

# **Borehole Summary Report for the Installation of Nine Injection Wells, Twenty-One Monitoring Wells, and Three Boreholes in the 300-FF-5 Operable Unit**

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



**P.O. Box 1600  
Richland, Washington 99352**



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C. Kildall  
CH2M HILL Plateau Remediation Company

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P.O. Box 1600  
Richland, Washington 99352

**APPROVED**

*By Janis Aardal at 12:15 pm, Jul 25, 2016*

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Release Approval

Date

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## Terms

bgs	below ground surface
BTR	Buyer's Technical Representative
CHPRC	CH2M HILL Plateau Remediation Company
DOE	U. S. Department of Energy
dpm	disintegration per minute
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ft	foot (feet)
gpm	gallons per minute
HCl	hydrochloric acid
hp	horse power
I.D.	inner diameter
ID	Identification
IHT	Industrial Hygiene Technician
in	inch (inches)
N/A	Not applicable
NTU	nephelometric turbidity unit
OD	outer diameter
OU	operable unit
PRZ	periodically rewetted zone
PVC	polyvinyl chloride
RCT	Radiological Control Technician
ROD	Record of Discussion
TD	total depth

## Metric Conversion Chart

<b>Into Metric Units</b>			<b>Out of Metric Units</b>		
<i>If you know</i>	<i>Multiply by</i>	<i>To get</i>	<i>If you know</i>	<i>Multiply by</i>	<i>To get</i>
<b>Length</b>			<b>Length</b>		
inches	25.4	millimeters	millimeters	0.0394	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.35	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles (statute)	1.69	kilometers	kilometers	0.621	miles
<b>Area</b>			<b>Area</b>		
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	0.45	hectares	hectares	2.471	acres
<b>Mass (weight)</b>			<b>Mass (weight)</b>		
ounces (avoir)	28.349	grams	grams	0.0353	ounces
pounds	0.454	kilograms	kilograms	2.25	pounds
tons (short)	0.97	ton (metric)	ton (metric)	1.12	tons (short)
<b>Volume</b>			<b>Volume</b>		
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	1.38	cubic yards
gallons	3.785	liters			
cubic feet	0.0283	cubic meters			
cubic yards	0.764	cubic meters			
<b>Radioactivity</b>			<b>Radioactivity</b>		
picocurie	37	millibecquerel	millibecquerel	0.027	picocurie

## 1 Introduction

The 300 Area encompasses approximately 105 km<sup>2</sup> (40 mi<sup>2</sup>) along the Columbia River in the southeast portion of the Hanford Site in Benton County, Washington. The 300 Area included a core industrial complex comprised of the buildings, facilities, and process units used during research and development activities and the production of uranium fuel. Past liquid waste disposal to subsurface infiltration waste sites has resulted in contamination of the vadose zone and groundwater. The 300 Area contains three operable units (OUs): the 300-FF-1 and 300-FF-2 soil OUs and the 300-FF-5 groundwater OU.

Many of the 300 Area waste sites have been remediated, but deeper residual uranium is contributing to persistent uranium groundwater concentrations that exceed the cleanup level in the *Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1* (EPA and DOE 2013) (hereafter referred to as the ROD/ROD Amendment). The selected remedy for uranium in the ROD/ROD Amendment (EPA and DOE 2013) is enhanced attenuation using sequestration. Sequestration will be carried out by infiltrating and injecting phosphate solutions into the vadose zone and the shallow aquifer to reduce the leachability of uranium from the soil. This will hinder or prevent further leaching of uranium to the aquifer.

The remedial actions selected in the ROD/ROD Amendment (EPA and DOE 2013) are implemented through DOE/RL-2014-13, *Integrated Remedial Design Report/Remedial Action Work Plan for the 300 Area (300-FF-1, 300-FF-2 & 300-FF-5 Operable Units)*. A detailed discussion of uranium sequestration activities can be found in DOE/RL-2014-13-ADD2, *Remedial Design Report/Remedial Action Work Plan Addendum for the 300 Area Groundwater* (referred to hereafter as the Groundwater Addendum).

The Groundwater Addendum (DOE/RL-2014-13-ADD2) calls for the enhanced attenuation area to target a 1 ha (3 ac) area containing a persistent source of uranium contamination to groundwater. In accordance with the Groundwater Addendum, uranium sequestration will be implemented using a staged approach. Stage A will consist of performing infiltration/injection in one quadrant of the Enhanced Attenuation Area (EAA), covering approximately 0.3 ha (0.75 ac). The Stage A results will be used to refine the Stage B approach for the remaining three quadrants (0.9 ha [2.25 ac]).

The Stage A enhanced attenuation area is near the inlet end of two liquid waste disposal sites (Figure 1-1). The northwest corner of the Stage A area is located at the southern end of 300 Area Process Trenches (waste site 316-5) which operated from 1975 to 1994 and received cooling water and low-level liquid waste from the 300 Area fuel fabrication facilities. Between 1991 and 1998, the trenches were excavated to a depth of 14 feet (ft) and backfilled with clean fill. The northeast corner of the Stage A area is located at the southeast end of the 300 Area North Process Pond (waste site 316-2) near the pond inlet. The pond was operated between 1948 and 1974 to dispose of cooling water and low-level waste from the 300 Area fuel fabrication facilities. Between 1998 and 1999, the pond was excavated to 25 ft and backfilled with clean fill.

The Stage A well field consists of 9 injection wells and a network of 13 deep monitoring wells and 13 shallow monitoring wells. Because the groundwater level in the 300 Area fluctuates in response to seasonal changes in river stage, the injection wells and monitoring wells are designed to treat and monitor uranium in the aquifer and in the periodically rewetted zone (PRZ) between the seasonal high and low water tables. The injection wells are designed with an upper screen set across the PRZ and a lower screen set within the aquifer below the historic low water table extending across the zone of highest contaminant concentration. During injection operations, the upper and lower screens are to be separated by an inflatable packer. The monitoring well network consist of 13 monitoring wells screened across the PRZ at depths coincident with upper injection well screens, and 13 deep monitoring wells with screens set below

the low water table at depths coincident with the lower injection well screens. Five existing wells will be used as monitoring wells. The document controlling the well drilling and construction of the remaining 30 wells was SGW-58553, *Description of Work for the Installation of Twenty Two Monitoring Wells and Nine Injection Wells in the 300-FF-5 Operable Unit, FY2015*. An existing monitoring well was used in place of one of the 22 monitoring wells listed in SGW-58553.

These wells were installed between June 4, 2015 and August 6, 2015 by Holt Services Inc. using a sonic rig under the direction of CH2M HILL Plateau Remediation Company (CHPRC). Well-site geology services including contractor due diligence oversight was provided by TerraGraphics Environmental Engineering, Inc. and PBS Engineering and Environmental under direct management by CHPRC's Buyer's Technical Representative (BTR).

Following completion of the Stage A infiltration and injection activities, three characterization boreholes were drilled, sampled, and decommissioned in accordance with SGW-59369, *Description of Work for the Installation of Three Boreholes in the 300-FF-5 Groundwater Operable Unit, FY2016*. Samples were collected from these boreholes to compare to samples collected before the Stage A infiltration and injection activities. These three wells were drilled between January 5, 2016 and January 11, 2016 by Holt Service, Inc using a sonic Terra Sonic Compact Crawler Rig under the direction of CH2M HILL Plateau Remediation Company (CHPRC). Well-site geology services including contractor due diligence oversight was provided by TerraGraphics Environmental Engineering, Inc. and PBS Engineering and Environmental under direct management by CHPRC's Buyer's Technical Representative (BTR).

## 1.1 Purpose and Scope

This borehole summary report describes, in detail, field activities carried out during the installation and sampling of 30 wells, and 3 characterization boreholes, as part of the Stage A uranium sequestration remedial action for the 300-FF-5 OU. The breadth of field activities and associated data included herein consists of drilling, sampling, well construction, and development. Also included in the scope of this report are borehole lithology descriptions, waste management information, well survey data, and final well acceptance dates.

The locations of the wells in the Stage A well field, including the 30 wells installed in accordance with SGW-58553 and the 3 boreholes installed in accordance with SGW-59369, are shown in Figure 1-1. The 30 new wells and 3 characterization boreholes shown in Figure 1-1 are listed by well type in Table 1-1. This document is organized by well type for ease of reference, and document navigation. The Well Summary Sheets, Borehole Logs, and Final Survey Reports for each well are located in the Appendices.

CHPRC procedures governing the drilling, geologic logging, well construction, and well development activities are listed in Section 7 of this document.

All wells and boreholes are referred to by their Hanford (e.g. C-series) well identification (ID) numbers in the text of this report. All drilling data are reported in the original units recorded at the time of measurement.

**Table 1-1. Stage A Enhanced Attenuation Well Drilling Summary**

Well ID Number	Well Name	Drilling Dates		Washington State Department of Ecology Well Tag
		Start	Finish	
<b>PRZ Monitoring Wells</b>				
C8930	399-1-69	June 17, 2015	June 17, 2015	BJE 711
C8932	399-1-71	June 16, 2015	June 16, 2015	BJE 704
C8935	399-1-73	June 10, 2015	June 15, 2015	BJE 702
C8939	399-1-75	June 30, 2015	June 30, 2015	BJE 719
C8941	399-1-77	June 29, 2015	June 29, 2015	BJE 707
C9450	399-1-79	June 18, 2015	June 18, 2015	BJE 714
C9452	399-1-81	June 30, 2015	June 30, 2015	BJE 705
C9454	399-1-83	June 23, 2015	June 23, 2015	BJE 718
C9456	399-1-85	June 25, 2015	June 25, 2015	BJE 715
C9458	399-1-87	June 23, 2015	August 6, 2015	BJE 709
<b>Aquifer Wells</b>				
C8931	399-1-70	June 15, 2015	June 16, 2015	BJE 703
C8934	399-1-72	June 9, 2015	June 10, 2015	BJE 701
C8937	399-1-74	June 29, 2015	June 29, 2015	BJE 706
C8940	399-1-76	July 7, 2015	July 13, 2015	BJE 720
C8942	399-1-78	June 22, 2015	June 22, 2015	BJE 713
C9408	399-1-65	June 18, 2015	June 18, 2015	BJE 712
C9409	399-1-66	June 17, 2015	June 17, 2015	BJE 710
C9451	399-1-80	July 14, 2015	July 14, 2015	BJE 721
C9453	399-1-82	June 24, 2015	June 24, 2015	BJE 717
C9455	339-1-84	June 25, 2015	June 25, 2015	BJE 716
C9457	399-1-86	June 22, 2015	June 23, 2015	BJE 708
<b>Injection Wells</b>				
C9460	399-1-89	June 8, 2015	August 4, 2015	BJE 725
C6461	399-1-90	June 16, 2015	August 4, 2015	BJE 726
C9462	399-1-91	July 22, 2015	August 5, 2015	BJE 727
C9463	399-1-92	July 20, 2015	August 4, 2015	BJE 730
C9464	399-1-93	June 8, 2015	August 5, 2015	BJE 724
C9465	399-1-94	July 21, 2015	August 6, 2015	BJE 723
C9466	399-1-95	June 6, 2015	August 6, 2015	BJE 722
C9467	399-1-96	June 4, 2015	August 5, 2015	BJE 729

**Table 1-1. Stage A Enhanced Attenuation Well Drilling Summary**

Well ID Number	Well Name	Drilling Dates		Washington State Department of Ecology Well Tag
		Start	Finish	
C9468	399-1-97	July 27, 2015	August 6, 2015	BJE 728
<b>Characterization Boreholes</b>				
C9580	NA	January 5, 2016	January 6, 2016	NA
C9581	NA	January 6, 2016	January 6, 2016	NA
C9582	NA	January 7, 2016	January 11, 2016	NA

ID = Identification

NA=not applicable



## 1.2 Drilling Project Summary

This section summarizes the main elements of the drilling project and includes elements common to installation of all 30 wells and 3 boreholes.

