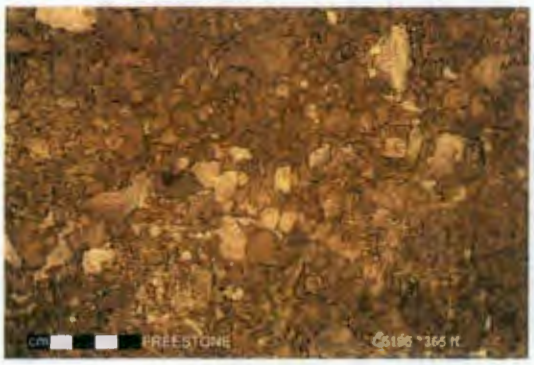
350 ft

355 ft

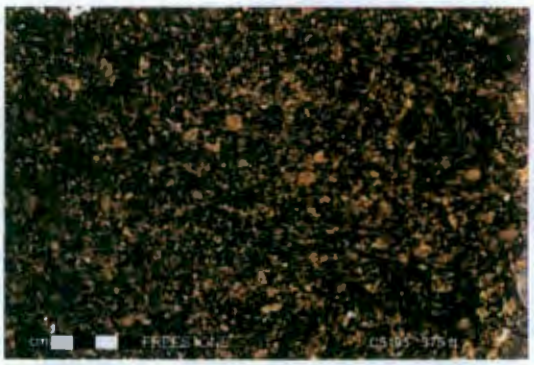
Well C5195

358 ft

360 ft



365 ft



375 ft

378 ft

381 ft

WELL SUMMARY SHEET	Start Date: 12-28-06 Finish Date: 3-29-07	Page 1 of 5
Well ID: C5195	Well Name: 299-E33-50	
Location: 100 yd N of B Tank farm, 50' E of Baltimore St.	Project: 200-BP-5 Monitoring Wells	
Prepared By: Jeff Fetters — Date: 3-9-07	Reviewed By: L. D. Walker — Date: 4/11/07	
Signature: Jeff Fetters	Signature: L. D. Walker	

CONSTRUCTION DATA

Description

6-in Concrete Pad

6-in I.D. Type 304/304L Stainless Steel Protective Casing: +3.0 ft above Ground Surface

Portland Cement Type I/II: 0 - 10.0 ft

Granular Bentonite Seal: 10.0 - 219.1 ft

4-in I.D. Type Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +2.0 - 316.06 ft

All depths are in feet below ground surface.

Borehole drilled with 10 3/4-in welded casing 0.0-234.0 ft and 8-in threaded casing 234.0-381.0 ft

All temporary drill casing was removed from the ground.

Diagram

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50, 60, 70, 80

Graphic Log

Lithologic Description/Groundwater Sample Depths (ft bgs)

0-4 Sand (S)
4-11 Silty Gravelly (mG)
11-15 Silty Sand (mS)
15-20 Sand (S)
20-23 Slightly Silty Sand (mS)
23-28 Sand (S)
63-64 Silt (M)
64-65 Sand (S)
65-75 Gravelly sand (gS)
74-80 Sand (S)
85-92 Silty Sand (mS)

WELL SUMMARY SHEET	Start Date: 12-28-06 Finish Date: 3-29-07	Page 2 of 5
Well ID: C5195	Well Name: 299-E33-50	
Location: 100 yd N of B Tank farm, 50' E of Baltimore St.	Project: 200-BP-5 Monitoring Wells	
Prepared By: Jeff Fetters — Date: 3-9-07	Reviewed By: L. D. Walker — Date: 4/11/07	
Signature:	Signature:	

CONSTRUCTION DATA

Granular Bentonite Seal: 10.0 - 219.1 ft

4-in I.D. Type Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +2.0 - 316.06 ft

All depths are in feet below ground surface.

Borehole drilled with 10 3/4-in welded casing 0.0-234.0 ft and 8-in threaded casing 234.0-381.0 ft

All temporary drill casing was removed from the ground.

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description/Groundwater Sample Depths (ft bgs)
90		
		92-103 Sand (S)
100		
		103-105 Gravelly Sand (gS)
		105-163.5 Sand (S)
110		
120		
130		
140		
150		
160		
		163.5-165 Silt (M)
		165-170 Sand (S)
170		170-171 Silty Sand (mS)
		171-187.5 Sand (S)

WELL SUMMARY SHEET	Start Date: 12-28-06 Finish Date: 3-29-07	Page 3 of 5

Well ID: C5195		Well Name: 299-E33-50	
Location: 100 yd N of B Tank farm, 50' E of Baltimore St.		Project: 200-BP-5 Monitoring Wells	
Prepared By: Jeff Fetters	Date: 3-9-07	Reviewed By: L. D. Walker	Date: 4/11/07
Signature:		Signature:	

CONSTRUCTION DATA

Description

Granular Bentonite Seal: 10.0-219.1 ft

4-in I.D. Type Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +2.0 - 316.06 ft

3/8-in Bentonite Pellets: 219.1 - 229.9 ft

Static Water Level: 224.64 ft bgs (3-26-2007)

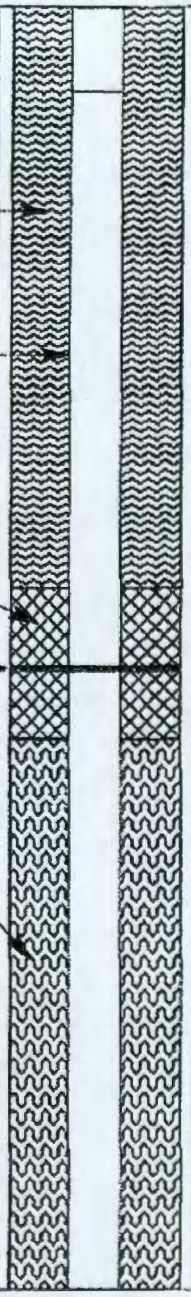
Portland Cement Type I/II: 229.9-307.5 ft

All depths are in feet below ground surface.

Borehole drilled with 10 3/4-in welded casing 0.0-234.0 ft and 8-in threaded casing 234.0-381.0 ft

All temporary drill casing was removed from the ground.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 180, 190, 200, 210, 220, 230, 240, 250, 260

Graphic Log

Lithologic Description/Groundwater Sample Depths (ft bgs)

187.5-225 Silty Sandy Gravel (msG)

225-233.6 Sandy Gravel (sG)

233.6-316.5 Basalt (Elephant Mountain)

WELL SUMMARY SHEET	Start Date: 12-28-06 Finish Date: 3-29-07	Page 4 of 5
Well ID: C5195	Well Name: 299-E33-50	
Location: 100 yd N of B Tank farm, 50' E of Baltimore St.	Project: 200-BP-5 Monitoring Wells	
Prepared By: Jeff Fetters — Date: 3-9-07	Reviewed By: L. D. Walker — Date: 4/11/07	
Signature: [signature]	Signature: [signature]	

CONSTRUCTION DATA

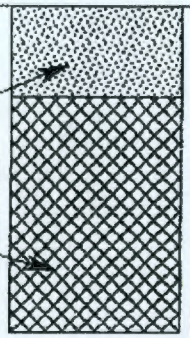
Description	Diagram
Portland Cement Type I/II: 229.9 - 307.5 ft	
4-in I.D. Type Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +2.0 - 316.06 ft	
3/8-in Bentonite Pellets: 307.5 - 309.6 ft	
Primary Filter pack 20-40 Mesh Colorado Silica Sand: 309.6 - 336.6 ft	
4-in I.D. Stainless Steel, Type 304, Slot 10 (.010-in) Screen: 316.06 - 331.06 ft	
3/8-in Bentonite Pellets: 336.6 - 343.7 ft	
10-20 Mesh Colorado Silica Sand: 343.7 - 364.2 ft	
All depths are in feet below ground surface.	
Borehole drilled with 10 3/4-in welded casing 0.0-234.0 ft and 8-in threadedcasing 234.0-381.0 ft All temporary drill casing was removed from the ground.	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description/Groundwater Sample Depths (ft bgs)
270		
280		
290		
300		
310		
		315 Basalt
		316.5-320 Silt (baked)
320		320-345 Sandy Silt (sM)
330		
340		
		345-351 Sand (S)
350		351-360 Sandy Silt/Clay (sM)

WELL SUMMARY SHEET	Start Date: 12-28-06 Finish Date: 3-29-07	Page 5 of 5
Well ID: C5195	Well Name: 299-E33-50	
Location: 100 yd N of B Tank farm, 50' E of Baltimore St.	Project: 200-BP-5 Monitoring Wells	
Prepared By: Jeff Fetters	Date: 3-9-07	Reviewed By: L. D. Walker	Date: 4/11/07
Signature: Jeff Fetters	Signature: L D Walker	

CONSTRUCTION DATA

Description	Diagram
10-20 Mesh Colorado Silica Sand: 343.7 - 364.2 ft 3/8-in Bentonite Pellets: 364.2 - 381.0 ft	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description/Groundwater Sample Depths (ft bgs)
360		360 Silt/Clay (M)
		365 - 370 Silty Sand (mS)
370		
		375 - Gravelly Silty Sand (gmS)
375.5		375.5 - 381 Pomona Basalt
380		
381		Total Depth Drilled = 381.0 ft bgs

All depths are in feet below ground surface.

Borehole drilled with 10 3/4-in welded casing 0.0-234.0 ft and 8-in threaded casing 234.0-381.0 ft

All temporary drill casing was removed from the ground.

WELL CONSTRUCTION SUMMARY REPORT

Start Date: 12/28/06
Finish Date: 3/29/07
Page 1 of 2

Well ID: C5195	Well Name: 299-E33-50	Approximate Location: 100 yd N B Tank Farm, 80' E Bartlimerch
Project: 200-BP-5 R/FS		Other Companies: Freestone Env. Serv. Inc.
Drilling Company: Blue Star		Geologist(s): Steve airhart, Erica Rinton JEFF FEHLES
Driller: Gary Howel	License #:	

TEMPORARY CASING AND DRILL DEPTH

*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.
10 3/4" O.D, 10" I.D	0 - 234.0	11 3/8" O.D.
8" O.D 7 5/8" I.D.	234.0 - 381.0	8 3/4" O.D.
	-	
	-	
	-	

*Indicate Welded (W) - Flush Joint (F.J) Coupled (C) & Thread Design

10 3/4" casing = welded
8" casing = Thread Design

DRILLING METHOD / HOLE DIAMETER (in.) / INTERVAL (ft)

Auger:	Diameter	From	to
Cable Tool: String #2	Diameter 8"	From 0	to 234.0
Air Rotary:	Diameter	From	to
A.R. w/Sonic:	Diameter	From	to
Cable tool: String #2	Diameter 10 3/4	From 234.0	to 381.0'
	Diameter	From	to
	Diameter	From	to

Drilling Fluid:

Total Drilled Depth: 381.0	Hole Dia @ TD: 8"	Total Amt. Of Water Added During Drilling:	
Well Straightness Test Results: Passed		Static Water Level: 224.64	Date: 3/26/07

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date	Sondes (type)	Interval	Date
Spectra Gamma	0 - 233.6	1/17/07	Spectra Gamma	316.5 - 381.0	3/8/07
Neutron (moisture)	0 - 224.0	1/17/07		-	
	-			-	

COMPLETED WELL

Size/Wt./Material	Depth	Thread	Slot Size	Type	Interval Annular Seal/Filter Pack	Volume	Mesh Size
4" I.D Type 304 S.S casing	+2.0 - 316.06	✓	—	Portland cement	0 - 10.0	6.94 lbs	—
4" ID S.S. Screen	316.06 - 331.06	✓	10	Granular Bentonite	10.0 - 219.1	18/50lb	—
4" SS Sump	331.06 - 334.06	✓	—	3/8 coated bentonite pellets	219.1 - 229.9	3/5gal	3/8"
316.06	-			Portland cement	229.9 - 357.5	16/94lb	—
cw 4/16/07	-			3/8 coated bentonite pellets	302.5 - 309.6	1/5gal	3/8"

OTHER ACTIVITIES

Aquifer Test:	Date:	Well Decommission:	Yes:	No:	Date:
Description:		Description:			

WELL SURVEY DATA (If applicable)

not surveyed at this time	Protective Casing Elevation:
Washington State Plane Coordinates:	Brass Survey Marker Elevation:

COMMENTS / REMARKS

Reported By:	Title:	Signature:	Date:
Jeff Fehles	geologist	Jeff Fehles	3/29/07

A-6003-658 (04/03)

WELL DEVELOPMENT AND TESTING DATA

Well Name:	Well ID:	Well Location:	Date:
299-E33-50	C5195	100yd NB tank farm, 50' E Baltimore	3/28/07

Reference Measuring Point (unless otherwise noted): TOP OF OUTER CASING (TOC)

Has the well been surveyed? ○ Yes ☒ No | Does the well have a cement pad? ☒ Yes ○ No

PART 1

STATIC WATER LEVEL:

Start of Job 224.92'

End of Job

DEPTH TO BOTTOM:

Start of Job 325.7' bgs

End of Job 333.6' bgs

PART 2

WELL DEVELOPMENT DATA

Pump Model 5 Hp

Intake Depth 325.59' bgs

Starting Turbidity 116 ntu

Pump Start	Stop	Flow Rate
1314	1543	4.5 gpm
~~1543~~		

Total Pumped 590 gallons

Final Turbidity 30 ntu

XD SN/Range (PSI)

PART 3

INSTANTANEOUS SLUG TEST

Static Water Level (TOC)

