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Revision 0

Borehole Summary Report for the Installation of 6 Replacement Multi-Purpose Wells and the Decommissioning of 1 Non-WAC Compliant Well in the 100-HR-3 Operable Unit, FY2013

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

Contractor for the U.S. Department of Energy
under Contract DE-AC06-08RL14788

CH2MHILL
Plateau Remediation Company
P.O. Box 1600
Richland, Washington 99352

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100-HR-3

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Terms

ags	above ground surface
bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CHPRC	CH2M Hill Plateau Remediation Company
EPA	U.S. Environmental Protection Agency
DOE	U.S. Department of Energy
DOW	Description of Work
DQO	Data Quality Objective
Fm.	Formation (formal name)
fm.	formation (informal name)
ft	feet
HCl	hydrochloric acid
HEIS	*Hanford Environmental Information System*
hp	horsepower
IH	Industrial Hygiene
ID	identification
in.	inch
mm	millimeter
MSW	miscellaneous solid waste
NTU	nephelometric turbidity units
OU	operable unit
ppm	parts per million
PNNL	Pacific Northwest National Laboratory
RCT	radiological control technician
ROD	Record of Decision
RO/RO	Roll on/Roll off
RUM	Ringold Upper Mud, Ringold Formation
SAP	Sampling and Analysis Plan
TD	total depth
toc	top of casing
WAC	*Washington Administrative Code*
WCH	Washington Closure Hanford, Inc.
WP/LIS	Waste Packaging/Labeling Instruction Sheet

Metric Conversion Chart

Into Metric Units			Out of Metric Units		
If you know	*Multiply by*	*To get*	*If you know*	*Multiply by*	*To get*
Length			**Length**		
inches	25.40	millimeters	millimeters	0.0394	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles (statute)	1.609	kilometers	kilometers	0.621	miles (statute)
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.0929	sq. meters	sq. meters	10.764	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.591	sq. kilometers	sq. kilometers	0.386	sq. miles
acres	0.405	hectares	hectares	2.471	acres
Mass (weight)			**Mass (weight)**		
ounces (avoir)	28.349	grams	grams	0.0353	ounces (avoir)
pounds	0.454	kilograms	kilograms	2.205	pounds (avoir)
tons (short)	0.907	ton (metric)	ton (metric)	1.102	tons (short)
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.034	ounces
tablespoons	15	milliliters	liters	2.113	pints
ounces	29.573	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.473	liters	cubic meters	35.315	cubic feet
quarts	0.946	liters	cubic meters	1.308	cubic yards
gallons	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
Radioactivity			**Radioactivity**		
picocurie	37	millibecquerel	millibecquerel	0.027	picocurie

1 Introduction

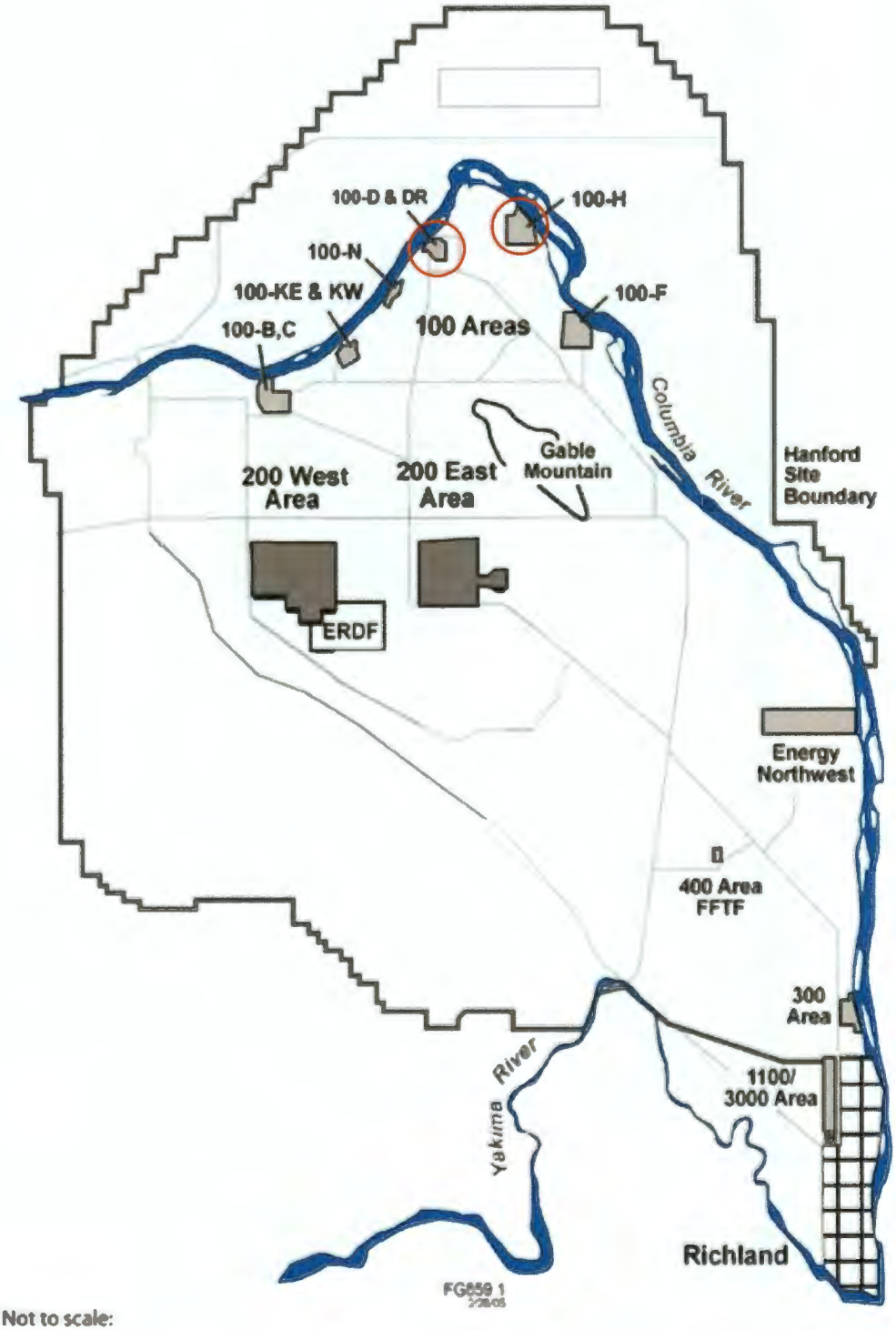
This summary report describes the fiscal year 2013 (FY13) field activities associated with the installation of six (6) replacement multi-purpose wells and decommissioning of one (1) non-*Washington Administrative Code* (WAC) compliant well in the 100-HR-3 groundwater Operable Unit (OU). The OU is located in the northern portion of the Hanford site along the Columbia River, which is commonly known as the 100 Areas, and is comprised of the 100-D and 100-H Reactor areas (Figure 1).

All of the multi-purpose replacement wells were installed by CH2M Hill Plateau Remediation Company (CHPRC) in conjunction with Washington Closure Hanford, Inc. (WCH) through a local drilling contractor. This work supported the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA), the *Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units* (ROD/R10-96/134, 1996), and the *Remedial Design Report and Remedial Action Work Plan for the 100-HR-3 and 100-KR-4 Groundwater Operable Units' Interim Action* (DOE/RL-96-84, 2003). Work was conducted in accordance with the approved Sampling and Analysis Plan (SAP) (*Sampling and Analysis Plan for Installation of 100-HR-3 Groundwater Operable Unit Replacement Wells* [DOE/RL-2012-45]). Well locations are presented in Figures 2 and 3 and well data is summarized in Table 1. The location of replacement Well 199-H4-86 was moved northward approximately 50 ft prior to drilling, with concurrence from the regulators and Department of Energy (DOE).

The non-compliant well was decommissioned in accordance to the decommissioning plan, as described in the *Description of Work for Decommissioning Five 100-H Wells for WCH* (SGW-52543), as well as WAC 173-160-460, *Decommissioning Process for Resource Protection Wells*. The decommissioned well location is presented in Figure 3 and decommissioning data is summarized in Table 1.

Technical information; including drilling summaries, borehole geology descriptions, well construction summaries and well development results are presented in Section 2. Waste management information is presented in Section 3. Civil Surveys performed are located in Section 4. Well acceptance is discussed in Section 5 and references cited are found in Section 6. Appendices include: (A) well summary/as-built sheets; (B) borehole lithology logs; and (C) well development sheets.

Figure 1 - River Corridor Decision Units



Not to scale:

Figure 2 - Well Locations for 100-D Area Wells

Figure 3 - Well Locations for 100-H Area Wells

Table 1 - Well Summary Information

Well Name	Well ID	Northing (m)[a]	Easting (m)[a]	Elevation – Brass Cap (m)[b]	Depth to Water (ft bgs)	Total Depth (ft bgs)
199-H4-85	C8723	152880.81	577980.02	128.029	42.7	52.5
199-H4-86	C8724	152745.65	577704.55	129.101	45.4	66.1
199-D5-145	C8725	151396.28	573215.62	144.209	85.05	118.9
199-D5-146	C8726	151345.59	573219.79	144.036	84.17	116.7
199-D5-147	C8727	151380.78	572993.13	143.846	84.40	108.3
199-D5-148	C8728	151083.48	573361.48	143.024	79.10	115.3
199-H4-3	A4629	152858.54	577940.50	129.300	N/A	N/A

Notes:

a = Washington State Plane Coordinates, NAD83[91], North American Datum of 1983
b = NAVD88, North American Vertical Datum of 1988 (in meters)
ft bgs = feet below ground surface
ID = Identification
m = meters
N/A = not applicable

1.1 Purpose/Scope

The current suite of wells will be used to monitor groundwater, extract contaminated groundwater and inject treated groundwater in support of the DX and HX Pump and Treat (P&T) systems, The current concentrations hexavalent chromium in groundwater exceed federal and state maximum contaminant levels (MCLs), state groundwater cleanup standards for use of the groundwater as a drinking water source, and the Ambient Water Quality Criteria (AWQC) for the protection of aquatic organisms.

1.2 Background

Information presented here was previously presented in SGW-53577, *Description of Work for the Installation of 6 Wells at 100-DH and Decommissioning of 199-H4-3, FY2013*, unless otherwise cited.

Between 1943 and 1963, nine plutonium production reactors were built along the Columbia River. Production of special nuclear materials for national defense was the core function of the 100 Area production reactors and their associated infrastructure.

Most of the groundwater contamination in the 100-D/H Area is the result of the cooling system used in the reactors. Sodium dichromate salts and aqueous solutions of varying concentrations were routinely added to the cooling water stream for corrosion prevention, typically to concentrations of approximately 2 mg/L hexavalent chromium. After passing through the reactor, the spent cooling water was discharged to concrete retention basins, where it was held for a number of hours before being piped back into the Columbia River. These basins periodically leaked, leading to widespread mounding of the aquifer up to 3 m (~10 ft) above the natural static water level, which in turn contributed to the growth of the contamination plumes located in the 100-D/ H. Contamination is also associated with a large scale infiltration test that was conducted in the spring-summer months of 1967. Approximately 1.287 x 10^{10} liters (3.4 billion gallons) of reactor coolant effluent was disposed directly to the ground at the 116-DR-1&2 Trench. This test raised the water level in the unconfined aquifer an additional 0.3 to 3 m (~1 to 10 ft) and significantly contributed to the migration of hexavalent chromium from the 100-D Area towards the central Horn and the 100-H Area.

Hexavalent chromium concentrations in the 100-D Area are locally much higher than 2 mg/L. Due to this fact, it has been suggested that there may have been unknown leaks or spills of concentrated hexavalent chromium solutions that are continuing to contaminate the 100-D Area groundwater 40 years after the termination of reactor operations.

1.3 Conceptual Model

Hexavalent chromium contamination remains in the vadose zone at 100-D/H and continues to contribute to the groundwater contamination identified at 100-HR-3. Ongoing remediation, such as the work that required removal and replacement of monitoring wells, is removing the source area and therefore reducing the continued contribution to groundwater.

2 Well Installation Activities

2.1 Well 199-H4-85 (C8723)

Well 199-H4-85 (C8723) was installed between March 5, 2013 and March 14, 2013. C8723 was drilled to a total depth (TD) of 53.5 feet below ground surface (ft bgs).

2.1.1 Drilling and Sampling

Drilling – On March 5, 2013 drilling began at borehole C8723 using 10 ¾-in. carbon steel threaded casing. Casing was advanced to a depth of 49.6 ft bgs on March 7, 2013. A geophysical survey using Spectral Gamma Logging System (SGLS) and Neutron Moisture Logging System (NMLS) was performed from ground surface to 49 ft bgs on March 11 and 12, 2013.

Sampling – Sampling at C8723 included water sample collecting for laboratory chemical analysis and soil sample collection for geologic archive purposes and sediment size distribution (sieve sample). Geologic archive soil samples were collected at 5-ft intervals and at lithology changes throughout the depth of the borehole. Water was encountered at a depth of 42.7 ft bgs on March 7, 2013. Ringold Upper Mud (RUM) was encountered at a depth of 47.5 ft bgs. One composite sample was collected throughout the depth of the zone of saturation for sieve analysis[1]. One water sample was collected at the end of development from the 0.5-hp permanent pump also used for development. A duplicate (DUP) was also collected for quality control purposes. Table 2 summarizes the sample collected for laboratory chemical analysis for this borehole. The borehole log associated to this well, located in Appendix B, shows specific sample locations in regard to depth and lithologic composition.

Table 2 - Sample Summary: Well 199-H4-85 (C8723)

Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
3/14/2013	46.6	Water	Pump	B2NR14
3/14/2013	DUP	Water	Pump	B2NR17

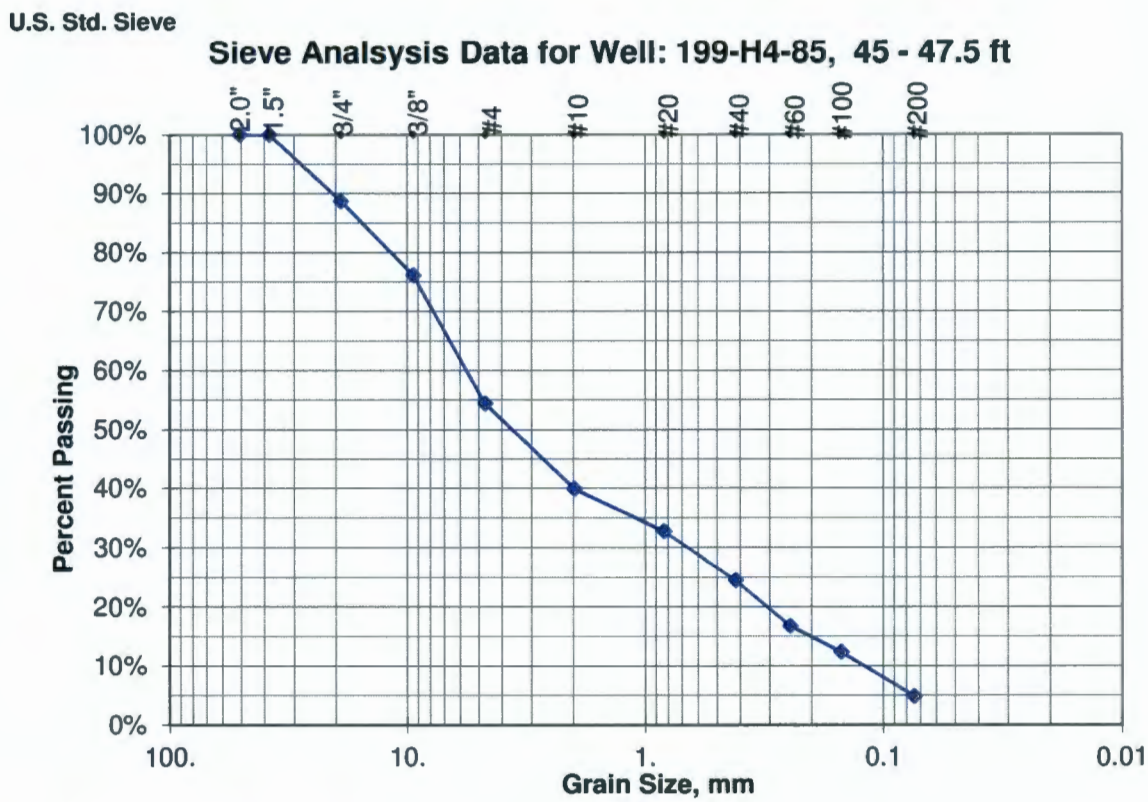
[1] Sieve analyses were performed using samples collected at 5-ft intervals from the top of the aquifer to TD. These were then composited into 20-ft bulk samples and the sieve analyses run. This approach is in contrast to the sampling analysis plan, which called for running one sieve at the top of the aquifer and one at the bottom separately. The short-coming of this approach is that sediments in the intermediate portion of the aquifer may not be characterized properly for grain distribution in these intervals. This limitation becomes more apparent where the aquifer is thicker and can lead to errors in filter pack selection. The 20-ft compositing technique is a more thorough approach and was used for all six of the replacement wells.

A sample for size distribution analysis was collected throughout the zone of saturation from 45 ft bgs to 47.5 ft bgs. The RUM was not included in the sieve sample. Results for the sieve analysis are shown in table 3.

Table 3 - Results of Size Distribution Analysis for C8723

Screen Size (mm)	19.05	9.525	4.750	2.000	0.850	0.425	0.250	0.150	0.075	Pan
% Retained	11.4	12.5	21.7	14.5	7.2	8.3	7.7	4.4	7.5	17.7

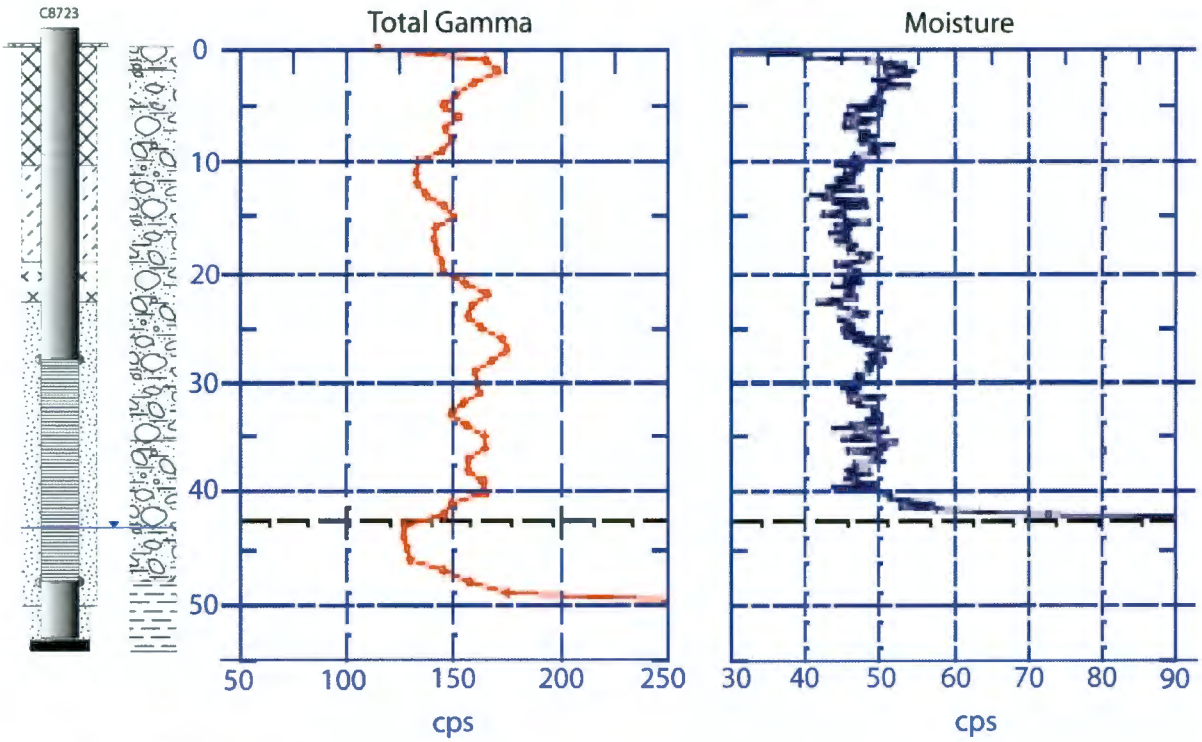
Figure 4 -Particle Size Distribution Curve for 199-H4-85 (C8723)



2.1.2 Geophysical Logging

Geophysical logging was performed by the SM Stoller Corporation on March 13, 2013 for this well location. A SGLS and NMLS were deployed to survey between ground surface and the total depth of the borehole as depicted in Figure 5, below. According to logging results, no manmade radionuclides were detected within the borehole at this location.

Figure 5 - 199-H4-85 (C8723) Total Gamma & Moisture Comparison Plot



2.1.3 Well Construction and Development

Well Construction – Well construction of C8723 took place between March 11, 2013 and March 13, 2013. On February 11, 2013 a well straightness test was performed. The tool passed successfully throughout the length of the 10 ¾-in. temporary casing. The well was constructed with 6 5/8-in. outer diameter (OD), schedule 10, type 316/316L stainless steel permanent casing and screens. A total of 20.00-ft of stainless screen with 0.040-in. apertures was used. A sump was placed below the screen with a length of 5.01 ft. Well construction and associated depths are summarized in table 4.

Table 4 - Construction Summary: Well 199-H4-85 (C8723)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	6-inch Diameter, Stainless Steel Well Materials			Annular Materials		
53.5	42.7	Material	Interval (ft bgs)	Slot Size (in.)	Material	Interval (ft bgs)	Mesh Size
		Casing	+2.0 – 27.39	Solid	Cement Grout	0.0 – 10.2	Slurry
		Screen	27.39 – 47.39	0.040	Bentonite Crumbles	10.2 – 18.9	8-20
		Sump	47.39 – 52.40	Solid	Bentonite Pellet Seal	18.9 – 22.5	1/4 in.
					Colorado Silica Sand	22.5 – 52.5	[10-20]

Development – C8723 was developed in accordance with section one of this document. Well development took place on March 14, 2013. One interval, of no greater than 20-ft, was used to develop this well. The 0.5-hp permanent pump was used for development because the temporary pump pumped too fast to stabilize with the water recharge. An average of 2.8 gallons per minute (gpm) was pumped during the course of final development; which took approximately one hour. A total of 160.4 gallons of water was extracted during this hour. Upon completion of final development, the permanent pump was installed and the intake was placed at 49.75 ft bgs.

2.2 Well 199-H4-86 (C8724)

Well 199-H4-86 (C8723) was installed between March 19, 2013 and April 4, 2013. C8724 was drilled to a total depth of 66.1 ft bgs.

2.2.1 Drilling and Sampling

Drilling – On March 19, 2013 drilling began on borehole C8724 using 10 ¾-in. carbon steel treaded casing. The casing was advanced to a final depth of 65.7 ft bgs on March 26, 2013. A geophysical survey using SGLS and NMLS was performed from ground surface to 65 ft bgs on March 27, 2013.

Sampling – Sampling at C8724 included water sample collecting for laboratory chemical analysis, soil sample collecting for geologic archive purposes, and sediment size distribution (sieve sample). Geologic archive soil samples were collected at 5-ft intervals and at lithology

changes throughout the depth of the borehole. Water was encountered on March 25, 2013 at a depth of 43.2 ft bgs. RUM was encountered at 60.5 ft bgs. One composite sample was collected throughout the depth of the zone of saturation for sieve analysis. One water sample was collected at the end of development from the 5-hp temporary pump. A field trip blank (FTB) was also collected for quality control purposes. The sample collected for laboratory chemical analysis for this borehole is summarized in table 5. The borehole log associated to this well, located in Appendix B, shows specific sample locations in regard to depth and lithologic composition.

Table 5 - Sample Summary: Well 199-H4-86 (C8724)

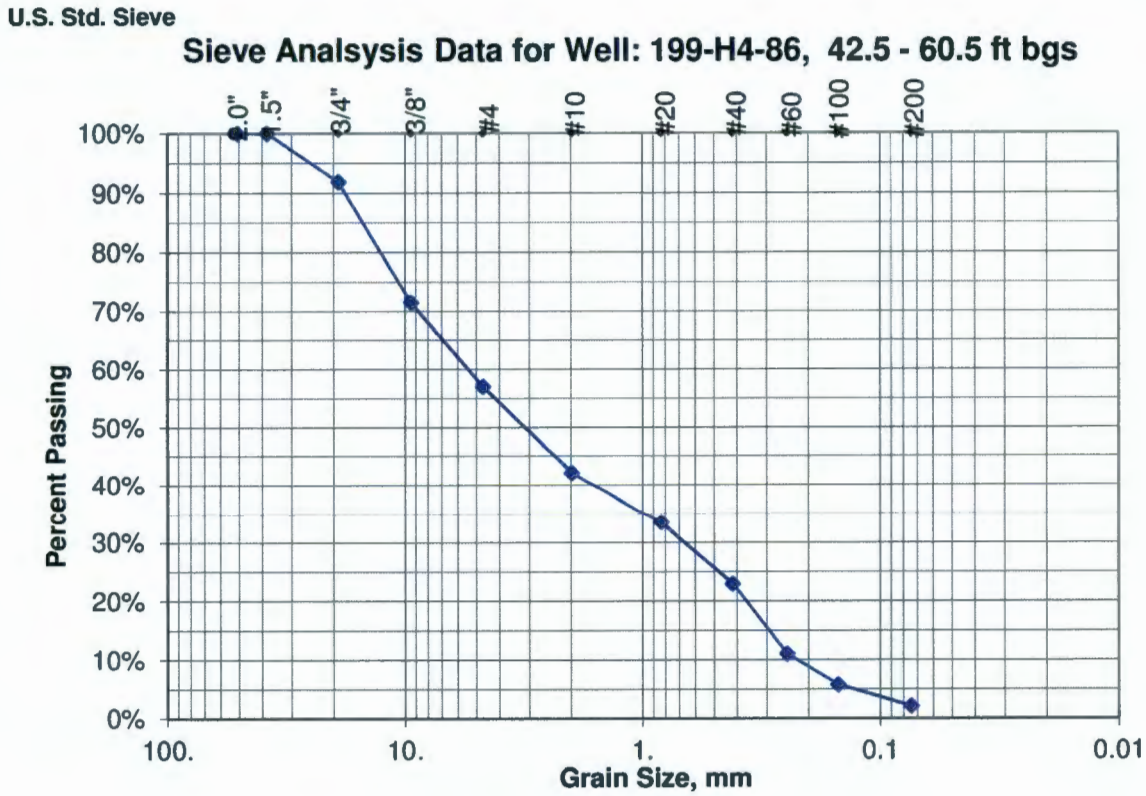
Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
4/3/2013	51.94	Water	Pump	B2NR20
4/3/2013	FTB	Water	Pump	B2NR23

A sample for size distribution analysis was collected throughout the zone of saturation from 43 ft bgs to 60.5 ft bgs. The RUM was not included in the sieve sample. Results for the sieve analysis are shown in table 6.

Table 6 - Results of Size Distribution Analysis for C8724

Screen Size (mm)	19.05	9.525	4.750	2.000	0.850	0.425	0.250	0.150	0.075	Pan
% Retained	8.1	20.4	14.4	14.9	8.7	10.4	12.0	5.3	3.6	8.0

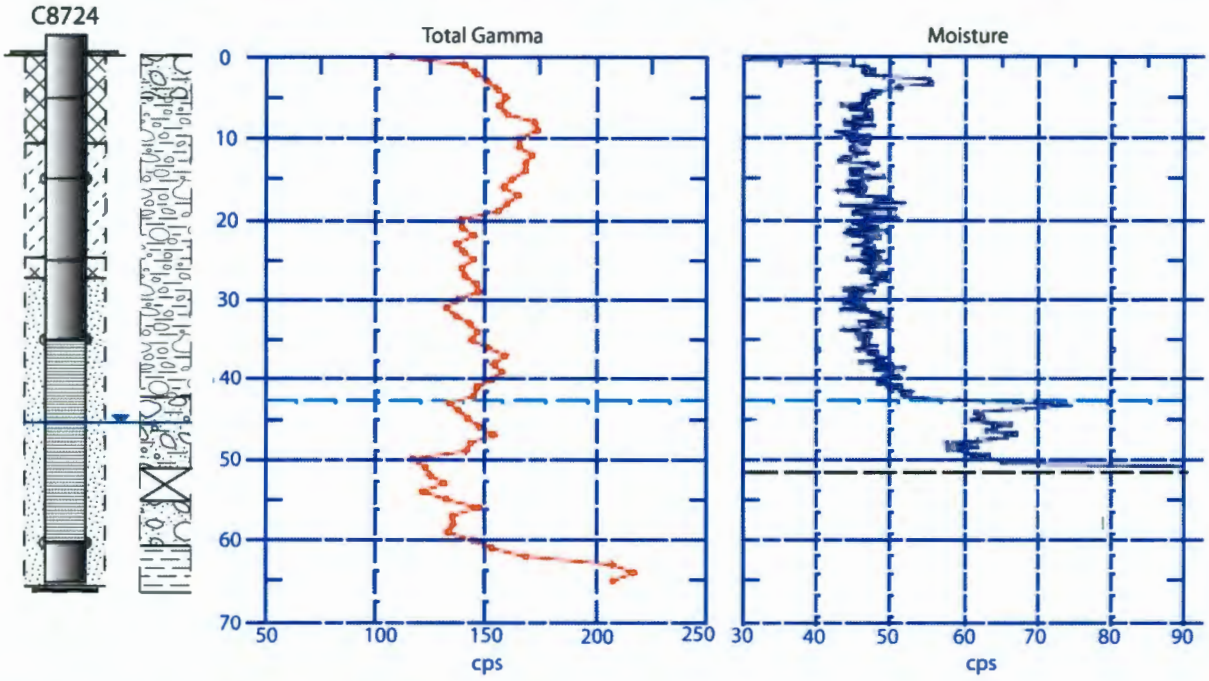
Figure 6 - Particle Distribution Curve for 199-H4-86 (C8724)



2.2.2 Geophysical Logging

Geophysical logging was performed by the SM Stoller Corporation on March 27, 2013 for this well location. A SGLS and a NMLS were deployed to survey between ground surface and the total depth of the borehole as depicted in Figure 7, below. According to logging results, no manmade radionuclides were detected within the borehole at this location.