### 1.2.1 Drilling

Drilling was conducted using a Terrasonic<sup>1</sup> 150 cc track-mounted sonic drill rig using unlined core barrels and temporary casing matched to the size of the core barrels with close tolerances. Aquifer, PRZ and characterization boreholes were drilled using a 4-in. inner diameter (I.D.), 4.875-in. outer diameter (OD) core barrel with 5-in. I.D., 6-in. OD threaded casing. Pilot holes for injection wells were drilled using the same size core barrel and casing configuration as the aquifer and PRZ wells. Injection well boreholes were drilled following pilot holes using 7-in. I.D., 8-in. OD core barrel with 9.75-in. I.D., 10.75-in. OD threaded casing.

Injection wells were drilled to approximately 50 ft below ground surface (bgs). Aquifer monitoring wells were drilled to approximately 50 ft bgs, and PRZ monitoring wells were drilled to approximately 40 ft bgs. Characterization boreholes were drilled from ground surface to approximately 35 ft bgs. All measurements are as noted at the time of record.

### 1.2.2 Sampling

Soil samples for archive purposes were collected at 5 ft intervals and at lithology changes by the field site geologist per SGRP-PRO-EN-50025 (GRP-EE-01-7.0), *Geologic Logging*. The samples were placed in pint-sized glass jars and chip trays. After the samples were collected and released by the radiological control technician (RCT), they were moved to CHPRC's soils archive library in the 400 Area.

Sieve samples were collected and analyzed per SGRP-PRO-OP-50037 (GRP-EE-05-1.21), *Particle Size Distribution of Soil- Wet Sieve Analysis* at the beginning of the project from four injection-well pilot boreholes to confirm anticipated sediment grain size distributions for well design. Sieve samples were collected by the field site geologist from split archive samples collected throughout the water table. The four wells sampled were C9460 (399-1-89), C9464 (399-1-93), C9466 (399-1-95), and C9467 (399-1-96).

Soil samples for analysis of uranium were collected from boreholes C8940 (399-1-76), C9451 (399-1-80), C9580, C9581, and C9582. Analytical soil samples were collected using a 4-in. by 2.5 ft long split spoon. Split spoon samplers were driven in continuous succession in boreholes C8940 (399-1-76) and C9451 (399-1-80) from 10 ft to 32 ft and samples were collected from select portions of each split spoon to capture information necessary to satisfy data needs identified in SGW-56993, *Sampling Instruction for the 300-FF-5 Operable Unit Supplemental Post-ROD Field Investigation*, as amended by TPA-CN-656, TPA Change Notice Form, dated March 31, 2015, for SGW-56993, *Sampling Instruction for the 300-FF-5 Operable Unit Supplemental Post ROD Field Investigation*. One additional soil sample was collected from borehole C8935 (399-1-74) from a depth of 18 ft bgs where elevated levels of radioactive contamination were encountered. This sample was collected in accordance with provisions set forth in SGW-56993. Split spoon samplers were driven in continuous succession in boreholes C9580, C9581, and C9582 from 20 ft to 35 ft and samples were collected from select portions of each split spoon to capture information necessary to satisfy data needs identified in SGW-59369.

### 1.2.3 Well Construction

**Well Materials** – All of the aquifer and PRZ monitoring wells were constructed using threaded, 2-in. diameter, schedule 40 polyvinyl chloride (PVC) sumps and riser casing. The well screens were

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<sup>1</sup> Terrasonic is a copyright of Terra Sonic International, Marietta, Ohio.

constructed using threaded, continuous wrap, 20-slot, 2-in. diameter, schedule 40 PVC. Screens for aquifer wells were placed below the seasonal low water level for the well field. Screens for PRZ wells were placed between the high and low seasonal water levels for the well field. Injection wells were constructed using threaded, 6-in. diameter, schedule 80 PVC for the sumps and riser casing. Injection wells were constructed with two 50-slot screens separated by a 5 ft blank casing section. Screens were constructed using 6-in. diameter, schedule 80 equivalent, continuous wrap PVC. Upper injection screens were placed in the PRZ and lower screens were placed below the low seasonal water level.

**Annular Materials** – All boreholes extending greater than 3 ft below the sump depths were decommissioned using bentonite. Aquifer and PRZ well annular fill materials included 10-20 mesh silica sand placed to within 5 ft of the top of the screens, 0.25-in. bentonite pellets placed 3 ft thick atop the filter pack, 0.375-in. bentonite chips placed to within 10 ft of ground surface, and neat cement-bentonite grout placed to within 2 ft of ground surface. Annular fill materials for all injection wells included: 8-16-mesh silica sand placed from just below the sumps to no greater than 5 ft above the top screen; 0.375-in. or 0.25-in. bentonite pellets placed 3 ft thick centered between screens; 0.25-in. bentonite pellets placed 3 ft. thick atop the upper interval filter pack; 0.375-in. bentonite chips placed to within 10 ft of ground surface; neat-cement-bentonite grout placed to within 2 ft of ground surface.

**Well heads** – Well heads were capped using a 12-in. diameter by 12-in. deep, weatherproof well vault placed in a 2 ft by 2 ft concrete pad set approximately 1-in. above ground surface. The well name, Hanford well identification number (i.e., C-number) and finish date were embossed on a bronze marker placed in the concrete pad on the north side of the well. Washington State Department of Ecology (Ecology) unique well identification tags were installed on the well casing inside the well vault.

#### 1.2.4 Well Development

Well development for injection wells was conducted in accordance with SGRP-PRO-OP-50024 (GRP-EE-01-6.3), *Well Development and Testing*. Well development for aquifer monitoring wells and PRZ monitoring wells was conducted in accordance with SGRP-PRO-OP-50024, with special provisions made, as detailed in Section 2.

All of the wells were bailed, using a ball valve bailer, prior to development. The aquifer wells and PRZ wells were developed using a 12-volt submersible pump capable of pumping up to 2 gallons per minute (gpm). During pumping, the pump was raised and lowered by hand through the screened interval. Development continued until purge water “visibly cleared” per direction of the BTR and approval of CHPRC technical leads. Injection well lower screens were developed using a 2-horsepower (hp) submersible pump set in the center of the lower screen. Well C9468 (399-1-97) was developed using a 0.5-hp submersible pump approved by the BTR and CHPRC project management. Upper screens of injection wells were not developed since the upper screens were dry above the seasonal-low water level.

#### 1.2.5 Environmental Monitoring

**Radiological Field Screening** – Screening was initially conducting during two daily checks in accordance with Revision 0 of GW-053, *Radiological Work Permit*. After encountering elevated radiological contamination in sediment during drilling at C8935 (399-1-73) (Section 2.1.5) on June 22, 2015, radiological field screening was conducted to provide full time monitoring in accordance with Revision 2 of GW-053. Full time screening continued for the remainder of the project.

**Air Quality Monitoring** – Monitoring was provided twice daily by an Industrial Hygiene Technician (IHT) throughout the duration of the project, and during applicable split spoon soil sampling. No sustainable elevated readings for volatile organic compounds were reported during the project.

## 2 Well Specific Information

The following sections provide detailed information collected by the field geologists from TerraGraphics Environmental Engineering, Inc. and PBS Engineering and Environmental during the installation, sampling, and completion of the Stage A enhanced attenuation well field. This section is organized by well type to facilitate document navigation. Section 2.1 covers details specific to PRZ monitoring wells, Section 2.2 covers details specific to aquifer monitoring wells, Section 2.3 covers details specific to injection wells, and Section 2.4 covers detailed information about the characterization boreholes. At the beginning of each section for the wells, construction summary tables and development tables are provided.

### 2.1 Ten PRZ Monitoring Wells: Drilling, Sampling, and Completion Activities

This section provides detailed information collected during drilling, sampling, construction, and development of the 10 PRZ monitoring wells. Well construction and development information for all 10 PRZ monitoring wells is summarized in Tables 2-1 and 2-2, respectively.

**Drilling** – Drilling was conducted using a Terrasonic 150 cc sonic drill rig. The temporary casing was threaded, carbon steel, 6-in. OD, 5-in. I.D., and 10 ft long. The core barrel was 4.875-in. outer diameter by 10 ft long. Drilling of all 10 wells took place between June 10, 2015 and June 30, 2015. All of the wells were drilled from ground surface to approximately 40 ft bgs.

**Sampling** – Sampling consisted of soil grab samples collected in 5 ft intervals, or at lithology changes, by the field site geologist for archive purposes. The samples were placed in pint jars and chip trays and were not collected if contamination was present. After the samples were surveyed and released by the RCT, they were moved to CHPRC’s soils archive library in the 400 Area.

**Well Construction** – All of the PRZ wells were constructed using 2-in. diameter, schedule 40 PVC for the sumps and raisers. The well screens were 20-slot, 2-in. diameter, schedule 40 PVC. Table 2-1 and Appendix A provide the well construction details for each of the PRZ wells.

**Well Development** – The wells were bailed using a bailer with a ball valve. Bailing was done first in order to remove fines from the well. After the fines were removed, the well was pumped using a 2 gpm submersible pump. During the pumping process, the pump was raised and lowered by hand through the screened interval, to better develop the well. Development was concluded when the purgewater was determined to be “visibly clear” per direction of the BTR and CHPRC technical leads. Table 2-2 provides the well development details for each of the PRZ wells.

#### 2.1.1 C8930 (399-1-69)

Drilling, sampling, and construction were performed at this site on June 17, 2015. The borehole was drilled from ground surface to a TD of 40 ft bgs. Static water level was measured at 29.3 ft bgs (June 17, 2015).

Well construction was conducted on June 17, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen, and riser casing. The permanent casing was placed from 0.4 ft bgs to 38.4 ft bgs. The sump with end cap was set at 38.4 ft bgs to 35.7 ft bgs. The screen was placed from 35.7 ft bgs to 30.7 ft bgs. Riser casing was placed from 30.7 ft bgs to 0.4 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40 ft bgs to 29.5 ft bgs. A bentonite pellet seal was placed from 29.5 ft bgs to 25.9 ft bgs. Bentonite chips were placed from 25.9 ft bgs to 9.7 ft bgs. Neat cement grout was used as a surface seal from 9.7 ft bgs to 0.84 ft bgs. Surface completion included the installation of a

12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 711) was placed inside the protective monument on the grout surface seal.

Well development was performed on July 16, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

### **2.1.2 C8932 (399-1-71)**

Drilling, sampling, and construction were performed at this site on June 16, 2015. The borehole was drilled from ground surface to a TD of 40 ft bgs. Static water level was measured at 31.2 ft bgs (June 16, 2015).