Transducer Depth

Baseline Start

Injection Start

Baseline Start

Withdrawal Start

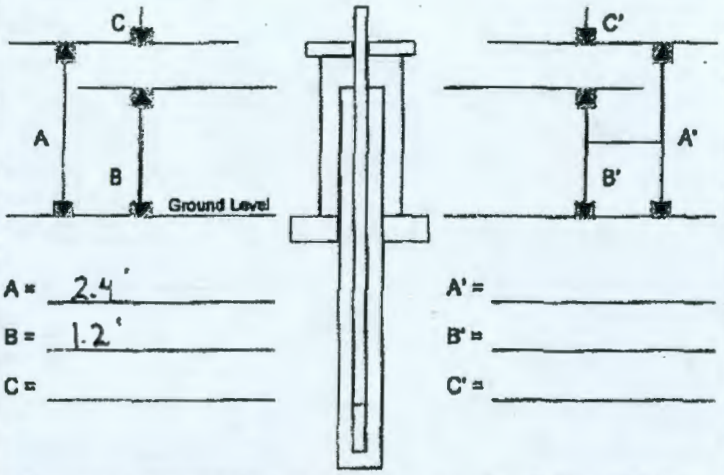
Slug Volume

XD SN/Range (PSI)

PART 4

Last Recorded Measurements Date:

Current Measurements Date:



A = 2.4'

B = 1.2'

C =

A' =

B' =

C' =

Are there any reference marks on the casing strings? ○ Yes ○ No

PART 5

COMMENTS:

Test #1 Draw Down

Test #2 Recovery

Prepared by (print name):	Signature:	Date:
Jeff Fetters	Jeff Fetters	3/28/07
Reviewed by (print name):	**Signature:**	**Date:**
L.D. Walker	L.D. Walker	4/16/07

A-6003-644 (03/03)

WELL DEVELOPMENT AND TESTING DATA

Well Name:	Well ID:	Well Location:	Date:
299-E33-50	C5195	100yd N Blank Farm, 50' E Battinger St.	3/29/07

Reference Measuring Point (unless otherwise noted): TOP OF OUTER CASING (TOC)

Has the well been surveyed? ○ Yes ☒ No

Does the well have a cement pad? ☒ Yes ○ No

PART 1

STATIC WATER LEVEL:

Start of Job 224.92'

End of Job

DEPTH TO BOTTOM:

Start of Job 325.7' bgs

End of Job 333.6' bgs

PART 2

WELL DEVELOPMENT DATA

Pump Model 5 hp

Intake Depth 326.34'

Starting Turbidity 20.3

Pump Start	Stop	Flow Rate
0702	0940	3 gpm

Total Pumped 477 gallons

Final Turbidity 2.15

XD SN/Range (PSI)

PART 3

INSTANTANEOUS SLUG TEST

Static Water Level (TOC)

Transducer Depth

Baseline Start

Injection Start

Baseline Start

Withdrawal Start

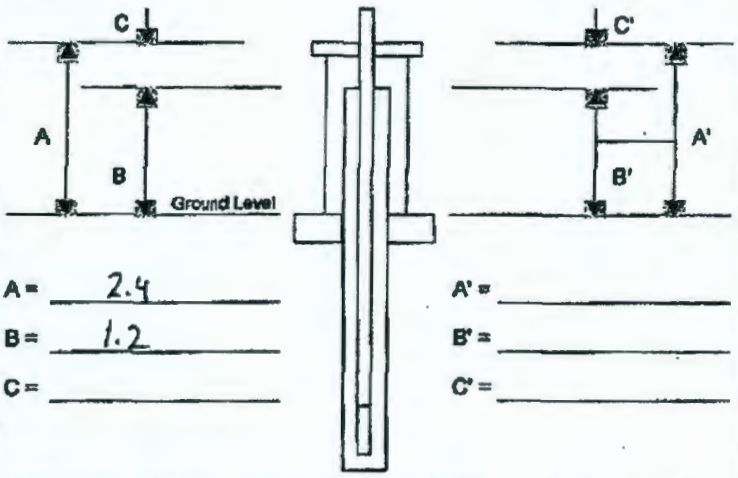
Slug Volume

XD SN/Range (PSI)

PART 4

Last Recorded Measurements Date:

Current Measurements Date:



A = 2.4

B = 1.2

C =

A' =

B' =

C' =

Are there any reference marks on the casing strings? ○ Yes ○ No

PART 5

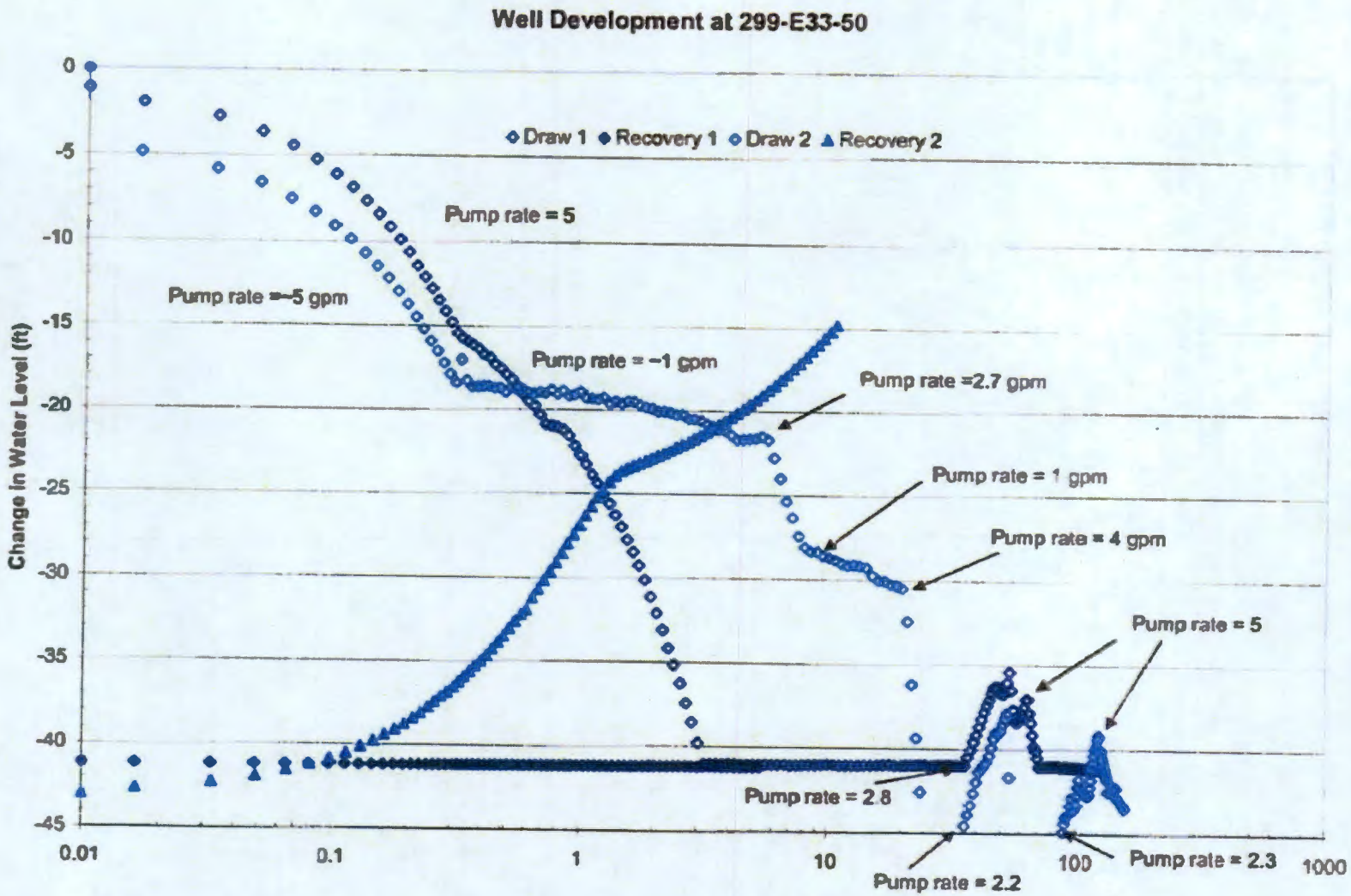
COMMENTS:

Test #3 Drawdown

Test #4 Recovery

Prepared by (print name):	Signature:	Date:
Jeff Fellers	[signature]	3/29/07
Reviewed by (print name):	**Signature:**	**Date:**
L.D. Walker	[signature]	4/16/07

A-6003-644 (03/03)


Well Development at 299-E33-50
Draw 1
Recovery 1
Draw 2
Recovery 2
Change in Water Level (ft)
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
0.01
0.1
1
10
100
1000
Pump rate = 5
Pump rate =-5 gpm
Pump rate = -1 gpm
Pump rate =2.7 gpm
Pump rate = 1 gpm
Pump rate = 4 gpm
Pump rate = 5
Pump rate = 2.8
Pump rate = 2.2
Pump rate = 2.3

WELL SURVEY DATA REPORT

Project:	**Prepared By:** S. Wray **Company:** FGG Survey Dept.
Date Requested: 5/01/07	**Requestor:** Chris Wright (FH)
Date of Survey: 5/14/07	**Surveyor:** N. Fastabend (FGG)
ERC Point of Contact:	**Survey Co. Point of Contact:** N. Fastabend (FGG)
Description of Work: Civil Survey of Groundwater Monitoring Well #C5195 (299-E33-50)	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** METERS **Hanford Area Designation:** 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments: Gable Mtn. (FH), 2E-1 (FGG)

Vertical Control Monuments: HSWB-032 (COE), 2E-121 (FGG)

Well ID	Well Name	Easting	Northing	Elevation	
C5195	299-E33-50	573773.61	137599.30		Center of Casing
				191.487	Top Pump Baseplate, N. Edge
				191.480	Top Casing, N. Edge
				190.742	Brass Survey Marker

Notes:

EQUIPMENT USED: TRIMBLE GPS 5800 RTK
TRIMBLE DiNi 12 LEVEL

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
EXPIRES Sept 23, 2007

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in May, 2007 under my direct supervision, and that the data contained here is true and correct.

Original to:
Distribution by DIS:

Well Survey

Table A-1. Sample Depths and HEIS #s for C5195. (4 sheets)

Sample Interval	Sample Depth (ft bgs)	Sample Method	HEIS #
Split-Spoon Interval #1	0-2	Split-Spoon	B1LWY8, B1LV27, B1LWY8-MB, B1LX01
	2-4	Split-Spoon	B1LWY6, B1LWY9, B1LWY9-MB, B1LX02
	4-6	Split-Spoon	B1LWY7, B1LX00, B1LX03, B1LXOO-MB
Split-Spoon Interval #2	60-62	Split-Spoon	B1L9T6
	60	Quart Grab	B1L9F1
	62-64	Split-Spoon	B1L9T7
	62	Quart Grab	B1L9F2
	64-66	Split-Spoon	B1L9T8
	64	Quart Grab	B1L9F3
	66-68	Split-Spoon	B1L9T9
	66	Quart Grab	B1L9F4
	68-70	Split-Spoon	B1L9V0
	68	Quart Grab	B1L9F5
	70-72	Split-Spoon	B1L9V1
	70	Quart Grab	B1L9F6
	72-74	Split-Spoon	B1L9V2
	72	Quart Grab	B1L9F7
	74-76	Split-Spoon	B1L9V3
	74	Quart Grab	B1L9F8
	76-78	Split-Spoon	B1L9V4
	76	Quart Grab	B1L9F9
	78-80	Split-Spoon	B1LX26
	78	Quart Grab	B1LX27
	80-82	Split-Spoon	B1LX28
	80	Quart Grab	B1LX29
	82.5-58	Split-Spoon	B1L9V5, B1LBK7 (DUP)
	82.5	Quart Grab	B1L9H0
	85	Quart Grab	B1L9H1
	87.5	Quart Grab	B1L9H2
	90	Quart Grab	B1L9H3
	92.5	Quart Grab	B1L9H4
	95	Quart Grab	B1L9H5
	97.5	Quart Grab	B1L9H6
	102	Quart Grab	B1L9H8

Table A-1. Sample Depths and HEIS #s for C5195. (4 sheets)

Sample Interval	Sample Depth (ft bgs)	Sample Method	HEIS #
Split-Spoon Interval #3	105-107.5	Split-Spoon	B1L9V6
	105	Quart Grab	B1L9H9
	107.5-110	Split-Spoon	B1L9V7
	107.5	Quart Grab	B1L9J0
	110-112.5	Split-Spoon	B1L9V8
	110	Quart Grab	B1L9J1
	112.5-115	Split-Spoon	B1L9V9
	112.5	Quart Grab	B1L9J2
	115-117.5	Split-Spoon	B1L9W0
	115	Quart Grab	B1L9J3
	117.5-120	Split-Spoon	B1L9W1
	117.5	Quart Grab	B1L9J4
	120	Quart Grab	B1L9J5
	122.5	Quart Grab	B1L9J6
	125	Quart Grab	B1L9J7
	127.5	Quart Grab	B1L9J8
	130	Quart Grab	B1L9J9
	132.5	Quart Grab	B1L9K0
	135	Quart Grab	B1L9K1
	140	Quart Grab	B1L9K3
	142.5	Quart Grab	B1L9K4
	145	Quart Grab	B1L9K5
	147.5	Quart Grab	B1L9K6
	150	Quart Grab	B1L9K7
	152.5	Quart Grab	B1L9K8
	155	Quart Grab	B1L9K9
	157.5	Quart Grab	B1L9L0
Split-Spoon Interval #4	160-162.5	Split-Spoon	B1L9W2
	160	Quart Grab	B1L9L1
	162.5-165	Split-Spoon	B1L9W3
	162.5	Quart Grab	B1L9L2
	165-167.5	Split-Spoon	B1LWL4
	165	Quart Grab	B1L9L3
	165-167.5	Split-Spoon	B1LBK8
	167.5-170	Split-Spoon	B1L9W5
	167.5	Quart Grab	B1L9L4
	170	Quart Grab	B1L9L5