Figure 7 - 199-H4-86 (C8724) Total Gamma & Moisture Comparison Plot



2.2.3 Well Construction and Development

Well Construction – Well construction of C8724 took place between March 27, 2013 and April 2, 2013. A well straightness test was performed on March 27, 2013 and the tool successfully passed through the 10 ¾-in. temporary casing. The well was constructed using 6 5/8-in. OD, schedule 10, type 316/316L stainless steel permanent casing and screens. A total of 25.02 ft of stainless steel screen with 0.055-in. apertures was used. Placed below the screen was the 5.01 ft sump. Well construction and associated depths are summarized in table 7.

Development – C8724 was developed in accordance with section one of this document. The well development took place on April 3, 2013. One interval, of no greater than 20-ft, was used to develop this well. The 5-hp temporary pump was used for development and the intake was placed at 51.94 ft bgs. Water was pumped at 68.4 gpm during the course of final development; which took approximately one hour and forty-eight minutes to complete. A total of 7,318.8 gallons of water was extracted during this time period. A permanent pump was not installed within this well, due to it being an injection well.

Table 7 - Construction Summary: Well 199-H4-86 (C8724)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	6-inch Diameter, Stainless Steel Well Materials			Annular Materials		
66.1	45.4	**Material**	**Interval (ft bgs)**	**Slot Size (in.)**	**Material**	**Interval (ft bgs)**	**Mesh Size**
		Casing	+2.02 – 35.04	Solid	Cement Grout	0.0 – 10.7	Slurry
		Screen	35.04 – 60.06	0.055	Bentonite Crumbles	10.7 – 24.6	8-20
		Sump	60.06 – 65.07	Solid	Bentonite Pellet Seal	24.6 – 27.2	1/4 in.
					Silica Sand	27.2 – 66.0	[8-16]

2.3 Well 199-D5-145 (C8725)

Well C8725 was installed between January 14, 2013 and February 27, 2013. C8725 was drilled to a TD of 119 ft bgs.

2.3.1 Drilling and Sampling

Drilling - Drilling at borehole C8725 began on January 14, 2013 with 10 ¾-in. carbon steel threaded casing. Casing was extended to 119 ft bgs on February 4, 2013. On February 5, 2013 a geophysical survey using SGLS and NMLS was performed from ground surface to 118 ft bgs.

Sampling – Sampling at this borehole included water sample collecting for laboratory chemical analysis and soil sample collecting for geologic archive purposes and sediment-size distribution analysis (sieve samples). Geologic archive soil samples were collected at 5-ft intervals and at lithology changes throughout the depth of the borehole. Water was encountered at 85.05 ft bgs on January 23, 2013. RUM was encountered at 113.5 ft bgs. One composite sieve sample was collected from the zone of saturation starting at 79 ft bgs. One water sample was collected after development from the permanent pump. A DUP was also collected for quality control. Table 8 summarizes the sample collected from this borehole for laboratory chemical analysis. The borehole log associated to this well, located in Appendix B, shows specific sample locations in regard to depth and lithologic composition.

Table 8 - Sample Summary: Well 199-D5-145 (C8725)

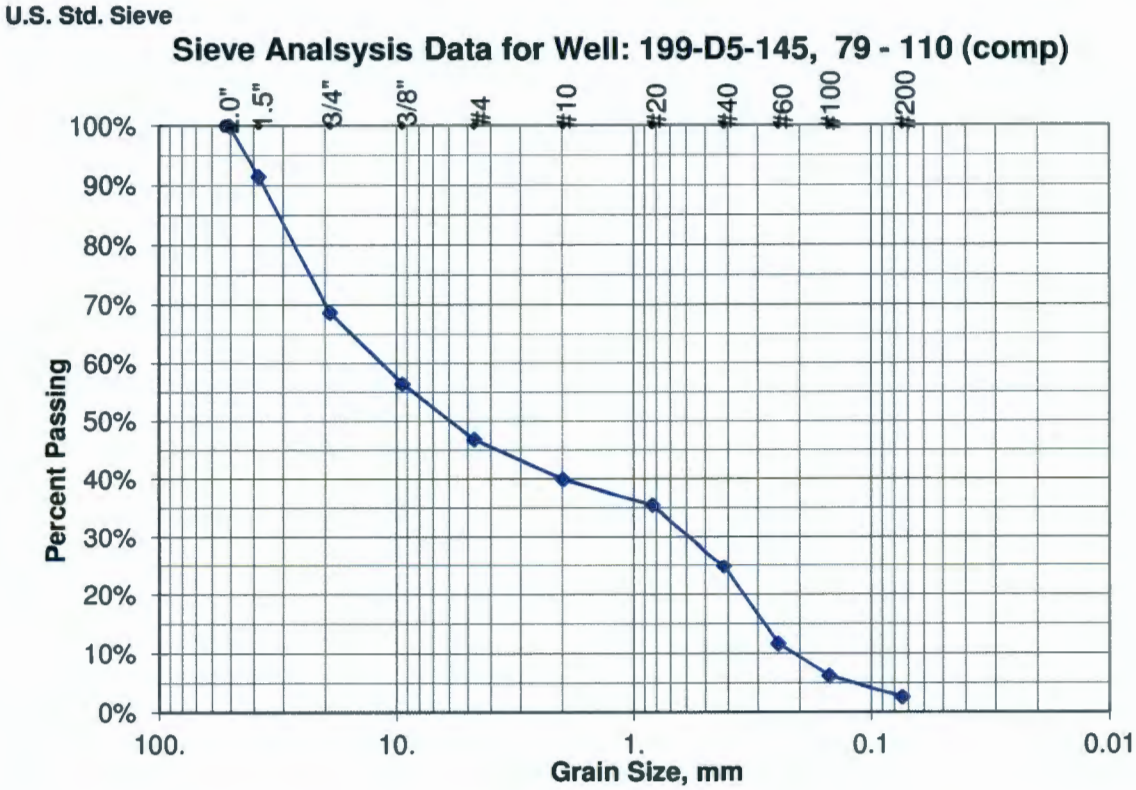
Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
2/27/2013	110.79	Water	Pump	B2NR26, B2NR52
2/27/2013	DUP	Water	Pump	B2NR29

A sample for size distribution analysis was collected throughout the zone of saturation starting at 79 ft bgs to 110 ft bgs. The RUM was not included in the sieve sample. Results for the sieve analysis are shown in table 9.

Table 9 - Results of Size Distribution Analysis for C8725

Screen Size (mm)	38.1	19.05	9.525	4.750	2.000	0.850	0.425	0.250	0.150	0.075	Pan
% Retained	8.5	22.8	12.3	9.6	6.9	4.4	10.8	13.1	5.4	3.6	6.9

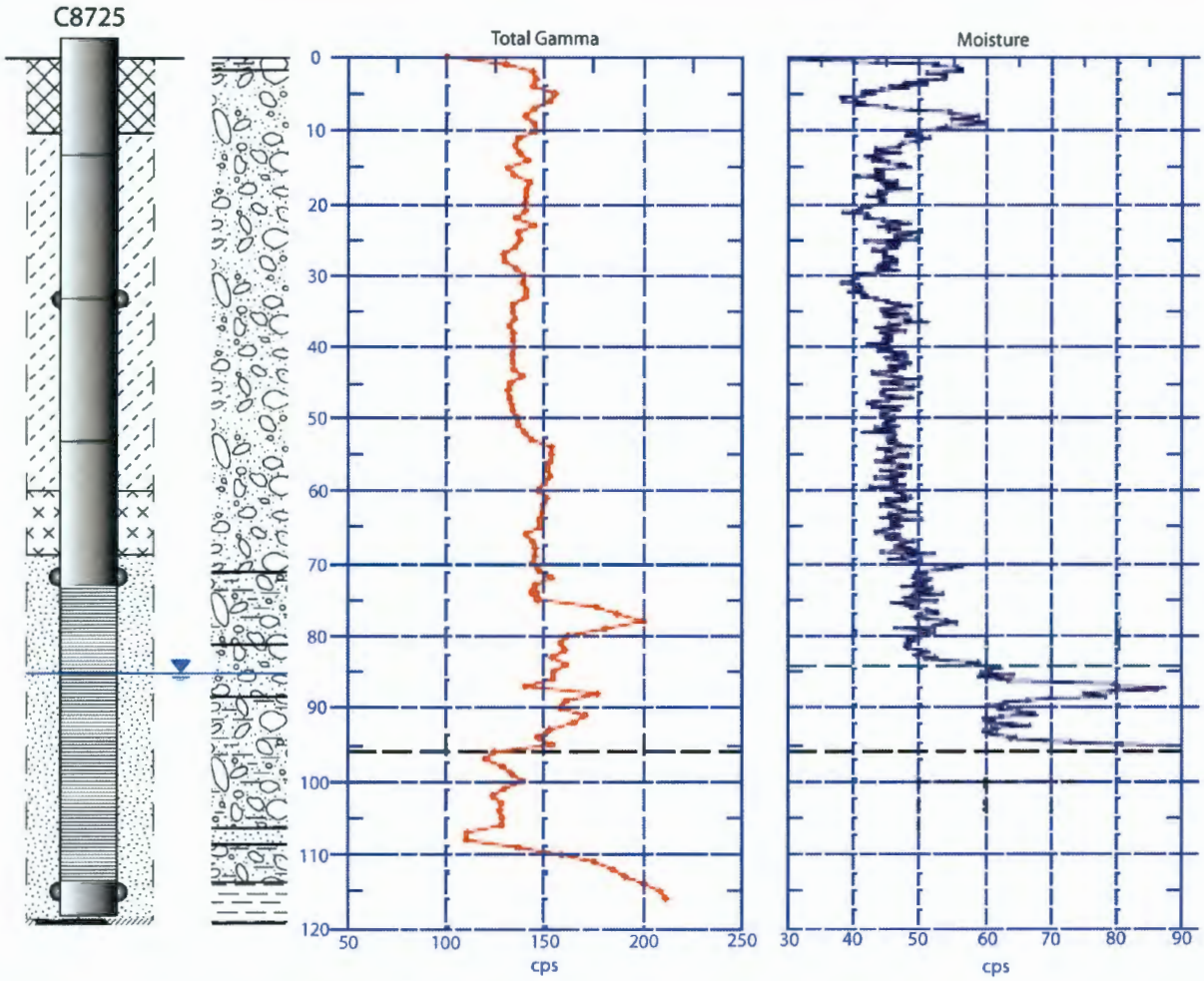
Figure 8 - Particle Size Distribution Curve for 199-D5-145 (C8725)



2.3.2 Geophysical Logging

Geophysical logging was performed by the SM Stoller Corporation on February 5, 2013 for this well location. A SGLS and a NMLS were deployed to survey between ground surface and the total depth of the borehole as depicted in Figure 9, below. According to logging results, no manmade radionuclides were detected within the borehole at this location.

Figure 9 - 199-D5-145 (C8725) Total Gamma & Moisture Comparison Plot



2.3.3 Well Construction and Development

Well Construction – Well construction of C8725 took place between February 5, 2013 and February 12, 2013. A well straightness test was performed through the 10 ¾-in. temporary casing on February 5, 2013 and passed through without binding. The well was constructed with 6 5/8-in. OD, schedule 10, type 316/316L stainless steel casing and screens. A total of 40.00 ft of stainless steel screen was used with 0.040-in. apertures. A 4.99-foot long sump was placed at the bottom of the screen. Well construction and associated depths are summarized in table 10.

Table 10 - Construction Summary: Well 199-D5-145 (C8725)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	6-inch Diameter, Stainless Steel Well Materials			Annular Materials		
119.0	85.08	**Material**	**Interval (ft bgs)**	**Slot Size (in.)**	**Material**	**Interval (ft bgs)**	**Mesh Size**
		Casing	+1.72 – 73.62	Solid	Cement Grout	0.0 – 10.14	Slurry
		Screen	73.62 – 113.62	0.040	Bentonite Crumbles	10.14 – 65.05	Slurry
		Sump	113.62 – 118.61	Solid	Bentonite Pellet Seal	65.05 – 68.1	1/4 in.
					Colorado Silica Sand	68.1 – 118.9	[10-20]

Development – C8725 was developed in accordance with section one of this document. Final well development took place on February 13, 2013. Development took 2 intervals, at no greater than 20-ft, using a 5-hp pump pumping 60 gpm; which took approximately one hour and eleven minutes. A total of 4,260 gallons of water was extracted from the ground during this period of time. The permanent 0.5-hp pump was installed on February 14, 2013. The intake was placed at 110.79 ft bgs.

2.4 Well 199-D5-146 (C8726)

Well C8726 was installed between February 19, 2013 and March 11, 2013. C8726 was drilled to a TD of 116.7 ft bgs.

2.4.1 Drilling and Sampling

Drilling – Drilling at borehole C8726 began on February 19, 2013 with 10 ¾-in. carbon steel threaded casing. On February 26, 2013 the casing was extended to 116.17 ft bgs. A geophysical survey using SGLS and NMLS was performed from ground surface to 116 ft bgs on February 27, 2013.

Sampling – Sampling at this borehole included water sample collecting for laboratory chemical analysis and soil sample collecting for geologic archive purposes and sediment-size distribution analysis (sieve samples). Geologic archive soil samples were collected at 5-ft intervals and at lithology changes throughout the depth of the borehole. On February 25, 2013 water was

encountered at a depth of 84.12 ft bgs. RUM was encountered at 111.1 ft bgs. One composite sieve sample was collected from the zone of saturation starting at 84 ft bgs. One water sample was collected at the end of development using the 5-hp temporary pump. An FTB sample was collected for quality purposes. Table 11 summarizes the sample collected from this borehole for laboratory chemical analysis. The borehole log associated to this well, located in Appendix B, shows specific sample locations in regard to depth and lithologic composition.

Table 11 - Sample Summary: Well 199-D5-146 (C8726)

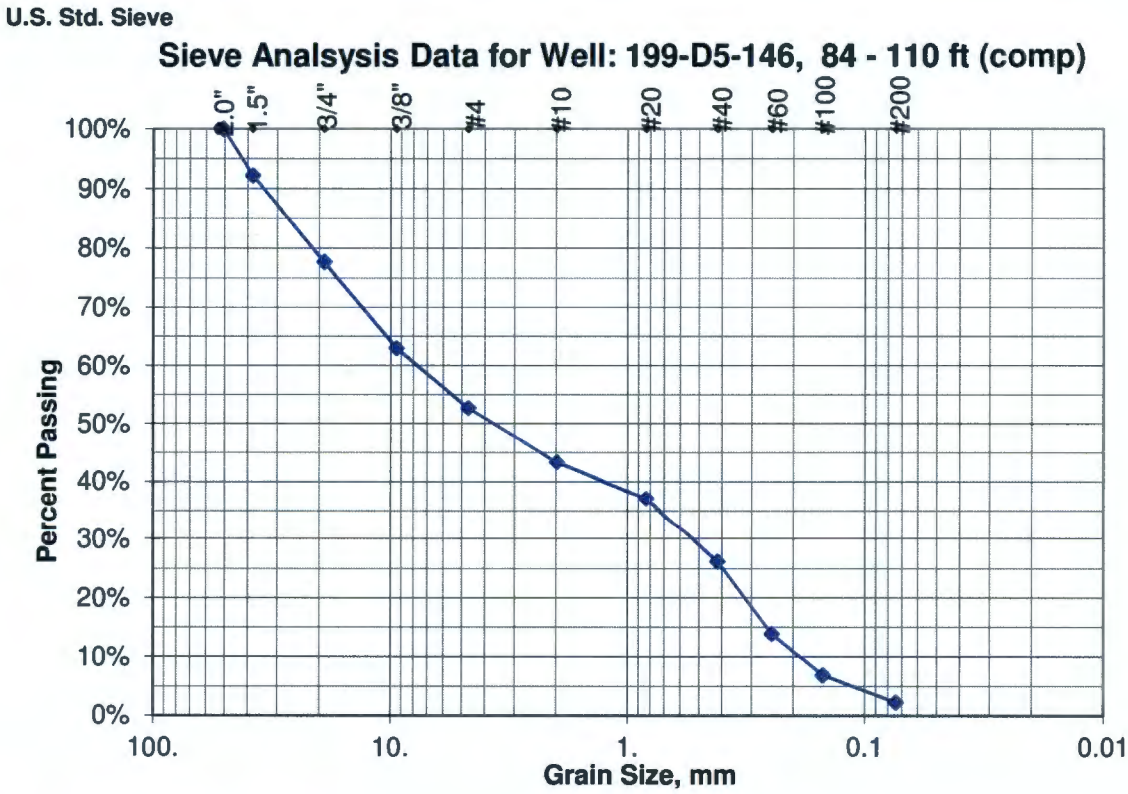
Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
3/11/2013	88.1	Water	Pump	B2NR32
3/11/2013	FTB	Water	Pump	B2NR35

A sample for size distribution analysis was collected throughout the zone of saturation starting at 84 ft bgs to 110.5 ft bgs. The RUM was not included in the sieve sample. Results for the sieve analysis are shown in table 12.

Table 12 - Results of Size Distribution Analysis for C8726

Screen Size (mm)	38.1	19.05	9.525	4.750	2.000	0.850	0.425	0.250	0.150	0.075	Pan
% Retained	7.8	14.5	14.7	10.3	9.3	6.3	10.8	12.4	6.9	4.1	10.7

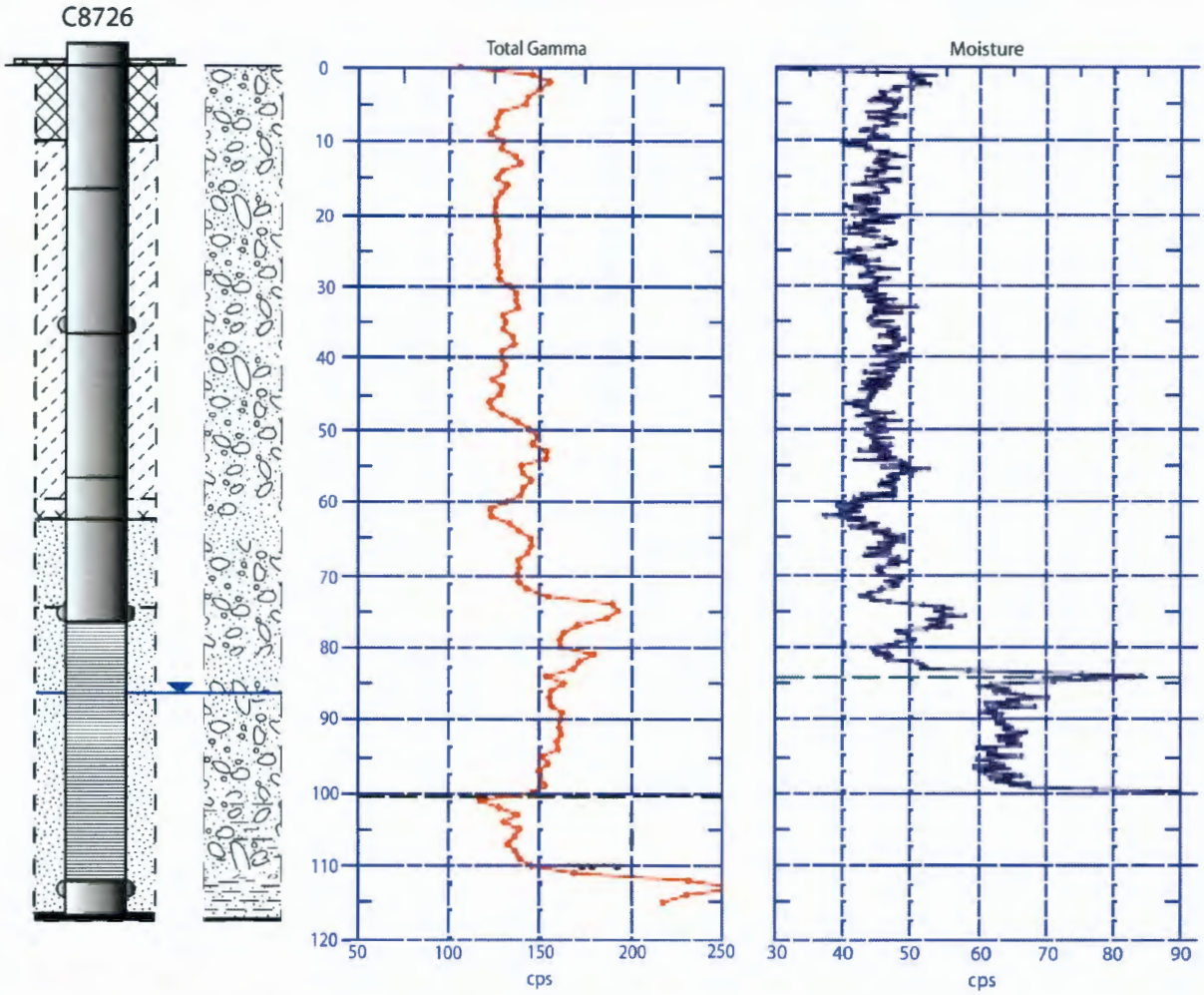
Figure 10 - Particle Size Distribution Curve for 199-D5-146 (C8726)



2.4.2 Geophysical Logging

Geophysical logging was performed by the SM Stoller Corporation on February 27, 2013 for this well location. A SGLS and a NMLS were deployed to survey between ground surface and the total depth of the borehole as depicted in Figure 11, below. According to logging results, no manmade radionuclides were detected within the borehole at this location.

Figure 11 - 199-D5-146 (C8726) Total Gamma & Moisture Comparison Plot



2.4.3 Well Construction and Development

Well Construction – Well construction of C8726 took place between February 28, 2013 and March 7, 2013. A well straightness test was performed on February 28, 2013. The test was successful and the tool passed through the 10 ¾-in. temporary casing without binding. The well was constructed with 6 5/8-in. OD, schedule 10, type 316/316L stainless steel permanent casing and screens. A total of 35.03-ft of stainless steel screen with 0.055-in. apertures was used. A 5.01-foot long stainless steel sump was placed at the bottom of the screen. Well construction and associated depths are summarized in table 13.

Table 13 - Construction Summary: Well 199-D5-146 (C8726)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	6-inch Diameter, Stainless Steel Well Materials			Annular Materials		
116.7	84.12	**Material**	**Interval (ft bgs)**	**Slot Size (in.)**	**Material**	**Interval (ft bgs)**	**Mesh Size**
		Casing	+2.05 – 76.44	Solid	Cement Grout	0.0 – 10.08	Slurry
		Screen	76.44 – 111.47	0.055	Bentonite Crumbles	10.08 – 59.68	Slurry
		Sump	111.47 – 116.48	Solid	Bentonite Pellet Seal	59.68 – 62.85	1/4 in.
					Colorado Silica Sand	62.85 – 74.23	[8-12]
					Silica Sand	74.23 – 115.8	[8-16]

Development – C8726 was developed in accordance with section one of this document. Final well development took place on March 11, 2013. Development took 2 intervals at no greater than 20-ft using a 5-hp pump pumping 43 gpm on average; which took approximately two hours and twenty-five minutes to complete. A total of 6,020 gallons of water was extracted from the ground during this period of time. The permanent 0.5-hp pump intake was set at 106.98 ft bgs on March 11, 2013.

2.5 Well 199-D5-147 (C8727)

Well C8727 was installed between February 12, 2013 and February 28, 2013. C8727 was drilled to a TD of 108.3 ft bgs.

2.5.1 Drilling and Sampling

Drilling – Drilling began at borehole C8727 on February 12, 2013 using 10 ¾-in. carbon steel casing with threads. The casing was advanced to 105.9 ft. bgs on February 19, 2013. The following day February 20, 2013 a geophysical survey using SGLS and NMLS was performed from ground surface to 105 ft bgs.

Sampling – Sampling at this borehole included water sample collecting for laboratory chemical analysis and soil sample collecting for geologic archive purposes and sediment-size distribution

analysis (sieve samples). Geologic archive soil samples were collected at 5-ft intervals and at lithology changes throughout the depth of the borehole. Water was encountered on February 14, 2013 at a depth of 84.4 ft bgs. RUM was encountered at 103.0 ft bgs. A single composite sieve sample was collected throughout the depth of the zone of saturation. One water sample was collected at the end of development using a 5-hp temporary pump. Table 14 summarizes the sample collected for laboratory chemical analysis for this borehole. The borehole log associated to this well, located in Appendix B, shows specific sample locations in regard to depth and lithologic composition.

Table 14 - Sample Summary: Well 199-D5-147 (C8727)

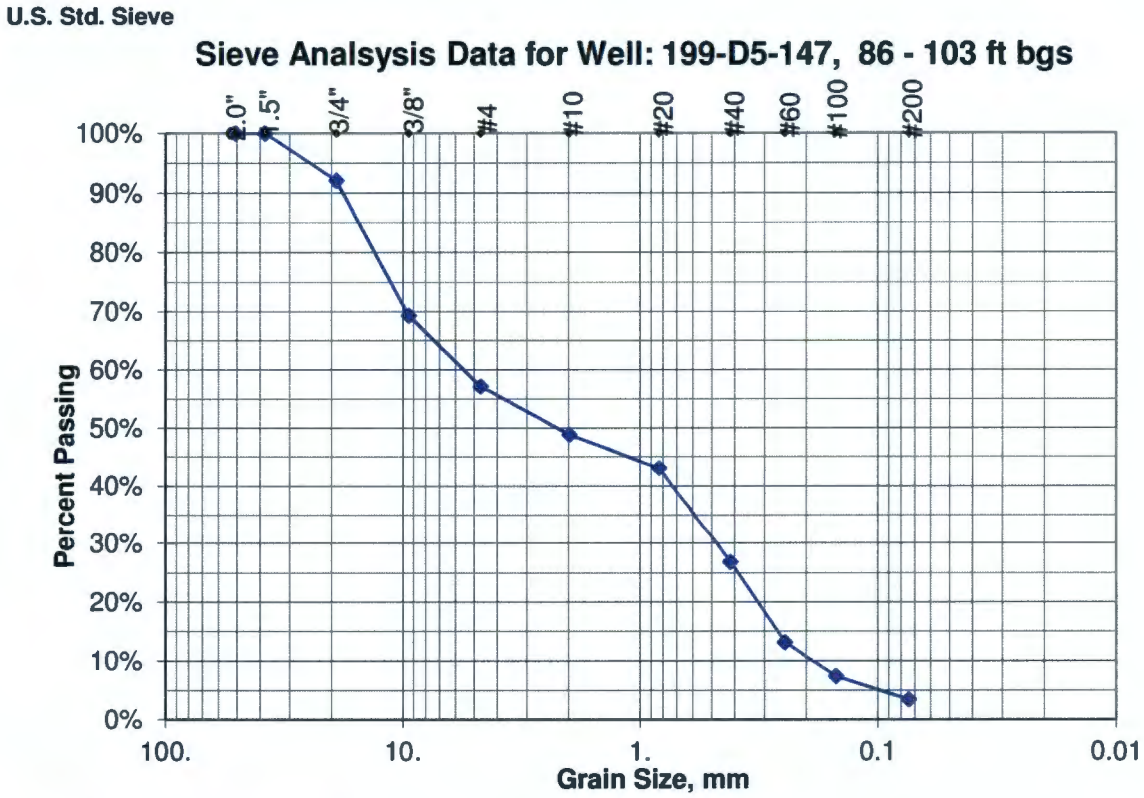
Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
2/27/2013	100.9	Water	Pump	B2NR38

A sample for size distribution analysis was collected throughout the zone of saturation. The composite sieve sample was collected from 90 ft bgs to 103 ft bgs. The RUM was not included in the sieve sample. Results for the sieve analysis are shown in table 15.