Well construction was conducted on June 16, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.45 ft bgs to 38.2 ft bgs. The sump with end cap was set at 38.2 ft bgs to 35.46 ft bgs. The screen was placed from 35.46 ft bgs to 30.43 ft bgs. Riser casing was placed from 30.43 ft bgs to 0.45 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40 ft bgs to 27.7 ft bgs. A bentonite pellet seal was placed from 27.7 ft bgs to 24.7 ft bgs. Bentonite chips were placed from 24.7 ft bgs to 10 ft bgs. Neat cement grout was used as a surface seal from 10 ft bgs to 1.3 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C8932 is BJE 704.

Well development was performed on July 9, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

### **2.1.3 C8935 (399-1-73)**

Drilling, sampling, and construction were performed at this site from June 10, 2015 to June 17, 2015. The borehole was drilled from ground surface to a TD of 40.5 ft bgs. The maximum concentration of radiological contamination detected during drilling activities at C8935 was 18,000 disintegrations per minute (dpm) above background at 18 ft bgs. Static water level was measured at 31.1 ft bgs (June 11, 2015).

One soil sample was collected from a depth of 18 ft bgs where the highest level of radioactive contamination was encountered.

Well construction was conducted on June 15, 2015 using schedule 40, 2.375-in. OD and 2.125-in. ID PVC sump, screen and riser casing. The permanent casing was placed from 0.4 ft bgs to 35.9 ft bgs. The sump with end cap was set at 35.9 ft bgs to 33.27 ft bgs. The screen was placed from 33.27 ft bgs to 28.27 ft bgs. Riser casing was placed from 28.27 ft bgs to 0.4 ft bgs. A bentonite pellet seal was placed from 40 ft bgs to 35.9 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 35.9 ft bgs to 24.9 ft bgs. A bentonite pellet seal was placed from 24.9 ft bgs to 22.4 ft bgs. Bentonite chips were placed from 22.4 ft bgs to 10 ft bgs. Neat cement grout was used as a surface seal from 10 ft bgs to 0.75 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C8935 is BJE 702.

Well development was performed from July 15, 2015 to July 16, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

#### **2.1.4 C8939 (399-1-75)**

Drilling, sampling, and construction were performed at this site on June 29, 2015. The borehole was drilled from ground surface to a TD of 40.1 ft bgs. Static water level was measured at 31.8 ft bgs (June 29, 2015).

Well construction was conducted on June 29, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.36 ft bgs to 38.2 ft bgs. The sump with end cap was set at 38.2 ft bgs to 35.57 ft bgs. The screen was placed from 35.57 ft bgs to 30.57 ft bgs. Riser casing was placed from 30.57 ft bgs to 0.36 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40.1 ft bgs to 28 ft bgs. A bentonite pellet seal was placed from 28 ft bgs to 25 ft bgs. Bentonite chips were placed from 25 ft bgs to 10 ft bgs. Neat cement grout was used as a surface seal from 10 ft bgs to 1.5 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 707) was placed inside the protective monument on the grout surface seal.

Well development was performed on July 9, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

#### **2.1.5 C8941 (399-1-77)**

Drilling, sampling, and construction were performed at this site on June 30, 2015. The borehole was drilled from ground surface to a total depth (TD) of 40.17 ft bgs. Static water level was measured at 32.65 ft bgs on June 30, 2015.

Well construction was conducted on June 30, 2015. This well was constructed using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.55 ft bgs to 38 ft bgs. The sump with end cap was set at 38 ft bgs to 35.37 ft bgs. The screen was placed from 35.37 ft bgs to 30.37 ft bgs. Riser casing was placed from 30.37 ft bgs to 0.55 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40.17 ft bgs to 27.75 ft bgs. A bentonite pellet seal was placed from 27.75 ft bgs to 25 ft bgs. Bentonite chips were placed from 25 ft bgs to 10.09 ft bgs. Neat cement grout was used as a surface seal from 10.09 ft bgs to 1.2 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 719) was placed inside the protective monument on the grout surface seal.

Well development was performed on July 15, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

#### **2.1.6 C9450 (399-1-79)**

Drilling, sampling, and construction were performed at this site on June 18, 2015. The borehole was drilled from ground surface to a TD of 40.17 ft bgs. Static water level was measured at 31.6 ft bgs (June 18, 2015).

Well construction was conducted on June 18, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.8 ft bgs to 38.2 ft bgs. The sump with end cap was set at 38.2 ft bgs to 35.25 ft bgs. The screen was placed from 35.25 ft bgs to 30.25 ft bgs. Riser casing was placed from 30.25 ft bgs to 0.6 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40.17 ft bgs to 28.09 ft bgs. A bentonite pellet seal was placed from 28.09 ft bgs to 25.13 ft bgs. Bentonite chips were placed from 25.13 ft bgs to 10.2 ft bgs. Neat cement grout was used as a surface seal from 10.2 ft bgs to 0.8 ft bgs. Surface completion included

the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C9450 is BJE 714.

Well development was performed on July 13, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

#### **2.1.7 C9452 (399-1-81)**

Drilling, sampling, and construction were performed at this site on June 30, 2015. The borehole was drilled from ground surface to a TD of 40.7 ft bgs. Static water level was measured at 34.8 ft bgs (June 30, 2015).

Well construction was conducted on June 30, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.25 to 38.25 ft bgs. The sump with end cap was set at 38.25 ft bgs to 35.61 ft bgs. The screen was placed from 35.61 to 30.61 ft bgs. Riser casing was placed from 30.61 to 0.25 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40.7 to 28 ft bgs. A bentonite pellet seal was placed from 28 to 25.1 ft bgs. Bentonite chips were placed from 25.1 to 9.83 ft bgs. Neat cement grout was used as a surface seal from 9.83 to 1.2 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C9452 is BJE 705.

Well development was performed on July 9, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

#### **2.1.8 C9454 (399-1-83)**

Drilling, sampling, and construction were performed at this site from June 23, 2015 to June 24, 2015. The borehole was drilled to a TD of 39.98 ft bgs. The temporary casing was advanced from ground surface to 39.98 ft bgs. Static water level was measured at 34.8 ft bgs (June 30, 2015).

Well construction was conducted on June 24, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.9 to 38.1 ft bgs. The sump with end cap was set at 38.1 to 35.35 ft bgs. The screen was placed from 35.35 to 30.35 ft bgs. Riser casing was placed from 30.35 to 0.9 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 39.98 to 28 ft bgs. A bentonite pellet seal was placed from 28 to 25 ft bgs. Bentonite chips were placed from 25 to 9.7 ft bgs. Neat cement grout was used as a surface seal from 9.7 to 0.7 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C9454 is BJE 718.

Well development was performed on July 13, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

#### **2.1.9 C9456 (399-1-85)**

Drilling, sampling, and construction were performed at this site on June 25, 2015. The borehole was drilled from ground surface to a TD of 40.5 ft bgs. Static water level was measured at 31.8 ft bgs (July 14, 2015).

Well construction was conducted on June 25, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.64 to 38.21 ft bgs. The

sump with end cap was set at 38.21 to 35.58 ft bgs. The screen was placed from 35.58 to 30.58 ft bgs. Riser casing was placed from 30.58 to 0.64 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40.5 to 27.3 ft bgs. A bentonite pellet seal was placed from 27.3 to 24.9 ft bgs. Bentonite chips were placed from 24.9 to 10 ft bgs. Neat cement grout was used as a surface seal from 10 to 0.7 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C9456 is BJE 715.

Well development was performed on July 14, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

#### **2.1.10 C9458 (399-1-87)**

Drilling, sampling, and construction were performed at this site on June 23, 2015. The borehole was drilled from ground surface to a TD of 40.2 ft bgs. Static water level was measured at 31.6 ft bgs (July 20, 2015).

Well construction was conducted on June 23, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.5 to 38 ft bgs. The sump with end cap was set at 38 to 35.57 ft bgs. The screen was placed from 35.57 to 30.57 ft bgs. Riser casing was placed from 30.57 to 0.5 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 40.2 to 28.2 ft bgs. A bentonite pellet seal was placed from 28.2 to 25 ft bgs. Bentonite chips were placed from 25 to 9.5 ft bgs. Neat cement grout was used as a surface seal from 9.5 to 2 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C9458 is BJE 709.

Well development was performed on July 20, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

Table 2-1. PRZ Monitoring Well Construction Summary

Well ID/Well Name	TD (ft bgs)	Permanent Casing and Screen					Annular Materials				
		Well Riser Pipe <sup>a</sup> (ft bgs)	Screen <sup>a</sup> (ft bgs)	Screen Slot Size (inches)	Sump <sup>a</sup> (ft bgs)	Surface Seal <sup>b</sup> (ft bgs)	Surface Seal <sup>c</sup> (ft bgs)	Annular Seal <sup>d</sup> (ft bgs)	Annular Seal <sup>e</sup> (ft bgs)	Filter Pack <sup>f</sup> (ft bgs)	Annular Seal <sup>g</sup> (ft bgs)
C8930/ 399-1-69	40	0.4 – 30.7	30.7 – 35.7	0.020	35.7 – 38.4	0.8 – 0.84	0.84 – 9.7	9.7 – 25.9	25.9 – 29.5	29.5 – 40	N/A
C8932/ 399-1-71	40	0.45 – 30.43	30.43 – 35.46	0.020	35.46 – 38.2	0.6 – 1.3	1.3 – 10.8	10.8 – 24.7	24.7 – 27.7	27.7 – 40	N/A
C8935/ 399-1-73	40	0.4 – 28.27	28.27 – 33.27	0.020	33.27 – 35.9	0 – 0.75	0.75 – 10	10 – 22.4	22.4 – 24.9	24.9 – 35.9	35.9 – 40
C8939/ 399-1-75	40.1	0.36 – 30.57	30.57 – 35.57	0.020	35.57 – 38.2	0 – 1.5	1.5 – 10	10 – 25	25 – 28	28 – 40.1	N/A
C8941/ 399-1-77	40.17	0.55 – 30.37	30.37 – 35.37	0.020	35.37 – 38	0 – 1.2	1.2 – 10.09	10.09 – 25	25 – 27.75	27.75 – 40.17	N/A
C9450/ 399-1-79	40.17	0.6 – 30.25	30.25 – 35.25	0.020	35.25 – 38.2	0 – 0.8	0.8 – 10.2	10.2 – 25.13	25.13 – 28.09	28.09 – 40.17	N/A
C9452/ 399-1-81	40.7	0.25 – 30.61	30.61 – 35.61	0.020	35.61 – 38.25	0 – 1.2	1.2 – 9.83	9.83 – 25.1	25.1 – 28	28 – 40.7	N/A
C9454/ 399-1-83	39.98	0.9 – 30.35	30.35 – 35.35	0.020	35.35 – 38.1	0 – 0.7	0.7 – 9.7	9.7 – 25	25 – 28	28 – 39.98	N/A
C9456/ 399-1-85	40.5	0.64 – 30.58	30.58 – 35.58	0.020	35.58 – 38.21	0 – 0.7	0.7 – 10	10 – 24.9	24.9 – 27.3	27.3 – 40.5	N/A
C9458/ 399-1-87	40	0.5 – 30.57	30.57 – 35.57	0.020	35.57 – 38	0.7 – 2	2 – 9.5	9.5 – 25	25 – 28.2	28.2 – 40	N/A

a. 2.375-in. OD and 2.125-in. I.D. schedule 40, PVC

b. Concrete

c. Type I-II Portland Cement grout

d. 3/8-in. bentonite crumbles

e. 3/8-in. bentonite pellets

f. 10-20 mesh Colorado Silica Sand

g. 3/8-in. bentonite pellets

N/A = not applicable

**Table 2-2. PRZ Monitoring Well Development Summary**

Well ID Number/Well Name	Date Developed	Initial Water Level (ft bgs)	Duration Pumped (minutes)	Total Gallons Pumped
C8930/ 399-1-69	7/16/2015	30.7	36	~36
C8932/ 399-1-71	7/09/2015	30.8	37	~37
C8935/ 399-1-73	7/16/2015	31.74	25	~25
C8939/ 399-1-75	7/09/2015	30.2	39	~39
C8941/ 399-1-77	7/15/2015	32.65	50	~50
C9450/ 399-1-79	7/13/2015	32.1	31	~31
C9452/ 399-1-81	7/09/2015	31.5	10	~10
C9454/ 399-1-83	7/13/2015	32.72	21	~21
C9456/ 399-1-85	7/14/2015	31.8	52	~52
C9458/ 399-1-87	7/20/2015	31.6	39	~39