Table A-1. Sample Depths and HEIS #s for C5195. (4 sheets)

Sample Interval	Sample Depth (ft bgs)	Sample Method	HEIS #
	172.5	Quart Grab	B1L9L6
	175	Quart Grab	B1L9L7
	177.5	Quart Grab	B1L9L8
	180	Quart Grab	B1L9L9
	182.5	Quart Grab	B1L9M0
Split-Spoon Interval #5	185-187.5	Split-Spoon	B1L9W6
	185	Quart Grab	B1L9M1
	187.5-190	Split-Spoon	B1L9W7
	187.5	Quart Grab	B1L9M2
	190-192.5	Split-Spoon	B1L9W8
	190	Quart Grab	B1L9M3
	192.5-195	Split-Spoon	B1L9W9
	192.5	Quart Grab	B1L9M4
	195	Quart Grab	B1L9M5
	197.5	Quart Grab	B1L9M6
	200	Quart Grab	B1L9M7
	202.5	Quart Grab	B1L9M8
	205	Quart Grab	B1L9M9
	207.5	Quart Grab	B1L9N0
	210	Quart Grab	B1L9N1
	212.5	Quart Grab	B1L9N2
	215	Quart Grab	B1L9N3
	217.5	Quart Grab	B1L9N4
Split-Spoon Interval #6	217.5-220	Split-Spoon	B1L9X0
	220-222.5	Split-Spoon	B1L9X1
	220	Quart Grab	B1L9N5
	222.5-225	Split-Spoon	B1L9X2
	222.5	Quart Grab	B1L9N6
	225-227.5	Split-Spoon	B1L9X3
	225	Quart Grab	B1L9N7
	227.5-230	Split-Spoon	B1L9X4
	227.5	Quart Grab	B1L9N8
	230-232.5	Split-Spoon	B1L9X5
	230	Quart Grab	B1L9N9
	232.5-233.6	Split-Spoon	B1L9X6
	232	Quart Grab	B1L9P0
	253	Pumped Water Sample	B1MC67

Table A-1. Sample Depths and HEIS #s for C5195. (4 sheets)

Sample Interval	Sample Depth (ft bgs)	Sample Method	HEIS #
Rattlesnake Ridge Interbed	318-320.5	Split-Spoon	B1LBJ8, B1L9P6, B1L9P7, B1L9P8, B1LP9, B1L9RO, B1LBC9
	325	Pumped Water Sample	B1LBL2, B1LHJ7, B1LBK9
	341-343.5	Split-Spoon	B1L9T5, B1LBD0, B1LBK0, B1L9R1, B1L9R2, B1L9R3, B1L9R4, B1L9R5, B1L0T2, B1L9T3, B1L9T4
	349.5	Pumped Water Sample	B1LBJ9, B1LBL0, B1LBL3
	362.4-364.2	Split-Spoon	B1LBK1, B1L9R6, B1L9R7, B1L9R8, B1L9R9, B1L9T0, B1LBD1
	377.8	Pumped Water Sample	B1LBK2, B1LBKB1, B1LBL4, B1LBL5

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APPENDIX B

WELL DOCUMENTATION FOR 699-48-50B (C5196)

Borehole Log

Photographic Log

Well Summary Sheet

Well Construction Summary Report

Well Development and Testing Data

Well Survey

Sample Depths and HEIS #s

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BOREHOLE LOG

Page 1 of 6
Date: 10/25/06

Well ID: C5196 | Well Name: 699-48-50B | Location: 300yd N of 200 E Fence near 1 Rt 12 & 41

Project: 200-BP-5 | Reference Measuring Point: ground

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0 - 5' no Recovery	Cable tool, ~~7.5"~~ 8" casing. Drive Barrel
5	Grab			5' - Gravelly silt gM: 60% gvl 40% silt Gvl: 95% basalt, 5% qzt/other, 8cm - 3cm (sc - VFP) R, Silt: VFS - Silt R, 90% qzt/other 10% basalt, 2.5y 4/3 Olive Brown, Moist, Wk Rxn HCl	7' DR ↑ 8' cuttings contain ↑ sand
10	Grab			10' - 26' Sand S: C-VF, ~~90% basalt~~ 90% qzt 10% basalt, Slightly Moist No Rxn HCl, Angular, 2.5y 6/1 Gray	
15	Grab			15' same as above w/ higher % Coarse Sand	DR ↑
20	Grab			20' Same as above w/ Darker Color 2.5y 4/1. Clumps of Sand Show orange mottling	
25	Grab			25' - Gravelly Sand gS: 90% sand 10% gvl; Gvl: 60% qzt/other, 40% basalt, R, 6cm - 3mm (sc - VFP) Sand: VC - F, A, 70% qzt/other 30% basalt, 2.5y 4/1, Dark gray, Moist, VW Rxn HCl	26' gvl ↑ to 10 cm DR ↓ 28' Sand less Coarse
30	Grab			28-35' Silty Sandy Gravel msG: 70% gvl 15% sand 15% silt; Gvl: 7cm - 3mm (sc - VFP) 70% basalt 30% qzt, R-SR, Art = ↑ Rounding Sand: C-F 60% qzt 40% basalt, A, 2.5y 4/2 Drk gray/Brown, Moist, Wk Rxn HCl	
35	Grab			35' Sandy Gravel sG: 70% gvl 30% sand gvl: 60% basalt 40% qzt, R-SR. Sand: VC - F, 60% qzt 40% basalt, A, Moist No Rxn HCl 2.5y 4/2 Dk grayish brown	gvl 11cm - 3mm

Reported By: JEFF FETHERS | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: [signature] Date: 10/26/06 | Signature: [signature] Date: 3/12/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 6
Date: 10/26/06

Well ID: C5196 | Well Name: 699-48-50B | Location: 300 yd N of 200E Fence near + R12 & 4

Project: 200BP5 | Reference Measuring Point: ground

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	grab			40' Sandy Gravel sG: Same as above w/clasts upto 13cm (L.C), more moist, Suspect larger Clasts	38' DR ↓
	grab			42' Gravelly Sandy Silt gsM: 50% Silt, 25% snd 25% gvl; Snd: VC-F 50% basalt 50% qzt, A; Gvl: 6cm-3mm (VCR-VFP) 60% basalt 40% qzt, R-SR; Silt Vwk Rxn HCl 2.5y 5/2 grayish brown moist	43' DR ↑
45	grab				46' DR ↑
				45' Sand S: 95% snd 5% gvl; gM 1-2cm (MP), R, basalt; Snd: VC-M, A, 50% qzt, 50% qzt, 2.5y 4/2 Dk grayish brown, moist, no Rxn HCl	
50	grab			50' Same as above w/gvl upto 3cm	
				53' ≤1' silt lens, S Rxn HCl, moist 10yR 5/3 Brown	
55	grab			55' Same as above w/gvl upto 5.5cm	
60	grab			60' Same as above. w/gvl 1cm-3cm	
65	grab			65' Sand S: C-M, 90% qzt, 10% basalt A 2.5y 5/2 Grayish Brown, moist Vwk Rxn HCl	
70	grab			70' Same as above, 80% qzt 20% basalt, Basalt = C sand / 1ea" sized gvl.	
75	grab			75' Sand S: 90% qzt 10% basalt Med - Fine grain, A - SA no Rxn HCl, 10YR 5/3 brown, moist	

Reported By: Jeff Fetters | Reviewed By: L. D. Walker

Title: Geologist | Title: Geologist

Signature: [signature] | Date: 10/26/06 | Signature: [signature] | Date: 3/12/07

A-BC03-E42 (03/03)

BOREHOLE LOG

Page 3 of 6
Date: 10/26/06

Well ID: C5196 | Well Name: 699-48-50B | Location: 300yd N of 200E Fence near ± Rt 12 & 4

Project: 200-BP-5 | Reference Measuring Point: Ground

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
80	grab			80' - Same as above w/ VC - M grain Snd. 80% med grain	Cable tool 7.5" Casing, 6.5" DB
85	grab			85' - Slightly Silty Sand: 80% Snd 20% Silt; Snd: VC - VF, 90% qzt 10% basalt, A, moist, 10YR 4/3 Brown; wk Rxn HCl	
90	grab			86' Sand is lighter gray w/ strong Rxn HCl, same lithology as above, 10YR 6/2 light brownish gray	91-92' gravelly sand weakly cemented, str Rxn HCl, gvl to 3cm 70% qzt 30% basalt
				90' - Sand S: 90% Snd 10% gvl; Gvl: 1.5cm - 3mm, 50% basalt 50% qzt, SR - SA, Snd VC - F, 70% qzt 30% basalt, moist, med Rxn HCl 10YR 6/2	Snd = same litho as 90'
95	grab			95' - Sand S: 80% qzt/other 20% basalt VC - F, A, Dry, 10YR 5/2 grayish brown V wk Rxn HCl	
100	grab			100' Same as above	
105	grab			105' Same as above	
110	grab			110' Same as above	
	grab			112' Silty Sand mS: 80% Snd 20% Silt; Snd: 90% qzt/other 10% basalt, A, VC - VF; Silt: Dry, 10YR 6/2 lt. brownish gray, strong Rxn HCl	111' sand becoming Finer grained
115	grab			115' - lithology same as 110' bgs.	

Reported By: Jeff Fetters | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: Jeff Fetters | Date: 10/26/06 | Signature: L.D. Walker | Date: 3/12/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 4 of 6
Date: 10/27/06

Well ID: C5196 | Well Name: 699-40-50B | Location: 300yd N of 200 Fence near ⊥ R1234

Project: 200-BP-5 | Reference Measuring Point: ground

Depth (FL)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120	grab			120' Sand S; same lithology as above, no Rxn HCl	Cable Tool 8" casing 6.5" DB
121	grab			121' Silt M; str Rxn HCl, 10YR 6/2 lt. brownish gray, Dry	121' thick lenses of VF Sand < 6" thick
125	grab				
130	grab			130' Silt M; moist vstr Rxn HCl, 10YR 6/3 Pale Brown, low strength	
135	grab			135' Silt M; moist, str Rxn HCl, mod strength, 10YR 4/3 Dk grayish brown thin lenses of VF Sand, Reddish brown mottling.	135' sample saturated but no free water present.
137	grab			137' Silt M; moist (less than above) low strength, str Rxn HCl, 10YR 4/2 Dk grayish brown	
140	grab			140' Silt M; moist (same as 135') 10YR 5/3 brown, mod Rxn HCl, no mottling high strength	140' lithology present @ 139' bgs. Sample is saturated w/ no free H_2O present
144	grab			144' Silty Sand mS; 75% sand 25% silt Sand: VC-VF, 60% qzt/other 40% basalt, A, gvl up to 20cm ≤ 3% of sample; Silt VWK Rxn HCl, DRY, 10YR 6/2, lt. grayish brown	
145	grab			145' Silt M; 80% silt 20% sand; Sand 80% qzt/other 20% basalt, A, C-VF, Silt: str Rxn HCl, Dry, 10YR 6/2 lt. brownish gray	147' add 2 liters H_2O
150	grab			150' Sand S; 90% qzt 10% basalt C-VF, A, Dry, VWK Rxn HCl, 2.5Y 5/2 grayish brown	151' add 2 liters H_2O
155	grab			155' Silty Sand mS; 60% sand 40% silt Sand: VC-VF, A-SA 90% qzt 10% basalt; Silt: Mod Rxn HCl, Dry, 10YR 6/2 lt. brownish gray	

Reported By: Jeff Fetters | Reviewed By: L.D. Walker
Title: Geologist | Title: Geology
Signature: [signature] Date: 10/27/06 | Signature: [signature] Date: 3/12/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 5 of 6

Date:

Well ID: C5196 | Well Name: 699-48-50B | Location: 300yd N of 200E fence near Lrt 12 & 4

Project: 200-BP-5 | Reference Measuring Point: ground

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
160	grab			160 silt M; 90% silt 10% snd; snd m-vf, qtz, A-SA; silt, dry, mod rxn HCL 10YR 7/2 lt. gray	
					162' cutting chnging ↑ in snd
165	grab			165' silt M 80% silt 15% snd 5% gvl; gvl up to 3mm (vfp), A-SA, qtz/other; snd c-vf, qtz 90% basalt 10%, A, silt 10YR 5/2 lt. brownish gray dry, mod rxn HCL	
170	grab			170 sandy silt sM: 70% silt 25% snd 5% gvl; gvl 1-3mm (vfp) 50% basalt 50% qtz, A-SA; sand vc-vf, A-SA, 80% qtz 20% basalt; silt strong rxn HCL dry, 10YR 6/2 lt. brownish gray	169' ↑ snd content 172' ↑ snd-c
175	grab			175 gravelly sandy silt gsM: 70% silt 15% snd 15% gvl; gvl 50% basalt 50% qtz 2cm-3mm (mp-vfp) SA-SR; snd 90% qtz, 10% basalt, A-SA, vc-vf; silt strong rxn HCL, dry, 10YR 5/2 grayish brn	
180	grab			180-same as above	
185	grab			185-185 sandy silt sM; silt 60% snd 35% gvl 5% lith same as above	185.5
	GRAB				~~186.5~~ grab HEIS#B1L1P9
	GRAB			190-same as above	189.3' GRAB HEIS#B1L1R0
190	grab				191.2' GRAB HEIS#B1L1R1
					193.5' GRAB HEIS#B1L1T0
	GRAB S/S				193.5'-196' SS HEIS#B1L1B2
195	grab			195-197 sandy silt sM 40% silt, 15% clay 25% snd lith same as above w/ clay nodules; clay strong rxn HCL, 2.5Y 4/2 dk grayish brn	196' GRAB HEIS#B1L1R3 199.5' GRAB HEIS#B1L1R4
	GRAB/SS				198.5-201 SS HEIS#B1L1T1