Table 15 - Results of Size Distribution Analysis for C8727

Screen Size (mm)	19.05	9.525	4.750	2.000	0.850	0.425	0.250	0.150	0.075	Pan
% Retained	7.9	22.8	12.2	8.4	5.7	16.2	13.7	5.8	3.9	9.0

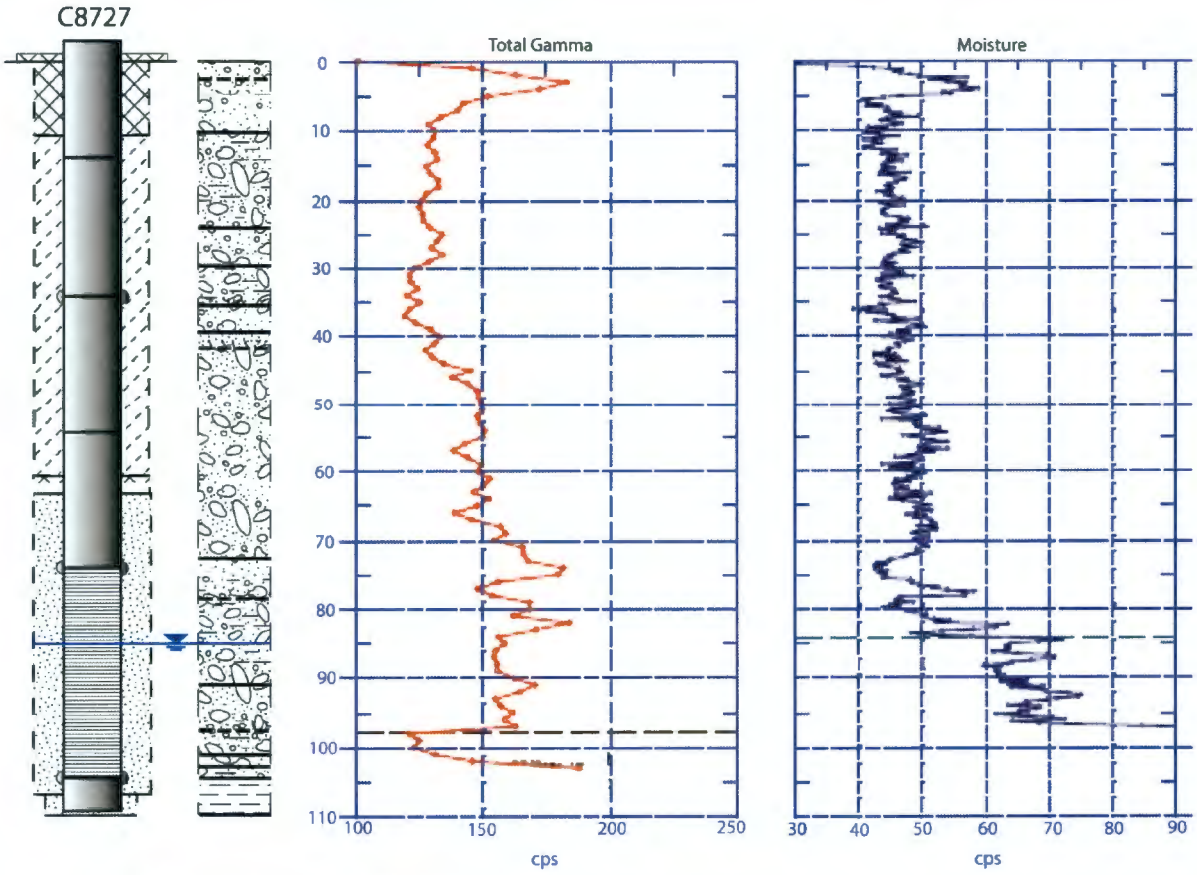
Figure 12 - Particle Distribution Curve for 199-D5-147 (C8727)



2.5.2 Geophysical Logging

Geophysical logging was performed by the SM Stoller Corporation on February 20, 2013 for this well location. A SGLS and a NMLS were deployed to survey between ground surface and the total depth of the borehole as depicted in Figure 13, below. According to logging results, no manmade radionuclides were detected within the borehole at this location.

Figure 13 - 199-D5-147 (C8727) Total Gamma & Moisture Comparison Plot



2.5.3 Well Construction and Development

Well Construction – Well construction of C8727 took place between February 21, 2013 and February 26, 2013. A well straightness test was performed successfully when the tool passed without binding through the length of the 10 ¾-in. temporary casing on February 21, 2013. The well was constructed with 6 5/8-in. OD, schedule 10, type 316/316L stainless steel permanent casing and screens. A total of 30.00-ft of stainless steel screen with 0.050-in. apertures was used. A 5.03-foot long stainless steel sump was placed at the bottom of the screen. Well construction and associated depths are summarized in table 16.

Development – C8727 was developed in accordance with section one of this document. Final well development took place on February 27, 2013. Development took one interval, at no greater than 20-ft, using a 5-hp pump pumping at 40.7 gpm; which took approximately one hour and ten minutes to complete. A total of 2,849 gallons of water was extracted from the ground during this period of time. The permanent pump was installed on February 28, 2013 with the intake placed at 102.55 ft bgs.

Table 16 - Construction Summary: Well 199-D5-147 (C8727)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	6-inch Diameter, Stainless Steel Well Materials			Annular Materials		
108.3	84.4	**Material**	**Interval (ft bgs)**	**Slot Size (in.)**	**Material**	**Interval (ft bgs)**	**Mesh Size**
		Casing	+2.0 – 73.02	Solid	Cement Grout	0.0 – 10.21	Slurry
		Screen	73.02 – 103.02	0.040	Bentonite Crumbles	10.21 – 65.00	8-20
		Sump	103.02 – 108.05	Solid	Bentonite Pellet Seal	65.00 – 67.85	1/4 in.
					Colorado Silica Sand	67.85 – 108.35	[10-20]

2.6 Well 199-D5-148 (C8728)

Well C8728 was installed between January 14, 2013 and February 27, 2013. C8728 was drilled to a TD of 115.25 ft bgs.

2.6.1 Drilling and Sampling

Drilling – On January 14, 2013 drilling began at borehole C8728 using 10 ¾-in. carbon steel threaded casing. Casing was advanced to a depth of 114.9 ft bgs on January 24, 2013. On January 24, 2013 a geophysical survey using SGLS and NMLS was performed from ground surface to 114 ft bgs.

Sampling – Sampling at C8728 included water sample collecting for laboratory chemical analysis and soil sample collecting for geologic archive purposes and sediment size distribution (sieve sample). Geologic archive soil samples were collected at 5-ft intervals and at lithology changes throughout the depth of the borehole. On January 23, 2013 water was encountered at a depth of 82.7 ft bgs. RUM was encountered at 107.0 ft bgs. One composite sieve sample was collected throughout the depth of the zone of saturation. One water sample was collected after development and the permanent pump was installed. The sample was collected from the 0.5 hp permanent pump. An equipment blank (EB) sample was also collected for quality control. Table 17 summarizes the sample collected for laboratory chemical analysis for this borehole. The borehole log associated to this well, located in Appendix B, shows specific sample locations in regard to depth and lithologic composition.

Table 17 - Sample Summary: Well 199-D5-148 (C8728)

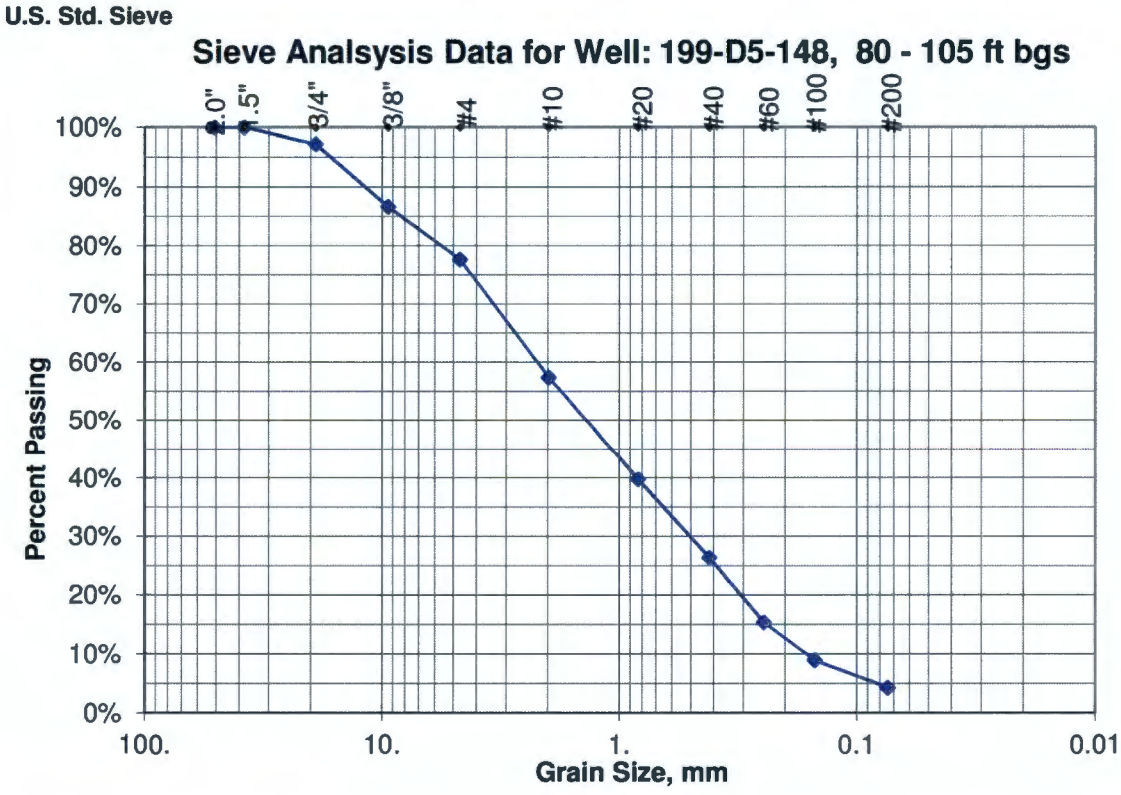
Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
2/27/2013	107.11	Water	Pump	B2NR41, B2NR55
2/27/2013	EB	Water	Pump	B2NR44

A sample for size distribution analysis was collected throughout the zone of saturation from 75 ft bgs to 107 ft bgs. The RUM was not included in the sieve sample. Results for the sieve analysis are shown in table 18.

Table 18 - Results of Size Distribution Analysis for C8728

Screen Size (mm)	19.05	9.525	4.750	2.000	0.850	0.425	0.250	0.150	0.075	Pan
% Retained	2.8	10.5	9.0	20.3	176	13.4	11.0	6.4	4.7	14.2

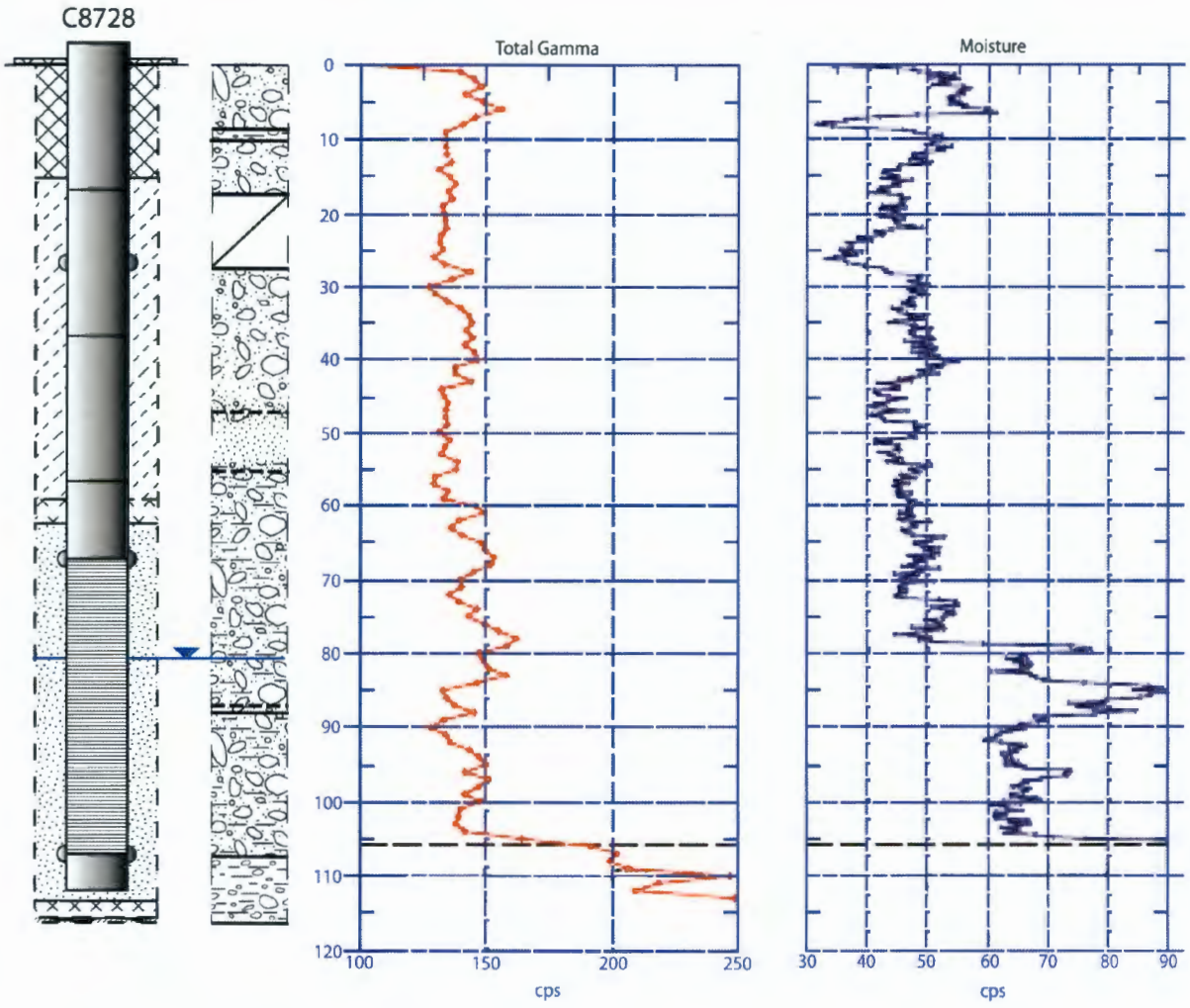
Figure 14 - Particle Size Distribution Curve for 199-D5-148 (C8728)



2.6.2 Geophysical Logging

Geophysical logging was performed by the SM Stoller Corporation on January 29, 2013 for this well location. A SGLS and a NMLS were deployed to survey between ground surface and the total depth of the borehole as depicted in Figure 15, below. According to logging results, no manmade radionuclides were detected within the borehole at this location.

Figure 15 - 199-D5-148 (C8728) Total Gamma & Moisture Comparison Plot



2.6.3 Well Construction and Development

Well Construction – Well construction of C8728 took place between January 30, 2013 and February 5, 2013. The well was constructed with 6 5/8-in. OD, schedule 10, type 316/316L stainless steel permanent casing and screens. A total of 20.01-ft of stainless steel screen with 0.040-in. apertures was used. A 4.99-foot long stainless steel sump was placed below the screen. Well construction and associated depths are summarized in table 19.

Table 19 - Construction Summary: Well 199-D5-148 (C8728)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	6-inch Diameter, Stainless Steel Well Materials			Annular Materials		
115.25	82.7	**Material**	**Interval (ft bgs)**	**Slot Size (in.)**	**Material**	**Interval (ft bgs)**	**Mesh Size**
		Casing	+2.0 – 66.94	Solid	Cement Grout	0.4 – 15.0	Slurry
		Screen	66.94 – 106.95	0.040	Bentonite Crumbles	15.0 – 59.10	8-20
		Sump	106.95 – 111.94	Solid	Bentonite Pellet Seal	59.10 – 62.40	1/4 in.
					Colorado Silica Sand	62.40 – 113.15	[10-20]
					Bentonite Pellet Seal	113.15 – 115.05	1/4 in.

Development – C8728 was developed in accordance with section one of this document. Final well development took place on February 6, 2013. Development was completed in 2 intervals no greater than 20-ft using a 5-hp pump pumping at 58 gpm; which took approximately two hours and one minute to complete. A total of 7,018 gallons of water was extracted from the ground during this period of time. The permanent pump was installed on February 7, 2013. The intake for the permanent pump placed at 107.1 ft bgs.

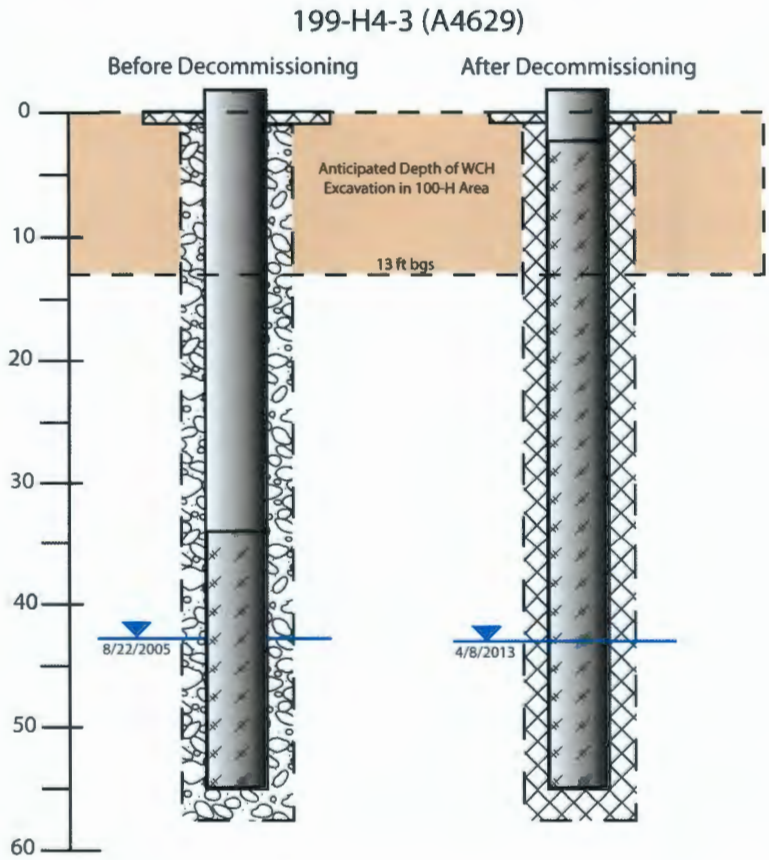
3 Well Decommission Activities

In accordance with the Washington Administrative Code (WAC) the well for this project was decommissioned. According to WAC 173-160-460, "What is the decommissioning process for resource protection wells" there are 2 options for decommissioning a well that was not built to WAC standards. For both options all debris, sediment and equipment must be removed for the well before decommissioning. The first option states to perforate the casing and pressure grout the well. The second option states to remove the casing from the ground and grout the borehole. For this project the first option was chosen from decommissioning. See Figure 16, 199-H4-3 (A4629) Decommissioning: Before & After, for visual reference.

CHPRC regulation also requires that the well stick up be removed and a brass survey marker, marked with the well name, ID number, and the date of decommissioning, be placed at the well location as stated in GRP-EE-02-14.1 *Drilling, Remediating, and Decommissioning Resource Protection Wells, and Geotechnical Soil Borings*. However this was waved due to the well being excavated with a nearby active waste site (SGW-53577, 2012).

Well 199-H4-3 (A4629) was not initially constructed in compliance with WAC standards, but the well was decommissioned in accordance with WAC standards. In the processes of decommissioning the well, built with carbon steel casing, was perforated 4 times every foot to ground surface and then the well was pressure grouted. Pressure grouting occurred from the bottom of the casing, 56 ft bgs to 4 ft bgs. The well was cemented from 4 ft bgs to the ground surface. No surface components were removed and no surface markers were placed.

Figure 16 - 199-H4-3 (A4629) Decommissioning: Before & After



4 Geology of 100-HR-3 OU

The Hanford Site is located within the west-central Pasco Basin in south-central Washington. The Pasco Basin lies within the Columbia Plateau, identified as the portion of the Columbia Intermontane Province that is underlain by the Columbia River Basalt Group according to the WHC-SA-1764, Late Cenozoic Structure and Stratigraphy of South-Central Washington (Reidel. et al., 1993). Over the last 17 million years Miocene flood basalt volcanism and regional deformation occurred. This activity has defined the Columbia Intermontane Province. The cyclic cataclysmic floods that originated from Montana and Northern Idaho and one of the most notable events that altered the topography in the last several million years. Geomorphic features that are prominent from these floods are channeled scablands, giant ripple marks, giant flood bars and deposited sediment within the Pasco Basin.

4.1 Stratigraphy

The stratigraphy of the 100-D/H area is consistent with the regional geologic setting, composed of unconsolidated sedimentary deposits overlying the Columbia River Basalt Group and associated Ellensburg Formation interbeds. Units overlying the basalt include Holocene alluvial, eolian, and anthropogenic deposits, the Pleistocene Hanford formation, and the Miocene-Pliocene Ringold Formation.

The ground surface in the 100-HR-3 groundwater OU reflects the influence of the Pleistocene Missoula Floods (discussed below) and subsequent reestablishment and migration of the Columbia River through the Hanford Area. Surface features that reflect the catastrophic Missoula floods in the area include giant ripple marks and gravel bars. Well-defined curvilinear channel trace features are visible in aerial photographs on both sides of the current river, indicating that the channel has repeatedly migrated across the valley floor. Additionally, eolian sands may be present to depths up to 10 ft. Contact depths in the Horn area (between the 100-D and 100-H) depend greatly on the degree of Pleistocene flood and Holocene river erosion that has taken place.

Depending on proximity to former facilities and/or remediation sites, the ground surface of the 100-D Area has been extensively disturbed by grading, construction, and demolition work. Disturbed sediments can extend more deeply, but in general range from 1 to 15 ft below ground surface (bgs) in disturbed areas.

Underlying any Holocene deposits, the Hanford formation is a Pleistocene, cataclysmic flood and interflood deposit unit resulting from the Missoula Floods that occurred from 15,000 to 12,000 years ago. The Hanford formation can be divided loosely into three facies: gravel-dominated, sand-dominated, and slackwater (WCH-SD-EN-TI-011). In the 100 Areas, the gravel facies is most common. The gravel-dominated Hanford formation is highly basaltic, ranging from approximately 50% to 80% basalt (WHC-SD-EN-TI-011). Limited examples of in-situ Hanford formation (from outcrop or excavations) have shown common open-framework textures.

Discrete sand lenses are present in the 100-D/H Area, which may form preferential flow paths or collection zones for vadose-zone contaminants. Borehole logs have reported these sand lenses to be nearly 100% basalt (for example, at well 199-D4-96). However, WHC-SD-EN-TI-132 reports that in general, Hanford formation matrix sands in the vicinity of 100-HR-3 are less basaltic than elsewhere on the site.

Sediments of the Hanford formation within the 100-D/DR Facility Area are expected to extend to between 45 ft and 60 ft bgs towards the northern end of the Facility Area and to between 60 and 75 ft bgs towards the southern end of the Facility Area.

Disconformably underlying the Hanford formation, the Ringold Formation Unit E is composed of fluvial matrix-supported gravels and sands with intercalated fine to coarse sand and silt lenses. Unit E lithology is between 35% and 90% felsic consisting mainly of metamorphic, intermediate volcanics, and felsic volcanics (WHC-SD-EN-TI-011). Silica and/or carbonate cementation is/are highly variable depending on depth and location.

The contact between the Hanford formation and Ringold Unit E can be difficult to distinguish. Borehole logs suggest that the Hanford forms a disconformable, gradational (i.e. reworked) contact with the Ringold Unit E, with felsic content and cementation increasing with depth. In general, Ringold Unit E gravels are more rounded, may be more cemented, and show a distinct oxidized brown color as compared to the Hanford formation (WCH-SD-EN-TI-132). Ringold Unit E is mostly absent east of the 100-D Area, except for isolated erosional remnants throughout the Horn area. Where Unit E is not present, the Hanford formation sediments directly overlay the RUM.

The RUM is primarily composed of variably cemented overbank flood deposits and paleosols. Primarily composed of silt and clay, the RUM is typically described as various shades of brown to olive-brown. Within the RUM, thin sand-to-gravel lenses form discontinuous confined-to-semi-confined aquifers. The RUM is expected to be encountered at depths ranging from 109 ft bgs. At some locations in the 100-HR-3 area, the lower Hanford formation contains isolated but numerous rip-up clasts of the RUM (WCH-SD-EN-TI-132).

4.2 Structural Geology

The Pasco Basin is bounded to the north, west, and south by a series of east-west trending, north vergent anticlines. A west-dipping monocline bounds the basin to the east (Lindsey, 1996; Reidel et al., 1993). The western part of the Pasco Basin is divided by a series of asymmetrical, east-west-trending folds that verge to the north. Gable Mountain is included in these folds, and divided the western part of the basin into the Wahluke syncline to the north and the Cold Creek syncline to the south. The 100-D and 100-H areas lie within the Wahluke syncline as stated in Geology of the Northern Part of the Hanford Site: An Outline of Data Sources and the Geologic Setting of the 100 Areas (WHC-SD-EN-IT-011).

5 Geology

Geologic formations and units encountered during the drilling for this project include the Hanford formation (fm.), Ringold Formation (Fm.), Unit E, and Ringold Fm. RUM. Geologic units were identified using several publications including:

- Neitzel, D.A.(editor), 2001, *Hanford Site NEPA Characterization,* Rev. 13, PNNL-6415, Pacific Northwest National Laboratory, Richland, Washington
- Reidel S.P., N.P. Campbell, K.R. Fetch, K.A. Lindsey, 1993, *Late Cenozoic Structure and Stratigraphy of South-Central Washington,* WHC-SA-1764-FP, Westinghouse Hanford Company, Richland Washington
- Reidel, S.P., and M.A. Chamness, 2007, *Geology Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site,* PNNL-15955, Pacific Northwest National Laboratory, Richland, Washington
- WHC-SA-1764-FP, *Late Cenozoic Structure and Stratigraphy of South-Central Washington.* (Reidel et al., 1993)

These publications were also used in tandem with borehole logs of the drilling which can be found in Appendix B. A summary of geologic units encountered throughout each borehole is presented in the sections below.

5.1 Borehole Geology

This section includes summarized descriptions of the geology encountered during the drilling of the boreholes throughout this project. Geologists looked at the following attributes while describing sediments in the field: grain size, max particle size, sorting, angularity, amount of calcium carbonate (using 10% dilute hydrochloric acid [HCl]), mineralogy, color, and plasticity. Sediment colors were described using Munsell® rock and soil color charts. Sediments were described based on drill cuttings collected and observations made of drilling dynamics. Some information such as grain size and percent distribution may be skewed as a result of the drilling method used. For example cable tool drilling tends to pulverize rocks and air rotary drilling tends to remove sediments gradationally. The amount of calcareous material may be greater than recorded in borehole logs due to HCl reactions inhibited by ground water or water added during the drilling process.

5.2 Geology of the 100-D Area

5.2.1 Well 199-D5-145 (C8725)

Well 199-D5-145 (C8725) is located approximately a quarter of a mile west of the DR Reactor in the 100-D area. The well was built just off of Paha Avenue. Prominent units that were encountered while drilling were the Hanford fm., the Ringold Fm. Unit E and the Ringold Fm. RUM.

The Hanford fm. was encountered just below the drill pad roughly 1-foot bgs and extended to approximately 59 ft bgs. The entirety of the Hanford fm. was categorized as Sandy Gravel. Size of particles range from silt to large boulders and their angularity is mostly round to sub-round. The sediments within this formation have a 70-80% dominant mafic composition. The contact between the Hanford fm. and the underlying Ringold Fm. is mostly indistinct.

The Ringold Fm. was encountered from a depth of approximately 59 ft bgs to 119 ft bgs. Within this borehole the Ringold Fm. is comprised of two distinctive units; Unit E and the RUM. Unit E can be found from approximately 59 ft bgs to 113.5 ft bgs. Sediment description for this formation varies and includes Sandy Gravel, Silty Sandy Gravel, and Sand. Particle size ranges from silt to cobble sized and the angularity ranges from round to angular throughout the depth of the Ringold Fm., Unit E. The composition is mostly felsic, ranging from 60% to 70%. The RUM has a distinct contact with the Unit E at 113.5 ft bgs.