~ = approximate  
 ft bgs = feet below ground surface

## 2.2 Eleven Aquifer Monitoring Wells: Drilling, Sampling, and Completion Activities

This section provides detailed information collected during drilling, sampling, construction, and development of the 11 aquifer monitoring wells. Well construction and development information for all 11 aquifer monitoring wells is summarized in Tables 2-5 and 2-6, respectively.

**Drilling** – Drilling was conducted using a Terrasonic 150 cc sonic drill rig using 6-in. OD, and 5-in. I.D. temporary, carbon steel, threaded casing. The core barrel used was 4.875-in. OD by 10-in. Drilling of all 11 wells took place between June 9, 2015 and July 13, 2015. All of the wells were drilled from ground surface to approximately 48 ft bgs.

**Sampling** – Sampling consisted of soil grab samples collected in 5 ft intervals, or at lithology changes, by the field site geologist for archive purposes. The samples were placed in pint jars and chip trays, and were not collected if contamination was present. After the samples were surveyed and released by the RCT, they were moved to CHPRC’s soils archive library in the 400 Area. In addition to archive samples two of the boreholes had split spoon samples collected. Both C8940 (399-1-76) (Table 2-3) and C9451 (399-1-80) (Table 2-4) had split spoon samples collected continuously from approximately 10 to 32.5 ft bgs. Continuous IHT and RCT coverage was provided during the split spoon sampling process.

**Well Construction** – All of the aquifer monitoring wells were constructed using 2-in. schedule 40 PVC for the sumps and raisers. The well screens were 20-slot, 2-in. diameter, schedule 40 PVC. Table 2-5 and Appendix B provide the well construction details for each of the aquifer monitoring wells.

**Well Development** – The wells were bailed, using a ball bailer. Bailing was done first in order to remove fines from the well. After the fines were removed, the well was pumped using a 2 gpm submersible pump. During the pumping process the pump was raised and lowered, to better develop the well. Development was concluded when the purgewater was determined to be “visibly clear” per direction of the BTR and

CHPRC technical leads. Table 2-6 provides the well development details for each of the aquifer monitoring wells.

### **2.2.1 C9408 (399-1-65)**

Drilling, sampling, and construction were performed at this site on June 18, 2015. The borehole was drilled from ground surface to a TD of 49.7 ft bgs. The maximum concentration of radiological contamination detected during drilling activities at this well was 3,000 dpm above background from 30 to 40 ft bgs. A radiological contamination reading of 1,000 dpm above background was also detected at 5 ft bgs. Static water level was measured at 30.33 ft bgs (June 30, 2015).

Well construction was conducted on July 18, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.35 to 48.6 ft bgs. The sump with end cap was set at 48.6 to 45.96 ft bgs. The screen was placed from 45.96 to 40.93 ft bgs. Riser casing was placed from 40.93 to 0.35 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 49.7 to 37.9 ft bgs. A bentonite pellet seal was placed from 37.9 to 34.7 ft bgs. Bentonite chips were placed from 34.7 to 10.86 ft bgs. Neat cement grout was used as a surface seal from 10.86 to 0.8 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument on the grout surface seal. The Ecology tag assigned to C9408 is BJE 712.

Well development was performed on June 30, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

### **2.2.2 C9409 (399-1-66)**

Drilling, sampling, and construction were performed at borehole C9409 on June 17, 2015. The borehole was drilled from ground surface to a TD of 50.1 ft bgs. Static water level was measured at 31.15 ft bgs (July 20, 2015).

Well construction was conducted on July 17, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.4 to 47.1 ft bgs. The sump with cap was set at 47.1 to 44.47 ft bgs. The screen was placed from 44.47 to 39.48 ft bgs. Riser casing was placed from 39.48 to 0.4 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 50.1 to 37.95 ft bgs. A bentonite pellet seal was placed from 37.95 to 35.1 ft bgs. Bentonite chips were placed from 35.1 to 9.8 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.8 to 1.3 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument. The Ecology tag assigned to C9409 is BJE 710.

Well development was performed on July 13, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

### **2.2.3 C8931 (399-1-70)**

Drilling, sampling, and construction were performed at borehole C8931 from June 15, 2015 to June 16, 2015. The temporary casing was advanced from ground surface to 48.5 ft bgs. The borehole was further advanced uncased from 48.5 to 48.9 ft bgs using the down-hole drill bit. Static water level was measured at 33.8 ft bgs (June 15, 2015).

Well construction was conducted on June 16, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.3 to 48.98 ft bgs. The sump

with cap was set at 48.98 to 46.25 ft bgs. The screen was placed from 46.25 to 41.25 ft bgs. Riser casing was placed from 41.25 to 0.3 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 48.9 to 37.1 ft bgs. A bentonite pellet seal was placed from 37.1 to 34.9 ft bgs. Bentonite chips were placed from 34.9 to 10.1 ft bgs. Neat bentonite cement grout was used as a surface seal from 10.1 to 1.5 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument. The Ecology tag assigned to C8931 is BJE 703.

Well development was performed on August 6, 2015 using a 12-volt submersible pump capable of pumping up to 2gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

#### **2.2.4 C8934 (399-1-72)**

Drilling, sampling, and construction were performed at borehole C8934 from June 9, 2015 to June 10, 2015. The borehole was drilled from ground surface to a TD of 48.5 ft bgs. Static water level was measured at 31.69 ft bgs (July 16, 2015).

Well construction was conducted on June 10, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.35 to 47.4 ft bgs. The sump with cap was set at 47.4 to 44.67 ft bgs. The screen was placed from 44.67 to 39.67 ft bgs. Riser casing was placed from 39.67 to 0.35 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 48.5 to 39.9 ft bgs. A bentonite chips were placed from 39.9 to 10 ft bgs. Neat bentonite cement grout was used as a surface seal from 10 to 1.3 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument. The Ecology tag assigned to C8934 is BJE 701.

Well development was performed on July 16, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

#### **2.2.5 C8937 (399-1-74)**

Drilling, sampling, and construction were performed at borehole C8937 on June 29, 2015. The borehole was drilled from ground surface to a TD of 50.07 ft bgs. Static water level was measured at 30.2 ft bgs (July 9, 2015).

Well construction was conducted on June 29, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.3 to 47.8 ft bgs. The sump with cap was set at 47.8 to 45.17 ft bgs. The screen was placed from 45.17 to 40.17 ft bgs. Riser casing was placed from 40.17 to 0.3 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 50.07 to 37.2 ft bgs. A bentonite pellet seal was placed from 37.2 to 34.2 ft bgs. Bentonite chips were placed from 34.2 to 10.5 ft bgs. Neat bentonite cement grout was used as a surface seal from 10.5 to 1.25 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument. The Ecology tag assigned to C8937 is BJE 706.

Well development was performed on July 9, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

#### **2.2.6 C8940 (399-1-76)**

Drilling, sampling, and construction were performed at borehole C8940 from July 7, 2015 to July 13, 2015. The borehole was drilled from ground surface to a TD of 50.85 ft bgs. The maximum

concentration of radiological contamination detected during drilling activities at C8940 was 10,000 dpm above background at 38 ft bgs. A radiological contamination reading of 8,000 dpm above background was also detected at 22 ft bgs. Static water level was measured at 32.7 ft bgs (July 15, 2015). Continuous split spoon sampling was conducted from 10 to 32 ft bgs, and is presented in Table 2-3.

**Table 2-3. Sample Summary: Well C8940 (399-1-76)**

Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
7/13/2015	10 – 12	Soil	Split Spoon	B31MY0, B31MY1, B31MY2, B31MY4
7/13/2015	12.5 – 14.5	Soil	Split Spoon	B31MY6, B31MY7, B31N00
7/13/2015	15 - 17	Soil	Split Spoon	B31N03, B31N05
7/13/2015	20 – 22	Soil	Split Spoon	B31N15 QC, B31N14, B31N13
7/13/2015	22.5 – 24.5	Soil	Split Spoon	B31N20, B31N19
7/13/2015	25 – 27	Soil	Split Spoon	B31N22, B31N23, B31N24, B31N25, B31N26
7/13/2015	27.5 – 29.5	Soil	Split Spoon	B31N27, B31N28, B31N29, B31N30, B31N31
7/13/2015	30 - 32	Soil	Split Spoon	B31N33, B31N34, B31N35, B31N36

HEIS = Hanford Environmental Information System  
 ft bgs = feet below ground surface

Well construction was conducted on July 13, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.45 to 47.85 ft bgs. The sump with cap was set at 47.85 to 45.23 ft bgs. The screen was placed from 45.23 to 40.22 ft bgs. Riser casing was placed from 40.22 to 0.45 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 50.85 to 37.92 ft bgs. A bentonite pellet seal was placed from 37.92 to 35 ft bgs. Bentonite chips were placed from 35 to 10 ft bgs. Neat bentonite cement grout was used as a surface seal from 10 to 0.8 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument. The Ecology tag assigned to C8940 is BJE 720.

Well development was performed on July 15, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

### 2.2.7 C8942 (399-1-78)

Drilling, sampling, and construction were performed at borehole C8942 on June 22, 2015. The borehole was drilled from ground surface to a TD of 50.3 ft bgs. The maximum concentration of radiological contamination detected during drilling activities at C8942 was 3,000 dpm above background from 22 to 30 ft bgs. Static water level was measured at 31.2 ft bgs (June 30, 2015).

Well construction was conducted on June 22, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.5 to 48.3 ft bgs. The sump with cap was set at 48.3 to 45.52 ft bgs. The screen was placed from 45.52 to 40.51 ft bgs. Riser casing

was placed from 40.51 to 0.5 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 50.3 to 37.8 ft bgs. A bentonite pellet seal was placed from 37.8 to 35.1 ft bgs. Bentonite chips were placed from 35.1 to 9.8 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.8 to 1.4 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument. The Ecology tag assigned to C8942 is BJE 713.