Reported By: Erika Rincon | Reviewed By: L.D. Walker

Title: geologist | Title: Geologist

Signature: Erika R | Date: 11-2-06 | Signature: LD Walker | Date: 3/12/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 6 of 6
Date: 11-14-06

Well ID: C5196 | Well Name: 699-48-50B | Location: 300 yd N of 200 E fence near L & 12 & 4

Project: 200-BP-5 | Reference Measuring Point: ground surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
200	grab			197-205 clay M 100% clay	
	GRAB			GLEY 2 4/5B dark bluish gray, moist	
				strong rxn HCL	201 GRAB HEIS# B1L1R5
	GRAB				
					2035 GRAB HEIS# B1L1R6
205	grab			205-207 silty clay M, 70% clay 30% silt	
	GRAB			2.5Y 4/3 olive brown moist strong rxn	206 GRAB HEIS# B1L1R7
	S/S GRAB			to HCL	207 S-S HEIS# B1L1T2,
				207-209.5 sandy gravel	B1L355, B1L361, B1L362,
	S/S				B1L363, B1L374, B1L377
210	grab			209.5-214.7 basalt mixed w/ coarse	B1L378, B1L379
				sand; basalt 70% sand 30%; basalt	2nd S-S 207.7-209.4
				2.5Y 2.5/1, black; sand rc, qtz, feldspar;	207 GRAB HEIS# B1L2R8
				wet, no rxn HCL	209.4 S-S no recovery
215					~~TD 214.7' bgs~~
					TD = 215.2' bgs

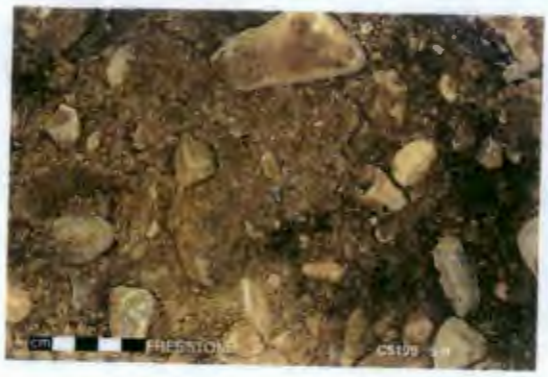
Reported By: Erika Rincon | Reviewed By: L.D. Walker

Title: geologist | Title: Geologist

Signature: Erika R | Date: 11-14-06 | Signature: L.D. Walker | Date: 3/12/07

A-8003-642 (03/03)

Well C5196

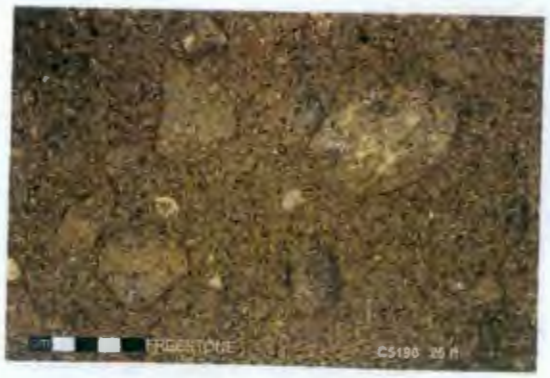


5 ft

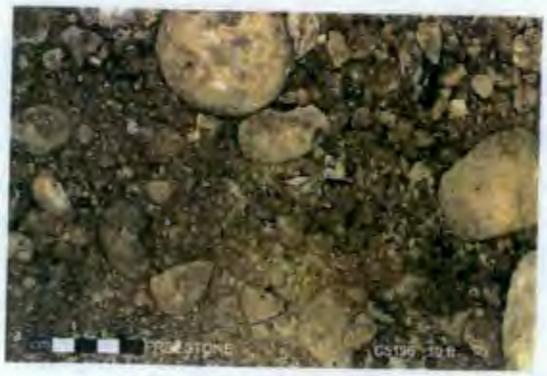
10 ft

15 ft

20 ft



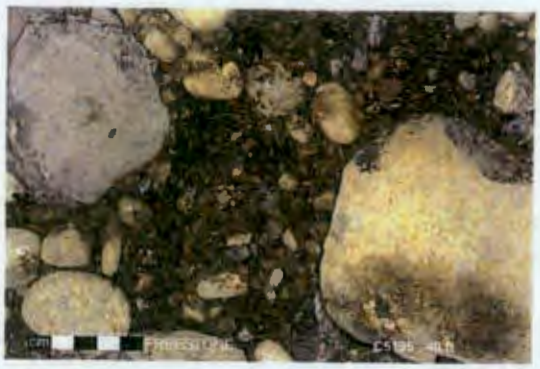
25 ft



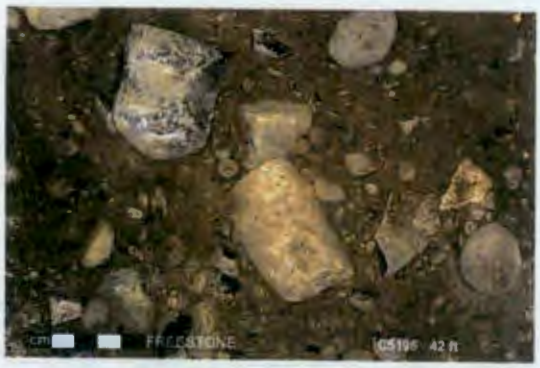
30 ft

Well C5196

35 ft



40 ft



42 ft

45 ft

50 ft

53 ft

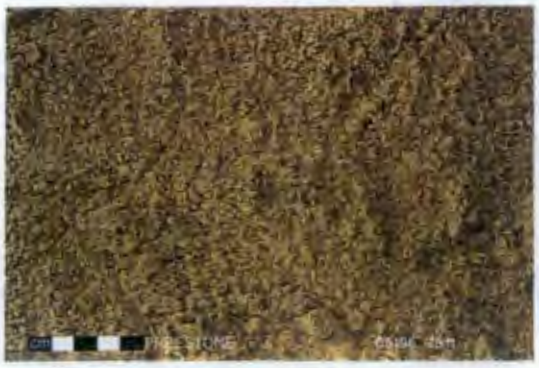
Well C5196

55 ft

60 ft

65 ft

70 ft



75 ft

80 ft

Well C5196

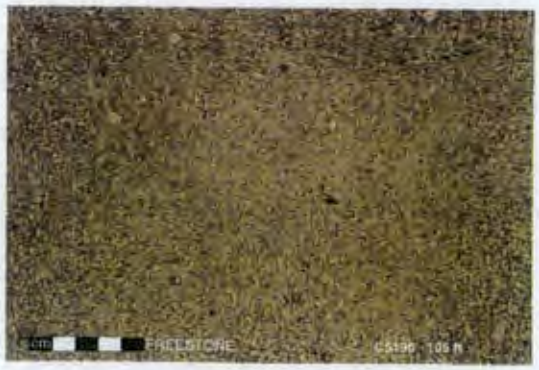
85 ft

86 ft

90 ft

95 ft

100 ft



105 ft

Well C5196

110 ft

113 ft

115 ft

120 ft

121 ft

125 ft

Well C5196

130 ft

135 ft

137 ft

140 ft

144 ft

145 ft

Well C5196

150 ft

155 ft

160 ft

165 ft

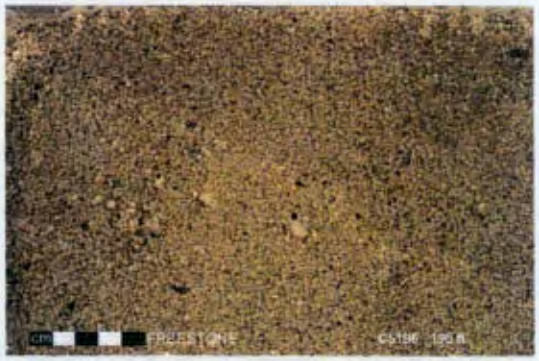
170 ft

175 ft

Well C5196

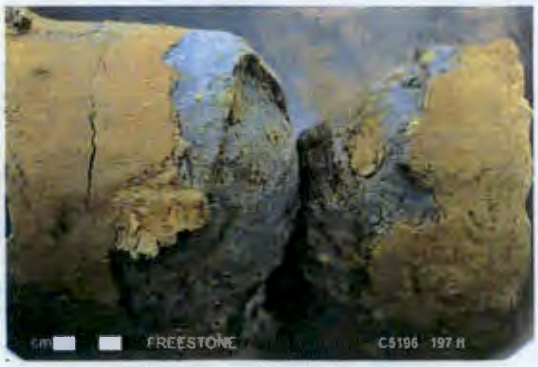
180 ft

185 ft

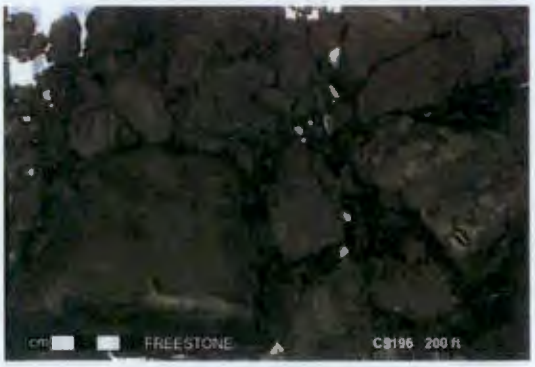


190 ft

195 ft



197 ft

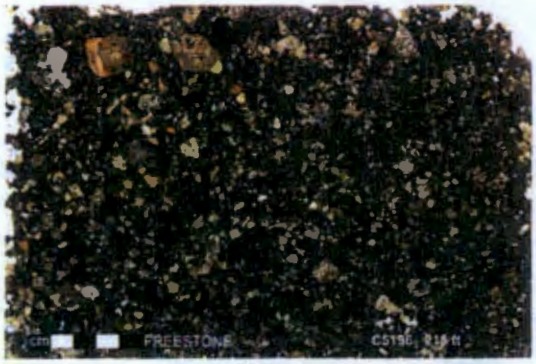


200 ft

Well C5196

205 ft

210 ft



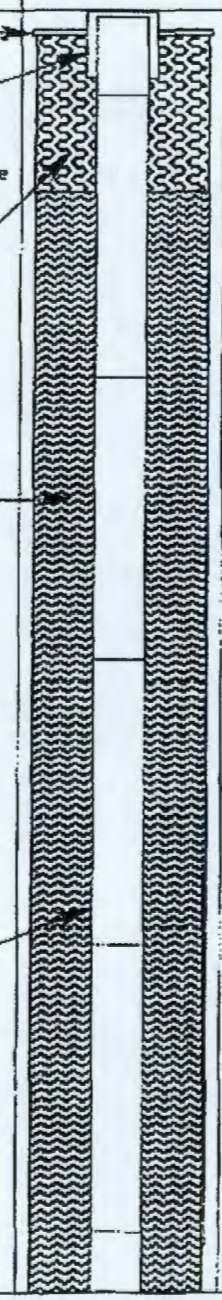
215 ft

WELL SUMMARY SHEET	Start Date: 10-25-06 Finish Date: 12-5-06	Page 1 of 3

Well ID: C5196	Well Name: 699-48-50B
Location: 300 yd N of 200E fence near intersection of Rt. 4 &12	Project: 200-BP-5 Monitoring Wells
Prepared By: Jeff Fetters — Date: 12/21/06	Reviewed By: L. D. Walker — Date: 3/12/07
Signature: [signature]	Signature: [signature]

CONSTRUCTION DATA

Description	Diagram
6-in Concrete Pad	
6-in I.D. Type 304/304L Stainless Steel Protective Casing: +2.1 ft above Ground Surface	
Portland Cement Type I/II: 0 - 10.7 ft	
Granular Bentonite Crumbles: 10.7 - 193.9 ft	
4-in I.D. Type Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +2.1 - 204.2 ft	



All depths are in feet below ground surface.

Borehole drilled with 8-in threaded casing.

All temporary drill casing was removed from the ground.