The RUM was encountered from 113.5 ft bgs to 119 ft bgs where drilling stopped. Comprised mostly of silt there were trace sand and gravels also found within the unit. The silt unit had a low plasticity using only the moisture found in the unit itself.

The borehole log can be found in Appendix B.

5.2.2 Well 199-D5-146 (C8726)

Well 199-D5-146 (C8726) is located about a quarter mile west of the DR Reactor and can be accessed from Paha Avenue. Prominent formations and units encountered throughout the borehole include the Hanford fm., Ringold Fm. Unit E, and the Ringold Fm. RUM.

The Hanford fm. can be found just below the drill pad to a depth of approximately 75 ft bgs. Within this formation the sediment descriptions are Sandy Gravel, Silty Sandy Gravel, and Sand. Particle size within this formation ranges from silt to small boulder. Angularity of the sediment ranges from sub-round to sub-angular. The Hanford fm. has a mafic sediment content ranging from 70% to 90% throughout its depth. At 75 ft bgs an indistinct contact between the Hanford fm. and the Ringold Fm. Unit E is determined by a change in the percentage of mafic to felsic sediment content.

The Ringold Fm. extends from approximately 75 ft bgs to a total borehole depth of 116.7 ft bgs. The Ringold Fm. Unit E extends from approximately 75 ft bgs to 111.1 ft bgs. Sediment description of this unit includes Sandy Gravel, Silty Sandy Gravel, Gravelly Sand, Sand, and Gravelly Silty Sand. In this unit particle size ranges from silt to small cobble with an overall angularity of sub-round to sub-angular. The felsic composition of this unit ranges from 40% to 90%. The Unit E at this location has a lower distinct contact with the RUM at 111.1 ft bgs.

The RUM was encountered from 111.1 ft bgs to a final depth of 116.7 ft bgs. The sediment description for the RUM ranges from Gravelly Sandy Silt at the contact to Sandy Silt. No water was added to find the plasticity of the RUM. By rolling the RUM into a snake shape using only the water that came up with the sediment it was determined to have a medium plasticity. This level of plasticity was observed from the contact transition to the TD of the borehole (116.7 ft bgs).

The borehole log can be found in Appendix B.

5.2.3 Well 199-D5-147 (C8727)

Well 199-D5-147 (C8727) is located on the corner of D. Avenue and Pioneer Way within the fence in the 100-D area. Prominent formation and units encountered throughout the borehole include the Hanford fm., Ringold Fm. Unit E, and the Ringold Fm. RUM.

The Hanford fm. can be found below the drill pad roughly 2.5 ft bgs to 55 ft bgs. The sediment descriptions throughout this formation are Sandy Gravel, Gravelly Sand, Silty Sandy Gravel, and Sand. Angularity of the sediment ranges from round to angular and the particle size ranges from silt to large cobbles. The Hanford fm. has a mafic composition that ranges from 60% to 80%. The contact between the Hanford fm. and the underlying Ringold Fm. is determined by the reduced amount of mafic composition, indicating the contact to be at 55 ft bgs.

The Ringold Fm. extends from 55 ft bgs to the total depth of 108.3 ft bgs. Within this borehole the Ringold Fm. is comprised of two units, Unit E and the RUM. Unit E extends from the upper contact of 55 ft bgs to 103.0 ft bgs. Particle size for this unit ranges from silt to large cobble that have an angularity that ranges from round to angular. Unit E has a composition that ranges from 70% to 80% felsic material. The lower contact is a distinct contact with the RUM at 103.0 ft bgs.

The RUM was encountered from 103.0 ft bgs to the final depth of 108.3 ft bgs. The sediment description for the RUM is Silt. The plasticity of the RUM starts out non-plastic but with depth it increases to very plastic. The plasticity is determined by the natural amount of water within the drill cuttings, no additional water was added. The borehole was terminated within the RUM at a TD of 108.3 ft bgs.

The borehole log can be found in Appendix B.

5.2.4 Well 199-D5-148 (C8728)

Well 199-D5-148 (C8728) is located SW of DR Reactor, on Pioneer Way in the D area. Prominent formation and units encountered throughout the borehole include the Hanford fm., Ringold Fm. Unit E, and Ringold Fm. RUM.

The Hanford fm. can be found just below the drill pad and extends to 55 ft bgs. The Hanford fm. sediment descriptions are Sandy Gravel, Silty Gravel, and Sand. The particle size ranges from silt to large cobbles with angularity ranging from angular to sub-round. The mafic sediment content within the Hanford fm. ranges from 60% to 75%. The lower contact of the Hanford fm. and the Ringold Fm. Unit E is located at 55 ft bgs.

The Ringold Fm. extends from 55 ft bgs to the TD of the borehole at 115.25 ft bgs. The Ringold Fm., Unit E extends from 55 ft bgs to 107 ft bgs. The sediment descriptions for this unit consist of Silty Sandy Gravel and Silty Gravel. Particles range from silt to small boulders. Angularity ranges from round to angular. The felsic composition of Unit E ranges from 50% to 70%. Underlying the Ringold Fm. Unit E is the RUM. The contact of these two units is 107 ft bgs.

The RUM was encountered from 107 ft bgs to 115.25 ft bgs. The sediment description for this unit was Gravelly Sandy Silt. Angularity of the sand and gravel components is angular to sub-round. The RUM was found to have a very high plasticity without adding any water. The depth of the borehole was terminated within the RUM at 115.25 ft bgs.

The borehole log can be found in Appendix B.

5.3 Geology of the 100-H Area

5.3.1 Well 199-H4-85 (C8723)

Well 199-H4-85 (C8723) is located north of H Reactor on H. Avenue in the 100-H area. Prominent formations and units encountered throughout the borehole include the Hanford fm. and Ringold Fm. RUM.

The Hanford fm. can be found just below the drill pad and to 47.5 ft bgs. Sediment descriptions for the Hanford fm. are Silty Sandy Gravel and Sandy Gravel. Particle size throughout the formation ranges from silt to large cobble. Angularity ranges from sub-round to sub-angular throughout the depth of the formation. The Hanford Formation has a mafic composition that ranges from 40% to 65%. A distinct contact with the Ringold Fm. RUM is found at 47.5 ft bgs.

The RUM was encountered from 47.5 ft bgs to 53.5 ft bgs. The sediment description for the RUM is Silt. Trace amounts of Sand and gravel can also be found within the RUM as well as some calcareous stringers. Without adding any additional water the RUM was found to have a low plasticity. The depth of the borehole was terminated within this unit at 53.5 ft bgs.

The borehole log can be found in Appendix B.

5.3.2 Well 199-H4-86 (C8724)

Well 199-H4-86 (C8724) is located north of H Reactor on Hoko Drive in the 100-H area. Formations and units encountered during the drilling of this borehole include the Hanford fm. and Ringold Fm. RUM.

The Hanford fm. was encountered from just blow the drill pad, roughly 5 ft bgs, to a depth of 60.5 ft bgs. The sediment descriptions for the Hanford fm. are Silty Sandy Gravel, Sitly Gravel and Sandy Gravel. The mafic content of the silt to large cobble sediment ranges from 25 % to 50%. The angularity of the sediment ranges from round to angular. A distinct contact with the Ringold Fm. is found at 60.5 ft bgs.

The Ringold Fm., RUM is the upper most visible layer of the Ringold Fm. found from a depth of 60.5 ft bgs to 66.1 ft bgs. The RUM's sediment description is Silt. There are trace amounts of well rounded sand and gravels. From 60.5 ft bgs to approximately 62 ft bgs, without adding any water, the RUM has a high plasticity but after 62 ft bgs it is dry and is non plastic. Throughout the RUM calcareous stringers can also be found. The depth of the borehole was terminated within the RUM at 66.1 ft bgs.

The borehole log can be found in Appendix B.

6 Environmental Monitoring

6.1 Radiological Monitoring

Radiological monitoring was provided every day throughout the drilling operations on site. During drilling operations radiological monitoring was provided twice daily. Monitoring became intermittent once construction of the well began. Radiological Control Technicians (RCTs) conducted surveys of drill cuttings, drilling tools, personal protective equipment, sediment storage containers, archive samples, and anything that made contact with water or drill cuttings from the well. The RCTs used multiple meters to detect levels of beta and gamma radiation contamination. No readings throughout the project duration exceeded the background readings.

6.2 Industrial Hygiene (Air Quality) Monitoring

Air quality monitoring of organic vapors was conducted by an industrial hygienist twice daily during drilling operations. Monitoring was done in and around the borehole opening using an organic vapor meter. With the exception of two events throughout the project, which were determined none events, the industrial hygienist recorded sustainable readings between zero and 2 parts per million (ppm). These readings were below the permissible exposure limit for all suspect contaminants of concern for the area.

The first event occurred on January 30, 2013 at well 199-D5-145 (C8725). The organic vapor meter got a reading of 60 ppm of volatile organic compounds (VOCs) from the well head. The industrial hygienist had the drillers stop work. After a 10 minute wait the well head was checked again receiving a reading of 12 ppm. The breathing area had a reading of 0.1 ppm. The industrial hygienist determined that no action needed to be taken and cleared the drillers to continue work.

The second event occurred on March 19, 2013 at well 199-H4-86 (C8724). The organic vapor meter got a maximum reading of 87 ppm of VOCs from the well head. Drilling continued with close monitoring by the industrial hygienist. The VOC levels decreased with depth. It was determined that no further action needed to be taken and drilling continued as usual.

7 Waste Management

7.1 Solid Waste

In accordance with Remedial Design Report/Remedial Action Work Plan for the 100 Area (DOE/RL-96-17, Rev. 6) and the Washington Closure Hanford (WCH) Field Remediation Site Specific Waste Management Instruction (WMI-100DH001), all drill cuttings and miscellaneous solid waste (MSW) were disposed of in Environmental Restoration Disposal Facility (ERDF) roll off box. Each drill site received an ERDF roll off box to dispose of drill cuttings from the entire well.

7.2 Water Waste

All water generated during the well drilling and sampling was stored appropriately until a purge truck was able to remove the water from the well site and safely transport the water to the Modular Storage Unit. This is in accordance with purgewater guidance provided in DOE/RL 2009-39, *Investigation-Derived Waste Purgewater Management Action Memorandum* and DOE/RL-2009-80, *Investigation Derived Waste Purgewater Management Work Plan.*

8 Civil Survey

Final locations for the six wells were surveyed by a Washington State licensed Professional Land Surveyor contracted by CHPRC. Surveys were collected on March 8, 2013 for wells C8725, C8727, and C8728. Surveys were collected on March 21, 2013 for wells C8723 and C8726. Surveys were collected on April 11, 2013 for well C8724. The horizontal survey was performed using a Trimble[2] R8 RTK global positioning system (GPS) receiver and a Trimble DiNi 12 level under the Washington State Plane Coordinates, WSC83S [91] and the North American Datum of 1991 (NAD83[91]). Elevations were surveyed also using a Trimble R8 RTK GPS receiver under the North American Datum of 1988 (NAVD88). Survey reports have been entered into the Hanford Well Information and Document Lookup (WIDL) database. Survey data for project wells is summarized in Table 1, Well Summary Information.

[2] Trimble is a trademark of Trimble Navigation Limited, Sunnyvale California.

9 Well Acceptance

A final well acceptance walkdown was conducted by representatives of the drilling contractor and CHPRC.

The well inspections and well acceptance activities included representatives from Carpenter Drilling Company, CHPRC's Buyer's Technical Representative, CHPRC's Well Drilling Management and CHPRC's Quality Assurance/Quality Control representative.

The final acceptance walkdowns included verification of attributes such as surface protection, well identification, well functionality, and site cleanup. CHPRC surveillance report of the acceptance of the wells/boreholes discussed in this summary report will be attached at a later date.

Wells 199-H4-85 (C8723), 199-D5-145 (C8725), 199-D5-146 (C8726), 199-D5-147 (C8727) and 199-D5-148 (C8728) were all accepted on April 9, 2013. Well 199-H4-86 (C8724) was accepted on April 23, 2013.

10 References

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 U.S.C. 9601, et seq.

DOE/RL-96-17, 2009, *Remedial Design Report/Remedial Action Work Plan for the 100 Are*, Rev. 6, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2009-39, 2009, *Investigation-Derived Waste Purgewater Management Action Memorandum,* Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2009-80, 2009, *Investigation Derived Waste Purgewater Management Work Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2012-45, 2012, *Sampling and Analysis Plan for Installation of 100-HR-3 Groundwater Operable Unit Replacement Wells*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, Ecology, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

GRP-EE-02-14.5, Rev. 1, Procedure, *Returning Vadose Zone Drill Cuttings/Soils to the Environment*, CH2M Hill Plateau Remediation Company, Richland, Washington.

Lindsey, K.A., 1996, *The Miocene to Pliocene Ringold Formation and Associated Deposits of the Ancestral Columbia River System, South-central Washington and North-central Oregon*. Washington Division of Geology and Earth Resources Open File Report 96-8, Washington State Department of Natural Resources, Olympia, Washington.

Neitzel, D.A.(editor), 2001, *Hanford Site NEPA Characterization,* Rev. 13, PNNL-6415, Pacific Northwest National Laboratory, Richland, Washington.

Reidel S.P., N.P. Campbell, K.R. Fetch, K.A. Lindsey, 1993, *Late Cenozoic Structure and Stratigraphy of South-Central Washington,* WHC-SA-1764-FP, Westinghouse Hanford Company, Richland Washington.

Reidel, S.P., and M.A. Chamness, 2007, *Geology Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site,* PNNL-15955, Pacific Northwest National Laboratory, Richland, Washington.

ROD/R10-96/134, 1996, *Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

SGW-52543, 2012, *Description of Work for Decommissioning Five 100-H Wells for WCH*, Rev. 0, CH2M Hill Plateau Remediation Company, Richland, Washington.

SGW-53577, 2012, *Description of Work for the Installation of 6 Wells at 100-DH and Decommissioning of 199-H4-3, FY2013*, Rev. 0, CH2M Hill Plateau Remediation Company, Richland, Washington.

WAC 173-160, "*Minimum Standards for Construction and Maintenance of Wells,*" Washington Administrative Code, as amended.

WAC 173-160-420, "*General Construction Requirements for Resource Protection Wells,*" Washington Administrative Code, as amended.

WAC 173-160-460, "*Decommissioning Process for Resource Protection Wells*," Washington Administrative Code, as amended.

WHC-SD-EN-TI-011, 1992, *Geology of the Northern Part of the Hanford Site: An Outline of Data Sources and the Geologic Setting of the 100 Areas*. Rev. 0, Westinghouse Hanford Company, Richland, Washington.

WMI-100DH001, 2013, *Site Specific Waste Management: Instruction for the 100-D and 100-H Remedial Action*. Rev. 1, Washington Closure Hanford, Richland, Washington.

Appendix A

Well Summary Sheets (As-Built)

WELL SUMMARY SHEET

Start Date: 3/05/2013
Finish Date: 3/14/2013

Page 1 of 1

Well ID: C8723	Well Name: 199-H4-85
Location: 100-H, North of Reactor on H Ave.	Project: WCH Replacement Wells at 100-D/H
Prepared by: Tessa Clark — Date: 3/18/2013	Reviewed by: L. Craig Swanson — Date: 5/29/13
Signature: [signature]	Signature: [signature]

CONSTRUCTION DATA

Description

Surface Completion: 4'x4'x6" Concrete Pad w/brass survey marker and 8 5/8" protective monument (3 ft ags).

Concrete Surface Seal:
Type I/II Portland Cement
0.0' bgs - 10.2' bgs.

Permanent Well:
6 5/8" OD Stainless Steel Blank
2.0' ags - 27.39' bgs

6 5/8" OD Stainless Steel 0.040 slot Screen
27.39' bgs - 47.29 ' bgs

6 5/8" Stainless Steel Sump w/end cap
47.29' bgs - 52.40' bgs

#8 Granular Bentonite Crumbles:
10.2' bgs - 18.9' bgs

1/4" Uncoated Bentonite Pellets:
18.9' bgs - 22.5' bgs

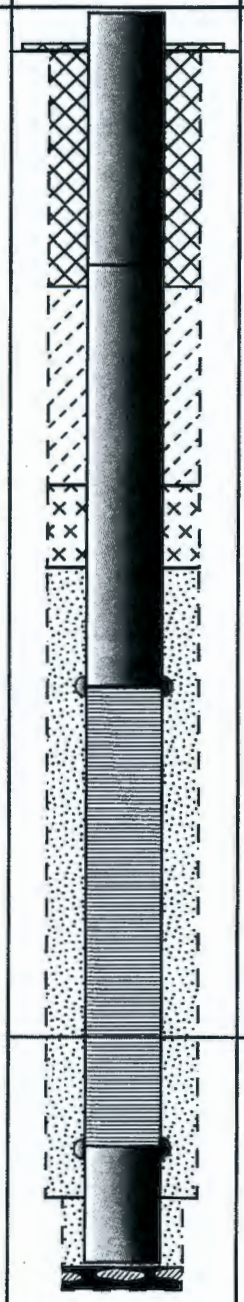
10-20 Colorado Silica Sand Pack:
22.5' bgs - 52.5' bgs

Natural Backfill:
52.5' bgs - 53.5' bgs

All temporary 10 3/4" OD casing completely removed from ground (3/13/2013).

bgs = below ground surface
ags = above ground surface

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 10, 20, 30, 40, 50

Graphic Log

Lithologic Description

0 - 2: Silty Sandy Gravel, msG

2 - 5: Sandy Gravel, sG

5 - 35: Silty Sandy Gravel, msG

35 - 47.5: Silty Sandy Gravel, msG

DTW = 42.6'bgs (3/11/2013)

47.5 - 53.5: Silt, M

TD = 53.5' bgs (3/7/2013)

WELL SUMMARY SHEET

Start Date: 3/19/2013
Finish Date: 4/3/2013
Page 1 of 1

Well ID: C8724	Well Name: 199-H4-86
Location: 100-H, North of H Reactor on Hoko Drive	Project: WCH Replacement Wells at 100-D/H
Prepared by: Julie Johanson — Date: 4/2/2013	Reviewed by: L. Craig Swanson — Date: 5/29/13
Signature: Julie Johanson	Signature: LC Swanson

CONSTRUCTION DATA

Description

Surface Completion: 4'x4'x6" Concrete Pad w/brass survey marker and 8 5/8" protective monument (3.02 ft ags).

Permanent Well:
6 5/8" OD Stainless Steel Blank
2.02' ags - 35.04' bgs

6 5/8" OD Stainless Steel 0.055 slot Screen
35.04' bgs - 60.06 ' bgs

6 5/8" Stainless Steel Sump w/end cap
60.06' bgs - 65.07' bgs

Concrete Surface Seal:
Type I/II Portland Cement
0.0' bgs - 10.7' bgs.

#8 Granular Bentonite Crumbles:
10.7' bgs - 24.6' bgs

1/4" Uncoated Bentonite Pellets:
24.6' bgs - 27.2' bgs

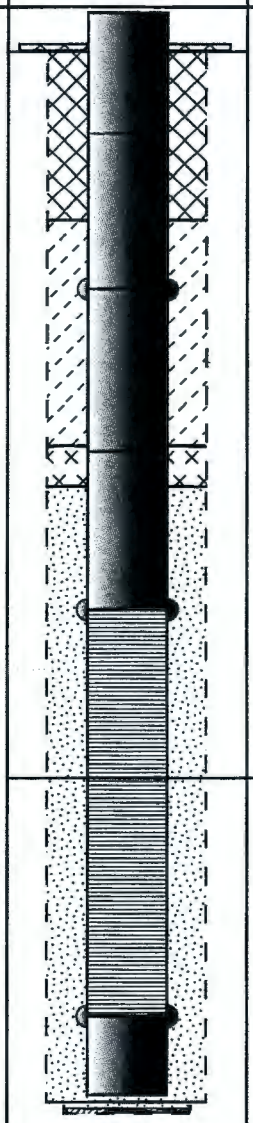
10-20 Colorado Silica Sand Pack:
27.2' bgs - 66.0' bgs

Natural Backfill:
66.0' bgs - 66.1' bgs

All temporary 10 3/4" OD casing completely removed from ground (4/2/2013).

bgs = below ground surface
ags = above ground surface

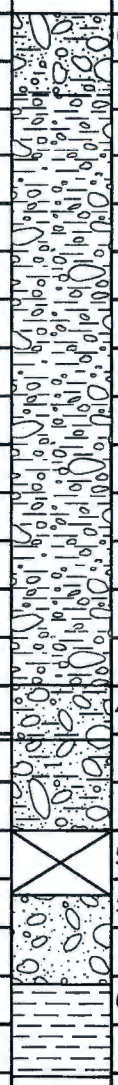
Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 15, 30, 45, 60, 75

Graphic Log



Lithologic Description

0-5: Silty Sandy Gravel (msG)

5-42.5: Silty Gravel (mG)

42.5-51: Silty Sandy Gravel (msG)

51-55: No Recovery

55-60.5: Sandy Gravel (sG)

60.5-66.1: Silt (M)

WELL SUMMARY SHEET

Start Date: 1-14-2013
Finish Date: 2-14-2013
Page 1 of 1

Well ID: C8725	Well Name: 199-D5-145
Location: ~ 1/4 mile W. of DR Reactor	Project: WCH Replacement Wells at 100-D/H
Prepared by: Kyle Stiles — Date: 2-14-2013	Reviewed by: L. Craig Swanson — Date: 5/29/13
Signature: [illegible]	Signature: [illegible]

CONSTRUCTION DATA

Description

Surface Completion: 4'x4'x6" Concrete Pad w/brass survey marker and 8 5/8" protective monument (3 ft ags)

Cement Surface Seal:
Type I/II Portlant Cement
Ground surface - 10.14' bgs

Permanent Well:
6 5/8" OD Stainless Steel Blank
1.72' ags - 73.3' bgs

6 5/8" OD Stainless Steel 0.040 slot Screen
73.3' bgs - 113.3' bgs

6 5/8" OD Stainless Steel Sump w/end cap
113.3' bgs - 118.29' bgs

8 Bentonite Crumbles:
10.14' bgs - 65.05' bgs

1/4" Coated Bentonite Pellets:
65.05' bgs - 68.10' bgs

10-20 Colorado Silica:
68.10' bgs - 118.9' bgs

10 3/4" OD Temporary Casing:
Carbon Steel; 0.0' bgs - 119.0' bgs

All temporary casing completely removed from ground.

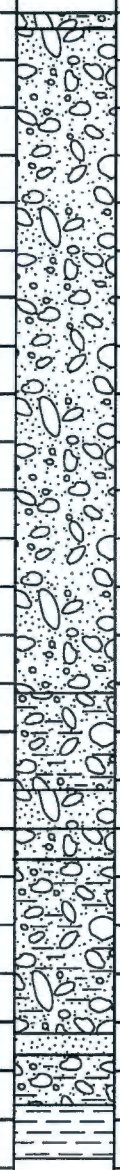
bgs = below ground surface
ags = above ground surface

Diagram

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 25, 50, 75, 100, 125

Graphic Log



Lithologic Description

0 - 1' Silty Sandy Gravel, msG

1 - 71' Sandy Gravel, sG

71 - 81' Silty Sandy Gravel, msG

81 - 88' Sandy Gravel, sG

DTW = 85.05' bgs (2/13/2013)

88 - 106' Silty Sandy Gravel, msG

106 - 108' Sand, S

108 - 113.5' Silty Sandy Gravel, msG

118.8' SCB 5/29/13

113.5 - ~~119.0'~~ Silt, M

TD = ~~119.0'~~ bgs
118.8'

WELL SUMMARY SHEET

Start Date: 2/19/13
Finish Date: 3/11/13
Page 1 of 1

Well ID: C8726	Well Name: 199-D5-146
Location: W. of D and DR Reactors, Off Paha Ave.	Project: WCH Replacement Wells at 100-D/H
Prepared by: Julie Johanson — Date: 3/12/13	Reviewed by: L. Craig Swanson — Date: 5/29/13
Signature: Julie Johanson	Signature: LCSwanson

CONSTRUCTION DATA

Description

Surface Completion: 4'x4'x6" Concrete Pad w/brass survey marker and 8 5/8" protective monument (3 ft ags).

Concrete Surface Seal:
Type I/II Portland Cement
0.0' bgs - ~~10.0'~~ bgs.
10.08' AJG 6/10/13

Permanent Well:
6 5/8" OD Stainless Steel Blank
~~2.0'~~ ags - 76.44' bgs
2.05' AJG 6/10/13
6 5/8" OD Stainless Steel 0.055 slot Screen
76.44' bgs - 111.47 ' bgs

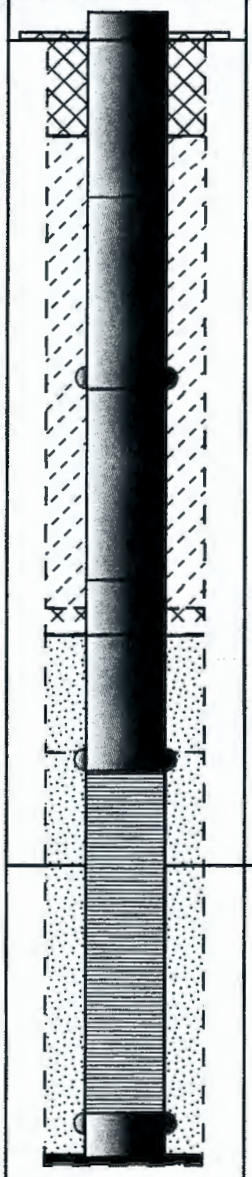
6 5/8" Stainless Steel Sump w/end cap
111.47' bgs - 116.48' bgs

#8 Granular Bentonite Crumbles:
~~10.0'~~ bgs - ~~59.10'~~ bgs
10.08' AJG 6/10/13 59.68'
1/4" Coated Bentonite Pellets:
~~59.10'~~ bgs ~~59.68'~~ bgs
59.68' 62.85' AJG 6/10/13
8-12 Colorado Silica Sand Pack:
~~59.68'~~ bgs - ~~62.85'~~ bgs
62.85' 72.23' AJG 6/10/13
8-16 Silica Sand Pack:
~~62.85'~~ bgs - 115.8' bgs
74.23' AJG 6/10/13
Natural Backfill:
115.8' bgs - 116.7' bgs

All temporary casing completely removed from ground (3/7/2013).

bgs = below ground surface
ags = above ground surface

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 25, 50, 75, 100, 125

Graphic Log

Lithologic Description

0-62: Sandy Gravel (sG)
62-65: Sand (S)
65-80: Sandy Gravel (sG)
80-81: Gravelly Sand (gS)
81-84: Sand (S)
DTW: 86.45 ft bgs
86-87: Sand (S)
87-100: Sandy Gravel (sG)
100-108: Silty Sandy Gravel (msG)
108-110: Sandy Gravel (sG)
110-110.5: Gravelly Silty Sand (gmS)
110.5-111.1: Silty Gravel (mG)
111.1-112: Gravelly Silt (gM)
112-116.7: Sandy Silt (sM)
TD: 116.7 ft bgs

WELL SUMMARY SHEET

Start Date: 2/12/2013
Finish Date: 2/28/2013
Page 1 of 1

Well ID: C8727	Well Name: 199-D5-147
Location: 100-D, Corner of D.Ave/Pioneer Way, In Fence	Project: WCH Replacement Wells at 100-D/H
Prepared by: Tessa Clark — Date: 3/4/2013	Reviewed by: L. Craig Swanson — Date: 5/29/13
Signature: [signature]	Signature: [signature]

CONSTRUCTION DATA

Description

Surface Completion: 4'x4'x6" Concrete Pad w/brass survey marker and 8 5/8" protective monument (3 ft ags).

Concrete Surface Seal:
Type I/II Portland Cement
Ground Surface - 10.21' bgs.