Well development was performed on June 30, 2015 and July 1, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer. During pumping, the pump was raised and lowered by hand through the screened interval. During this process the pump was separated from the drop pipe connecting it to the surface. There were several attempts to recover the pump. However, no attempts were successful and the pump remains in the sump. Development continued until purge water visibly cleared per direction of the BTR and approval of CHPRC technical leads.

### 2.2.8 C9451 (399-1-80)

Drilling, sampling, and construction were performed at borehole C9451 on July 14, 2015. The borehole was drilled from ground surface to a TD of 50.5 ft bgs. Static water level was measured at 32.8 ft bgs (July 14, 2015). Continuous split spoon sampling was conducted from 10 to 32 ft bgs, and is presented in Table 2-4.

**Table 2-4. Sample Summary: Well C9451 (399-1-80)**

Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
7/14/2015	10 – 12	Soil	Split Spoon	B31N62, B31N63, B31N65, B31N64, B31N66
7/14/2015	12.4 – 14.4	Soil	Split Spoon	B31N70, B31N69, B31N71
7/14/2015	15 - 17	Soil	Split Spoon	B31N72, B31N73, B31N75, B31N74, B31N76 (DUP)
7/14/2015	17.5 – 19.5	Soil	Split Spoon	B31N78, B31N79, B31N81, B31N80, B31N82
7/14/2015	20 – 22	Soil	Split Spoon	B31N84, B31N86, B31N85, B31N87
7/14/2015	22.5 – 24.5	Soil	Split Spoon	B31N91, B31N90
7/14/2015	25 – 27	Soil	Split Spoon	B31N97, B31N96
7/14/2015	27.5 – 29.5	Soil	Split Spoon	B31NB0, B31NB2, B31NB1, B31NB3
7/14/2015	30 - 32	Soil	Split Spoon	B31NB7, B31NB6

HEIS = Hanford Environmental Information System  
ft bgs = feet below ground surface

Well construction was conducted on July 14, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen, and riser casing. The permanent casing was placed from 0.29 to 48.3 ft bgs. The sump with cap was set at 48.3 to 45.56 ft bgs. The screen was placed from 45.56 to 40.54 ft bgs. Riser casing was placed from 40.54 to 0.29 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica

sand from 50.5 to 37.11 ft bgs. A bentonite pellet seal was placed from 37.11 to 35 ft bgs. Bentonite chips were placed from 35 to 9.5 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.5 to 1 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument. The Ecology tag assigned to C9451 is BJE 721.

Well development was performed on July 15, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

### **2.2.9 C9453 (399-1-82)**

Drilling, sampling, and construction were performed at borehole C9453 on June 24, 2015. The borehole was drilled from ground surface to a TD of 51.0 ft bgs. Static water level was measured at 31.4 ft bgs (June 30, 2015).

Well construction was conducted on June 24, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.5 to 48.3 ft bgs. The sump with cap was set at 48.3 to 45.55 ft bgs. The screen was placed from 45.55 to 40.5 ft bgs. Riser casing was placed from 40.5 to 0.5 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 51 to 35.6 ft bgs. A bentonite pellet seal was placed from 35.6 to 32.1 ft bgs. Bentonite chips were placed from 32.1 to 10 ft bgs. Neat bentonite cement grout was used as a surface seal from 10 to 1.8 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument. The Ecology tag assigned to C9453 is BJE 717.

Well development was performed on July 14, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

### **2.2.10 C9455 (399-1-84)**

Drilling, sampling, and construction were performed at borehole C9455 on June 25, 2015. The borehole was drilled from ground surface to a TD of 60.0 ft bgs. The borehole was drilled an additional 10 feet to drill beyond a silt layer encountered at the planned screened interval. Static water level was measured at 32 ft bgs (July 14, 2015).

Well construction was conducted on June 25, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.45 to 55.66 ft bgs. The sump with cap was set at 55.66 to 53.02 ft bgs. The screen was placed from 53.02 to 48.01 ft bgs. Riser casing was placed from 48.01 to 0.45 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 57 to 44.7 ft bgs. A bentonite pellet seal was placed from 44.7 to 42 ft bgs. Bentonite chips were placed from 42 to 10.2 ft bgs. Neat bentonite cement grout was used as a surface seal from 10.2 to 1.6 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument. The Ecology tag assigned to C9455 is BJE 716.

Well development was performed on July 14, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm. Prior to development, fines were bailed from the sump using a ball valve bailer.

### 2.2.11 C9457 (399-1-86)

Drilling, sampling, and construction were performed at borehole C9457 from June 22, 2015 to June 23, 2015. The borehole was drilled from ground surface to a TD of 50.1 ft bgs. Static water level was measured at 29.14 ft bgs (July 20, 2015).

Well construction was conducted on June 23, 2015 using schedule 40, 2.375-in. OD and 2.125-in. I.D. PVC sump, screen and riser casing. The permanent casing was placed from 0.5 to 48.02 ft bgs. The sump with cap was set at 48.02 to 45.39 ft bgs. The screen was placed from 45.39 to 40.39 ft bgs. Riser casing was placed from 40.39 to 0.5 ft bgs. The filter pack surrounding the screen consists of 10-20 mesh silica sand from 50.1 to 38 ft bgs. A bentonite pellet seal was placed from 38 to 35.1 ft bgs. Bentonite chips were placed from 35.1 to 10.5 ft bgs. Neat bentonite cement grout was used as a surface seal from 10.5 to 2 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag was placed inside the protective monument. The Ecology tag assigned to C9457 is BJE 708.

Well development was performed on July 20, 2015 using a 12-volt submersible pump capable of pumping up to 2 gpm (Table 2-6). Prior to development, fines were bailed from the sump using a ball valve bailer.

## 2.3 Nine Injection Wells: Drilling, Sampling, and Well Completion Activities

This section provides detailed information collected during drilling, sampling, construction, and development of the nine injection wells. Well construction and development information for all 9 injection wells is summarized in Tables 2-7 and 2-8, respectively.

**Drilling** – Drilling was conducted using a Terrasonic 150 cc sonic drill rig. The carbon steel, threaded, temporary casing used was 10.75-in. OD and 9.75-in. I.D. The core barrel was 8-in. OD by 10 ft long. Drilling of all nine wells took place between June 4, 2015 and August 6, 2015. All of the wells were drilled from ground surface to approximately 50 ft bgs. Four of the boreholes had 6-in. diameter pilot holes drilled initially, in order collect sieves samples to determine the screen aperture for well construction.

**Sampling** – Sampling consisted of soil grab samples collected in 5 ft intervals, and at lithology changes, by the field site geologist for archive purposes. The samples were placed in pint jars and chip trays, and were not collected if contamination was present. After the samples were surveyed and released by the RCT, they were moved to CHPRC's soils archive library in the 400 Area. Sieve samples were collected from wells C9460 (399-1-89), C9466 (399-1-95), C9467 (399-1-96), and C9468 (399-1-97) by compiling split portions of grab samples collected from below the water table over 10 ft long intervals into batches for the sieve analysis. The composited sieves samples were processed to determine particle size distribution for the selection of well screen slot size.

**Well Construction** – All of the injection wells were constructed using 6.75-in. OD, 6-in. I.D., schedule 80 PVC for the sumps and risers. The well screens were 50 slot, 6.75-in. OD, 6-in. I.D., schedule 80 PVC. Table 2-7 and Appendix C provide the well construction details for each of the injection wells.

**Well Development** – Well development of the lower screened intervals took place between August 4, 2015 and August 6, 2015. In accordance with CHPRC procedure GRP EE 01 6.3, Well Development and Testing. Drawdown and recovery tests were monitored using an In-Situ<sup>2</sup> Inc. Level

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TROLL 700 pressure transducer/data logger. Table 2-8 provides the well development details for the lower screened interval in each of the injection wells.

Table 2-5. Aquifer Monitoring Well Construction Summary

Well ID/Well Name	TD (ft bgs)	Permanent Casing and Screen					Annular Materials			
		Well Riser Pipe <sup>a</sup> (ft bgs)	Screen <sup>a</sup> (ft bgs)	Screen Slot Size (inches)	Sump <sup>a</sup> (ft bgs)	Surface Seal <sup>b</sup> (ft bgs)	Surface Seal <sup>c</sup> (ft bgs)	Annular Seal <sup>d</sup> (ft bgs)	Annular Seal <sup>e</sup> (ft bgs)	Filter Pack <sup>f</sup> (ft bgs)
C9408/ 399-1-65	49.7	0.35 – 40.93	40.93 – 45.96	0.020	45.96 – 48.6	0 – 0.8	0.8 – 10.86	10.86 – 34.7	34.7 – 37.9	37.9 – 49.7
C9409/ 399-1-66	50.1	0.4 – 39.48	39.48 – 44.47	0.020	44.47 – 47.1	0 – 1.3	1.3 – 9.8	9.8 – 35.1	35.1 – 37.95	37.95 – 50.1
C8931/ 399-1-70	48.9	0.3 – 41.25	41.25 – 46.25	0.020	46.25 – 48.98	0 – 1.5	1.5 – 10.1	10.1 – 34.9	34.9 – 37.1	37.1 – 48.9
C8934/ 399-1-72	48.5	0.35 – 39.67	39.67 – 44.67	0.020	44.67 – 47.4	0 – 1.3	1.3 – 10	10 – 39.9	N/A	39.9 – 48.5
C8937/ 399-1-74	50.07	0.3 – 40.17	40.17 – 45.17	0.020	45.17 – 47.8	0 – 1.25	1.25 – 10.5	10.5 – 34.2	34.2 – 37.2	37.2 – 50.07
C8940/ 399-1-76	50.85	0.45 – 40.22	40.22 – 45.23	0.020	45.23 – 47.85	0 – 0.8	0.8 – 10	10 – 35	35 – 37.92	37.92 – 50.85
C8942/ 399-1-78	50.3	0.5 – 40.51	40.51 – 45.52	0.020	45.52 – 48.3	0 – 1.4	1.4 – 9.8	9.8 – 35.1	35.1 – 37.8	37.8 – 50.3
C9451/ 399-1-80	50.5	0.29 – 40.54	40.54 – 45.56	0.020	45.56 – 48.3	0 – 1	1 – 9.5	9.5 – 35	35 – 37.11	37.11 – 50.5
C9453/ 399-1-82	51	0.5 – 40.5	40.5 – 45.55	0.020	45.55 – 48.3	0 – 1.8	1.8 – 10	10 – 32.1	32.1 – 35.6	35.6 – 51
C9455/ 399-1-84	60	0.45 – 48.01	48.01 – 53.02	0.020	53.02 – 55.66	0 – 1.6	1.6 – 10.2	10.2 – 42	42 – 44.7	44.7 – 57
C9457/ 399-1-86	50.1	0.5 – 40.39	40.39 – 45.39	0.020	45.39 – 48.02	0 – 2	2 – 10.5	10.5 – 35.1	35.1 – 38	38 – 50.1

a. 2.375 in. OD, 2.125 in. ID. schedule 40, PVC

b. Concrete

c. Type I-II Portland Cement grout

d. 3/8-in. bentonite crumbles

e. 3/8-in. bentonite pellets

f. 10-20 mesh Colorado Silica Sand

ft bgs = feet below ground surface

N/A = not applicable

**Table 2-6. Aquifer Monitoring Well Development Summary**

<b>Well ID Number/Well Name</b>	<b>Date Developed</b>	<b>Initial Water Level (ft bgs)</b>	<b>Duration Pumped (minutes)</b>	<b>Total Gallons Pumped</b>
C8931/399-1-70	6/29/2015	30.85	17	~17
C8934/399-1-72	7/16/2015	31.69	41	~41
C8937/399-1-74	7/9/2015	30.2	44	~44
C8940/399-1-76	7/15/2015	32.7	30	~30
C8942/399-1-78	7/11/2015	31.2	36	~36
C9408/399-1-65	6/30/2015	30.33	72	~72
C9409/399-1-66	7/13/2015	31.15	70	~70
C9451/399-1-80	7/15/2015	31.78	103	~103
C9453/399-1-82	7/14/2015	32.36	29	~29
C9455/399-1-84	7/14/2015	32	80	~80
C9457/399-1-86	7/20/2015	29.14	58	~58