GEOLOGIC/HYDROLOGIC DATA

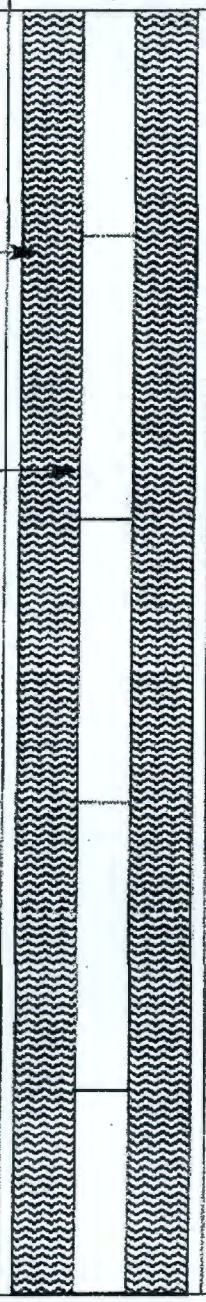
Depth in Feet	Graphic Log	Lithologic Description/Groundwater Sample Depths (ft bgs)
0		0-5 Sandy Gravel sG (Fill)
		5-10 Gravelly Silt gM
10		10-25 Sand S
20		
		25-28 Gravel Sand gS
30		28-35 Silty Sandy Gravel msG
		35-42 Sandy Gravel sG
40		42-45 Gravelly Sandy Silt gsM
		45-65 Sand S
50		53 Silt Lens ~ 1 ft
60		
		65-75 Sand S
70		
		75-85 Sand S
80		
		85-90 Slightly Silty Sand mS

WELL SUMMARY SHEET	Start Date: 10-25-06 Finish Date: 12-5-06	Page 2 of 3

Well ID: C5196		Well Name: 699-48-50B	
Location: 300 yd N of 200E fence near intersection of Rt. 4 & 12		Project: 200-BP-5 Monitoring Wells	
Prepared By: Jeff Fetters	Date: 12-21-06	Reviewed By: L. D. Walker	Date: 3/12/07
Signature: [signature]	2/7/06	Signature: [signature]	

CONSTRUCTION DATA

Description	Diagram
Granular Bentonite Crumbles: 10.7 - 193.9 ft	
4-in I.D. Type Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +2.1 - 204.2 ft	
All depths are in feet below ground surface.	
Borehole drilled with 8-in threaded casing.	
All temporary drill casing was removed from the ground.	



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description/Groundwater Sample Depths (ft bgs)
90		90-112 Sand S
100		
110		112-115 Silty Sand mS
		115-121 Sand S
120		121-144 Silt M
130		
140		144-145 Silty Sand mS
		145-150 Silt M
150		150-155 Sand S
		155-170 Silt M
160		
170		170-175 Sandy Silt sM
		175-185 Gravelly Sandy Silt gsM

WELL SUMMARY SHEET	Start Date: 10-25-06 Finish Date: 12-5-06	Page 3 of 3
Well ID: C5196	Well Name: 699-48-50B	
Location: 300 yd N of 200E fence near intersection of Rt. 4 & 12	Project: 200-BP-5 Monitoring Wells	
Prepared By: Jeff Fetters Date: 12-21-06	Reviewed By: L. D. Walker	Date: 3/12/07
Signature: 2/7/06	Signature:	

CONSTRUCTION DATA

Description

Granular Bentonite Crumbles: 10.7 - 193.9 ft

1/4-in Bentonite Pellets: 193.9 - 199.6 ft

Primary Filter pack
10-20 Mesh Colorado Silica Sand: 199.6 - 214.7 ft

Static Water Level: 208.14 ft bgs (11-29-2006)

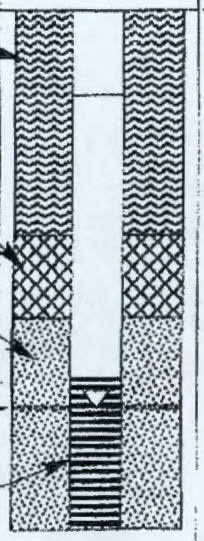
4-in I.D. Stainless Steel, Type 304, Slot 20 (.020 in) Screen: 204.2 - 214.5 ft

All depths are in feet below ground surface.

Borehole drilled with 8-in threaded casing.

All temporary drill casing was removed from the ground.

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 180, 190, 200, 210, 214

Graphic Log

Lithologic Description/Groundwater Sample Depths (ft bgs)

185-197 Sandy Silt sM
185.5 Grab HEIS# B1LP9
189.3 Grab HEIS# B1L1R0
191.2 Grab HEIS# B1L1R1
193.5 Grab HEIS# B1L1T0*
196 Grab HEIS# B1L1R3
197-205 Clay M
198.5 Grab HEIS# B1L1R4*
201 Grab HEIS# B1L1R5
203.5 Grab HEIS# B1L1R6*
205-207 Silty Clay M
207-209.5 Sandy Gravel
209.5-214.7 Basalt

215.2 ft Total Depth Drilled (11/15/2006)

* See Below For Additional Sample Locations and HEIS#s

193.5-196 SS HEIS# B1L1R2
198.5-201 SS HEIS# B1L1T1
206 Grab HEIS# B1L1T2
207 SS (See FAR and Borehole Log for HEIS#)
207 Grab HEIS# B1L1R8
211.93 Water Sample HEIS # B1L1370 & B1L1371

WELL CONSTRUCTION SUMMARY REPORT

Start Date: 10/25/06
Finish Date: 12/5/06
Page 1 of 1

Well ID: C5196 | Well Name: 699-48-50B | Approximate Location: 300 yd N 200 E Fence near 1 Rt 12 & 4

Project: 200-BP-5 monitoring wells | Other Companies: Freestone Environmental Services

Drilling Company: Blue Star | Geologist(s): Erika Rincon, Greg Kazos, Jeff Fetters

Driller: Justin England | License #:

TEMPORARY CASING AND DRILL DEPTH			DRILLING METHOD	HOLE DIAMETER (in.) / INTERVAL (ft)
*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.	Auger:	Diameter: ____ From ____ to ____
8" ID / 8 3/4" OD	0 - 209.9	8" ID / 8 3/4" OD	Cable Tool:	Diameter: 8 3/4 From 0 to 214.4 215.2
	-		Air Rotary:	Diameter ____ From ____ to ____
	-		A.R. w/Sonic:	Diameter ____ From ____ to ____
	-			Diameter ____ From ____ to ____
	-			Diameter: ____ From ____ to ____
*Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design				Diameter: ____ From ____ to ____

Drilling Fluid: Water

Total Drilled Depth: ~~214.7~~ 215.2 | Hole Dia @ TD: 6" | Total Amt. Of Water Added During Drilling: 1700 gal

Well Straightness Test Results: | Static Water Level: 207.88' | Date: 12/5/06

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date	Sondes (type)	Interval	Date
Spectral Gamma	0 - 210	11/13/07		-	
moisture	0 - 207	11/13/07	NA	-	
	-			-	

COMPLETED WELL

Size/Wt./Material	Depth	Thread	Slot Size	Type	Interval Annular Seal/Filter Pack	Volume	Mesh Size
4" ID / Sch. 10 / TP 304 SS	+2.1 - 204.2	F480	NA	Portland Cement	0 - 10.7		NA
4" ID / Sch. 10 / TP 304 SS	204.2 - 214.5	F480	20	Bentonite Crumbles	10.7 - 193.9		NA
	-			Bentonite Pellets	193.9 - 199.6		1/4"
	-			Colorado Silica Sand	199.6 - 215.2		#-20
	-				-		

OTHER ACTIVITIES

Aquifer Test: NA | Date: | Well Decommission: NA | Yes: | No: | Date:

Description: | Description:

WELL SURVEY DATA (if applicable)

Not surveyed at this time | Protective Casing Elevation:

Washington State Plane Coordinates: | Brass Survey Marker Elevation:

COMMENTS / REMARKS

Reported By: Jeff Fetters | Title: geologist | Signature: [signature] | Date: 12/5/07

A-6003-858 (04/03)

WELL DEVELOPMENT AND TESTING DATA

Well Name:	Well ID:	Well Location:	Date:
699-48-50B	C5196	300 yd N of 200E Fence near L Rt 4W	12/4/06

Reference Measuring Point (unless otherwise noted): TOP OF OUTER CASING (TOC)

Has the well been surveyed? ○ Yes ☒ No | Does the well have a cement pad? ○ Yes ☒ No

PART 1

STATIC WATER LEVEL:

Start of Job	207.98' bgs
End of Job	207.84' bgs

DEPTH TO BOTTOM:

Start of Job	213.1' bgs
End of Job	214.22' bgs

PART 2

WELL DEVELOPMENT DATA

Pump Model	Redi-Flo
Intake Depth	211.93
Starting Turbidity	> 1000 NTU

Pump Start	Stop	Flow Rate
(12/4) 1247	1610	1gpm
(12/5) 0828	1420	1.5gpm

Total Pumped	690 gal.
Final Turbidity	1.14
XD SN/Range (PSI)	

PART 3

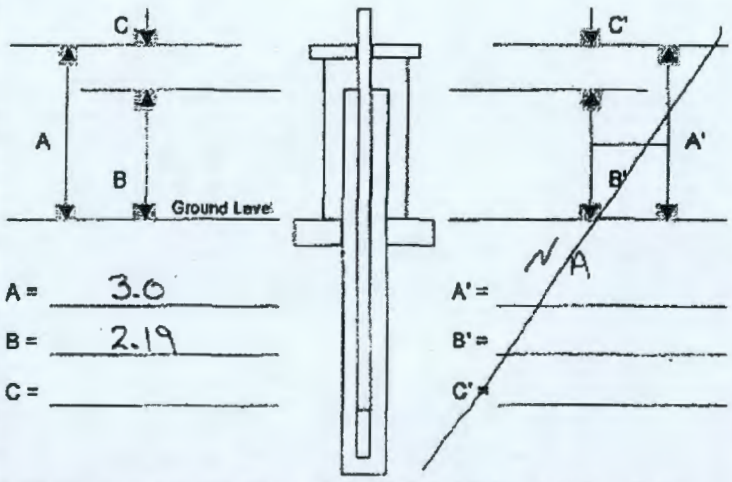
INSTANTANEOUS SLUG TEST

Static Water Level (TOC)	
Transducer Depth	
Baseline Start	
Injection Start	
Baseline Start	
Withdrawal Start	
Slug Volume	
XD SN/Range (PSI)	

PART 4

Last Recorded Measurements Date: 12/4/06

Current Measurements Date:



A =	3.0	A' =	N/A
B =	2.19	B' =	
C =		C' =	

Are there any reference marks on the casing strings? ○ Yes ○ No

PART 5

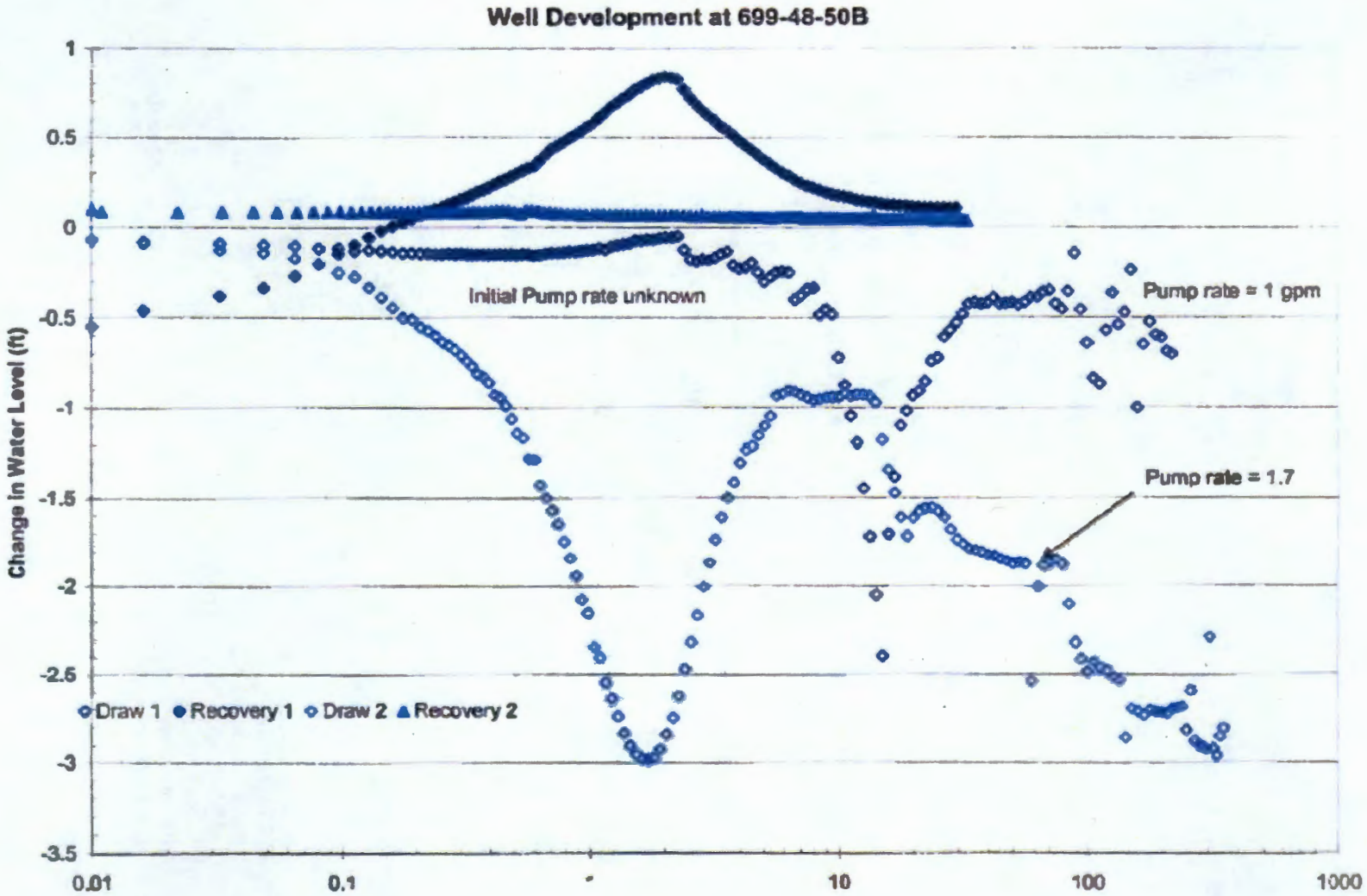
COMMENTS:

Test # 1 (Draw Down)
Test # 2 (Recovery) } - 12/4/06

Test # 3 (Draw Down)
Test # 4 (Recovery) } - 12/5/06

Prepared by (print name):	Signature:	Date:
Jeff Fetness	[signature]	12/21/06
Reviewed by (print name):	**Signature:**	**Date:**
L.D. Walker	[signature]	3/12/07

A-6003-644 (03/03)


Well Development at 699-48-50B
Change in Water Level (ft)
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
0.01
0.1
10
100
1000
Initial Pump rate unknown
Pump rate = 1 gpm
Pump rate = 1.7
Draw 1
Recovery 1
Draw 2
Recovery 2

WELL SURVEY DATA REPORT

Project:	**Prepared By:** N.P. Fastabend **Company:** FGG
Date Requested: 1/23/07	**Requestor:** C.S. Wright (FH)
Date of Survey: 2/26/07	**Surveyor:** N.P. Fastabend FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** J.M. Schwing
Description of Work: Civil Survey of Groundwater Monitoring Well C5196 / 699-48-50B.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** METERS **Hanford Area Designation:** 600A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
GABLEMTN (FH), 2E-1 (FGG)

Vertical Control Monuments:
J317 (C.O.E.), HSWB-032 (C.O.E.)