Permanent Well:
6 5/8" OD Stainless Steel Blank
2.0' ags - 73.02' bgs

6 6/5" OD Stainless Steel 0.040 slot Screen
73.02' bgs - 103.02 ' bgs

6 5/8" Stainless Steel Sump w/end cap
103.02' bgs - 108.05' bgs

#8 Granular Bentonite Crumbles:
10.21' bgs - 65.00 bgs

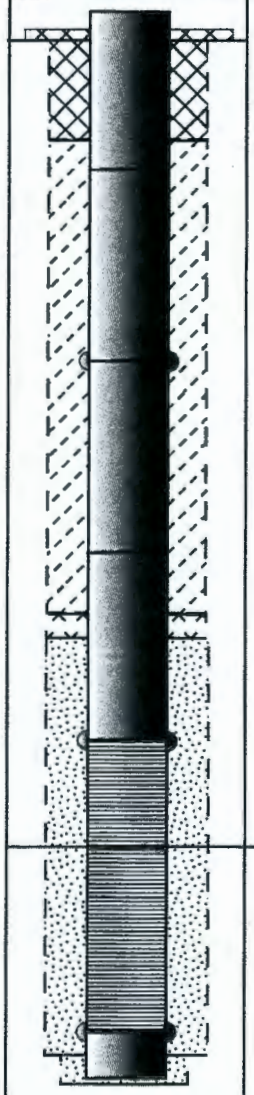
1/4" Uncoated Bentonite Pellets:
65.00' bgs - 67.85' bgs

10-20 Colorado Silica Sand Pack:
67.85' bgs - 108.30' bgs

All temporary casing completely removed from ground (2/26/2013).

bgs = below ground surface
ags = above ground surface

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 25, 50, 75, 100, 125

Graphic Log

Lithologic Description

0 - 2.5: Sandy Gravel, sG
2.5 - 10: Gravelly Sand, gS
10 - 24.5: Silty Sandy Gravel, msG
24.5 - 29: Sandy Gravel, sG
29 - 35: Silty Sandy Gravel, msG
35 - 39: Sandy Gravel, sG
39 - 42: Sand, S
42 - 72: Sandy Gravel, sG
72 - 77.5: Gravelly Silty Sand, gmS
77.5 - 90: Silty Sandy Gravel, msG
DTW = 84.4'bgs (2/28/2013)
90 - 96: Sandy Gravel, sG
96 - 100: Silty Sandy Gravel, msG
100 - 102: Sandy Gravel, sG
102 - 103: Silty Sandy Gravel, msG
103 - 108.3: Silt, M
TD = 108.3' bgs (2/19/2013)

WELL SUMMARY SHEET

Start Date: 1/14/2013
Finish Date: 2/27/2013
Page 1 of 1

Well ID: C8728	Well Name: 199-D5-148
Location: 100-D, SW of Reactors on Pioneer Way	Project: WCH Replacement Wells at 100-D/H
Prepared by: Tessa Clark — Date: 3/4/2013	Reviewed by: L. Craig Sivamian — Date: 5/29/13
Signature: for Tessa Clark	Signature:

CONSTRUCTION DATA

Description

Surface Completion: 4'x4'x6" Concrete Pad w/brass survey marker and 8 5/8" protective monument (3 ft ags).

Concrete Surface Seal:
Type I/II Portland Cement
0.4' bgs - 15.0' bgs.

Permanent Well:
6 5/8" OD Stainless Steel Blank
2.0' ags - 66.94' bgs

6 5/8" OD Stainless Steel 0.040 slot Screen
66.94' bgs - 106.95 ' bgs

6 5/8" Stainless Steel Sump w/end cap
106.95' bgs - 111.94' bgs

#8 Granular Bentonite Crumbles:
15.0' bgs - 59.10' bgs

1/4" Uncoated Bentonite Pellets:
59.10' bgs - 62.40' bgs

10-20 Colorado Silica Sand Pack:
62.40' bgs - 113.15' bgs

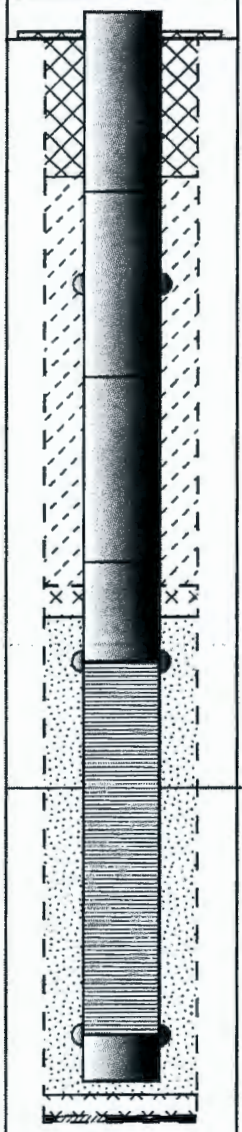
1/4" Uncoated Bentonite Pellets"
113.15' bgs - 115.05'bgs

Natural Backfill:
115.05' bgs - 115.25' bgs

All temporary casing completely removed from ground (2/5/2013).

bgs = below ground surface
ags = above ground surface

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 25, 50, 75, 100, 125

Graphic Log

Lithologic Description

0 - 9: Sandy Gravel, sG
9 - 10: Silty Gravel, mG
10 - 17.5: Sandy Gravel, sG
17.5 - 27.5: No Recovery
27.5 - 47: Sandy Gravel, sG
47 - 55: Sand, S
55 - 87: Silty Sandy Gravel, msG
DTW = 80.1'bgs (1/30/2013)
87 - 87.5: Silty Gravel, mG
87.5 - 107: Silty Sandy Gravel, msG
107 - 115.25: Silty Gravel, mG
TD = 115.25' bgs (1/24/2013)

Appendix B

Borehole Logs

BOREHOLE LOG

Page 1 of 2
Date: 3-5-13

Well ID: C8723 | Well Name: 199-H4-85 | Location: 100-H, N. of Reactor on H. Ave

Project: 100-D/H Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				— (Ground Surface) —	Drilling w/ 13-E Cable Tool rig w/ drive barrel method.
	G.S.			0.0 – 2.0 'bgs: silty sand, gravel (msG) ~40% v.fn to sm. cobbs (max 120mm) (sub-rnd to v. angular), 40% sand (v.fn to v.crs); 20% silt; 10YR 4/2 "dk gray, sh brown", moist, v. loose, v. poorly sorted (gravel drill pad), 60% felsic, 40% mafic, slt rxn w/ HCl.	Grab sample (G.S.) collected @ 2.0' bgs + 1.0' bgs.
	G.S.				G.S. @ 5.0' bgs.
5				2.0 – 5.0 'bgs: sandy gravel (sG) ~50% v.fn to sm. cobbs (max 120mm) @ 3-5-13, 40% v.fn to v.crs sand, ≤10% silt, 10YR 3/2 "v. dk gray, sh brown", moist, v. loose, v. poorly sorted, 65% mafic, 35% felsic, slt rxn w/ HCl. → 2 large cobbs (~160mm) @ ~5.0' bgs.	→ V. Hard drilling @ ~5.5' bgs. → Drilling = easier @ ~7.5' bgs.
10	G.S.				G.S. @ 10.0' bgs.
				5.0 – 35.0 'bgs: silty sand, gravel (msG) ~40% v.fn to lg cobb (~160mm) gravel, 35% v.fn to v.crs sand, 25% silt; 5Y 5/1 "gray", v. dry, v. loose, v. poorly sorted, g's = sub-rnd to sub-ang, 50% mafic @ 3-6-13, 50% felsic @ 3-6-13, strong rxn w/ HCl; gradational contact @ 5' bgs.	
15	G.S.				G.S. @ 15' bgs.
				→ @ ~8.0' bgs, silt inc to 30%, s. dec to 30%.	V. hard drilling @ 19' bgs
20	G.S.			→ @ ~12.0' bgs, 2 large cobbles (230mm) @ 3-8-13	G.S. @ 20' bgs.
				→ @ 18' bgs, large cobb (200mm)	
				→ @ 21' bgs, large cobbs (200-230mm).	
					G.S. @ 25' bgs.
25	G.S.				@ ~25' bgs, drilling gets easier
				→ large cobbs (150-220mm) @ 30' bgs.	
30	G.S.				Grab sample @ 30' bgs.
				35.0 – 47.5 'bgs: silty sand, gravel (msG) ~45% v.fn to sm cobb (max 110mm) gravel (well-rnd to ang), 40% v.fn to v.crs sand (maj. fine-med), 5Y 5/2 "olive gray", slt moist, v. loose, poorly sorted, ~~60% felsic, 40% mafic~~ @ 3-7-13, slt to no rxn w/ HCl, gravels = 60% fels, 40% mafic, sand = 75% fels, 25% mafic.	
35	G.S.				G.S. @ 35' bgs (15% silt) @ 3-7-13
				— (see pg 2 →) —	— (see pg 2 →) —

Reported By: T. Clark | Reviewed By: BRUCE A. WILLIAMS

Title: Geologist | Title: SENIOR GEOLOGIST

Signature: [signature] | Date: 3/7/13 | Signature: [signature] | Date: 5/9/13

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2
Date: 3-7-13

Well ID: C8723 | Well Name: 199-H4-85 | Location: 100-H, N. of Reactor on H. Ave.

Project: 1001/H Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	G.S.			(see pg. 1)	(see pg. 1)
					Drilling w/cable tool rig via drive barrel method.
					• Grab sample (G.S) @ 40' bgs
45	G.S.				→ Soils = v. damp @ ~43' bgs
					• G.S @ 45' bgs.
	G.S.			47.5 – 53.5' bgs: silt	
				95% silt, ≤ 5% gravels + sand "stringers" (< 5mm), 7.5YR 4/4 "brown"; damp, v. consolidated, v. well sorted, low plasticity; no rxn w/HCl, some (< 10% of silt mass) calcareous "stringers" @ 48' bgs (≤ 5mm thick) that react v. strongly w/HCl (light in color).	• G.S. @ 47.5' bgs
					→ Tag H_2O @ 48' bgs 3/7/13
50	G.S.				• G.S @ 50' bgs. (@ 3-7-13)
					→ Tag H_2O @ 42.6' bgs 3/11/13
			T.D.	* @ ~50' bgs, calcareous stringers ≤ 2cm thick.	T.D. @ 53.5' bgs.
55					
60					
65				not used. (@ 3-11-13)	
70					
75					

Reported By: T. Clark | Reviewed By: BRUCE A. WILLIAMS

Title: Geologist | Title: SENIOR GEOLOGIST

Signature: [signature] | Date: 3/11/13 | Signature: [signature] | Date: 5/9/13

A-6003-642 (03/03)

BOREHOLE LOG

Page 1 of 2
Date: 3-19-13

Well ID: C8724 | Well Name: 199-H4-86 | Location: 100-H, N. of Reactor on Hoko Drive

Project: 100 D/H Replacement Wells for WCH | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				Ground Surface	Drilling w/ cable tool + drive barrel method.
	G.S.			0.0 – 5.0 'bgs: silty sandy gravel (ms(2)) ~30% v. fn to v. crs gravel (max 60mm) (n angl to sub-rnd), 50% v. fn to v. crse sand, ≤20% silt, "gravel drill pad", 10YR 4/2 "dk grayish brown", slightly damp, n loose, v. poorly sorted, gravel = 50/50, sand = 65/35 felsic/mafic, mod. rxn w/ HCl.	Grab sample (G.S) @ 2.5' bgs.
5	G.S			→ Gravels = v. fn to large cobbs (≤200mm) @ ~20' bgs.	G.S. @ 5.0' bgs v. difficult drilling
10	G.S.			5.0 – 42.5' bgs: silty gravel (mG) ~40% v. fn to sm. cobb (≤200mm) gravels (v. ang to sub-rnd) (RC) 3-19-13, 25% v. fn to v. crse (mostly v. fn to med) sand, 35% silt; 2.5Y 5/1 "gray", n dry, n loose, v. poorly sorted, 65% felsic, 35% mafic comp, strong rxn w/ HCl; gradational contact @ 5.0' bgs.	G.S. @ 10' bgs.
15	G.S.				G.S. @ 15 ft bgs
20	G.S.				G.S. @ 20.0' bgs.
				→ large cobbles (230mm max) @ ~22.5' bgs.	
25	G.S.			→ 1 boulder (280mm) @ 25' bgs.	G.S. @ 25' bgs.
				→ large cobbles (200mm max) @ 29' bgs.	
30	G.S.				G.S. @ 30' bgs.
35	G.S.			→ large cobbs (~210mm) @ 35' bgs.	G.S. @ 35' bgs.
				(See pg. 2)	(See pg. 2)

Reported By: T. Clark | Reviewed By: BRUCE A. WILLIAMS

Title: Geologist | Title: SR. GEOLOGIST

Signature: [signature] Date: 3/21/13 | Signature: [signature] Date: 5/9/13

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2
Date: 3-21-13

Well ID: C8724 | Well Name: 199-H4-86 | Location: 100-H, N. of Reactor on Hoke Drive

Project: 100 D/H Replacement Wells for WCH | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
40	G.S.			(see pg. 1)	(see pg. 1)
					Drilling w/drive barrel via cable tool drill rig.
	G.S.			→@~41.5' bgs, sand inc to ~30%, silt dec to 30%	
				42.5'-45.0' bgs: silty sandy gravel (msG)	
		▽ (3/25/13)		~40% v. fn to large cobbs (≤150mm) gravels (sub. rnd to angular), 40% v. fn to v. crs sand (maj. fine-med), 20% silt; 10YR 3/1 "very dark gray", ~~moist~~ damp, v. loose, v. poorly sorted, no rxn w/HCl; gradational contact @ 42.5' bgs. Gravels = 50/50, sand = 75/25 ~~sm~~ felsic/mafic. (@ 3-25-13)	· Grab sample (G.S) @ 40' bgs. · Grab sample @ 42.5' bgs; soils = damp. →@ 43' bgs, soils = wet. · G.S @ 45.0' bgs. →Tag H_2O @ 43.2' bgs (3/25/13)
45	G.S.				
50	G.S.			45.0-55' bgs: silty sandy gravel (msG) (@ 3-25-13) ~55% v. fn to sm cobbs (≤100mm) gravel (well rnd. to sub-ang), 25% silt, 20% v. fn to v. crse sand (maj. v. fn to med), 5Y 3/2 "dark olive gray", wet, semi-consolidated (via silt), v. poorly sorted, 65% felsic, 35% mafic (g's & s's), no rxn w/HCl.	· G.S. @ 50' bgs. - v. hard drilling.
		60 bpm @ recovery ↓	no recovery		
55	G.S.				· G.S. @ 55' bgs.
				→1 v. large cobble (≥30mm) @ 47' bgs	
				→@~47.0' bgs, sand inc to 30%, silt dec to 20%, gravels dec. to 50%.	
				→large cobb (≤20mm) @ 50' bgs.	
60	G.S.			55.0-60.5' bgs: sandy gravel (sG)	GS @ 60' bgs.
	G.S.			~45% v. fn to large cobbs (≤180mm) gravels (w. rnd to sub ang), 45% v. fn to v. coarse sand, ≤10% silt; 5Y ~~4/2~~ 4/1 "dark gray", wet, v. loose, v. poorly sorted, 60% ~~sm~~ felsic, 40% mafic, no rxn w/HCl. (@ 3-25-13) (@ 3-25-13)	GS @ 60.5' bgs. - H_2O tag @ 45.4' bgs 3/26/13.
65				60.5-66.1' bgs: silt (Rum)	
			T.O.	~90% silt, ≤5% med-coarse gravels (well rnd), ≤5% v. fn to med sand, 10YR 5/4 "yellowish brown", damp, v. compact, well sorted, s+g = 60% felsic, 40% mafic, silt = ⊘ rxn w/HCl, but has calcic "stringers" (≤5mm thick) that = vicident rxn w/HCl; silt = highly plastic	Total Depth (TD) = 66.2' bgs.
70				→@~62' bgs, silt = dry, non-plastic, w/many (~25% of fm) stringers of calcium carbonate silt, 5-10mm thick, 2.5Y 7/4 "pale yellow"; also, g = 0%, s = 0%, m = 100%.	
75					

Reported By: T. Clark | Reviewed By: BRUCE A. WILLIAMS

Title: Geologist | Title: SR GEOLOGIST

Signature: [signature] Date: 3/26/13 | Signature: [signature] Date: 5/9/13

A-6003-642 (03/03)

BOREHOLE LOG

Page 1 of 3

Date: ~~Start:~~ 1-15-13 to 1-21-13

Well ID: C8725	Well Name: 199-D5-145	Location: ~1/4 mile W of DR Reactor
Project: WCH Replacement Wells @ 100-D/H		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0'-1': Silty Sandy Gravel (msG); poorly sorted construction pad material, 50% gravel, 40% sand, 10% silt; gravel 30% lg-sm cobbles, 40% v.crs to crs pebbles, 30% med to v.fn pebbles	Cable Tool w/Drive Barrel; Max cobbles ≈ 200 mm
5	Grab			1'-7': Sandy Gravel (sG); 60% gravel, 35% sand, ~5% silt; gravels 30% cobble max ~150 mm, 50% v.crs to crs pebbles, 20% med to fn.; sand 60% v.crs - crs 30% med, 10%	5' - Grab Sample; *-encountered boulder @ 5' just to West of borehole - *; 7' - Add ~15 gal H_2O
10	Grab			fn to v.fn.; poorly sorted, gravels rnd to sub-rnd, 80% basalt, 20% granitic sand ~75% mafic, 25% felsic "Grayish Brn" (10YR, 5/2), dry no HCl rxn	10' - Grab Sample; *8' Hard tool to break obstructing boulder/lg cobble
15	Grab			7'-9': Large boulder, basalt/mafic, rounded, no RXN to HCl, dry	15' - Grab Sample
				9'-39': Sandy Gravel (sG) 70% gravel, 30% sand; gravels 30%	
20	Grab			cobbles, 40% vcrs to crs pebbles, 30% v.fn to fn., rounded to sub-round, 70% mafic, 30% felsic; sand 60% v.crs to crs., 30% med., 10% v.fn to fn.	20' - Grab Sample
25	Grab			sub-angular, 80% mafic, 20% felsic, poorly sorted, wet due to water added, no rxn to HCl, "Grayish Brown" (10YR 5/2)	25' - Grab Sample; ~~Increase sand 10%~~ KS 1-17-13
30	Grab				30' - Grab Sample
35	Grab			35': same as above (increase sand 5%)	35' - Grab Sample

Reported By: K. Stiles		Reviewed By: BRUCE A. WILLIAMS	
Title: Env. Engr.		Title: SR. GEOLOGIST	
Signature: [signature]	Date: 1-21-13	Signature: [signature]	Date: 5/9/13

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 3

Date: Start: 1-21-13 to 1-22-13

Well ID: C8725 | Well Name: 199-D5-145 | Location: ~ 1/4 mile W. of DR Reactor

Project: WCH Replacement wells @ 100-D/H | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	Grab			39' – 71' bgs: Sandy Gravel (sG) 60% gravels, 35% sand, ~5% silt gravels 20% small cobbles, 40% v. crs to med. pebbles, 40% fn to v. fn, rnd to sub-rnd, 70/30 mafic to felsic, mostly basalt. Sand is 60% v. crs to crs, 25% med, 15% fn to v. fn, sub-angular, 80/20 mafic/felsic, poorly sorted, 60% basalt, 30% quartz, 10% other "Grayish Brn" 10YR(5/2), dry, no rxn HCl max cobble ≈ 100 mm	Cable tool rig w/ drive barrel 40' – Grab Sample
45	Grab				45' – Archive Grab
50	Grab				50' – Archive Grab
55	Grab				55' – Archive Grab
60	Grab			~59' Indistinct Hanford/Ringold Contact, probable mixing of reworked gravels, Sand is ~60/40 felsic/mafic, mod rxn HCl, (still sG as above) (Gradational Contact) "Lt. Brownish Gray" 10YR(6/2)	60' – Archive Grab
65	Grab				65' – Archive Grab
70	Grab			71' – 81' bgs: Silty Sandy Gravel (msG) 50% gravel, 35% sand, 15% silt, gravels ~10% sm. cobbles, 40% v. crs to med. pebbles, 50% fn to v. fn, rnd to sub-rnd 60/40 felsic/mafic, max ~70 mm, sand is 50% v. crs to crs, 25% med, 25% fn to v. fn, ang to s. ang., 60/40 felsic/mafic, ~60% quartz well to poor sorted, moist to dry, strong rxn HCl "Lt. Brownish Gray" 10YR(6/2)	70' – Archive Grab
75	Grab				75' – Archive Grab 79' – Sieve grab

Reported By: K. Stiles | Reviewed By: BRUCE A. WILLIAMS

Title: Env. Engr | Title: SR. GEOLOGIST

Signature: [signature] | Date: 1/23/13 | Signature: [signature] | Date: 9/5/13

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 3
Date: Start 1-23-13 to 2/4/13

Well ID: C8725 | Well Name: 199-D5-145 | Location: ~1/4 mile W. of DR Reactor

Project: WCH Replacement Wells @ 100-D/H | 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	N/A		Silty Sandy Gravel (msG) [as described above]	Cable tool rig w/ drive barrel setup
				81-88 'bgs: Sandy Gravel (sG) 50% gravels, 50% sand, trace silt gravels ~10% sm. cobbles, 70% med-v. crs pebb 20% fn to v.fn, s. rnd to rnd, 70/30 felsic/mafic, sand is 60% v. crs to med, 40% fn to v. fn, mod to poor sorted, 90% qtz & feldspar, 10% other, wk to mod rxn HCl, moist to dry, "Lt. Gray" 10YR (7/2), max gravel ≈ 80 mm	80'- Archive grab
85	Grab				84.5'- moist (rewetted) soils encountered
		Static H_2O 86.5' 1-23-13			Static H_2O Level = 86.5' 1-23-13 @ 1410
					85'- Archive Grab & Sieve Grab
90	Grab			88'-106' bgs: Silty Sandy Gravel (MSG) 50% gravel, 35% sand, 15% silt, gravels trace cobbles, 60% v.crs to med pebbles, 40% fn to v.fn, rnd to sub-rnd, ~20% angular, 70/30 felsic/mafic, max ~60 mm, sand is 30% v.crs to crs, 40% med, 30% fn to v.fn, 90/10 felsic/mafic, Angular to sub-rnd, poorly sorted, 10YR (7/2) "Lt. Gray" Wet, weak rxn to HCl	90'- Archive & Sieve Grab
95	Grab				Static H_2O Level = 84.8' bgs (1-24-13 am) & (1-30-13 am)
					95'- Archive & Sieve Grab
100	Grab				100'- Archive & Sieve Grab
					Static @ 85.3' bgs (1-31-13 a.m.)
105	Grab				105'- Archive & Sieve Grab
				106'-108' bgs: Sand (S) tr. gravel, 95% sand, tr. silt, Sand is 30% v.crs to crs., 20% med., 50% fn to v.fn, 70/30 felsic/mafic, wk rxn to HCl, wet, Ang-Sub-ang. 20% s. rnd 10YR (7/2) "Lt. Gray", mod sorted	
110	Grab				110'- Archive & Sieve Grab
				108'-113.5' bgs: Silty Sandy Gravel (as above)	
					113.5'- Archive Grab
					119.0'- Archive Grab
	Grab			113.5'-119' bgs: Silt (M) 100% silt, trace sand & gravel 113.5'-115', dry, well sorted, no rxn to HCl, low plasticity "Very Pale Brown" 10YR (8/2)	Ringold Upper Mud (RUM)
115		N/A			TD = 118.8' bgs 2-4-13
119'	Grab	TD			

Reported By: K. Stiles | Reviewed By: BRUCE A. WILLIAMS

Title: Env. Engr | Title: SR. GEOLOGIST

Signature: [signature] | Date: 2/4/13 | Signature: [signature] | Date: 3/9/13

A-6003-642 (03/03)

BOREHOLE LOG

Page 1 of 4
Date: 2-19-13

Well ID: C8726 | Well Name: 199-D5-146 | Location: W. of D+DR reactors, S. of 199-D5-145, off Baha Ave.

Project: 100-D 6 wells 100-H Decomission 1 well | Reference Measuring Point: Ground Surface.

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0					Cable tool w/drive barrel
				Sandy Gravel (sG): 5% silt; 60% v.fine to v.coarse sand; 35% v.fine pebble to small cobble; max 11.5cm; moist; subangular to subround; moderatly sorted; Strong HCl rxn; 10YR 3/3 dark brown; 90% mafic/10% felsic (0-54' bgs)	
5	G.S.				
	G.S.			@ 6': 5% silt, 55% v.fine to v.coarse sand; 40% v.fine pebble to small cobble; max 7cm; 80% mafic/20% felsic; poorly sorted; moderate to strong HCl rxn; 2.5Y 4/2 dark grayish brown; moist	Archive @ 5' bgs Archive @ 6' bgs
10	G.S.			@ 10' bgs: 10% silt; 50% v.fin to v.coarse sand; 40% v.fine pebble to large cobble; max 15cm; 85% mafic/15% felsic; dry; poorly sorted, weak to moderate HCl rxn; 2.5Y 6/1 gray	Archive @ 10' bgs.
15	G.S.			@ 15' bgs: 5% silt; 45% v.fine to v.coarse sand; 50% v.fine pebble to small cobble; max 12.5cm; moist moderate HCl rxn; 10YR 4/1 gray	Archive @ 15' bgs.
20	G.S.			@ 20' bgs: 5% silt; 50% v.fine to v.coarse sand; 45% v.fine pebble to small cobble; max 10.2cm; dry; 90% mafic/10% felsic; weak HCl rxn; 10YR 5/2 grayish brown	Archive @ 20' bgs
25	G.S.			@ 25' bgs: 5% silt; 25% v.fine to v.coarse sand; 70% v.fine to v.coarse pebble; max 60mm; weak to moderate HCl rxn; moderatly sorted; 5Y 4/1 dark gray	Archive @ 25' bgs
30	G.S.			@ 30' bgs: 5% silt; 65% v.fine to v.coarse sand; 30% v.fine to v.coarse pebble; slightly moist; moderate HCl rxn; 2.5Y 4/1 dark gray.	Archive @ 30' bgs
35	G.S.			@ 35' bgs: 5% silt; 55% v.fine to v.coarse sand; 40% v.fine pebble to small cobble; max 100mm; 85% mafic/15% felsic; dry; poorly sorted; 2.5Y 5/1 gray	Archive @ 35' bgs

Reported By: Julie Johanson | Reviewed By: BRUCE A. WILLIAMS
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A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 4
Date: 2-20-13

Well ID: C8726 | Well Name: 199-D5-146 | Location: W. of D+DR reactors; off Paha Ave

Project: 100-D 6 wells, 100-H Decomission 1 well | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	G.S.			40' bgs Sandy Gravel (sG): 5% silt; 55% v.fine to v.coarse sand; 40% v.fine pebble to large cobble; max 17cm; moderatly sorted; dry; 80% mafic/20% felsic; subangular to subround; few angular due to drilling method; moderate HCl rxn; 5Y 5/1 gray (0-54' bgs)	Cable tool w/drive barrel Archive @ 40' bgs.
45	G.S.			@ 45' bgs: >5% silt; 65% v.fine to v.coarse sand; 30% v.fine to v.coarse pebbles; max 48mm; moist; 75% mafic/25% felsic; weak HCl rxn; 5Y 2.5/1 black	Archive @ 45' bgs
50	G.S.				
	G.S.			@ 51' bgs: >5% silt; 55% v.fine to v.coarse sand; 40% v.fine to v.coarse pebble; max 43mm; moist; weak HCl rxn; 2.5Y 3/2 very dark grayish brown	Archive @ 51' bgs Archive @ 52' bgs
	G.S.				
55	G.S.			@ 52' bgs: increase in size to small cobble, increase in felsic material to 30%; increase in angular gravel possibly due to drilling method; slightly moist; 10YR 5/2 grayish brown	Archive @ 54' bgs Archive @ 55' bgs
				@ 54' bgs Silty Sandy Gravel (SSG): 10% silt 50% v.fine to v.coarse sand; 40% v.fine pebble to small cobble max 10cm; poorly sorted; dry; 80% mafic/30% felsic; subangular to subround; moderate HCl rxn; 5Y 5/2 olive gray; chuncks of cemented silt v. strong HCl rxn. Immediatly goes back to (sG). possibly caliche	
60	G.S.				Archive @ 60' bgs
	G.S.				Archive @ 62' bgs
65	G.S.			55' bgs Sandy Gravel (sG): 5% silt; 45% v.fine to v.coarse sand, 50% v.fine pebble to small cobble; max 10cm; 70% mafic/30% felsic; dry; poorly sorted; subangular to subround; moderate HCl rxn; 5Y 5/1 gray (55-62' bgs) @ 60' bgs: max 78mm; angular to subround, strong HCl rxn 10YR 5/2 grayish brown	Archive @ 65' bgs
70	G.S.			62' bgs Sand (S): 5% silt; 90% v.fine to v.coarse sand; 5% v.fine to v.coarse pebble; max 60mm; well sorted, 85% mafic/15% felsic; dry-moist; subangular to sub round, weak HCl rxn; cemented chuncks strong HCl rxn; 5Y 3/1 very dark gray (62'-65' bgs)	Archive @ 70' bgs (description on pag 3)
75	G.S.			Sandy Gravel (sG): 65'-78' bgs 5% silt, 65% v.fine to v.coarse sand; 30% v.fine pebble to small cobble; max ; 70% mafic/30% felsic; slightly moist; poorly sorted; sub angular to sub round; moderate HCl rxn; 10YR 4/1 dark gray. @ 64' bgs color change to 10YR 6/2 light brownish gray (dry) @ 69' bgs color change to 5Y 4/1 dark gray (moist)	Archive @ 75' bgs (description on page 3)
	G.S.				Archive @ 78' bgs (description on page 3)

Reported By: Julie Johanson | Reviewed By: BRUCE A. WILLIAMS

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A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 4
Date: 2-21-13

Well ID: C8726 | Well Name: 199-D5-146 | Location: W. of D+DR reactors, off Baba Ave.