~ = approximate

ft bgs = feet below ground surface

Table 2-7. Injection Well Construction Summary

Well ID/Well Name	TD (ft bgs)	Permanent Casing and Screen				Annular Materials						
		Well Riser Pipe <sup>a</sup> (ft bgs)	Upper Screen <sup>a</sup> / Lower Screen (ft bgs)	Screen Slot Size (inches)	Sump <sup>a</sup> (ft bgs)	Surface Seal <sup>b</sup> (ft bgs)	Surface Seal <sup>c</sup> (ft bgs)	Annular Seal <sup>d</sup> (ft bgs)	Annular Seal <sup>e</sup> (ft bgs)	Filter Pack <sup>f</sup> (ft bgs)	Annular Seal <sup>e</sup> (ft bgs)	Filter Pack <sup>f</sup> (ft bgs)
C9460/ 399-1-89	50.9	0.7 – 20.39 / 30.39 – 35.39	20.39 – 30.39 / 35.39 – 45.39	0.050 / 0.050	45.39 – 48.9	0 – 1	1 – 10.2	10.2 – 14.1	14.1 – 16.89	16.89 – 31.99	31.99 – 34.92	34.92 – 50.9
C9461/ 399-1-90	51.03	0.7 – 20.42 / 30.43 – 35.43	20.42 – 30.43 / 35.43 – 45.44	0.050 / 0.050	45.44 – 48.95	0 – 1.2	1.2 – 9.87	9.87 – 14.1	14.1 – 16.83	16.83 – 31.95	31.95 – 34.9	34.9 – 51.03
C9462/ 399-1-91	50.17	0.35 – 19.98 / 29.98 – 34.98	19.98 – 29.98 / 34.98 – 44.97	0.050 / 0.050	44.97 – 48.54	0 – 1	1 – 9.15	9.15 – 14.08	14.08 – 17.08	17.08 – 32	32 – 35.33	35.33 – 50.17
C9463/ 399-1-92	49.55	0.7 – 20.3 / 30.3 – 35.31	20.3 – 30.3 / 35.31 – 45.31	0.050 / 0.050	45.31 – 48.88	0 – 2.3	2.3 – 9.92	9.92 – 14	14 – 16.92	16.92 – 32.17	32.17 – 35	35 – 49.55
C9464/ 399-1-93	50.9	0.2 – 19.95 / 29.95 – 34.94	19.95 – 29.95 / 34.94 – 44.94	0.050 / 0.050	44.94 – 48.45	0 – 2.05	2.05 – 10.2	10.2 – 14	14 – 16.97	16.97 – 32.18	32.18 – 34.98	34.98 – 50.9
C9465/ 399-1-94	49.82	0.55 – 20.24 / 30.24 – 35.24	20.24 – 30.24 / 35.24 – 45.23	0.050 / 0.050	45.23 – 48.8	0 – 1.05	1.05 – 10	10 – 14	14 – 16.92	16.92 – 31.83	31.83 – 35	35 – 49.82
C9466/ 399-1-95	50.3	0 – 20.92 / 30.92 – 35.92	20.92 – 30.92 / 35.92 – 45.91	0.050 / 0.050	45.91 – 49.44	0 – 2.8	2.8 – 10.16	10.16 – 14.5	14.5 – 16.8	16.8 – 31.96	31.96 – 35	35 – 50.3
C9467/ 399-1-96	49.38	0.2 – 19.88 / 29.88 – 34.88	19.88 – 29.88 / 34.88 – 44.87	0.050 / 0.050	44.87 – 48.38	0 – 2.8	2.8 – 9.94	9.94 – 14.1	14.1 – 16.7	16.7 – 32.18	32.18 – 34.83	34.83 – 49.38
C9468/ 399-1-97	50	0.2 – 19.9 / 29.9 – 34.9	19.9 – 29.9 / 34.9 – 44.9	0.050 / 0.050	44.9 – 48.42	0 – 1	1 – 9.76	9.76 – 13.87	13.87 – 16.9	16.9 – 32	32 – 34.92	34.92 – 50

- a. 6-in. schedule 80, PVC
  - b. Concrete
  - c. Type I-II Portland Cement grout
  - d. 3/8-in. bentonite crumbles
  - e. 3/8-in. bentonite pellets
  - f. 8-16 mesh Colorado Silica Sand
- ft bgs = feet below ground surface  
NA = not applicable

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Table 2-8. Injection Well Lower Screened Interval Development Summary

Well ID/Well Name	Date Developed	Initial Water Level (ft bgs)	Pump Intake Depth (ft bgs)	Duration Pumped (minutes)	Average Flow Rate (gpm)	Maximum Drawdown (ft)	Final Turbidity (NTU)	Specific Conductance (µS/cm)	pH	Temperature (C)	Total Gallons Pumped
C9460/399-1-89	8/04/2015	31.37	40.1	69	44.6	2.91	3.25	475	7.37	16.89	~3,077
C9461/399-1-90	8/04/2015	31.65	41.1	32	63.88	3.33	2.22	469	7.69	16.89	~2,044
C9462/399-1-91	8/04/2015	32	41.1	42	54.76	0.33	4.01	475	8.62	16.87	~2,945
C9463/399-1-92	8/05/2015	32.2	42.5	54	76	0	3.82	466	7.45	16.86	~4,101
C9464/399-1-93	8/05/2015	32.05	42.5	20	54.54	0.12	1.96	472	7.71	16.88	~1,090
C9465/399-1-94	8/05/2015	32.16	42.5	47	63.88	0.48	3.79	470	7.42	16.98	~3,002
C9466/399-1-95	8/06/2015	31.3	42.4	30	12.5	2.63	19	476	7.45	16.97	~500
C9467/399-1-96	8/05/2015	31.35	42.7	59	60.5	2.38	4.19	463	7.3	16.85	~3,570
C9468/399-1-97	8/06/2015	31.05	42.4	35	13	0.11	2.08	490	7.22	16.92	~465

ID = Identification  
 ft bgs = feet below ground surface  
 gpm = gallons per minute  
 NTU = nephelometric turbidity unit  
 ~ = approximately

### **2.3.1 C9460 (399-1-89)**

Well C9460 was drilled from ground surface to a TD of 50.5 ft bgs. The drilling was started on June 8, 2015 as a pilot hole. The pilot hole was drilled from ground surface using a 4-in. diameter by 10 ft long core barrel to 50.5 ft bgs. The pilot borehole was cased using 6-in. OD casing from ground surface to 40 ft. The pilot borehole was drilled in order to collect composite sieve samples to determine the required screen slot size. Water was tagged at 31.1 ft bgs. On June 9, 2015 the borehole was backfilled using 30-mesh silica sand. On July 15, 2015 the borehole was drilled in the same location using 10.75-in. OD casing from ground surface to 50.5 ft bgs, with an 8-in. diameter by 10 ft long core barrel. This process removed all of the 30-mesh silica sand.

Well construction was conducted on July 16, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 48.9 to 45.39 ft bgs. The first screen was placed from 45.39 to 35.39 ft bgs. The sump and first screen were surrounded by an 8-16 mesh sand from 50.9 to 34.92 ft bgs. A 5 ft blank riser was placed from 35.39 to 30.39 ft bgs. A bentonite pellet seal was placed from 34.92 to 31.99 ft bgs. A second screen was placed from 30.39 to 20.39 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 31.99 to 16.89 ft bgs. PVC riser was added from 20.39 to 0.7 ft bgs. Bentonite pellets were placed from 16.84 to 14.1 ft bgs to create a seal above the second screen. Bentonite chips were placed from 14.1 to 10.2 ft bgs. Neat bentonite cement grout was used as a surface seal from 10.2 to 1 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weatherproof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 725) was attached to the casing inside the vault.

Well development was conducted on August 4, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 3,077.4 gallons of water was pumped, at a purge rate of 44.6 gpm. Well development was deemed complete when the turbidity readings were less than 5 nephelometric turbidity units (NTU) and the remaining parameters were within 10% of the previous readings.

### **2.3.2 C9461 (399-1-90)**

Well C9461 was drilled from ground surface to a TD of 51.05 ft bgs. The drilling was conducted on July 16, 2015. The borehole was cased using 10.75-in. OD and 9.75-in. I.D. from ground surface to 50.3 ft bgs.

Well construction was conducted in July 20, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 48.95 to 45.44 ft bgs. The first screen was placed from 45.44 to 35.43 ft bgs. The sump and first screen were surrounded by 8-16 mesh sand from 51.05 to 34.9 ft bgs. A 5 ft blank riser was placed from 35.43 to 30.43 ft bgs. A bentonite pellet seal was placed from 34.9 to 31.95 ft bgs. A second screen was placed from 30.43 to 20.42 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 31.95 to 16.83 ft bgs. PVC riser was added from 20.42 to 0.7 ft bgs. Bentonite pellets were placed from 16.83 to 14.1 ft bgs to create a seal above the second screen. Bentonite chips were placed from 14.1 to 9.87 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.87 to 1.2 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 726) was attached to the casing inside the vault.

Well development was conducted on August 4, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 2,044.16 gallons of

water was pumped, at a purge rate of 63.88 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

### **2.3.3 C9462 (399-1-91)**

Well C9462 was drilled from ground surface to a TD of 50.17 ft bgs. The drilling was conducted on July 20, 2015. The borehole was cased using 10.75-in. OD and 9.75-in. I.D. from ground surface to 50.03 ft bgs.

Well construction was conducted in July 21, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 48.54 to 44.97 ft bgs. The first screen was placed from 44.97 to 34.98 ft bgs. The sump and first screen were surrounded by an 8-16 mesh sand from 50.17 to 35.33 ft bgs. A 5 ft blank riser was placed from 34.98 to 29.98 ft bgs. A bentonite pellet seal was placed from 35.33 to 32 ft bgs. A second screen was placed from 29.98 to 19.98 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 32 to 17.08 ft bgs. PVC riser was added from 19.98 to 0.35 ft bgs. Bentonite pellets were placed from 17.08 to 14.08 ft bgs to create a seal above the second screen. Bentonite chips were placed from 14.08 to 9.15 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.15 to 1 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 727) was attached to the casing inside the vault.