Well ID	Well Name	Easting	Northing	Elevation	
C5196	699-48-50B	573334.48	138044.28		Center of Casing
				186.313	Top Pump Baseplate, N. Edge
				186.303	Top of Casing, N. Edge
				185.562	Brass Survey Marker

Notes:

EQUIPMENT USED: TRIMBLE GPS 5800 RTK
TRIMBLE DiNi 12 LEVEL

LARRY A. HENKE
STATE OF WASHINGTON
38975
REGISTERED
PROFESSIONAL LAND SURVEYOR
Feb 26 2007
EXPIRES Sept. 23, 2007

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February, 2007 under my direct supervision, and that the data contained here is true and correct.

Original to:
Distribution by DIS:

Table B-1. Sample Depths and HEIS #s for C5196.

Sample Depth (ft bgs)	Sample Method	HEIS #
185.5	Quart Grab	B1L1P9
159.3	Quart Grab	B1L1R0
191.2	Quart Grab	B1L1R1
193.5	Quart Grab	B1L1T0
193.5-196	Split-Spoon	B1L1R2
196	Quart Grab	B1L1R3
198.5	Quart Grab	B1L1R4
198.5-201.0	Split-Spoon	B1L1T1
201	Quart Grab	B1L1R5
203.5	Quart Grab	B1L1R6
206	Quart Grab	B1L1R7
207-209.5	Split-Spoon	B1L1T2, B1L358, B1L361, B1L362, B1L363, B1L374, B1L377, B1L378, B1L379
207	Quart Grab	B1L1R8
209.4-211.9	Split-Spoon	No Recovery

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APPENDIX C

WELL DOCUMENTATION FOR 699-50-56 (C5197)

Borehole Log

Photographic Log

Well Summary Sheet

Well Construction Summary Report

Well Development and Testing Data

Well Survey

Sample Depths and HEIS #s

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BOREHOLE LOG

Page 1 of 5
Date: 10/16/06

Well ID: C5197
Well Name: 699-30-56
Location: 2 1/2 Mile E of R+H 200 yd N R+11
Project: 200-BP-5 monitoring wells
Reference Measuring Point: Ground

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0-5' no Recovery	Cable Tool, 8in ID Casing, 6.5" Drive barrel
				3'-8' Gravelly silt (gM) 70% silt, 20% gvl, 10% snd; Gvl: 50% basalt 50% qzt/other, R-SR, 6cm-3mm (mp-VFP); Snd: 50% basalt 50% qzt/other, vc-VF, A; Silt: moist, wk Rxn HCl, 2.5y 5/2 grayish brown	1st 5' = hard drilling, problems starting advancing casing
5	grab			8-15' Gravelly silt (gM) 70% silt 15% gvl 15% snd; Gvl: 7cm-3mm (mp-VFP) R-SR, 50% basalt, 50% qzt/other; Snd: 70% basalt 30% qzt/other, A, vc-VF; Silt: slightly moist, wk Rxn HCl, 2.5y 4/1 Dark gray	8' DR ↑
10	grab				14' ↑ gravel content
15	grab			15'-20' Silty Sandy Gravel (msG) 50% gvl, 30% silt, 20% snd; Gvl: 50% basalt 50% qzt/other 7cm-3mm (mp-VFP), R-SR; Snd 50% basalt 50% qzt/other, A, vc-VF; Silt: Dry, mod Rxn HCl, 2.5y 5/1 Gray	18 slight increase in moisture
20	grab			20'-22 Silty Sandy Gravel (msG) 70% gvl 15% snd 15% silt; Gvl: 7cm-3mm (mp-VFP), 50% basalt, 50% qzt/other R-SR; Snd: 60% qzt/other 40% basalt, A, vc-VF; Silt: moist, mod Rxn HCl, 2.5y 3/1 Very dark gray	22' ↑ moisture, cuttings more cohesive
25	grab			25'- Silty Sandy Gravel (msG) 80% gvl 15% snd 5% silt; Gvl: 8cm-3mm (cP-VFP) 60% basalt 40% qzt/other, R-SA; Snd: 50% basalt 50% qzt/other, vc-VF, A; Silt: moist, wk Rxn HCl 2.5y 4/2 Dark grayish brown	25' gvls coated w/silt, mod Rxn HCl; 28' ↑ moisture, no free water, ↑ clay content, gvl up to 12 cm
30	grab			30' Silty Sandy Gravel (msG) 80% gvl 10% silt 10% snd; Gvl: 80% basalt 20% qzt, 4cm-3mm (mp-VFP), R-SR, moist slightly larger than "pea" sized; Snd: 50% basalt 50% qzt, A, vc-VF; Silt: moist, wk Rxn HCl, 2.5y 3/1 Very Dk grey	30' gvls coated w/ clay/silt
35	grab			35' Same lithology as above	

Reported By: J. Fetters
Title: geologist
Signature: J. Fetters
Date: 11/16/06

Reviewed By: L.D. Walker
Title: Geologist
Signature: L.D. Walker
Date: 3/8/07

A-6003-842 (03/03)

BOREHOLE LOG

Page 2 of 5
Date: 11/17/06

Well ID: C5197 | Well Name: 699-50-56 | Location: 1/2 mile E Rt 4, 200 yd N Rt 11
Project: BP-5 monitoring wells | Reference Measuring Point: ground

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	grab			40' - Same lithology as above w/ gvl 50% qtz, 50% basalt, slightly less moist	Cable tool 8" ID casing 6.5" Drive barrel DR ↑
45	grab			45' Sandy Gravel (sG) 85% gvl 15% snd gvl: 12cm - 3mm (si - VFP) R-SR, 60% qtz 40% basalt; Snd: VC-VF, A, 50% basalt, 50% qtz, 2.5y 4/2 Dk grayish brown moist, vwk Rxn HCl	44' gvl ↑ size
48	grab			48' gravelly sand (gS) 85% snd 15% gvl; gvl: 3cm - 3mm (mp-VFP), R-SR, 80% basalt 20% qtz, moist "Rea" sized; Snd C-F, A, 70% qtz, 10% basalt, moist 2.5y 4/3 olive brown vwk Rxn HCl	48' ↑ mica content
50	grab			50' Same lithology as above	
55	grab			55' Gravelly Sand (gS) 80% snd 20% gvl; gvl 5cm - 2mm (mp - VFP), 80% basalt, 20% qtz R-A; Snd: F-C (mostly c) 90% qtz 10% basalt, A, vwk Rxn HCl, 2.5y 4/2 Dk grayish brown	
60	grab			60' Sand (S) 95% Snd 5% gvl; gvl: 5mm - 2mm (Fp-VFP) basalt, R-SR; Snd: C-F, A, 90% qtz 10% basalt, moist, 2.5y 5/2 grayish brown, wk Rxn HCl	62' Sand becoming finer, increased mica content
63	grab			63' Sand (S) 90% qtz 10% basalt, A. Fine, moist, 10YR 5/3 brown, vwk Rxn HCl	
65	grab			65' Same lithology as above	
70	grab			70' Same lithology as above w/ F-VF grain	
71	grab			71' Silt (m) moist str Rxn HCl 10YR 5/4 yellowish brown	72' increased "Rea" sized basalt gvl, str Rxn HCl, 2.5y R 6/2 lt brownish gray
75	grab			74' gravelly Silt/Sand (gmS) 70% Snd 20% Silt 10% gvl; Gvl: mp-FP, 90% basalt 10% qtz, R-SR Snd: VC-VF, 80% qtz 20% basalt, A; Silt: slightly moist, str Rxn HCl, 2.5y 6/2 lt brownish grey	

Reported By: Jeff Fehers | Reviewed By: L. J. Walker
Title: geologist | Title: Geologist
Signature: Jeff Fehers | Date: 11/17/06 | Signature: L. J. Walker | Date: 3/8/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 5
Date: 11/21/06

Well ID: C5197 | Well Name: 699-50-56 | Location: 1/2 mile E Rt.4, 200 yd N. Rt. 11

Project: BP-5 monitoring wells | Reference Measuring Point: ground

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
80	grab			80' sand(s) F-VF, A-SA, 90% Qtz, 10% basalt, 2.5y 6/2 lt brownish gray, slightly moist, wk Rxn HCl	
85	grab			85' same lithology as above w/ med Rxn HCl	
					87' cuttings are less moist than above w/ ↑ silt content
90	grab			90' silt(m) slightly moist, 10YR 6/2 lt brownis grey, str Rxn HCl	
95	grab			95' same lithology as above, slight moisture increase	
100	grab			100' same lithology as above	
103	grab			103'-110' silt(m) moist, 10YR 4/3 brown, str Rxn HCl	
105	grab				106' increase in moisture
110	grab			110' sand(s) 90% sand 10% gvl; gvl: basalt A. 2cm-2mm (mp-VFP); sand: VC-F, A. 80% Qtz 20% basalt, Dry, wk cement str Rxn HCl; 10YR 5/2, grayish brown	
111	grab			111' silt(m) same lithology as 103' w/ wk Rxn HCl	
115	grab			115' sand(s) F-VF, 90% Qtz 10% basalt, A-SA, slightly moist, wk Rxn HCl, 10YR 5/2 grayish brown	

Reported By: Jeff Fetters | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: [signature] Date: 11/21/06 | Signature: [signature] Date: 3/8/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 4 of 5
Date: 11/20/06

Well ID: C5197 | Well Name: 699-S0-S2 | Location: 1/2 mile E Rt 4 200 yd N Rt 11

Project: 200-BP-5 monitoring wells | Reference Measuring Point:

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
120	grab			120' same as above	Cable Tool 8" ID
					Casing, 6.5" Drive
				123' Silt (m), moist, wk Rxn HCl,	Barrel
				10YR 4/3 olive brown, slightly	
123	grab			Plastic, orange mottling present	
				125' Silt(m) moist, vwk Rxn HCl, 1gy 4/1	
125	grab			gy dark greenish gray	
				130' Same lithology as above	
130	grab				
131	grab				131-132.5 quart sample
132	grab	grab		132' silt(m) moist, wk Rxn HCl, 10YR 5/3	Heis# BIL7U7
133.5				light olive brown, orange to Red	133.5-134.7 quart sample
				Mottling Present	Heis# BIL7U8
		grab		135' Gravelly sand (gS) 85% sand 15% gvl;	135.5-136.5 quart sample
135	grab			gvl: 10cm-2mm (CP-VFP), 50% basalt 50%	Heis# BIL7U9
136.5		grab		qtz, R-SR; sand: VC-F, 70% qtz 30% basalt, A	
				wk Rxn HCl, 10YR 5/2 grayish brown, slight	138.5-140' quart sample
138.5				moist	Heis# BIL7U10
		grab		140' gravelly silty sand (gmS) 80% sand 10% gvl	
140	grab			10% silt; gvl: 3cm-2mm (FP-VFP), R-SR, 50%	141-142.5 quart sample
141		grab		basalt 50% qtz; sand: VC-VF, A, 90% qtz, 10%	Heis# BIL7U1
142.5				basalt; silt: silt is slightly moist, mod Rxn HCl	143.5-145' quart sample
143.5				10YR 5/2 grayish brown	Heis# BIL7U2
		grab		145' same lithology as above w/	
145	grab			wk Rxn HCl	146-147.5 quart sample
146					# BIL7U3
		grab		150' sand(S) 90% sand 10% gvl; gvl: 1cm	148.5-150 quart sample
148.5				-2mm (mp-VFP), 90% basalt 10% qtz, A-R;	# BIL7U4
150	grab	grab		sand: VC-F, A, 70% qtz 30% basalt, 2.5y	148' larger gvls present
151				4/1 Dark gray moist, no Rxn HCl	
151.5	grab	split spoon		151.5 gravelly silty sand (gmS) 80% sand	~~152'~~ 5/2
				10% gvl 10% silt; gvl 4cm-2mm (CP-VFP)	
153.5		split spoon		basalt 80% 20% qtz, R-SR; sand: VC-VF, A, 90	* See FAR (11-21-06) for
155	grab			% qtz 10% basalt; silt: very moist, no Rxn	Heis #3 for split
156				HCl, 2.5y 4/2 Dk grayish brown.	spoons samples
		split spoon		155' sandy gravel (SG) 60% gvl 40% sand trace 5% b.	159' water sample # BIL8T3
				50% qtz, 3cm-2mm (mp-VFP), R-SR; sand: VC-	Pump intake = 159' bgs
159.5				VF, 90% qtz 10% b, A, no Rxn HCl, 10YR 3/1, v Dk gray	