Project: 100-D 6 wells 100-H Decomission 1 well | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
80	G.S.			Sandy Gravel (sG): 65'-88' bgs; 5% silt; 45% v.fine to v.coarse sand, 50% v.fine pebble to small cobble; max 10.2cm; slightly moist; poorly sorted; 80% mafic/20% felsic; subangular to subround; Strong HCl rxn; 10YR 5/1 gray (Archived @ 70' bgs)	Cable tool w/drive barrel
	G.S.				Archive @ 80' bgs
					Archive @ 81' bgs
	G.S.				
85				@ 75' bgs: 5% silt, 60% v.fine to v.coarse sand; 35% v.fine to v.coarse pebble; max 60mm; dry, 60% f/40% m; moderate HCl rxn; 5Y 6/2 light olive gray (Archived @ 75' bgs)	Archive @ 84' bgs
	G.S.				Sieve Grab
	G.S.	WL.			DTW: 86.45' bgs (2-26-13)
				Silty Sandy Gravel (msG): 78'-80' bgs; 10% silt; 60% v.fine to v.coarse sand; 30% v.fine pebble to small cobble; max 70mm; moderatly sorted; dry; subangular to subround; 50% m/50% f; moderate HCl rxn; 2.5Y 7/2 light gray (Archived @ 78' bgs)	Archive @ 86' bgs Sieve grab; Archive @ 87' bgs Sieve grab
90	G.S.				Archive @ 90' bgs Sieve grab
				Gravelly Sand (gS): 80'-81' bgs; 25% silt; 75% v.fine to v.coarse sand; 20% v.fine pebble to small cobble; max 75mm; slightly moist; moderatly sorted; 90% f/10% m; subangular; weak to moderate HCl rxn; 10YR 5/2 grayish brown	
95	G.S.				Archive @ 95' bgs Sieve grab
				Sand (S): 81'-84' bgs; 5% silt; 95% v.fine to coarse sand; max 1mm; well sorted, moist, 90% f/10% m; subangular; v.weak to no HCl rxn; 2.5Y 5/2 grayish brown	
100	G.S.			Sandy Gravel (sG): 84'-86' bgs; 5% silt; 60% v.fine to v.coarse sand; 35% v.fine pebble to small cobble; moist; max 96mm; moderatly sorted; subangular to subround; 30% m/70% f; weak to moderate HCl rxn; 2.5Y 4/2 dark grayish brown	Archive @ 100' bgs Sieve grab
				Sand (S): 86'-87' bgs; 5% silt; 90% v.fine to coarse sand; 5% medium to v.coarse pebble; max 50mm; wet; subangular to subround; 70% f/30% m; well sorted; No HCl rxn; 2.5Y 5/2 grayish brown	
105	G.S.				Archive @ 105' bgs Sieve grab
	G.S.			Silty Sandy Gravel (msG): 87'-108' bgs; 10% silt; 30% v.fine to v.coarse sand; 60% v.fine to v.coarse pebble; max 62mm; wet; poorly sorted; subround; 50% m/50% f; No HCl rxn; 2.5Y 4/2 dark grayish brown	Archive @ 108' bgs Sieve grab (description on page 4)
110	G.S.				Archive @ 110' bgs Sieve grab
	G.S.				Archive @ 110.5' bgs Sieve grab
	G.S.			@ 90' bgs: ~~10% silt, 45% sand, 45% gravel; max 75mm~~; max 120mm; 60% f/40% m; weak to No HCl rxn; 2.5Y 5/2 grayish brown	Archive @ 111.1' bgs
				@ 95' bgs: 10% silt; 45% sand; 45% gravel; max 75mm; No HCl rxn; 2.5Y 4/2 dark grayish brown;	Archive @ 112' bgs (descriptions on page 4)
115				Silty Sandy Gravel (msG): @ 100' bgs: 15% silt; 45% sand, 40% gravel; max 83mm; 60% m/40% f; Nonplastic; weak to moderate HCl rxn; 5Y 5/2 olive gray.	RUM = 111.1' bgs
	TD				TD: 116.7' bgs
				@ 105' bgs; max 70mm; 50% m/50% f; v.weak HCl rxn; 5Y 4/1 dark gray	

Reported By: Julie Johanson | Reviewed By: BRUCE A WILLIAMS

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A-6003-642 (03/03)

BOREHOLE LOG

Page 4 of 4
Date: 2-26-13

Well ID: C8726 | Well Name: 199-D5-146 | Location: W. of D+DR reactors; off Paha Ave.

Project: 100-D 6 wells 100-H Decomission 1 well | 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
SRS 2-26-13				Sandy Gravel (sG): 108'-110' bgs; 5% silt; 65% v.fine to v.coarse sand; 30% v.fine to v.coarse pebble; max 40mm; wet; moderatly sorted, subround; 55% felsic/45% mafic; v.weak HCl rxn; nonplastic; 5Y 3/1 very dark gray (Archived @ 108' bgs)	Cable tool w/drive barrel TD: 116.7' bgs
				Gravelly Silty Sand (gmS): 110'-110.5' bgs; 35% silt; 45% v.fine to v.coarse sand; 20% v.fine pebble to small cobble; max 100mm; moderatly sorted; 50%m/50%f; wet; nonplastic; No HCl rxn; subround; 2.5Y 4/2 dark grayish brown (Archived @ 110' bgs)	
				Silty Sandy Gravel (msG): 110.5-111.1' bgs; 20% silt; 15% v.fine to v.coarse sand; 75% v.fine pebble to small cobble; wet; subangular to subround; max 82mm; poorly sorted; low plasticity; No HCl rxn; 10YR 4/2 dark grayish brown (Archived @ 110.5' bgs)	
				Gravelly Sandy Silt (gsM): RUM: 111.1'-112' bgs; 65% silt/clay; 10% v.fine to v.coarse sand; 25% v.fine pebble to small cobble; max 100mm; subangular to subround; moist; 50%m/50%f; low to medium plasticity; v.weak to weak HCl rxn; 10YR 4/3 brown (Archived @ 111.1' bgs) Tiny bits of green staining.	
				Sandy Silt (sM): RUM: 112-116.7' bgs; <50% silt/clay; 45% v.fine to v.coarse sand; >5% v.fine pebble; max 3mm; subangular; well sorted; wet; low to medium plasticity; v.weak HCl rxn; 2.5Y 5/2 grayish brown Yellow stain spots throughout mud; (Archived @ 112' bgs)	

Reported By: Julie Johansen | Reviewed By: BRUCE A. WILLIAMS

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Signature: Julie Johansen | Date: 2-26-13 | Signature: [signature] | Date: 5/9/13

A-6003-642 (03/03)

BOREHOLE LOG

Page 1 of 4
Date: 2-12-13

Well ID: C8727 | Well Name: 199-D5-147 | Location: 100-D, corner D Ave/Pioneer Way, in fence

Project: 100 D/H Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
0				(Ground Surface)	Drilling w/ Cable Tool rig fitted w/ drive (core) barrel.
	G.S.			0.0 - 2.5 'bgs: sandy Gravel (SG) ~50% (v.fn to sm. cobbles) gravels (ang to rnd), 40% v.fn to crs. sand, ≤10% silt; 2.5Y 4/3 "olive brown"; sltly moist; poor sorting; sand = 70/30, gravel = 50/50 felsic/mafic, max cobb = 80mm strong rxn w/HCl; gravel drill pad/fill.	Grab sample (G.S.) @ 2.5' bgs.
5	G.S.			2.5-10 'bgs: gravelly Sand (gS) ~~35% silt~~ ~~25% gravel~~ 65% sand (med-coarse), ~~25% gravel~~ (v.fn to large cobb [160cm max]), dry, loose, 5Y 3/2 "drk olive gray"; mod sorting; sand = 40/60, gravel = 30/70, fels/mafic (sand = v. basaltic); no rxn w/HCl; gradational contact @ 2.5' bgs.	G.S. @ 5.0' bgs.
10	G.S.			→ @ ~ 4.0' bgs, a 2" thick layer of v. consol. sand + silt (60/40, resp); 2.5YR 4/3 "ol. brn", ⊘ rxn w/HCl; moist.	G.S. @ 10.0' bgs.
15	G.S.			→ 1 large cobble (23cm) @ 5.5' bgs; 2 lg cobbs (20-25cm) @ 7.0' bgs	G.S. @ 15.0' bgs
20	G.S.			10.0 - 24.5' bgs: silty sandy gravel (msG) ~40% (v.fn to lg. cobbs) gravel (sub-rnd to ang), 30% v.fn to v.crs sand, 30% silt; 5Y 4/1 "drk gray"; dry, loose; poorly sorted; gravels + sand = 70/30 mafic/felsic (many SS = smashed gravel), max cobb = 130cm; mod rxn w/HCl.	GS @ 20.0' bgs
25	G.S.	3 @ 2/12/13		24.5-29.0 'bgs: sandy gravel (sG) ~45% v.fn to v.crs gravel (rnd to sub-ang, max = 60cm), 45% v.fn to v.crs (maj: med-crs) sand, ≤10% silt; 10YR 2/1 "black", sltly damp, loose, poorly sorted; gravel + sand = 80 basaltic/mafic + 20% felsic; ⊘ rxn w/HCl.	G.S @ 24.5' bgs
	G.S.				GS @ 29.0' bgs.
30				29.0 - 35.0 'bgs: silty sandy gravel (msG) → rxn to msg: 40% v.fn to lg cobb gravels, 30% v.fn to v.crs sand, 30% silt, 5Y 4/1, dry, loose, poorly sorted, 70/30 mafic/fels, mod rxn w/HCl.	
35	G.S			35.0 - 39 'bgs: sandy gravel (sG) → rxn to sG: ~45% v.fn to v.crs gravel (sub-rnd to ang) 45% v.fn to v.crs sand, ≤10% silt, 10YR 2/1, sltly damp, loose, poorly sorted, 80% mafic, 20% fels, ⊘ rxn w/HCl.	G.S. @ 35' bgs.
	G.S.				G.S @ 39.0' bgs (See pg 2 →)

Reported By: T. Clark | Reviewed By: BRUCE A WILLIAMS

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A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 4
Date: 2-12-13

Well ID: C8727 | Well Name: 199-D5-147 | Location: 100-D, corner of D Ave/Pioneer Way, w/in fence

Project: 100D/H Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	G.S.	Blows = 65/min		(See pg. 1)	Drilling w/cable tool drive barrel method.
				39.0–42.0' bgs: sand (S)	
	G.S.			~85% fn to crs sand (sub-rnd to ang), 10% silt, ≤5% fn to med gravel (sub ang to ang), 5Y 2.5/1 "black", loose, dry, 60 maf/40 felsic "salt + pepper", well sorted; max g = 10mm; ⊘ rxn w/HCl.	G.S. @ 39' bgs. G.S. @ 42.0' bgs.
45	G.S.			→@ 41' bgs, g's inc to 10% (gmax = 22cm), sand dec to 80%.	
				42.0–55.5' bgs: sandy gravel (sG)	
				→rtn to sG: ~45% gravel (v. fn to lg. cobb [14cm], sub-ang to rnd), 45% v. fn to crs (maj med–crs) sand, ≤10% silt; 10YR 2/1 "blk", dry, loose, poorly sorted; gravel + sand = 80% basaltic, 20% felsic, ⊘ rxn w/HCl; gradational contact @ 42' bgs.	
50	G.S.				G.S. @ 50' bgs.
				55.5'–72.0' bgs: sandy gravel (sG)	← "H/R contact."
55	G.S.			~50% gravel (v. fn to sm cobb (120cm max) (well rnd to ang), 40% sand (v. fn to crs), ≤10% silt; 5Y 5/1 "gray", dry, loose, v. poorly sorted, gravs = 70% fels (qtz-pathic), 30% mafic, sand = 60% fels, 30% mafic; strong rxn w/HCl; pieces of caliche (≤5%) = v. strong rxn; cali ≈ 1cm max.	G.S @ 55' bgs. G.S @ 55.5' bgs.
	G.S.				
60	G.S.			→Note: some gravels have slt. calcic cementation. →@ 61' bgs, 1 Large cobble (220mm); granodiorite?	Grab sample (G.S) @ 60' bgs.
65	G.S.				Grab sample @ 65' bgs. →drilling is slower/harder @ ~65' bgs.
				→@ ~67' bgs, soils = v. moist.	
				→@ ~68' bgs, soil = semi-consolidated w/semi-cement. of v. high calac. v. strong rxn w/HCl; caliche bits ≤ 2cm (max) when not cem. on gravels.	(G.S.M)
70	G.S.			→@ 70' bgs, soils = dry, + 1 large (130mm) cobble.	G.S @ 70' bgs.
	G.S.			72.0–77.5' bgs: gravelly silty sand (gmS)	G.S @ 72' bgs.
75	G.S.			~50% mfn to v. crs sand, 25% v. fn to coarse gravel (sub-rnd to ang), 25% silt; 2.5Y 6/2 "lt. brownish gray"; dry, loose w/many ~~constricted~~ cemented pieces (lighter in color), mod. sorted, 70% felsic, 30% mafic, v. little rxn w/HCl (cemented = ⊘ rxn)	G.S. @ 75' bgs.
	G.S.			→@ ~76' bgs, gravels inc. in size + % to sm. cobb (120mm max) + to 35%, sand dec to 40%, silt 25%	G.S. @ 77.5' bgs. — (see pg. 3)

Reported By: T. Clark | Reviewed By: Bruce A. Williams

Title: Geologist | Title: Sr. Geologist

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A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 4
Date: 2-14-13

Well ID: C8727 | Well Name: 199-D5-147 | Location: 100-D, corner of D Ave/Pioneer Way, in fence

Project: 100 D/H Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
80	G.S.	Blows = 64/min		(see pg. 2)	(See pg. 2)
				77.5-85.0' bgs: silty sandy gravel (ms(G)	Using cable tool drill rig w/
				~40% gravel (v.fn to sm. cobb [120mm]) (v.ang to	drive barrel (D.B),
				well rnd), 35% v.fn to v.crs sand (maj. fine	
		H2O 2/19/13		to med), 25% silt; 2.5Y 6/2 "lt. brownish gray",	·G.S.@ 80' bgs.
85	G.S.			dry, loose, v.poorly sorted, 80% felsic (quartz-	→ Drilling becomes more
		H2O 2/14/13		pathic), 20% mafic (basaltic); mod. rxn w/ HCl;	difficult @ ~ 82' bgs.
				gradational contact @ 77.5' bgs.	·G.S.@ 85' bgs.
				→ @ ~80' bgs, large cobbs more frequent (~10% g's).	
				→ @ ~81.5' bgs, some cobbs have cal. carbonate	
90	G.S.			cementation (~10% of g's). (dec to 15%)	
				→ @ ~83' bgs, s% inc. to 45%, silt ~~dec to 5%~~ TG 2/14/13	
				85.0 - 90.0' bgs: silty sandy gravel (ms(G)	*wet soils @ ~85' bgs*
				~50% v.fn to sm cobb (max 80mm) gravels, 35% v.fn	·G.S.@ ~~85.0'~~ bgs.
				to v.crse sand, 15% silt; 2.5Y 4/3 "olive brown";	90.0' bgs. TG 2/14/13
95	G.S.			wet, semiconsolidated, sand "packed" in some gravs,	·G.S.@ 95' bgs.
	G.S.			n poorly sorted, 75% felsic (qtz), 25% mafic;	·GS @ 96.0' bgs.
				& rxn w/ HCl; g's = ang to rnd (maj. sub-rnd).	→ @ ~97.0' bgs, v.hard
				90.0 - 96.0' bgs: sandy gravel (s(G)	drilling; many blows, v.
				~45% v.fn to v.crs gravel (sub-ang to rnd), 45%	little recovery.
100	G.S.			v.fn to v.crs sand (maj. fine-med), ≤10% silt,	*Tag lt, 0 @ 84.4' bgs 2/19/13
				2.5Y 4/2 "dk grayish brown", wet, v.loose w/ &	·G.S.@ 100.0' bgs.
	G.S.			cementation; sand compacts v.easily under pressure	·G.S.@ 102.0' bgs.
	G.S.			+ stays; mod. sorted (sand - v. well), 80% felsic / 20% maf,	
				TG 2/14/13	
				& rxn w/ HCl.	·G.S.@ 103.0' bgs.
105				→ 1 large cobble (~140mm) @ 92' bgs.	
				96.0' - 100.0' bgs: silty sandy gravel (ms(G)	
		TG 2/19/13		~35% v.fn. to lg cobb (max 130mm) gravels (ang to rnd),	·G.S.@ 108.0' bgs.
	G.S.			35% v.fn to v.crs sand (maj. v.fn - med), 30%	
			T.D.	silt, 2.5Y 5/4 "lt. olive brn", wet, consolidated/packed,	T.D.@ 108.3' bgs
110				v.poorly sorted, 70% fels, 30% maf, & rxn w/ HCl;	
				gradational contact @ 96' bgs.	
				100.0 - 102.0' bgs: sandy gravel (s(G)	
				~Rtn to sandy gravel: ~60% v.fn to crse (maj	
				fine-med) sand, 30% (v.fn. to sm. cobb [100mm])	not used TG 2/19/13
115				gravel (sub-rnd to sub ang), ≤10% silt; 2.5Y 4/2	
				"dk grayish brown", wet, v.loose, s. compacts easily,	
				mod. sorted (s. - v. well), rxn w/ HCl; 80%	
				felsic / 20% mafic.	
				(see pg. 4)	

Reported By: T. Clark | Reviewed By: BRUCE A. WILLIAMS

Title: Geologist | Title: SR. GEOLOGIST

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A-6003-642 (03/03)

BOREHOLE LOG

Page 4 of 4
Date: 2-19-13

Well ID: C8727 | Well Name: 199-D5-147 | Location: 100-D, corner of D-Ave/Pioneer Way, in fence

Project: 100D/H Replacement Wells | 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
				(see pg. 3)	
				102.0 - 103.0' bgs: silty, sandy gravel (ms(G))	
				→ ~45% (v.f.n to sm. cobbs (max 110mm)) gravels (v.ang to w.rnd), 30% v.f.n to v.crs sand, 25% silt; 5Y 4/2 "olive", wet, v. consolidated, v. poorly sorted, 70% felsic, 30% mafic, r+n w/HCl; some discoloration.	
				→ @ ~103.5 bgs, gravels, silts (+some sands) are more discolored, ranging from white, rust, blk; one large cobble (≥30mm).	
				103.0 - 108.3' bgs: silt	
				90% silt, ≤10% v.fn to fn sand; 5Y 6/3 "pale olive", v. dry, compact, unk. comp, well sorted, silt = ∅ r+n w/HCl; there are calcite veins/stringers randomly, (≤2mm - 2cm) that react violently w/HCl. Silt = nonplastic; possible altered rip-up clast? Non-laminated.	
				→ @ ~106.5' bgs, silt gains plasticity, w/H_2O.	
				→ @ ~108.0 bgs, slight color change: mostly 10YR 5/2 "grayish brown" w/ "spots" of 5Y 6/3.	not used (TC) 2/19/13
				→ @ 108' bgs, silt = all 10YR 5/2, v. plastic = clay.	
				→ T.D. @ 108.3' bgs.	
				not used (TC) 2/19/13	

Reported By: T. Clark | Reviewed By: BRUCE A. WILLIAMS

Title: Geologist | Title: SR GEOLOGIST

Signature: [signature] | Date: 2/19/13 | Signature: [signature] | Date: 5/9/13

A-6003-642 (03/03)

BOREHOLE LOG

Page 1 of 3

Date: ~~1-15-13~~ 1-14-13

Well ID: C8728 | Well Name: 199-D5-148 | Location: 100-D, SW of Reactor, on Pioneer Way

Project: 100-D/H Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
0	G.S.		G.S.	(Ground Surface)	Cable tool drilling w/drive barrel; See FAR pg 1, 1/14/13
				0.0-9.0' bgs - Sandy Gravel (sG) ~45% gravel (v.fn to sm. cobbles), 40% sand (v.fn to v. coarse), ≤10% silt; 2.5Y 4/2 "dark grayish brown"; moist; poorly sorted; very angular to sub-rnded; ~~60% fels c 40% maf~~ 60% mafic, 40% felsic; backfill; ⊘ rxn w/HCl.	Grab sample collected @ 0-5' bgs.
5	Grab				
	Grab			9.0-10.0' bgs: Silty Gravel (mG) ~45% gravel (v.fn to lg. cobbles), 30% silt, ~25% v.fn. to v. coarse sand; 2.5Y 3/2: v. dark grayish brown; moist; poorly sorted; v. ang to sub-rounded; compact, hard soil; strong rxn w/HCl.	Grab sample @ 9.0' bgs
10	Grab				Grab sample @ 10.0' bgs
15	Grab			10.0-27.5' bgs - Sandy Gravel (sG) ~50% v.fn to lg cobbs gravel, 40% v.fn to v.crs sand, ≤10% silt; 5Y 3/1 "very dark gray"; slt'ly moist; med. sorted; v.ang to v. round (large cobbs); loose; 75% mafic, 25% felsic → one boulder (>25cm) @ 14.5' bgs; slt rxn w/HCl.	Grab sample @ 15.0' bgs Hard-drilling; no returns from 17.5'-27.5' bgs; driller thinks fines + gravels are being pushed out; casing is driving normally.
		Hard drilling; no recovery			
20		Hard drilling;	no recovery 17.5'-27.5' bgs		
25					Grab sample @ 27.5' bgs
	Grab			27.5'-47.0' bgs - Sandy Gravel (sG) ~50% gravel (v.fn. to sm. cobbles, 40% v.fn to crs sand, ≤10% silt; 5Y 3/1 "very dark gray"; dry; v. ang to v. round (cobbs only); loose; 60% mafic, 40% felsic; cobbles = 50/50 maf/fels; no rxn w/HCl. → @ ~32.5' bgs, sand inc to 50%, silt to 0%, sand = more mafic/v. dark. → @ ~35' bgs, gravel size dec to sm. cobbs; silt inc to ≤10%; sand down to 40%.	Grab sample @ 30' bgs.
30	Grab				
35	Grab				Grab sample @ 35' bgs
				(see pg. 2)	(See pg. 2)

Reported By: T. Clark | Reviewed By: BRUCE A. WILLIAMS

Title: Geologist | Title: SR. GEOLOGIST

Signature: [signature] Date: 1/15/13 | Signature: [signature] Date: 5/9/13

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 3
Date: 1-15-13

Well ID: C8728 | Well Name: 199-D5-148 | Location: 100-D, SW of Reactor on Pioneer Way
Project: 100 D/H Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	Grab			(see pg 1)	(See pg 1). Cable-tool drilling method with drive barrel.
45	Grab			→@~45' bgs, sand% dec to 30%, silt inc to 20%; soil is very dry.	Grab sample @ 40' bgs.
	Grab			→@~46.5' bgs, large felsic cobbles reappear;	Grab sample @ 45' bgs.
50	Grab			47.0-55.0' bgs: sand (S) "salt & pepper" ~85% sand (v.fn to medium, 10% silt, ≤5% gravel (fine to coarse); 2.5YR 2.5/1 "black", moist; very well sorted; sub-angular to sub-rnd; 65% mafic, 35% felsic; gradational contact @ 47' bgs; Loose; ⊘ rxn w/ HCl;	Grab sample @ 47' bgs. Grab sample @ 50' bgs
55	Grab			→@~51.5' bgs, gravels = fine to sm. cobbs →@~53' bgs, g's inc to ~20%; m ≤ 5%.	Grab sample @ 55' bgs.
60	Grab			55-80.0' bgs - silt, sandy, gravel (msG) ~45% gravel (v.fn to sm. cobbs [~100mm], 25% silt, 30% sand (v.fn to v.crse); 2.5Y 4/1 "dark gray"; dry, loose w/some consolidation and sm (≤5mm) caliche bits; poorly sorted, sub-rnd to angular sand = 50/50 mafic/felsic, gravel = 30/70 mafic/fels; gradational contact @ 55' bgs, strong rxn w/ HCl.	← Hanf-Rmgold contact? Grab sample @ 60' bgs.
65	Grab			→@~58' bgs, HCl rxn = mod; silt dec to ≤10%, sand inc to 45%; "salt & pepper" still →@~63' bgs, HCl = strong rxn; silt inc to 25%, sand dec to 30%.	Grab sample @ 65' bgs.
70	Grab				Grab sample @ 70' bgs.
75	Grab			→@~75' bgs, soils become v. damp, and few (40%) gravels have minor, non-malleable lt. brn clay on them. Clay = ⊘ rxn w/ HCl. Prob. saturation zone. →@ 79' bgs, more gravels & moisture.	→Soils @ ~75' bgs = v. damp Grab sample @ 75' bgs.
				(see pg. 3 →)	(See pg. 3 →)

Reported By: T. Clark | Reviewed By: Bruce A. Williams
Title: Geologist | Title: Sr. Geologist
Signature: [signature] | Date: 1/17/13 | Signature: [signature] | Date: 5/9/13

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 3
Date: 1-17-13

Well ID: C8728 | Well Name: 199-D5-148 | Location: 100-D, SW of Reactor on Pioneer Way

Project: 100 D/H Replacement Wells | 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	1/17/13		(see pg. 2)	(see pg. 2)
				80-87 'bgs – silty, sandy gravel (msG) ~40% v.fn to v. crse gravel (well-rnd to v. ang), 35% v. fn to v. crse sand, 25% silt; 5Y 4/1 "dark gray"; v. damp; consoli/semi-cemented; minor clay cement; v. poorly sorted; gravel = 50/50, sand = 60/40 mafic/felsic; gradational contact @ 80'bgs; no rxn w/ HCl. → @ ~82.5'bgs formations = semi-consolidated + damp; not as cemented. → @ ~87'bgs, fm = compact/consolidated; very ~~tar~~ hard drilling; sm boulder, too. (TD) 1-17-13	Drilling w/ drive barrel cable-tool method.
85	Grab				Grab sample @ 80'bgs. H_2O tagged @ 80.0'bgs (1-17-13)
	Grab	1-21-13			Grab sample @ 85'bgs
		Hard tool 87.5' to TD			Grab sample @ 87'bgs.
90	Grab			87-87.5'bgs – silty gravel (mG) ~35% (v.fn to sm. boulder) gravel, sub-ang to well-rnd, 35% silt, 30% v.fn to v.crs sand; damp; 5Y 8/2 "pale yellow" when dry; cemented (slt rxn w/ HCl); v. poorly sorted; gravel = 70/30 felsic/mafic; gradational contact @ 87'bgs. → @ ~90'bgs, g's = 50/50 felsic/mafic. → @ ~92'bgs, 1 sm cobb in bailer (felsic); silt + sand still present; g's = v.fn to fn.	* Begin drilling w/ hard tool method on 1/21/13 @ 87.5' → DTW @ 79'bgs, 1/21/13. Grab sample @ 90'bgs → DTW @ 80.6'bgs, 1/22/13. → @ ~92'bgs, drilling + driving become easier; may not be "as" cemented.
95	Grab				→ Grab sample @ 95'bgs. → Drilling = hard @ 95' bgs. * DTW @ 85.1'bgs 1/23/13.
100	Grab				Grab sample @ 100'bgs.
105	Grab			87.5-107' bgs – silty, sandy gravel (msG) ~35% v.fn to v. crse (v. ang to sub-rnd) gravel, 35% v.fn to v. crse sand, 30% silt; hard tool cuttings/slurry; 5Y 4/2 "dark gray"; wet; v. loose; mod sorted; no rxn w/ HCl; gravel is 70/30 felsic/mafic. → @ 90'bgs, g's = 50/50 mafic/felsic. → @ 92'bgs, 1 sm. cobble in bailer (felsic); majority of gravel = v.fn to fine. → @ 107'bgs, v. malleable clay w/ sm. gravels.	Grab sample @ 105'bgs → V. easy casing driving + clay w/ gravels on hard tool @ 107' bgs; water may be sealed off.
	Grab				Grab sample @ 107'bgs.
110	Grab				Grab sample @ 110'bgs.
115	Grab			107-115.25' bgs – Silty gravel (sG) ~~gravelly sandy silt (gsM)~~ ~35% silt/clay, 30% v.fn to fine (ang to sub-rnd) gravel, 30% v.fn to v.crs sand; 2.5Y 6/2 "lt yellow brn"; wet, well-sorted; g's + s's = 70/30 felsic/mafic; very high plasticity; no rxn w/ HCl; v. compact; gravel may be pushed down via hard tool.	* RUM Contact? * DTW @ 82.7'bgs 1/24/13. Grab sample @ 115'bgs.
	TD.		T.D.		TD. @ 115.25'bgs on 1/24/13 not used. (TD) 1-28-13