Well development was conducted on August 4, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 2,945 gallons of water was pumped, at a purge rate of 54.76 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

### **2.3.4 C9463 (399-1-92)**

Well C9463 was drilled and cased from ground surface to a TD of 49.55 ft bgs. The drilling was conducted on July 22, 2015.

Well construction took place between July 22, 2015 and July 23, 2015 using schedule 80, 6.75-in., OD and 6-in. I.D. PVC sump, screens, and riser. The sump with cap was set at 48.88 to 45.31 ft bgs. The first screen was placed from 45.31 to 35.31 ft bgs. The sump and first screen were surrounded by an 8-16 mesh sand from 49.55 to 35 ft bgs. A 5.01 ft blank riser was placed from 35.31 to 30.3 ft bgs. A bentonite pellet seal was placed from 35 to 32.17 ft bgs. A second screen was placed from 30.3 to 20.3 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 32.17 to 16.92 ft bgs. PVC riser was added from 20.3 to 0.7 ft bgs. Bentonite pellets were placed from 16.92 to 14 ft bgs to create a seal above the second screen. Bentonite chips were placed from 14 to 9.92 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.92 to 2.3 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE-730) was attached to the casing inside the vault.

Well development was conducted on August 5, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 4,104 gallons of water was pumped, at a purge rate of 76 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

### **2.3.5 C9464 (399-1-93)**

Well C9464 was drilled from ground surface to a TD of 50.5 ft bgs. The drilling was started on June 8, 2015 as a pilot hole. The pilot hole was drilled from ground surface using a 4-in. by 10 ft core barrel to 50.5 ft bgs. The pilot borehole was cased using 6-in. OD casing from ground surface to 40 ft. The pilot borehole was drilled in order to collect composite sieve samples to determine the required screen size. Water was tagged at 31.6 ft bgs. On June 8, 2015 the borehole was backfilled using 30-mesh silica sand. On July 6, 2015 the borehole was drilled using 10.75-in. OD casing from ground surface to 50.5 ft bgs, with an 8-in. by 10 ft core barrel. This process removed all of the 30-mesh silica sand.

Well construction took place on July 15, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 48.05 to 44.54 ft bgs. The first screen was placed from 44.54 to 34.54 ft bgs. The sump and first screen were surrounded by an 8-16 mesh sand from 50.9 to 34.98 ft bgs. A 4.99 ft blank riser was placed from 34.54 to 29.55 ft bgs. A bentonite pellet seal was placed from 34.98 to 32.18 ft bgs. A second screen was placed from 29.55 to 19.55 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 32.18 to 16.97 ft bgs. PVC riser was added from 19.55 to 0.2 ft bgs. Bentonite pellets were placed from 16.97 to 14 ft bgs to create a seal above the second screen. Bentonite chips were placed from 14 to 10 ft bgs. Neat bentonite cement grout was used as a surface seal from 10 to 3.2 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE-724) was attached to the casing inside the vault.

Well development was conducted on August 5, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 1,090 gallons of water was pumped, at a purge rate of 54.54 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

### **2.3.6 C9465 (399-1-94)**

Well C9465 was drilled and cased from ground surface to a TD of 49.82 ft bgs on July 21, 2015.

Well construction took place on July 22, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 48.8 to 45.23 ft bgs. The first screen was placed from 45.23 to 35.24 ft bgs. The sump and first screen were surrounded by 8-16 mesh sand from 49.82 to 35 ft bgs. A 5 ft blank riser was placed from 35.24 to 30.24 ft bgs. A bentonite pellet seal was placed from 35 to 31.82 ft bgs. A second screen was placed from 30.24 to 20.24 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 31.83 to 16.92 ft bgs. PVC riser was added from 20.24 to 0.55 ft bgs. Bentonite pellets were placed from 16.92 to 14 ft bgs to create a seal above the second screen. Bentonite chips were placed from 14 to 10 ft bgs. Neat bentonite cement grout was used as a surface seal from 10 to 1.05 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 723) was attached to the casing inside the vault.

Well development was conducted on August 5, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 3,002.36 gallons of water was pumped, at a purge rate of 63.88 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

### **2.3.7 C9466 (399-1-95)**

Well C9466 was drilled from ground surface to a TD of 50.3 ft bgs. The drilling was started on June 6, 2015 as a pilot hole. The pilot hole was drilled from ground surface using a 4-in. by 10 ft core barrel to 50.3 ft bgs. The pilot borehole was cased using 6-in. OD casing from ground surface to 40 ft. The pilot borehole was drilled in order to collect composite sieve samples to determine the required screen size. The borehole was backfilled using 30-mesh silica sand. On July 23, 2015 the borehole was drilled using 10.75-in. OD casing from ground surface to 50.2 ft bgs, with an 8-in. by 10 ft core barrel. This process removed all of the 30-mesh silica sand.

Well construction was conducted in July 27, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 49.44 to 45.91 ft bgs. The first screen was placed from 45.91 to 35.92 ft bgs. The sump and first screen were surrounded by 8-16 mesh sand from 50.3 to 35 ft bgs. A 5 ft blank riser was placed from 35.92 to 30.92 ft bgs. A bentonite pellet seal was placed from 35 to 31.96 ft bgs. A second screen was placed from 30.92 to 20.92 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 31.96 to 16.8 ft bgs. PVC riser was added from 20.92 to 0 ft bgs. Bentonite pellets were placed from 16.88 to 14.5 ft bgs to create a seal above the second screen. Bentonite chip were placed from 14.5 to 10.16 ft bgs. Neat bentonite cement grout was used as a surface seal from 10.16 to 2.8 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 722) was attached to the casing inside the vault.

During excavation for the infiltration system, it was observed that the grout seal of injection well 399-1-95 was deficient and did not completely seal the annulus of the well. As a result, the grout seal was reconstructed on November 5, 2015. A geologist was not on site to observe the completion of the work. Details and a description of the work can be found in SGW-59455, *300-FF-5 Operable Unit Stage A Uranium Sequestration System Installation Report*.

Well development was conducted on August 6, 2015 using a 0.5-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 500 gallons of water was pumped, at a purge rate of 11 to 14 gpm. The pump would not successfully run for more than 10 minutes at a time, causing well development to be prematurely concluded (before turbidity dropped below 5 NTUs and field parameters stabilized).

### **2.3.8 C9467 (399-1-96)**

Well C9467 was drilled from ground surface to a TD of 49.38 ft bgs. The drilling was started on June 4, 2015 as a pilot hole. The pilot hole was drilled from ground surface using a 4-in. by 10 ft core barrel to 49.38 ft bgs. The pilot borehole was cased using 6-in. OD casing from ground surface to 40 ft. The pilot borehole was drilled in order to collect composite sieve samples to determine the required screen size. Water was tagged at 31.45 ft bgs. On June 4, 2015 the borehole was backfilled using 30-mesh silica sand. On July 23, 2015 the borehole was drilled using 10.75-in. OD casing from ground surface to 50.5 ft bgs, with an 8-in. by 10 ft core barrel. This process removed all of the 30-mesh silica sand.

Well construction was conducted in July 23, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D. PVC sump, screens, and riser. The sump with cap was set at 48.38 to 44.87 ft bgs. The first screen was placed from 44.87 to 34.88 ft bgs. The sump and first screen were surrounded by 8-16 mesh sand from 49.38 to 34.83 ft bgs. A 5 ft blank riser was placed from 34.88 to 29.88 ft bgs. A bentonite pellet seal was placed from 34.83 to 32.18 ft bgs. A second screen was placed from 29.88 to 19.88 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 32.18 to 14.1 ft bgs. PVC riser was added from 19.88 to 0.2 ft bgs. Bentonite pellets were placed from

16.84 to 14.1 ft bgs to create a seal above the second screen. Bentonite chips were placed from 14.1 to 9.94 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.94 to 2.8 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 729) was attached to the casing inside the vault.

Well development was conducted on August 5, 2015 using a 2-hp submersible pump to develop the lower screen only since the upper screen was above the seasonal low water mark. A total of 3,570.68 gallons of water was pumped, at a purge rate of 60.5 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

### **2.3.9 C9468 (399-1-97)**

Well C9468 was drilled and cased from ground surface to a TD of 50 ft bgs. The drilling was conducted between July 27, 2015 and July 28, 2015.

Well construction took place on July 28, 2015 using schedule 80, 6.75-in. OD and 6-in. I.D., PVC sump, screens, and riser. The sump with cap was set at 48.42 to 44.9 ft bgs. The first screen was placed from 44.9 to 34.9 ft bgs. The sump and first screen were surrounded by an 8-16 mesh sand from 50 to 34.92 ft bgs. A 5 ft blank riser was placed from 34.9 to 29.9 ft bgs. A bentonite pellet seal was placed from 34.92 to 32 ft bgs. A second screen was placed from 29.9 to 19.9 ft bgs to provide access to the PRZ during high water levels. The second screen was surrounded with 8-16 mesh silica sand from 32 to 16.9 ft bgs. PVC riser was added from 19.9 to 0.2 ft bgs. Bentonite pellets were placed from 16.9 to 13.87 ft bgs to create a seal above the second screen. Bentonite chips were placed from 13.87 to 9.76 ft bgs. Neat bentonite cement grout was used as a surface seal from 9.76 to 1 ft bgs. Surface completion included the installation of a 12-in. diameter by 12-in. deep cast iron weather proof well vault set in a 2 ft by 2 ft surface concrete pad. An Ecology well identification tag (BJE 728) was attached to the casing inside the vault.

Well development was conducted on August 6, 2015 using a 0.5-hp submersible pump in the lower screen only. The upper screen was not developed since it was above the seasonal low water mark at the time. A total of 465.5 gallons of water was pumped, at a purge rate of 13.33 gpm. Well development was deemed complete when the turbidity readings were less than 5 NTUs and the remaining parameters were within 10% of the previous readings.

## **2.4 Three Post-Injection Characterization Boreholes: Drilling, Sampling, and Decommissioning Activities**

This section provides detailed information collected during drilling, sampling, and decommissioning of three characterization boreholes following completion of the Stage A infiltration and injection activities. Sampling summaries can be found in Tables 2-9 through 2-11.

**Drilling** – Drilling was conducted using a Terrasonic 150 cc sonic drill rig. The temporary casing was threaded, carbon steel, 6-in. OD, 5-in. I.D., and 10 ft long. The core barrel was 4.875-in. outer diameter by 10 ft long. Drilling of all 3 boreholes took place between January 5, 2016 and January 11, 2016. All of the boreholes were drilled from ground surface to approximately 35 ft bgs.

**Sampling** – Sampling included grab samples for archive purposes and continuous split spoon samples from approximately 20 ft bgs to 35 ft bgs. See Tables 2-9 through 2-11 for detailed information on the split spoon samples.

**Decommissioning** – All three boreholes were decommissioned upon completion of drilling and sampling.

### 2.4.1 C9580

Drilling, sampling, and decommissioning were performed at this site between January 5, 2016 and January 6, 2016. The borehole was drilled from ground surface to a TD of 35 ft bgs. Static water level was measured at 31.8 ft bgs (January 5, 2016).

The borehole was decommissioned between January 5, 2016 and January 6, 2016, Bentonite chips were placed from 35 ft bgs to 4.9 ft bgs. The surface seal was poured from 4.9 ft bgs to ground surface on January 6, 2016. After the seal was poured a brass marker was placed bearing the well ID number and date of decommissioning.