Reported By: Jeff Fetters | Reviewed By: L. D. Walker

Title: Geologist | Title: Geologist

Signature: [signature] | Date: 11/22/06 | Signature: [signature] | Date: 3/8/07

A-6003-642 (03/03)

BOREHOLE LOG

Page 5 of 5
Date: 11/21

Well ID: C5197 | Well Name: 699-50-56 | Location: 1/2 mile E Bl.4, 200yd N Bl. 11

Project: 200-BP-5 Monitoring wells | Reference Measuring Point:

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
160	grab			160' Silty Sandy Gravel (msG) 60% gvl 30% snd 10% silt; Gvl: 7mm-2mm (sc-vfp)	160' Dr ↓
161				60% ~~gr~~ 40% basalt, R-SR, snd: vc-VF, A, 60% gr 40% basalt, silt: moist, no Rxn HCl,	8"
				10 YR 4/1 Dark gray	161' - 6.5 ft hard tool installed
164.1				161' Basalt contact	164.1' logs = TD
165				164.1' Total Depth	
					161 - 164.1' - Cable Tool 8" casing, 8" Hard tool.
170					

Reported By: Jeff Fellers | Reviewed By: L. D. Walker

Title: Geologist | Title: Geologist

Signature: Jeff Fellers | Date: 11/28/06 | Signature: LD Walker | Date: 3/8/07

A-6003-642 (03/03)

Well C5197

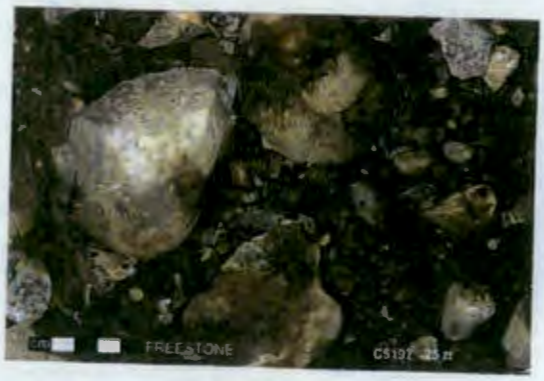
5 ft

10 ft

15 ft

20 ft

22 ft

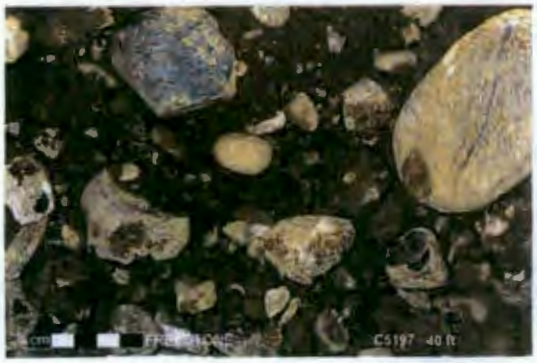


25 ft

Well C5197

30 ft

35 ft



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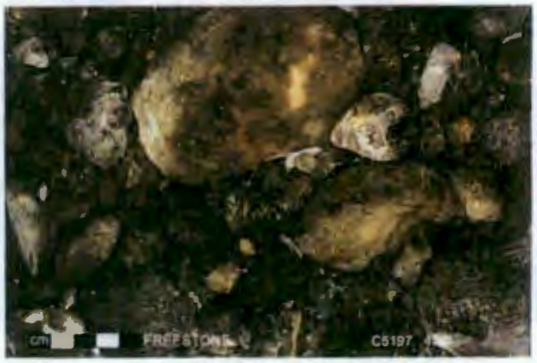
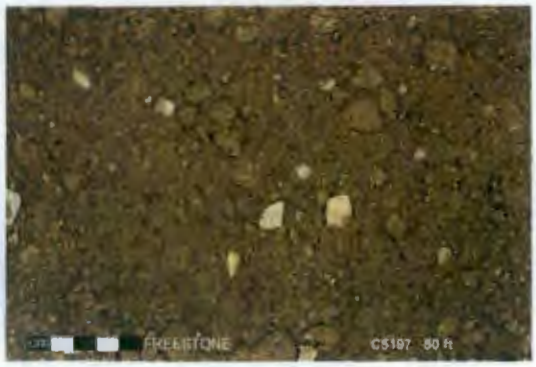


45 ft

48 ft



50 ft

Well C5197

55 ft

60 ft

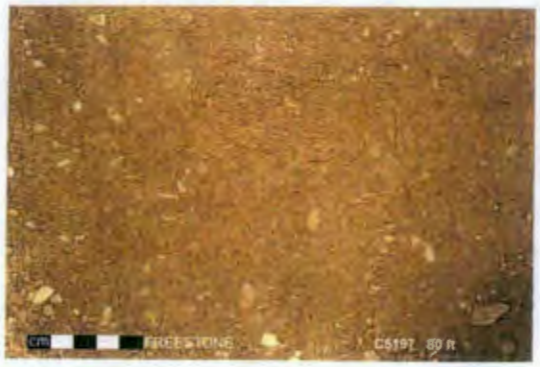
65 ft

70 ft

71 ft

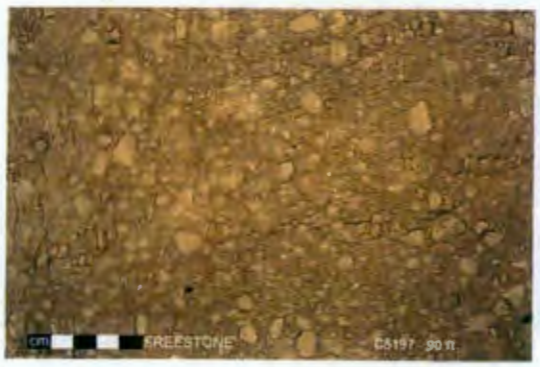
75 ft

Well C5197



80 ft

85 ft



90 ft

95 ft

100 ft

103 ft

Well C5197

105 ft

110 ft

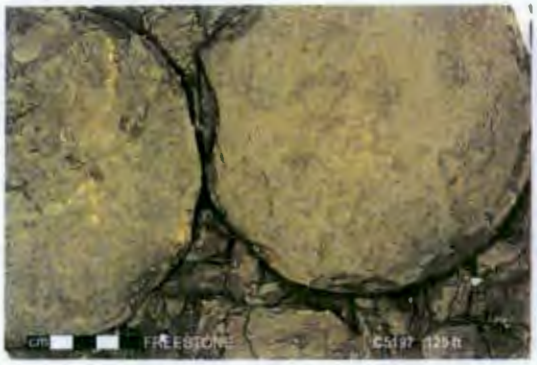
111 ft

115 ft

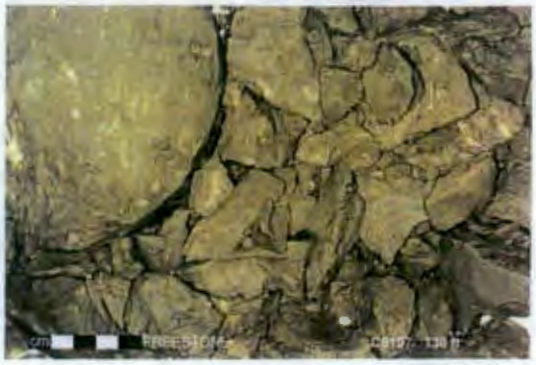
120 ft

123 ft

Well C5197

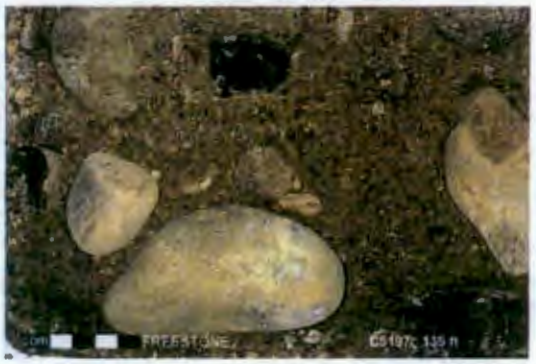


125 ft



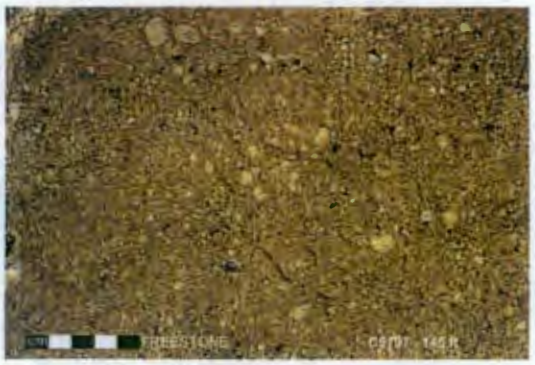
130 ft

132 ft



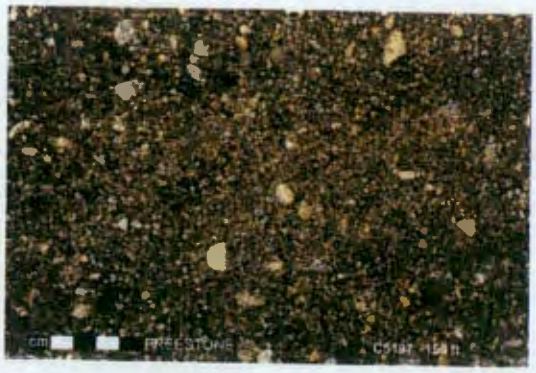
135 ft

140 ft



145 ft

Well C5197



150 ft

152 ft

155 ft

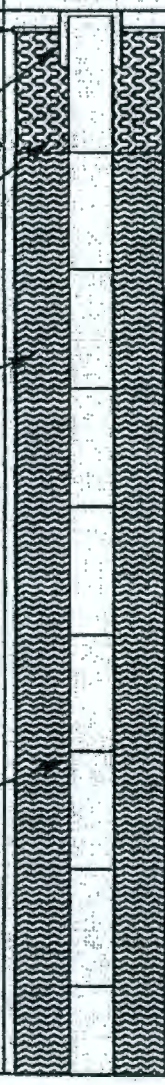
160 ft

164 ft

WELL SUMMARY SHEET	Start Date: 10-15-06 Finish Date: 12-15-06	Page 1 of 2
Well ID: C5197	Well Name: 699-50-56	
Location: 1/2 mile E. of Rt. 4, 200 yards N. of Rt. 11	Project: 200-BP-5 Monitoring Wells	
Prepared By: Erika Rincon — Date: 12/19/06	Reviewed By: L. D. Walker — Date: 9/2/07	
Signature:	Signature:	

CONSTRUCTION DATA

Description	Diagram
6-in Concrete Pad	
6-in I.D. Type 304/304L Stainless Steel Protective Casing: +2.37 ft Above Ground Surface	
Portland Cement Type I/II: 0 - 10.0 ft	
Granular Bentonite Crumbles: 10.0 - 137.9 ft	
4-in I.D. Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +1.9 - 151.2 ft	
All depths are in feet below ground surface. Borehole drilled with 8 5/8-in O. D. casing. All temporary drill casing was removed from the ground.	



GEOLOGIC/HYDROLOGIC DATA

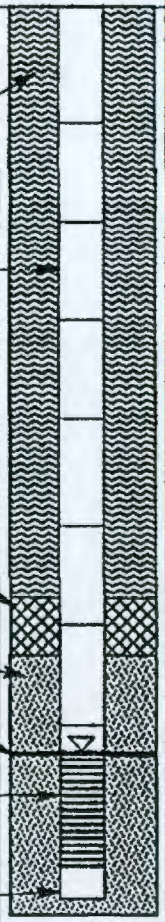
Depth in Feet	Graphic Log	Lithologic Description/Groundwater Sample Depths (ft bgs)
0		0-3 Sandy Gravel sG (Fill)
		3-15 Gravelly Silt gM
10		
		15-45 Silty Sandy Gravel msG
20		
30		
40		
		45-48 Sandy Gravel sG
		48-60 Gravelly Sand gS
50		
		60-71 Sand S
60		
70		
		71-74 Silt M
		74-80 Gravelly Silty Sand gmS
		80-90 Sand S
80		

WELL SUMMARY SHEET	Start Date: 10-15-06 Finish Date: 12-15-06	Page 2 of 2
Well ID: C5197	Well Name: 699-50-56	
Location: 1/2 mile E. of Rt. 4, 200 yards N. of Rt. 11	Project: 200-BP-5 Monitoring Wells	
Prepared By: Erika Rincon	Date: 12-19-06	Reviewed By: L.D. Walker	Date: 4/2/07
Signature: Erika R	Signature: LD Walker	

CONSTRUCTION DATA

Description	Diagram
Granular Bentonite Crumbles: 10.0 - 137.9 ft	
4-in I.D. Stainless Steel Type 304/304L, Schedule 10 Permanent Casing: +1.9 - 151.2 ft	
1/4-in Bentonite Pellets: 137.9 - 143.1 ft	
Primary Filter pack 10-20 Mesh Colorado Silica Sand: 143.1 - 164.5 ft	
Static Water Level: 151.39 ft bgs (12-11-2006)	
4-in I.D. Stainless Steel, Type 304, Slot 20 (.020-in) Screen: 151.2 - 161.2 ft	
4-in I.D. Stainless Steel, Type 304, Schedule 10 Sump: 161.2 - 164.1 ft	

All depths are in feet below ground surface.
Borehole drilled with 8 5/8-in O. D. casing.
All temporary drill casing was removed from the ground.