Reported By: T. Clark | Reviewed By: BRUCE A. WILLIAMS

Title: Geologist | Title: Sr. GEOLOGIST

Signature: [signature] Date: 1/24/13 | Signature: [signature] Date: 5/9/13

A-6003-642 (03/03)

Appendix C

Well Development Notes

FIELD ACTIVITY REPORT - DAILY DRILLING

Page 1 of 4

Date: 3-14-13

Well Name: 199-H4-85	Well ID: C8723
Location: 100-H, N. of Reactor, on 1t. Ave	Report No.: 7

Start	Finish	Total
Time 0600	Time 1500	Time 9.0 hrs
Hole Depth/Csg Ø / Ø	Hole Depth/Csg Ø / Ø	Hole Depth/Csg — / —

Reference Measuring Point: GROUND SURFACE

Casing String No. 1 (2) 3 4 ____ See Report No. 1

Rod Size: (2) Perm - 6 3/8" 5.2 well

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth (Attach applicable drawings and document straightness test results)
0600	0650	To MO-2753 for POD.
0650	0720	To site; drillers @ another site picking up pump + tremie pipe.
0720	/	Drillers to site; prep. to trip-in pump + pipe for development.
/	0740	→ Pump: Franklin-Electric 5HP, 5.9'L, intake 2.5' up.
0740	/	Install pump (5.9') + 3"OD/2"ID s.s. tremie pipe (21.17' + 21.20' + 5.03)
		= 53.3' tally (intake @ 50.8' tally) - 3.01' stick up = 50.29' bgs
		(intake @ 47.79' bgs); transducer = 47.29' bgs.
		Geo. runs standards on dev. equipment (calibrations):
		(@ 3-14-13) ~~pH~~ Turbidity
		standard: 4.64 reading: 4.54 w/in 10%: Y
		standard: 45.7 reading: 45.2 w/in 10%: Y
		standard: 544 reading: 542 w/in 10%: Y
		(@ 3-14-13) ~~Turbidity (NTU)~~ pH
		standard: 10.0 reading: 9.984 w/in 10%: Y
		standard: 7.0 reading: 7.08 w/in 10%: Y
		standard: 4.0 reading: 4.07 w/in 10%: Y
		Conductivity (uS/cm)
		standard: 1413 reading: 1490 w/in 10%: Y
		D.O.:
/	0800	→ no standard available.
0800	/	Wait for purge truck.
/	0840	→ Tag H_2O @ 45.8' TOC - 3.01' stick up = 42.79' bgs; bh @ ~~58~~ 53.8' - 2.0' = 51.8' bgs (@ 3-14-13)
0840	/	Purge truck to site; drillers connecting hoses + prep to
/	0904	begin well development; BTR notify NCOs. (see pg. 2 →)

Reported By: T. Clark	Reviewed By: L. Craig Swanson
Title: Geologist — Date: 3/14/13	Title: Hydrogeologist — Date: 5/23/13
Signature: [signature]	Signature: [signature]

A-6003-651 (REV 1)

FIELD ACTIVITY REPORT - DAILY DRILLING
Continuation Page

Page 2 of 34

Date: 3-14-13 (TC) 3-14-13

Well Name: 199-H4-85 | Well ID: C8723

Location: 100-H, N of Reactor, on H. Ave | Continuation of Report No.: 7

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth
0904	0907	Turn pump on; little to no H_2O being brought up; pump too strong.
0907	0915	Turn pump off, stop transducer/troll test; stop + discuss.
0915	/	Drillers trip-out tremie pipe, pump, + transducer.
/	0935	→ Remove 5.03' + 21.20' + 21.17' tremie + 5.9' sample pump = 53.3' removed.
0935	/	Prep. to install permanent pump. to use for development too.
/	/	→ Perm. pump = 0.94'L (intake 0.75' up), Grundfos 0.5HP 3+220v,
/	/	400Hz, class F, Type MP1-2-A-B-G-TV, Model: A 1A1606 03P112249 00008
/	/	→ Tremie = 1½" OD (@ coupling), ¾" I.D., s.s. pipe.
/	1020	→ Pump has 0.46' coupling (½ - ¾" size) attached = 1.40'L
1020	/	Add pump (via coupling) onto tremie + trip into well:
/	/	→ 1.4'L pump + 20.03' trem + 19.02' trem + 10.04' trem = 50.49' tall,
/	/	(intake @ 49.74') - 3.1' stkp = 47.49' bgs (intake @ 46.69' bgs).
/	1100	→ Initial x D = 3.66'
1100	/	Turn pump on; start test "C8723-2"; pump doesn't seem to be
/	1118	working. Turn pump/test off; stop work + try to fix.
1118	/	Try turning on pump w/ Sampler's Grundfos generator; no drawdown
/	1120	or H_2O recovery, does not work.
1120	1135	Check wiring; still not working; going to check wiring @ pump.
1135	/	Trip-out/remove tremie pipe + pump.
/	1140	→ Remove 10.04' + 19.02' + 20.03' + 1.4'L coupling + pump.
1140	1150	Test pump; doesn't work; drillers to re-wire + test connection.
1150	1200	Test again; still shuts off. Possible bad pump.
1200	1245	BTR leave to get new pump; take lunch.
1245	/	BTR return w/ new pump: Grundfos Redi-flo 2, 0.5HP, 3x220v, 400Hz,
/	/	Class F, Type MP1-2-A-B-G-TV, model # A1A1606 03P112500033; ~~0.94'L~~ 0.95'L (TC) 3-14-13
/	/	intake 0.75' up; has been tested (by Well Maintenance) + works; drillers cannot.
/	1305	→ pump + 0.46'L coupling = 1.41'L.
1305	/	Add-on pump + begin tripping-in w/ tremie:
/	/	→ Trip-in 1.41' pump + 20.03' tremie + 19.02' + 10.04 = 50.5' (see pg. 3 →)

Reported By: T. Clark | Reviewed By: L. Craig Swanson

Title: Geologist | Date: 3/14/13 | Title: Hydrogeologist | Date: 5/23/13

Signature: [signature] | Signature: [signature]

A-6003-652 (04/03)

FIELD ACTIVITY REPORT - DAILY DRILLING

Continuation Page

Page 3 of 34 @ 3-14-13

Date: 3-14-13

Well Name: 199-H4-85

Well ID: C8723

Location: 100-H, N. of Reactor on H. Ave

Continuation of Report No.: 7

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth
(1305)	/	tally - 3.1' stop = 47.4' bgs (int also @ 49.75' tally - 3.1' = 46.65' bgs).
/	1324	→ Trip-in Troll 700 transducer to 46.28' bgs (XD = 3.49').
1324	/	Start "C8723-Redi-flo-2" test + turn pump on
/	/	→ Bucket test = 3 gal/min
/	/	XD pH Temp (°C) Turbidity (NTU) Cond (µs/cm) D.O (mg/L)
/	1330	0.60 7.32 18.3 148 573 8.17
1335	/	Turn pump down.
/	/	→ Bucket test = 2.6 gpm
/		XD pH Temp (°C) Turb (NTU) Cond (µs/cm) D.O. (mg/L)
	1340	0.73 7.67 18.24 16.60 574 8.33
	1350	0.85 7.72 18.17 5.87 577 8.61
	1400	0.78 7.75 18.06 2.68 574 8.55
	1410	0.76 7.75 18.14 1.65 574 8.55
	1420	0.73 7.77 18.17 1.57 585 8.59
		→ Stabilized @ 1420.
		→ MCO's to site @ 1400; run their own stabilization + collect
		H_2O sample HEIS # B2NR14, B2NR17 DUP, @ 1420.
/	1424	(not used)
1424	/	Shut pump off + run recovery; drillers clean-up; geo finish paperwork,
/	1500	remove transducer, etc.
1500	/	Geo. leave site.

not used. (TC) 3-14-13

Reported By: T. Clark

Title: Geologist

Date: 3/14/13

Signature: [signature]

Reviewed By: L. Craig Swanson

Title: Hydrogeologist

Date: 5/23/13

Signature: [signature]

A-6003-652 (04/03)

WELL DEVELOPMENT AND TESTING DATA

Well Name:	Well ID:	Well Location:	Date:
199-H4-85	C8723	100-H, N. of Reactor on H. Ave	3-14-13

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	42.79' bgs
End of Job	42.73' bgs

DEPTH TO BOTTOM:

Start of Job	51.83' bgs
End of Job	52.0' bgs

PART 2

WELL DEVELOPMENT DATA

Pump Model	Grundfos Rediflo-2 (5HP)
Intake Depth	46.64' bgs
Starting Turbidity	16.6 NTU

Pump Start	Stop	Flow Rate
1324	1335	3.0 gpm
1335	1424	2.6 gpm

Total Pumped	160.4 gal
Final Turbidity	1.57 NTU
XD SN/Range (PSI)	2.76'

PART 3

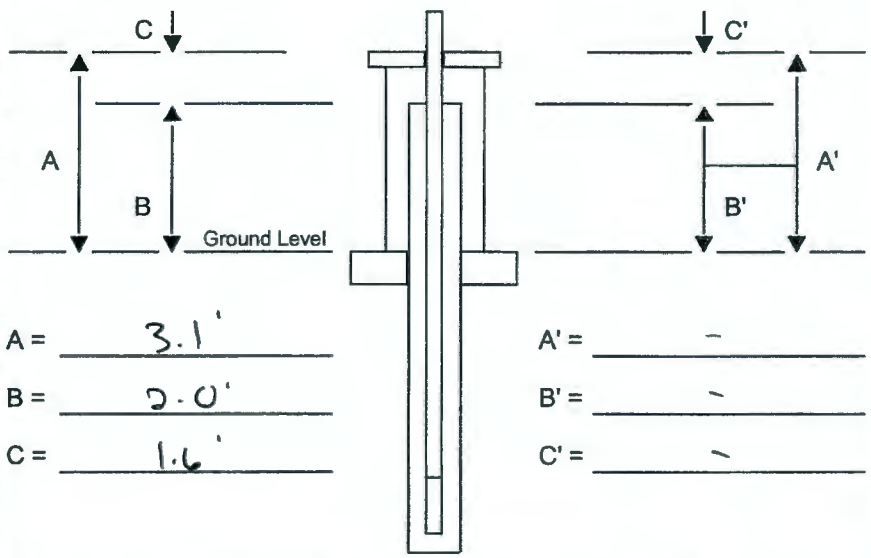
INSTANTANEOUS SLUG TEST

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

PART 4

Last Recorded Measurements Date:

Current Measurements Date:



A =	3.1'	A' =	–
B =	2.0'	B' =	–
C =	1.6'	C' =	–

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

PART 5

COMMENTS:

$X_{D\,initial} = 3.49'$

$X_{D\,final} = 0.73'$

Prepared by (print name):	Signature:	Date:
T. Clark	[signature]	3-14-13
Reviewed by (print name):	**Signature:**	**Date:**
L. Craig Swanson	[signature]	5/23/13

A-6003-644 (03/03)

FIELD ACTIVITY REPORT - DAILY DRILLING

Page 1 of 3

Date: 4-3-13

Well Name: 199-H4-86	Well ID: C8724
Location: 100-H area, N of H Reactor on Hoko Dr.	Report No.: 10

Start	Finish	Total
Time 0600	Time 1251	Time 6hr. 51 min.
Hole Depth/Csg 0 / 0	Hole Depth/Csg 0 / 0	Hole Depth/Csg – / –

Reference Measuring Point: GROUND SURFACE

Casing String No. 1 (2) 3 4 ____ Rod Size: (2) 6 5/8" Perm. well
See Report No. 1

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth (Attach applicable drawings and document straightness test results)
0600	0630	POD in 200E,
0630	–	Geo back to town to pick up troll. Drillers pick up trim pipe @ 100-D
–	0740	prep for days work, warm up rig.
0740	0755	Geo on site. Static water tag @ 45.9' ~~bgs~~ JMJ 4-3-13 TOC
0755	0825	Begin cleaning out well of sediment. Sediment tagged @ 57'4" bgs.
0825	–	Sediment tagged @ 68'3" TOC, Prepare to trip in pump for development.
–	0835	Stick-up is 3.07' ags, Water retagged @ 45.9' TOC
0835	–	Trip in pump. Pump = 5.9' Intake 3.4' from top. Troll intake @ 3.3 from
–	–	top of pump. Triming pipe totals: 21.16' + 20.77' + 5.03 + 5.15 = 52.11
–	–	Checking development standards.
–	–	Turbidity: 5.33 NTU STD = actual: 5.44 NTU
–	–	46.6 NTU std. = act. : 47.3 NTU
–	–	493 NTU std. = act: 500 NTU
–	–	All readings slightly high.
–	–	pH: 4 = act: 3.962
–	–	7 = act: 6.98
–	–	10 = act: 10.13
–	–	Conductivity: 1413 µS/cm std = 1539 µS/cm
–	–	this reading is off.
–	0901	No standard for D.O.
0901	–	Set up purge trucks. 0.5' triming pipe stick up over TOC. Intake set
–	–	@ 55.01' TOC.
–	–	Test name is C8724. Initial readings Pres: 3.96, Temp. 17.16,
–	0920	Depth: 9.15'

Reported By: Julie Johanson		Reviewed By: L. Craig Swanson	
Title: Geologist	Date: 4-3-13	Title: Hydrogeologist	Date: 5/23/13
Signature: Julie Johanson		Signature: L Swanson	

A-6003-651 (REV 1)

FIELD ACTIVITY REPORT - DAILY DRILLING

Continuation Page

Date: 4-3-13

Well Name: 199-H4-86 | Well ID: C8724

Location: 100-H, N. of H Reactor on Hoko Dr. | Continuation of Report No.: 10

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth					
0920	0924	Pump on XD; = 9.15'					
0924	0930	Messed up starting test. New test C8724 try 2 XD; = 9.14'					
0930	1101	Pump on					
–	–	initial drawdown to 7.48'					
0931	–	Water to surface. Pumping @ 68.4 gal/min					
–	–	XD	Turb. (NTU)	Cond. (µs/cm)	pH	Temp. °C	D.O. (mg/L)
JRJ 4-3-13 ~~0936~~	0936	7.45	28.7	661	7.81	16.6	9.24
–	0945	~~6.90~~ 7.43 JRJ 4-3-13	6.90	574	7.89	17.5	9.19
–	0953	7.42	3.62	573	7.93	18.0	9.10
–	1003	7.41	2.13	572	7.96	17.9	9.19
–	1010	7.40	2.13	576	7.97	17.7	9.22
–	1017	7.38	1.50	573	7.96	17.6	9.27
0942	~~0953~~ JRJ 4-3-13 1004	RCT on site; All readings @ or below bkgd.					
1012	1140	NCO's on site					
–	1025	7.38	1.46	572	7.98	17.5	9.33
–	1030	7.36	1.21	572	7.95	17.6	9.32
–	1035	7.36	1.14	568	7.96	17.7	9.29
–	1040	7.37	1.15	567	7.97	17.9	9.31
1031	1050	Carpenter drilling safety on site.					
–	1045	7.37	0.87	567	7.97	17.9	9.30
1048	–	NCOs begin collecting for water sample. Purge Vol. 76gal					
–	1101	Sample HEIS# B2NR20, B2NR23 (FTB)					
1101	1124	Pump off purge truck full. Wait for purge truck.					
1124	1127	Purge truck on site, hook up.					
1127	1139	Pump on					
1128	1140	Water to surface, NCO's continue collecting sample.					
1136	–	Official Sample time.					
1139	–	Pump off. Allow recharge. Drillers remove all water from site into					
–	1148	purge truck					

Reported By: Julie Johanson | Reviewed By: L. Craig Swanson

Title: Geologist | Date: 4-3-13 | Title: Hydrogeologist | Date: 5/23/13

Signature: Julie Johanson | Signature: L C Swanson

A-6003-652 (04/03)

FIELD ACTIVITY REPORT - DAILY DRILLING

Continuation Page

Page 3 of 3

Date: 4-3-13

Well Name: 199-H4-86

Well ID: C8724

Location: 100-H, N. of H Reactor on Hoko Dr.

Continuation of Report No.: 10

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth
1140	—	NCO's off site.
1148	1154	Purge Truck off site
1154	1218	Begin removing pump from well.
1218	1226	DTW 45.9' TOC; DTB: 68'2" TOC.; Driller clean up site.
1226	1244	Remove swab from tools
1228	1244	RCT on site; All readings @ or below bkgd.
1244	—	Shut down rig for rig break down. Geo pack up
1251	—	Geo off site

Not Used, JBJ 4-3-13

Reported By: Julie Johanson

Title: Geologist

Date: 4-3-13

Signature: Julie Johanson

Reviewed By: L. Craig Swanson

Title: Hydrogeologist

Date: 5/23/13

Signature: L C Swanson

A-6003-652 (04/03)

WELL DEVELOPMENT AND TESTING DATA

Well Name:	Well ID:	Well Location:	Date:
199-H4-86	C8724	100-H, N. of H Reactor on Haka Dr.	4-3-13

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 45.9'

End of Job 45.9'

DEPTH TO BOTTOM:

Start of Job 68.25'

End of Job 68.15'

PART 2

WELL DEVELOPMENT DATA

Pump Model Franklin Electric 5 Hp.

Intake Depth 55.01'

Starting Turbidity 28.7 NTU

Pump Start	Stop	Flow Rate
0920	0924	68.4
0930	1101	68.4
1127	1139	68.4

Total Pumped 7318.8 gal

Final Turbidity 0.87

XD SN/Range (PSI) 1.78'

PART 3

INSTANTANEOUS SLUG TEST

Static Water Level (TOC)

Transducer Depth

Baseline Start

Injection Start

Baseline Start

Withdrawal Start

Slug Volume

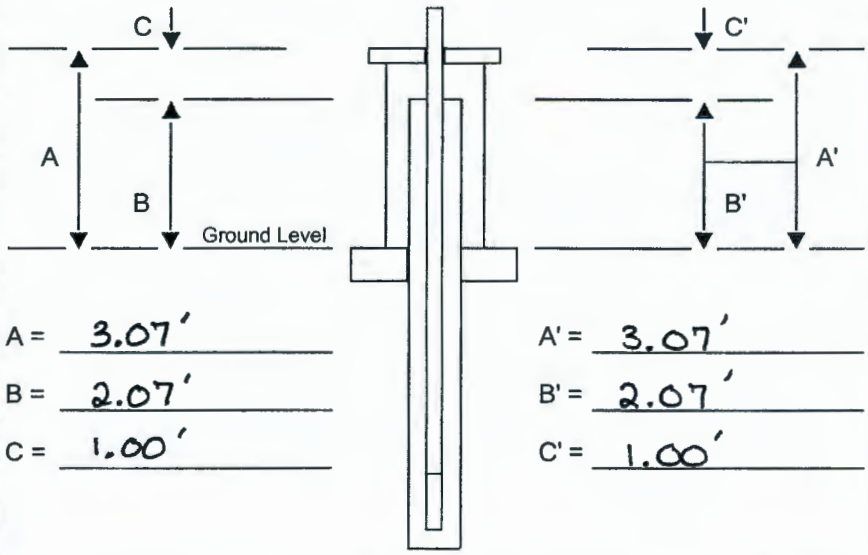
XD SN/Range (PSI)

Not Used JAS 43-43

PART 4

Last Recorded Measurements Date: 4-3-13

Current Measurements Date: 4-3-13



A = 3.07'

B = 2.07'

C = 1.00'

A' = 3.07'

B' = 2.07'

C' = 1.00'

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

PART 5

COMMENTS:

Intake @ 55.01' TOC

Prepared by (print name):	Signature:	Date:
Julie Johanson	Julie Johanson	4-3-13
Reviewed by (print name):	**Signature:**	**Date:**
L. Craig Swanson	L Swanson	5/23/13

A-6003-644 (03/03)

FIELD ACTIVITY REPORT - DAILY DRILLING

Page 1 of 2
Date: 2/13/13

Well Name: 199-D5-145	Well ID: C8725
Location: ~1/4 mile W. of DR reactor	Report No.: 17

Start	Finish	Total
Time 0600	Time 1430	Time 8.5 hrs
Hole Depth/Csg 117.1' / 118.29'	Hole Depth/Csg 118.20' / 118.29	Hole Depth/Csg — / —

Reference Measuring Point: GROUND SURFACE

Casing String No. (1) 2 3 4 ____ See Report No. 1 Rod Size: 6 5/8" @ 118.29'

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth (Attach applicable drawings and document straightness test results)
0600	0715	POD in 2753E @ 200-E, to site
0715	—	Warm rigs, prep to trip in pump and tremmie pipe for development
—	—	tag DTB @ 120.1' TOC - 3' stickup = 117.1' bgs, tag H_2O @ 88.5'
—	0745	TOC - 3' bgs = 85.05' bgs
0745	—	Start tripping in pump and tremmie for well development,
—	—	pump is Franklin Electric, 5HP, 5.95' L, tremmie is 2" ID,
—	—	length are as follows = 21' x 4 + 17' + 10' + 5.95 = 116.95 -
—	0830	2.5' for intake depth = 114.45' - 3' stickup = 111.45'
0830	—	Drillers set up manifold, wait for purge truck to arrive,
—	—	geo runs standard checks: (no 4.0 pH buffer available)
—	—	pH / conductivity (µs/cm) / turbidity (NTU)
—	—	known / actual / known / actual / known / actual
—	—	7.0 / 7.13 / 1413 / 1423 / 4.64 / 4.69
—	—	10.0 / 10.27 / / / 45.7 / 46.0
—	0925	4.0 / not available / / / 544 / 546
0925	—	Start development test "C8725 deep" with xD = 22.89' bgs, flow rate = 60 gpm,
—	—	intake depth = 111.45' bgs, pump on @ 0930, DTW = 85.05' bgs
—	—	Parameters: Time / pH / NTU / T(°C) / conductivity (µs/cm) / D/O (mg/L) / xD (ft bgs)
—	—	1 0935 7.39 >1000 15.93 833 8.50 18.10
—	—	2 0940 7.60 18.9 16.00 619 9.33 18.88
—	—	3 0945 7.77 8.37 16.00 613 9.43 18.83
—	—	4 0950 7.90 3.86 16.00 615 9.52 18.81
—	—	5 0955 7.96 3.43 16.01 621 9.48 18.79
—	—	6 1000 8.01 3.00 16.00 614 9.55 18.77
—	1010	7 1005 8.08 2.57 16.00 617 9.68 18.76
1010	—	Development complete, begin recovery test, pump off @ 1011 →

Reported By: K. Stokes		Reviewed By: L. Craig Swanson	
Title: Env. Engr	Date: 2/13/13	Title: Hydrogeologist	Date: 5/20/13
Signature: [signature]		Signature: [signature]	

A-6003-651 (REV 1)

FIELD ACTIVITY REPORT - DAILY DRILLING

Continuation Page

Page 2 of 2

Date: 2/13/13

Well Name: 199-DS-14S

Well ID: c8725

Location: ~1/4 mile W. of DR Reactor

Continuation of Report No.: 17

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth
1010	1040	Recovered to 88.1' TOC - 3' stickup = 85.1' bgs @ 1040
1040	—	Prep to begin 2nd Interval, remove 17' piece of tremmie, total
—	—	now = 99.95' - 3' stickup - 2.5' (intake) = 94.45' bgs (intake depth),
—	1125	wait for purge truck to return
1125	—	Start development test "c8725 shallow", xD = 5.81' bwt, flow rate = 60 gpm
—	—	intake depth = 94.45' bgs, DTW = 85.1' bgs, pump on @ 1131
—	—	Parameters: Time pH NTU T(°C) Conductivity (µS/cm) DO (mg/L) xD (ft bwt)
—	—	① 1135 7.90 57.0 16.17 680 9.37 2.10
—	—	② 1140 8.02 6.94 16.14 612 9.47 1.86
—	—	③ 1145 8.05 3.17 16.14 610 9.52 1.87
—	—	④ 1150 8.08 2.15 16.14 608 9.58 1.84
—	—	⑤ 1155 8.13 1.95 16.14 609 9.59 1.81
—	1205	⑥ 1200 8.15 1.47 16.14 615 9.44 1.78
1205	—	Development complete, begin recovery test, pump off @ 1201, DTWater
—	1220	recovered to 85.15' bgs
1220	—	Remove pump from the well and all associated wiring, tremmie, etc.,
—	—	tag bottom of well at 120.1' TOC - 3' stickup = 117.1' bgs,
—	1300	118.29 - 117.1 = 1.19' of fill in bottom of sump
1300	—	Bail out sand/fill from bottom with sand pump, tag DTB @ 121.2' TOC
—	1400	3' stickup = 118.2' bgs leaving ~0.09' on bottom
1400	—	Drillers swap out tools and start moving material to new site, geo finishes
—	1430	paperwork, leave for the day. (Permanent pump & posts/pad installed tomorrow)

Not Used
KS 2/13/13

Reported By: K. Stiles

Title: Env. Engr

Date: 2/13/13

Signature: [signature]

Reviewed By: L Craig Swanson

Title: Hydrogeologist

Date: 5/20/13

Signature: [signature]

A-6003-652 (04/03)

WELL DEVELOPMENT AND TESTING DATA

Well Name:	Well ID:	Well Location:	Date:
199-D5-145	C8725	~1/4 mile W. of DR Reactor	2/13/13

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	85.05' bgs
End of Job	85.15' bgs

DEPTH TO BOTTOM:

Start of Job	117.1' bgs
End of Job	117.1' bgs/ bailed to 118.2'

PART 2

WELL DEVELOPMENT DATA

Pump Model	Franklin Electric, 5hp	
Intake Depth	Test 1: 111.45' bgs	Test 2: 94.45' bgs
Starting Turbidity	Test 1: >1000	Test 2: 57.0

Pump Start	Stop	Flow Rate
#1: 0980	1011	60 gpm
#2: 1131	1201	60 gpm
	N/A	
	KS 2/13/13	

Total Pumped	Test 1: 2960 gal	Test 2: 1800 gal
Final Turbidity	Test 1: 2.57	Test 2: 1.47
XD SN/Range (PSI)	69 ft	

PART 3

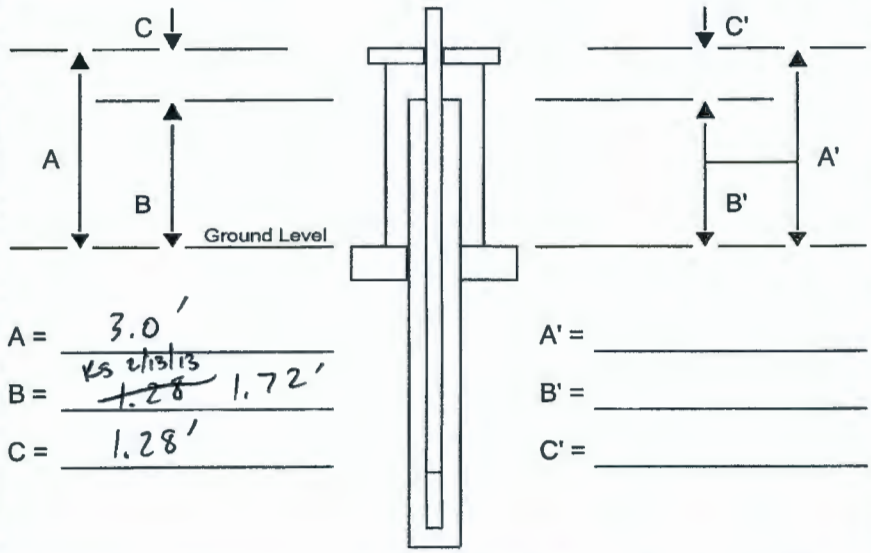
INSTANTANEOUS SLUG TEST

Static Water Level (TOC)	
Transducer Depth	
Baseline Start	N/A
Injection Start	KS 2/13/13
Baseline Start	
Withdrawal Start	
Slug Volume	
XD SN/Range (PSI)	

PART 4

Last Recorded Measurements Date: 2/13/13

Current Measurements Date:



A =	3.0'	A' =	
B =	~~1.28~~ KS 2/13/13 1.72'	B' =	
C =	1.28'	C' =	

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

PART 5

COMMENTS:

*1.19' of fill in bottom of sump, bailed to 118.2' bgs leaving ~0.05' of sand/fill in bottom of well. KS 2/13/13

*See FAR report # 17 for more details on development

Prepared by (print name):	Signature:	Date:
Kyle Stiles	[signature]	2/13/13
Reviewed by (print name):	**Signature:**	**Date:**
L. Craig Swanson	[signature]	5/20/13

A-6003-644 (03/03)

FIELD ACTIVITY REPORT - DAILY DRILLING

Page 1 of 3

Date: 3-11-13

Well Name: 199-D5-146 | Well ID: C8726

Location: W. of D+DR reactors; off Paha Ave. | Report No.: 11

Start	Finish	Total
Time 0600	Time 1612	Time 10 hrs. 12 min.
Hole Depth/Csg 116.7 / 116.48	Hole Depth/Csg 116.7 / 116.48	Hole Depth/Csg 0 / 0

Reference Measuring Point: GROUND SURFACE

Casing String No. 1 (2) 3 4 ____ Rod Size: (2): 6" Perm. Casing
See Report No. 1

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth (Attach applicable drawings and document straightness test results)
0600	0640	Monday Morning Tailgate meeting.
0640	—	POD in 200E; Paul(safety), Kelley, Rick (Drillers), Harry, Sam (Helper); Steve (BTR),
—	0705	Tessa, Julie (Geos)
0705	0736	Drive to site, Geo on site waite for Drillers.
0736	—	Geo, + Drillers now both on site. Warm up rig. Prepare for day.
—	—	pipes for developing: 2 1/16" ID / 2 1/4" OD. DTW = 87.31' TOC; 4.4' of
—	0820	sediment in well; Stkup = 3.14'
0820	—	Drillers clean out well.
—	—	Turbidity standards: 4.60 NTUs for standard 8453 (4.64)
—	—	45.5 NTUs for standard 8453 (45.7)
—	—	546 NTUs for standard 8453 (541)
—	—	*Note: Turbidimeter display is difficult to read.
—	—	pH standards: ~~7.267 for~~ JAJ 3-11-13 7pH standard was 7.27
0828	0835	RCT on site; All readings @ or below bkgd.
—	—	conductivity standards: 1449 µS/cm, standard 1413 µS/cm
—	0845	pH standard 10 was 10.45
0845	—	Clean up ~~around~~ JAJ 3-11-13 around well, prepare to trip in pump.
—	—	Pump: Franklin Electric Modle 2243038602 1-phase 5 HP 60Hz
—	—	SF1.15 Made in Mexico; Pump + top attachment = 5.9' Intake is
—	—	2.4' from bottom of pump. 98.9' of pipe will go into the
—	0908	well for the first interval. 103.8' to bottom of intake; ~~Intake~~ JAJ 3-11-13
0908	0942	~~set~~ JAJ 3-11-13 Begin tripping in pump.
0942	—	Initial readings 7.20 PSI; ~~14.81~~ 15.00 JAJ 3-11-13 °C; 16.62'; Intake set @
—	1307	100.1' bgs.; Drillers prepare to turn on pump

Reported By: Julie Johanson | Reviewed By: L. Craig Swanson

Title: Geologist | Date: 3-11-13 | Title: Hydrogeologist | Date:

Signature: Julie Johanson | Signature: L Swanson

A-6003-651 (REV 1)

FIELD ACTIVITY REPORT - DAILY DRILLING

Continuation Page

Page 2 of 3

Date: 3-11-13

Well Name: 199-D5-146

Well ID: C8726

Location: W. of D+DR reactors; off Paha Ave.

Continuation of Report No.: 11

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth
0953	0955	Pump on
0955	0956	Pump off, no draw
0956	~~1007~~ 1059 JMJ 3-11-13	Pump on (Test: C8726-deep)
0959	—	Water to the surface pumping 50 gal/min. Initial Turb. = 43.0 NTU
—	—	Turb. (NTU) / pH / Cond. (µS/cm) / Temp. (°C) / D.O. mg/L
—	1008	5.56 / 7.67 / 603 / 15.8 / 9.52
—	1020	2.27 / 7.84 / 571 / 15.13 / 9.55
—	1031	1.18 / 8.11 / 560 / 16.0 / 9.37
—	1041	1.09 / 8.15 / 557 / 16.3 / 9.38
—	1050	0.83 / 8.19 / 560 / 16.2 / 9.43
1007	1026	RCT on site, All readings @ or below bkgd.
1057	1314	NCOs on site
1059	1130	Pump off. final Turb. 1.02 NTU; Allow for recharge.
1130	—	Remove 17' of pipe and add on 5' in preperation for 2nd
—	1145	development interval. Intake will be @ 88.1' bgs
1145	—	Pump on (Test: C8726-shallow)
—	JMJ 3-11-13 ~~1151~~	Turb. (NTU) / pH / Cond. (µS/cm) / Temp. (°C) / D.O. mg/L
—	1151	2.97 / 7.96 / 559 / 17.0 / 9.51
—	1200	2.34 / 8.12 / 556 / 16.6 / 9.49
—	1208	2.17 / 8.17 / 557 / 16.4 / 9.50
—	1215	1.96 / 8.20 / 558 / 16.2 / 9.59
—	1220	2.68 / 8.21 / 558 / 16.1 / 9.67
—	1225	1.85 / 8.22 / 558 / 16.1 / 9.60
—	1230	1.60 / 8.21 / 559 / 16.2 / 9.63
—	1233	1.91 / 8.21 / 558 / 16.3 / 9.59
—	1237	2.35 / 8.21 / 557 / 16.5 / 9.60
1242	1307	NCO's begin collecting water sample.
1242	1305	Carpenter Drilling Safety on site.
1300	1310	RCT on site;

Reported By: Julie Johanson

Title: Geologist

Date: 3-11-13

Signature: Julie Johanson

Reviewed By: L. Craig Swanson

Title: Hydrogeologist

Date: 5/23/13

Signature: LC Swanson

A-6003-652 (04/03)

FIELD ACTIVITY REPORT - DAILY DRILLING

Continuation Page

Page 3 of 3

Date: 3-11-13

Well Name: 199-D5-146

Well ID: C8726

Location: W. of D+DR reactors; off Paha Ave.

Continuation of Report No.: 11

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth
1303	—	Official Sample time; B2NR32, FTB: B2NR35
1307	—	Pump off, allow for recharge. Drillers pump off all water on site.
—	1415	Prepare perm. pump to be set.
1412	1517	RCT on site
1415	—	Recharge complete; DTW: 87.43' TOC. Perm. pump is 0.95' intake
—	1429	is 0.18' from the top of JAJ 3-11-13 the pump.
1429	—	Begin removing development pump from well. Bottom of well tagged
—	1450	@ 119.42' TOC
1450	1454	Prepare to trip in perm. pump.
1454	1521	Remove swab from tools, put the jars back on.
1521	—	Begin tripping in perm. pump. 5 x 20' stainless steel pipe + 1 x 10'
—	—	stainless steel pipe. for JAJ 3-11-13 ~~106~~ 110' of stainless steel pipe. 3.20' stkup.
—	1605	Perm. Pump intake set @ 106.98' bgs.
1605	—	Shut down rig, clean up site. Pump installed but wiering incomplete.
—	1612	Drillers plan to complete wiering tomorrow.
1612	—	Drillers + Geo off site.

Not Used JAJ 3-11-13

Reported By: Julie Johanson

Title: Geologist

Date: 3-11-13

Signature: Julie Johanson

Reviewed By: L. Craig Swanson

Title: Hydrogeologist

Date: 5/23/13

Signature: LCSwanson

A-6003-652 (04/03)

WELL DEVELOPMENT AND TESTING DATA

Well Name:	Well ID:	Well Location:	Date:
199-D5-146	C8726	W. of D+DR reactors; off Paha Ave	3-11-13

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	87.31 TOC
End of Job	87.43 TOC

DEPTH TO BOTTOM:

Start of Job	119.5' TOC
End of Job	119.42' TOC

PART 2

WELL DEVELOPMENT DATA

Pump Model	Franklin Electric
Intake Depth	103.2' TOC/91.2' TOC
Starting Turbidity	43.0

Pump Start	Stop	Flow Rate
0956	1059	50 gal/min
1145	1307	35 gal/min

N/A

Total Pumped	6020 gal
Final Turbidity	1.02
XD SN/Range (PSI)	

PART 3

INSTANTANEOUS SLUG TEST

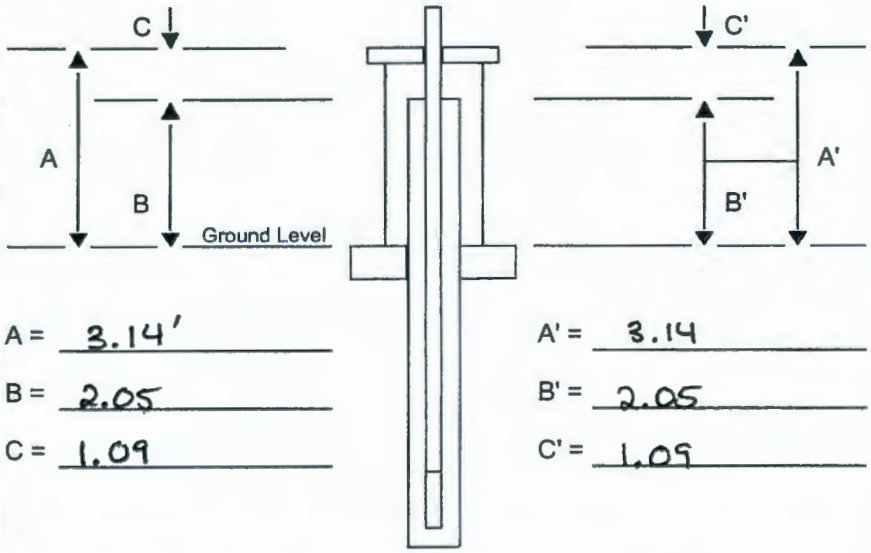
Static Water Level (TOC)	
Transducer Depth	
Baseline Start	
Injection Start	
Baseline Start	
Withdrawal Start	
Slug Volume	
XD SN/Range (PSI)	

N/A

PART 4

Last Recorded Measurements
Date: 3-11-13

Current Measurements
Date: 3-11-13



A =	3.14'	A' =	3.14
B =	2.05	B' =	2.05
C =	1.09	C' =	1.09

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

PART 5

COMMENTS:

Depth to bottom: 115.18' TOC bailed to 119.5' TOC

C8726-deep Intake @ 103.2 TOC

C8726-shallow Intake @ 91.2 TOC

Prepared by (print name):	Signature:	Date:
Julie Johanson	Julie Johanson	3-11-13
Reviewed by (print name):	**Signature:**	**Date:**
L. Craig Swanson	L C Swanson	6/25/13

A-6003-644 (03/03)

FIELD ACTIVITY REPORT - DAILY DRILLING

Page 1 of 3

Date: 2-27-13

Well Name: 199-D5-147 | Well ID: C8727

Location: 100-D, corner of D-Ave/Pioneer Way, inside fence | Report No.: 8

Start	Finish	Total
Time 0600	Time 1345	Time 7.75 hrs
Hole Depth/Csg 0.0 / 0.0	Hole Depth/Csg 0.0 / 0.0	Hole Depth/Csg — / —

Reference Measuring Point: GROUND SURFACE

Casing String No. 1 (2) 3 4 ____ Rod Size: (2)-6" perm s.s.
See Report No. 1

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth (Attach applicable drawings and document straightness test results)
0600	0700	To MO-2753 for POD
0700	0720	To site; drillers @ another site getting equipment.
0720	/	Drillers to site; prep. to clean sand out of sump & trip in temp pump
/	/	for well development.
/	/	→ Tag H_2O @ 87.3' TOC - 2.95' stkup = 84.35' bgs
/	0740	→ Tag inside well @ 106.1' TOC - 2.95' stkup = 103.15' bgs (4.87' in sump)
0740	/	Run-in sand bailer; bail ~7 gal sand/H_2O x 111 ≈ 21 gal bailed
/	0805	→ Tag inside well @ 111.2' TOC - 2.95' stkup = 108.25' bgs.
0805	0825	Prep. to run-in pump & tremmie pipe (+ transducer); F/E, SHP = pump.
0825	/	Run-in dev. pump (5.85' L, intake 3.40' down), transducer set @ ~6.0',
/	/	+ 3" OD, 2" ID s.s. tremie pipe: @ 20.7' + 20.7' + 20.8' + 21.15' + 17.1'
/		= 106.30' tally (intake @ 103.85' tally) - 2.95' stkup = 103.35' bgs (intake = 100.9' bgs).
		Drillers set up manifold/purge tank; prep. to begin development; geo ran
		field calibration on development equip:
		Conductivity (µS/cm)
		standard: 1413 reading: 1428 w/in 10%?: Y
		pH
		standard: 10.0 reading: 10.41 w/in 10%: Y
		standard: 7.0 reading: 7.30 w/in 10%: Y
		standard: 4.01 reading: 4.18 w/in 10%: Y
		Turbidity (NTU)
		standard: 4.64 reading: 4.62 w/in 10%: Y
		standard: 45.7 reading: 45.8 w/in 10%: Y
	0900	standard: 544 reading: 546 w/in 10%: Y (see pg. 2 →)

Reported By: T. Clark	Reviewed By: L. Craig Swanson
Title: Geologist — Date: 2/27/13	Title: Hydrogeologist — Date: 5/20/13
Signature: T. Clark	Signature: LC Swanson

A-6003-651 (REV 1)

FIELD ACTIVITY REPORT - DAILY DRILLING

Continuation Page

Page 2 of 3

Date: 2-27-13

Well Name: 199-D5-147

Well ID: C8727

Location: 100 D, corner of D Avenue Loop Way, inside fence

Continuation of Report No.: 8

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth
0900	~~1040~~ 1045 (TC) 2/27/13	Wait on other purge truck; notified by BTR that we can start @ 1040.
~~1040~~ 1045 (TC) 2/27/13		Turn pump on; run logging test w/ In-Situ Troll log "C8727"; 40.7 gal/min.

Time	XD	Conduct (us/cm)	Turbidity (NTU)	Temp (°C)	pH	DO (mg/L)
1050	9.92	~~70.2~~ 536 (TC) 2/27/13	70.2	16.86	7.46	9.13
1100	9.68	552	21.9	16.91	7.76	8.56
1110	9.19	558	10.9	16.93	7.86	8.57
1120	9.11	564	7.69	16.94	7.98	8.81
1130	8.98	573	4.62	16.92	8.00	8.76
1140	8.81	562	3.80	16.93	8.02	8.79
1150	8.80	571	4.15	16.93	8.01	8.75

Time From	Time To	Description of Activities/Operations with Depth
		→ Development complete w/ Troll 700 S/N 112657; see pg. 3 "Well development + testing data" for further info.
	1100	Samplers (NCOS) to site @ 1100 to collect H_2O sample, during development.
/		→ H_2O sample collected @ 1146; HEIS# B2NR38.
1155	1210	Shut pump off / begin recovery test.
1210	/	Drillers pump out excess H_2O + prep to trip out tremie, pump +
/	1230	transducer.
1230	1300	Break for lunch.
1300	1320	Remove manifold.
1320	/	Remove tremie pipe: 17.1' + 21.15' + 20.8' + 20.7' + 20.7' = 100.45' removed
/	/	+ 5.85' F.E SHP pump removed
/	1345	→ Tag inside well @ 111.2' TOC - 2.95' stick up = 108.25' bgs.
1345	/	Drillers prep. to + begin moving equip. to next hole, except rig; will
/		install perm. pump tomorrow. Geo. leave site.

not used (TC) 2-27-13

Reported By: T. Clark

Reviewed By: L. Craig Swanson

Title: Geologist

Date: 2/27/13

Title: Hydrogeologist

Date: 5/23/13

Signature: [signature]

Signature: [signature]

A-6003-652 (04/03)

WELL DEVELOPMENT AND TESTING DATA

pg. 3 of 3

Well Name:	Well ID:	Well Location:	Date:
199-D5-147	C8727	100-D, corner of D Ave/Pioneer Way, in fence	2-27-13

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	84.40
End of Job	84.53

DEPTH TO BOTTOM:

Start of Job	108.25
End of Job	

PART 2

WELL DEVELOPMENT DATA

Pump Model Franklin Electric SHP

Intake Depth 100.9' bgs

Starting Turbidity 70.2 NTU

Pump Start	Stop	Flow Rate
1045	1155	40.7 gpm

Total Pumped 2849 gal

Final Turbidity 4.15 NTU

XD SN/Range (PSI) 8.80'

PART 3

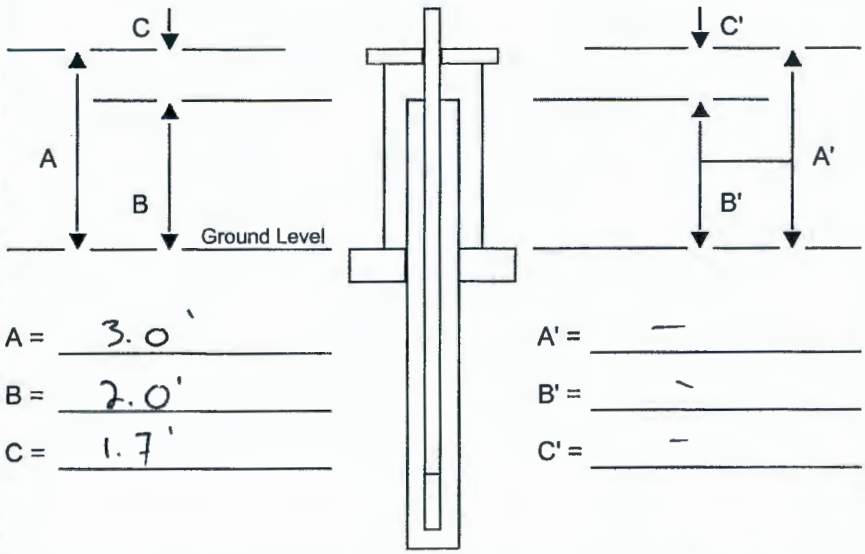
INSTANTANEOUS SLUG TEST

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

PART 4

Last Recorded Measurements Date:

Current Measurements Date:



A = 3.0'

B = 2.0'

C = 1.7'

A' = —

B' = —

C' = —

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

PART 5

COMMENTS:

XD_1 = 12.52'
XD_2 = 9.42
XD_3 = 9.68
XD_4 = see FAR pg 2.
XD_{last} = 8.80

Prepared by (print name):	Signature:	Date:
Tessa Clark	[signature]	2-27-13
Reviewed by (print name):	**Signature:**	**Date:**
L. Craig Swanson	[signature]	5/23/13

A-6003-644 (03/03)

FIELD ACTIVITY REPORT - DAILY DRILLING

Page 1 of 4

Date: 2-06-13

Well Name: 199-D5-148 | Well ID: C8728

Location: 100-D, SW of Reactor on Pioneer Way | Report No.: 12

Start	Finish	Total
Time 0600	Time 1430	Time 8.5 hrs
Hole Depth/Csg 0.4 / 0.0	Hole Depth/Csg 0.4 / 0.0	Hole Depth/Csg — / —

Reference Measuring Point: GROUND SURFACE

Casing String No. 1 (2) 3 4 ____ See Report No. 1

Rod Size: (1)-10" (2)-6" perm well

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth (Attach applicable drawings and document straightness test results)
0600	0715	To MO-2753 for POD.
0715	/	To site; prep. to begin final well development; wait for purgewater trucks.
/	/	→ Tag ~~tbh~~ H_2O @ 82.0' TOC - 3.0' stkup = 79.0' bgs. (TO) 2-6-13
/	/	→ Field test calibration parameters: D.O: no standard available
/	/	pH standard: 10 reading: 10.49 w/in 10%: Y
/	/	standard: 4.0 reading: 4.14 w/in 10%: Y
/	/	standard: 7.0 reading: 7.34 w/in 10%: Y
/	/	Conductivity
/	/	standard: 1413 µS/cm reading: 1844 w/in 10%: N (TO) 2/6/13
/	/	Turbidity: standard: 45.7 reading: 46.0 w/in 10%: Y
/	/	standard: 4.64 reading: 4.66 w/in 10%: Y
/	/	standard: 544 reading: 550 w/in 10%: Y
0800	/	Drillers begin tripping in pump + s.s. tremie pipe; pump = Franklin-Electric
(TO) 2/6/13	0800	4400, 230v, 5HP, model #35FA554-PE; ~~tremie~~ (TO) 2/6/13; 5.9'L (intake
	/	@ 2.5' up, 3.4' down); tremie = 3" OD, 2 1/4" ID.
/	/	→ Add-on 20.75' tremie (+ pump = 26.65' tall.).
/	/	→ Add on 21.20' tremie = 47.85' tall.
/	/	→ Add-on 20.75' tremie = 68.60' tall.
/	/	→ Add-on 20.75' tremie = 89.35' tall.
/	/	→ Add-on 17.10' tremie = 106.45' tall. (intake @ 103.95' tall.) - 3.5'
/	0850	stkup = 102.95' bgs (bottom of pump); 100.45' bgs (depth to intake).
0850	0943	Drillers add-on manifold + prep. to begin pumping.
0943	/	Turn pump on (H_2O @ 82' TOC - 3.0' stkup = 79.0' bgs) (TO) 2/6/13 to geo. at time.
/	/	→ Geo hand-measure drawdown; troll not available (see pg. 2 →)

Reported By: T. Clark | Reviewed By: L. Craig Swanson

Title: Geologist | Date: 2/6/13 | Title: Hydrogeologist | Date: 5/23/13

Signature: [signature] | Signature: [signature]

A-6003-651 (REV 1)

FIELD ACTIVITY REPORT - DAILY DRILLING

Continuation Page

Page 2 of 4

Date: 2-6-13

Well Name: 199-D5-148 | Well ID: C8728

Location: 100-D, SW of Reactor on Pioneer Way | Continuation of Report No.: 12

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth
(0943)	/	→ Bucket test = 5 gal / 5.175 = 58 gal/min
		Drawdown #5: (See pg 41 "Well Development + Testing Data").

Time	DTW (bgs)	Time	DTW (bgs)	Time	DTW (bgs)
0943	79.0				
0946	79.6				
0948	~~85.6~~ 82.6	TC 2/6/13			
0950	~~86.0~~ 83.0	TC 2/6/13	N/A		N/A
0951	~~86.7~~ 83.7	TC 2/6/13			
1004	84.9				
1005	~~88.2~~ 85.2	TC 2/6/13			
1010	~~89.3~~ 86.3	TC 2/6/13			
1014	86.2				
1016	85.2				

Field Readings

	xD (ft)	NTU	Temp (°C)	pH	Cond (µs/cm)
1017	N/A	N/A	N/A	N/A	N/A

1017 / Valve on T-joint of tremie riser is full of cement; cannot open or sample. Shut off pump. Drillers look to repair.

Time	DTW (bgs)	Time	DTW (bgs)	Time	DTW (bgs)	Time	DTW
1041	82.4	1044	~~83~~ TC 2/6/13	83.6	1055	84.1	1110	84.1
1042	82.7	1045	~~86.7~~ 83.7 TC 2/6/13	1100	84.0	1115	84.1
1043	83.4	1050	~~87.~~ 84.0 TC 2/6/13	1105	84.0	1120	84.1

Field Readings (pump rate = 58 gpm).

	xD (ft)	NTU	Temp (°C)	pH	Cond (µs/cm)	DO (mg/L)
1045	16.25	34.3	17.7	7.50	1023	8.80
1100	16.45	4.02	16.7	7.59	502	9.17
1115	16.55	1.83	16.8	7.69	495	9.13
1125	16.55	2.16	16.3	7.87	500	9.25
1135	16.55	1.18	16.5	7.89	502	9.33 (See pg 3)

Reported By: T. Clark | Reviewed By: L. Craig Swanson

Title: Geologist | Date: 2/6/13 | Title: Hydrogeologist | Date: 5/23/13

Signature: [signature] | Signature: [signature]

A-6003-652 (04/03)

FIELD ACTIVITY REPORT - DAILY DRILLING
Continuation Page

Page 3 of 4
Date: 2/6/13

Well Name: 199-D5-148 | Well ID: C8728
Location: 100-D, SW of Reactor on Pioneer Way | Continuation of Report No.: 12

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth
(1135)	1138	(see pg 2)
1138	1140	Turn pump off (development complete); run recovery
1140	/	Full recovery (H_2O @ 79.0' bgs); drillers prep. to move
/	1150	pump to 2nd interval.
1150	/	Remove 17.1' tremie + add-on 5.1' tremie = 94.45' fall (intake
/	1205	@ 91.95' fall) - 3.5' stick up = 90.95' bgs (intake @ 88.45' bgs).
1205	1219	Add on manifold + hoses; prep. to begin pumping 2nd interval.
1219		Begin pumping.

Drawdown #'s:

Time	DTW ('bgs)	Time	DTW ('bgs)	Time	DTW ('bgs)
1219	79.2	1225	83.8	1237	84.0
1220	82.7	1226	83.8	1240	84.0
1221	83.3	1227	83.9	1247	84.0
1222	83.6	1228	83.9		
1223	83.7	1229	83.9		
1224	84.0	1230	84.0		

Field Readings:

	xD (ft)	NTU	Temp (°C)	pH	Cond (uS/cm)	D.O. (mg/L)
1227	4.55	3.03	15.1	7.92	513	9.10
1237	4.45	1.29	15.5	7.94	512	9.29
1247	4.45	0.78	15.2	7.94	508	9.22

1252	1310	Turn pump off + run recovery.
1310	/	Recover to 79.2' bgs (H_2O); drillers remove manifold + prep to
/	1350	trip-out pump + tremie.
1350	1418	Trip out tremie pipe (88.55' fall) + 5.9' F/E Pump
1418	1420	Tag inside well @ 115.4' TOC (-3.0' stick up = 112.4' bgs); tag H_2O @ 79.1' bgs.
1420	1430	Drillers clean-up/secure site; geo finish paperwork.
1430	/	Geo. leave site.

Reported By: T. Clark
Title: Geologist | Date: 2/6/13
Signature: [signature]

Reviewed By: L. Craig Swanson
Title: Hydrogeologist | Date: 5/23/13
Signature: [signature]

A-6003-652 (04/03)

WELL DEVELOPMENT AND TESTING DATA

Pg. 4 of 4

Well Name:	Well ID:	Well Location:	Date:
199-D5-148	C8728	100-D, SW of Reactor on Pioneer Way	2/06/13

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	79.0' bgs
End of Job	79.1' bgs

DEPTH TO BOTTOM:

Start of Job	~~115.60~~ 112.0' bgs 2/6/13
End of Job	112.40

PART 2

WELL DEVELOPMENT DATA

Pump Model	Franklin-Electric 5HP
Intake Depth ①	100.5' bgs ② 88.5' bgs
Starting Turbidity ①	34.3 NTU ② 3.03

Pump Start	Stop	Flow Rate
#1 0943	1017 (not complete)	58 gpm
1041	1140	58 gpm
1219	1247	58 gpm

Total Pumped	7,078 gal
Final Turbidity	0.78 NTU
XD SN/Range (PSI)	N/A

PART 3

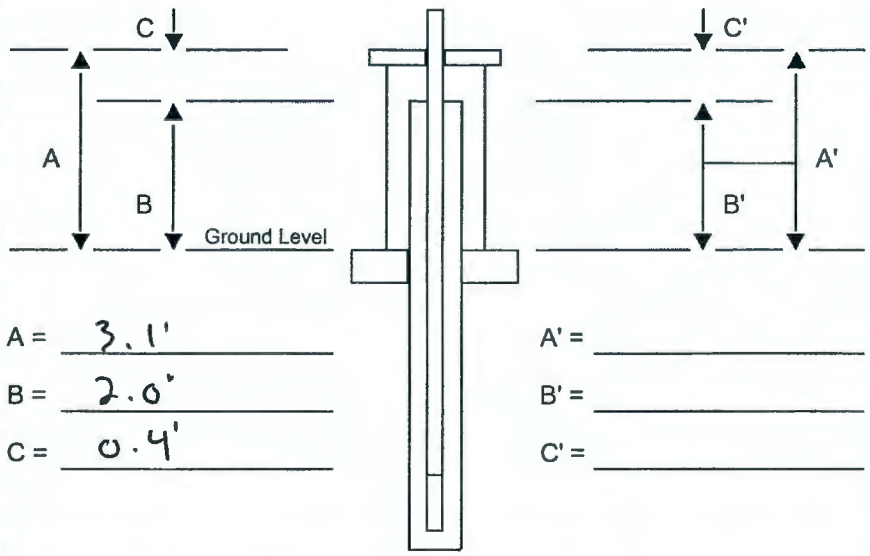
INSTANTANEOUS SLUG TEST

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

PART 4

Last Recorded Measurements Date: 2/6/13

Current Measurements Date:



A = 3.1'
B = 2.0'
C = 0.4'

A' =
B' =
C' =

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

PART 5

COMMENTS:
- DO. standard not available.
- Conductivity, not w/in 10% of standard.

Prepared by (print name):	Signature:	Date:
Tessa Clark	[signature]	2/6/13
Reviewed by (print name):	**Signature:**	**Date:**
L. Craig Swanson	[signature]	5/23/13

A-6003-644 (03/03)

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