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description/Groundwater Sample Depths (ft bgs)
90		90-110 Silt M
100		
110		110-111 Sand S 111-115 Silt M
120		115-123 Sand S
130		123-135 Silt M 131 Grab Sample: HEIS# B1L7V7 133.5 Grab Sample: HEIS# B1L7V8 135-140 Gravelly Sand gS 135.5 Grab Sample: HEIS# B1L7V9 138.5 Grab Sample: HEIS# B1L7W0
140		140-150 Gravelly Silty Sand gmS 141 Grab Sample: HEIS# B1L7W1 143.5 Grab Sample: HEIS# B1L7W2 146 Grab Sample: HEIS# B1L7W3 148.5 Grab Sample: HEIS# B1L7W4
150		150-151.5 Sand S 151 Split-Spoon Sample* 151.5-155 Gravelly Silty Sand gmS 153.5 Split-Spoon Sample* 156 Split-Spoon Sample*
160		155-160 Sandy Gravel sG 159 Water Sample: HEIS # B1L853 160-161 Silty Sandy Gravel msG 161-164.1 Basalt
170		164.1 Total Depth Drilled (11-30-2006) 164.5 Total Depth (Bailed 12-8-06)

*See Field Activity Report (11-21-2006) for sample location.

WELL CONSTRUCTION SUMMARY REPORT

Start Date: 10/15/06
Finish Date: 12/15/06
Page 1 of 1

Well ID: C5197	Well Name: 699-50-56	Approximate Location: 1/2 mile E Rt. 4, 200 yd N Rt. 11
Project: 200-BP-5 RI/FS		Other Companies: Free Stone Environmental Services
Drilling Company: Blue Star		Geologist(s): Erika Rincon, Greg Koza, Steve Hall, Jess Fetters
Driller:	License #:	

TEMPORARY CASING AND DRILL DEPTH			DRILLING METHOD	HOLE DIAMETER (in.) / INTERVAL (ft)
*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.	Auger:	Diameter 8" ID From 0 to 164.1
8" ID Threaded (C)	0 - 164.1		Cable Tool: X	Diameter ____ From ____ to ____
	-		Air Rotary:	Diameter ____ From ____ to ____
	-		A.R. w/Sonic:	Diameter ____ From ____ to ____
	-			Diameter ____ From ____ to ____
	-			Diameter ____ From ____ to ____
*Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design				Diameter ____ From ____ to ____

164.5 TF		Drilling Fluid: Water	
Total Drilled Depth: ~~164.1~~	Hole Dia @ TD: 8" ID	Total Amt. Of Water Added During Drilling: 168 gallons	
Well Straightness Test Results: Passed (12/8/06)		Static Water Level: 154.3'	Date: 1/11/07

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date	Sondes (type)	Interval	Date
Spectral Gamma	0' - 163'	12/1/06		-	
	-			-	
	-			-	

COMPLETED WELL

Size/Wt./Material	Depth	Thread	Slot Size	Type	Interval Annular Seal/Filter Pack	Volume	Mesh Size
4" I.D. Sch. 10 304/304L SS	+1.9 - 151.2'	✓	NA	Portland Cement	0 - 10.0'	4,944 lbs	NA
4" I.D. .020", 304 SS Screen	151.2 - 161.2	✓	.020	Bentonite Crumbles	10.0' - 137.9'	87 50 lb sacks	NA
4" I.D. 304/304L SS Sump	161.2 - ~~164.2~~ 164.1 TF	✓	NA	1/4" Bentonite Pellets	137.9' - 143.1'	22 5 gal buckets	1/4"
	-			10-20 CSS	143.1' - ~~165.0'~~ 164.5 TF	12 50 lb bag	10-20
	-				-		

OTHER ACTIVITIES

Aquifer Test: NA	Date:	Well Decommission: NA	Yes:	No:	Date:
Description:		Description:			

WELL SURVEY DATA (if applicable)

Not Surveyed at this time	Protective Casing Elevation:
Washington State Plane Coordinates:	Brass Survey Marker Elevation:

COMMENTS / REMARKS

Reported By:	Title:	Signature:	Date:
J. Fetters	Geologist	For J. Fetters	3-8-07

A-6003-658 (04/03)

WELL DEVELOPMENT AND TESTING DATA

Well Name:	Well ID:	Well Location:	Date:
699-50-56	C5197	200 yds N of Rt 11, ½ mi E of Rt 4	12-15-06

Reference Measuring Point (unless otherwise noted): TOP OF OUTER CASING (TOC)

Has the well been surveyed? ○ Yes ⊗ No | Does the well have a cement pad? ⊗ Yes ○ No

PART 1

STATIC WATER LEVEL: (TOC)

Start of Job	154.35 ft
End of Job	154.33 ft

DEPTH TO BOTTOM:

Start of Job	166.3 ft
End of Job	166.2 ft

PART 2

WELL DEVELOPMENT DATA

Pump Model	REDI-FLO 4
Intake Depth	161.2 ft
Starting Turbidity	19.5 NTU

Pump Start	Stop	Flow Rate
0928	1028	11.5 GPM

Total Pumped	~ 690 gal
Final Turbidity	2.13 NTU
XD SN/Range (PSI)	5219

PART 3

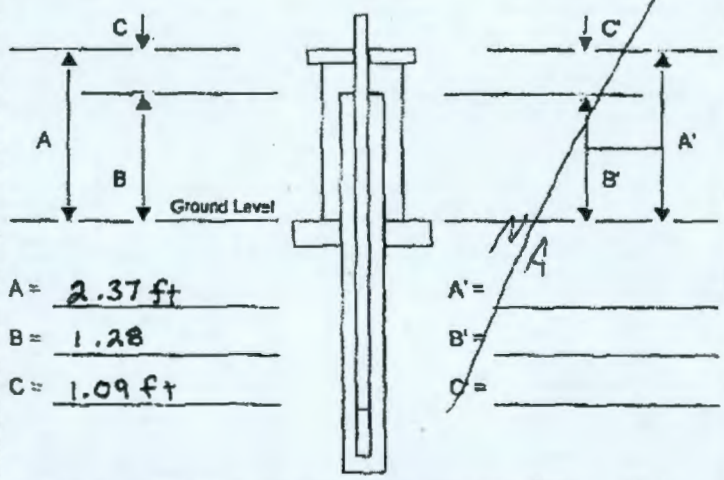
Static Water Level (TOC)	
Transducer Depth	
Baseline Start	
Injection Start	
Baseline Start	
Withdrawal Start	
Slug Volume	
XD SN/Range (PSI)	

N/A

PART 4

Last Recorded Measurements Date: 12-15-06

Current Measurements Date:



A = 2.37 ft
B = 1.28
C = 1.09 ft

A' =
B' =
C' =

N/A

Are there any reference marks on the casing strings? ○ Yes ○ No

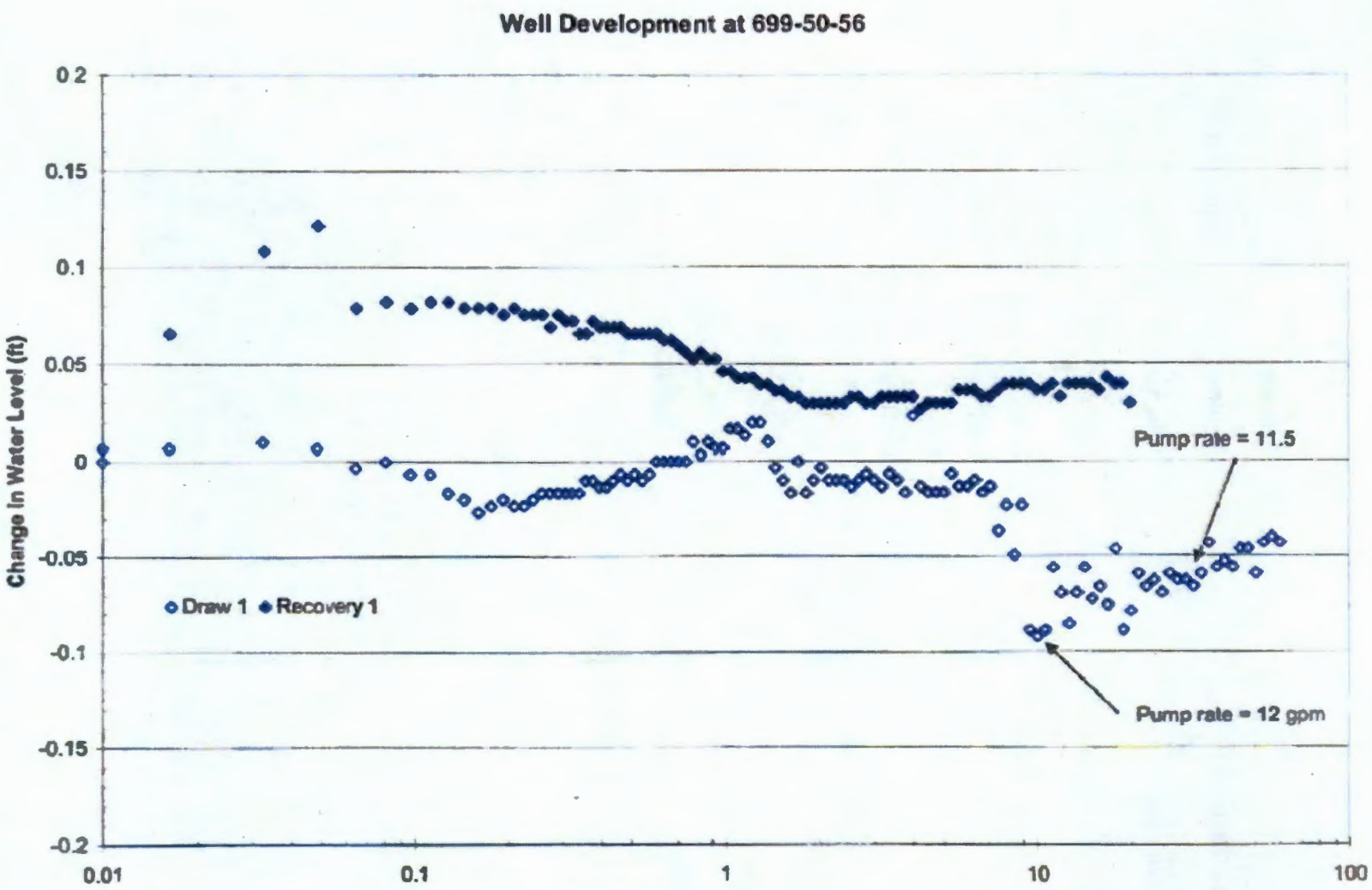
PART 5

COMMENTS:

12-15-06 measurements of surface completion are without pump or top plate installed

Prepared by (print name):	Signature:	Date:
S. Hall	for S. Hall	12-15-06
Reviewed by (print name):	**Signature:**	**Date:**
C. B. Walker		3-8-07

A-6003-644 (03/03)


Well Development at 699-50-56
Change in Water Level (ft)
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
0.01
0.1
1
10
100
Draw 1
Recovery 1
Pump rate = 11.5
Pump rate = 12 gpm

WELL SURVEY DATA REPORT

Project:	**Prepared By:** N.P. Fastabend **Company:** FGG
Date Requested: 1/23/07	**Requestor:** C.S. Wright (FH)
Date of Survey: 2/26/07	**Surveyor:** N.P. Fastabend FGG Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** J.M. Schwing
Description of Work: Civil Survey of Groundwater Monitoring Well C5197 / 699-50-56.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** METERS **Hanford Area Designation:** 600A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
GABLEMTN (FH), 2E-1 (FGG)

Vertical Control Monuments:
J317 (C.O.E.), HSWB-032 (C.O.E.)

Well ID	Well Name	Easting	Northing	Elevation	
C5197	699-50-56	572748.21	138841.55		Center of Casing
				168.906	Top Pump Baseplate, N. Edge
				168.896	Top of Casing, N. Edge
				168.178	Brass Survey Marker

Notes:

EQUIPMENT USED: TRIMBLE GPS 5800 RTK
TRIMBLE DiNi 12 LEVEL

Surveyor Statement:
I, Larry A. Henke, a Professional Land Surveyor registered in the State of Washington (Registration No. 38975), hereby certify that this report is based on a field survey performed in February 2007 under my direct supervision, and that the data contained here is true and correct.

LARRY A. HENKE
STATE OF WASHINGTON
Feb 26 2007
38975
REGISTERED PROFESSIONAL LAND SURVEYOR
EXPIRES Sept. 23, 2007

Original to:
Distribution by DIS

Table C-1. Sample Depths and HEIS #s for C5197.

Sample Depth (ft bgs)	Sample Method	HEIS #
131-132.5	Quart Grab	B1L7V7
133.5-134.7	Quart Grab	B1L7V8
135.5-136.5	Quart Grab	B1L7V9
138.5-140	Quart Grab	B1L7W0
141-142.5	Quart Grab	B1L7W1
143.5-145	Quart Grab	B1L7W2
146-147.5	Quart Grab	B1L7W3
148.5-150	Quart Grab	B1L7W4
151.153.5	Split-Spoon	B1L803, B1L804, B1L805, B1L806, B1L815, B1L816, B1L817, B1L818, B1L7X7, B1L7Y0
153.5-156	Split-Spoon	B1L807, B1L808, B1L809, B1L810, B1L7X8
156-158.5	Split-Spoon	B1L811, B1L812, B1L813, B1L814, B1L7X9
159	Pumped Water Sample	B1L853

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