**Table 2-9. Sample Summary; Borehole C9580**

Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS #
1/5/2016	20-22.5	Soil	Split Spoon	B347C7, B347C8
1/5/2016	22.5-25	Soil	Split Spoon	B347D3, B347D4
1/5/2016	25-27.5	Soil	Split Spoon	B347D8, B347D9
1/5/2016	27.5-30	Soil	Split Spoon	B347F1, B347F2
1/5/2016	30-32.5	Soil	Split Spoon	B347F6, B347F7
1/5/2016	32.5-35	Soil	Split Spoon	B347H1, B347H2, B347H3, B347H4

HEIS = Hanford Environmental Information System  
ft bgs = feet below ground surface

### 2.4.2 C9581

Drilling, sampling, and decommissioning were performed at this site on January 6, 2016. The borehole was drilled from ground surface to a TD of 35 ft bgs. Static water level was measured at 32.9 ft bgs (January 6, 2016).

The borehole was decommissioned on January 6, 2016. Bentonite chips were placed from 35 ft bgs to 5.15 ft bgs. The surface seal was poured from 5.15 ft bgs to ground surface on January 6, 2016. After the seal was poured a brass marker was placed bearing the well ID number and date of decommissioning.

**Table 2-9. Sample Summary; Borehole C9581**

Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS #
1/6/2016	20-22.5	Soil	Split Spoon	B347J6, B347J7, B347J8, B347J9
1/6/2016	22.5-25	Soil	Split Spoon	B347K2, B347K3, B347K4
1/6/2016	25-27.5	Soil	Split Spoon	B347K7, B347K8, B347K9, B347L0, B347L1
1/6/2016	27.5-30	Soil	Split Spoon	B347L3, B347L3, B347L4, B347L5

1/6/2016	30-32.5	Soil	Split Spoon	B347M0,B347M1
1/6/2016	32.5-35	Soil	Split Spoon	B347M3

HEIS = Hanford Environmental Information System  
ft bgs = feet below ground surface

### 2.4.3 C9582

Drilling, sampling, and decommissioning were performed at this site between January 7, 2016 and January 11, 2016. The borehole was drilled from ground surface to a TD of 35 ft bgs. Static water level was measured at 31.4 ft bgs (January 11, 2016).

The borehole was decommissioned on January 11, 2016. Bentonite chips were placed from 35 ft bgs to 4.85 ft bgs. The surface seal was poured from 4.85 ft bgs to ground surface on January 11, 2016. After the seal was poured a brass marker was placed bearing the well ID number and date of decommissioning.

**Table 2-11. Sample Summary; Borehole C9582**

Sample Date	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS #
1/11/2016	20-22.5	Soil	Split Spoon	B347N8 B347N9, B347P0, B347P1
1/11/2016	22.5-25	Soil	Split Spoon	B347P3,B347P4, B347P5B347P6, B347P8
1/11/2016	25-27.5	Soil	Split Spoon	B347P9 B347R0, B347R1, B347R1, B347R2, B347R4, B347R3(Dup)
1/11/2016	27.5-30	Soil	Split Spoon	B347R5, B347R6, B347R7, B347R8
1/11/2016	30-32.5	Soil	Split Spoon	B347T0, B347T1
1/11/2016	32.5-35	Soil	Split Spoon	B347T5, B347T6, B347T7, B347T8, B347T9

HEIS = Hanford Environmental Information System  
ft bgs = feet below ground surface

### 3 Geology

Section 3.1 summarizes the general stratigraphy and depositional setting of the Pasco Basin and Hanford Site, including the 300 Area. Section 3.2 provides detailed descriptions of geologic units encountered in the Stage A enhanced attenuation area. Section 3.3 provides well-specific geologic details encountered during drilling of each borehole.

#### 3.1 Geology of the 300 Area

The 300 Area is located along the southeastern margin of the Hanford Site within the Pasco Basin. The principal stratigraphy of the Hanford Site in ascending age is as follows:

- Holocene surficial deposits
- Pleistocene Hanford formation sediments
- Post-Ringold/Pre-Hanford deposits (Cold Creek unit) (not present under well field)
- Miocene-Pliocene Ringold Formation sediments
- Miocene Columbia River Basalt Group and interbedded Miocene Ellensburg Formation sediments

Holocene surficial deposits in the 300 Area includes a thin veneer of surficial sediments consisting of unconsolidated Holocene aeolian sands and loess, generally less than 16 ft in thickness. Locally, these sediments have been removed from the well field during previous work to install, and later remediate, the north process ponds, trenches and adjacent grounds (PNNL-18340, *Borehole Completion and Conceptual Hydrogeologic Model for the IFRC Well Field, 300 Area, Hanford Site*).

The Hanford formation represents Pleistocene-age cataclysmic flood and inter-flood deposits and can be principally divided into three major facies each deposited in different portions of the Pasco basin (DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for the Post-Ringold-Formation Sediments Within the Central Pasco Basin*). These facies include a gravel-dominated facies, a sand-dominated facies and a fine-grained interbedded sand-and silt-facies. The gravel-dominated facies is deposited throughout the central portion of the Pasco basin roughly following the Columbia River forming several bars to the south of Gable Mountain cross most of the Hanford Site. These gravels were deposited by the highest energy flow paths of the cataclysmic floods. The sand-dominated facies is principally deposited to the south of Gable Mountain extending across the bulk of the Hanford Site to the foot of Rattlesnake Mountain and overlies much of the Hanford gravels, where present, in this area. The sand-dominated facies were deposited by intermediate- to low-flow floodwaters. The fine-grained interbedded sand- and silt-dominated facies is deposited on the margins of the Pasco Basin and were deposited by slack water deposits at the peripheries of the cataclysmic flood channels (DOE/RL-2002-39). The 300 Area lies in the main channel of the flood waters, consequently, only the gravel-dominated facies of the Hanford formation are present in the 300 Area (PNNL-18340). The Hanford gravels in the 300 Area are up to 50 ft thick.

Calcareous sediments of the Cold Creek unit separate the Hanford formation from the Ringold Formation, and represent mainstream alluvial, calcic paleosol, sidestream alluvial, colluvial, and overbank-aeolian environments marginal to the ancestral Columbia River. These sediments are not present at the 300-FF-5 OU, although gravels belonging to the Cold Creek unit are found to the north and west of the OU (WHC-EP-0500, *Geology and Hydrology of the 300 Area and Vicinity, Hanford Site, South Central Washington*).

The Ringold Formation is primarily composed of fluviially-derived sand and gravel. The Ringold Formation, in descending order, consists of the Upper Ringold Unit (primarily gravelly sand), Unit "E" of

the Ringold Formation (primarily sandy gravel), the Ringold Lower Mud (primarily silt and fine sand) and Unit "A" of the Ringold Formation (primarily sandy gravel). The Ringold Formation Unit E underlies the Hanford formation throughout the 300 Area. Two discontinuous mud and silt intervals are reported (WHC-SD-EN-TI-052, *Phase I Hydrogeologic Summary of the 300-FF-5 Operable Unit, 300 Area*) within the Ringold Unit "E" gravels in the 300 Area. These units are potentially important because they may create semi-confined conditions in the 300 Area. Thickness of the Ringold Formation ranges from approximately 95 to 144 ft in the vicinity of the 300 Area (PNNL-18340).

Unit "E" of the Ringold Formation is dominated by clast-supported gravels. It is estimated that Unit "E" has a thickness of 50 to 65 ft. Based on two nearby wells (wells 399-1-16D and 399-1-17C), the contact between the Hanford formation and Unit "E" of the Ringold Formation is located at approximately 40 to 50 ft bgs (DOE/RL-2014-13).

The Ringold Formation Lower Mud Unit sequence underlies the Ringold Formation unit E, and is composed of crudely laminated clay and silt and appears to be continuous across the operable unit. The lower mud sequence is approximately 30 to 40 ft thick. Based on two nearby wells (wells 399-1-16D and 399-1-17C), the Ringold Formation Lower Mud Unit is located at approximately 115 to 120 ft bgs (DOE/RL-2014-13).

Gravels of the Ringold Formation Unit A are not present in the 300 Area (DOE/RL-2014-13).

The Ringold Formation is underlain by flood basalt flows of the Miocene Columbia River Basalt Group. The uppermost basalt unit encountered in the 300 Area is the Ice Harbor Member. The basalt surface dips towards the northwest (i.e., towards the axis of the Cold Creek syncline). Depth to basalt from surface ranges from approximately 193 ft at the western boundary of the 300 Area to approximately 175 ft adjacent to the river (DOE/RL-2014-13).

During this project, only the gravel-dominated unit of the Hanford formation and Ringold Formation Unit E gravels were encountered. Ringold Formation Unit E was not fully penetrated.

### **3.2 Geology of the Stage A Enhanced Attenuation Area**

This section includes detailed lithologic descriptions of units encountered across the Stage A enhanced attenuation area.

Disturbed surface sediments and back fill of the 316-2 North Process Pond and 316-5 300 Area Process Trenches are comprised of Hanford formation sediments. This material is dark gray to very dark gray, matrix to clast supported, very poorly sorted, sandy cobble gravel and clast supported gravel with no apparent fabric. Large boulders are often present throughout the fill material as well. Bedding and grading may be present in fill material as a relic of layering from the back-fill process. Fill in the 316-5 300 Area Process Trenches is present from ground surface to 16 to 18 ft bgs. Fill in the 316-2 North Process Pond extends from ground surface to no greater than 24 ft bgs, and disturbed surface sediments surrounding the trenches and ponds extend from ground surface to approximately 2 ft. The interval consisting of fill material often had very little resistance to drilling and produced very low- to no-recovery due to lack of moisture, and lack of cohesion.

The Hanford formation underlies the Stage A area between 2 ft and 50 ft bgs. It ranges in color from gray to dark grayish brown to black. The sediment is comprised principally of unconsolidated, poorly-sorted, clast-supported, slightly-silty, sandy pebble- to cobble-gravel. Grain size ranges widely from silt to boulders. Bedding, where present, ranges from 4-in. to several feet thick and typically exhibits normal grading with no apparent fabric in core. Beds less than 4 ft thick typically exhibit better overall sorting and better apparent grading than thicker beds. The formation contains abundant, sporadic, very-well-

sorted, open-matrix beds and lenses of nearly 100% basalt. These matrix free beds and lenses range in thickness from a few inches up to 6 ft and are very discontinuous (often, not traceable between boreholes as close as 3 to 4 ft apart). Lithology of the Hanford formation across the well field is prominently comprised of 70 to 99% sub-angular basalt, and 1% to 30% well rounded, intermediate composition porphyritic volcanics, quartzite, and gneiss. Sand composition typically ranges between 85% and 90% mafic medium to very-coarse granules, with 10% to 20% fine to medium quartz-feldspar granules. Silt matrix in the Hanford formation typically does not exceed 15%.

Rip up clasts of silt and gravelly silt are present in abundance throughout the Hanford formation as encountered sporadically throughout the well field. Rip up clasts are typically composed of non- to very-well indurated massive to finely laminated silt, clayey silt, and gravelly silt. The rip up clasts encountered throughout the well field range in size from a few inches up to 4 ft. Rip up clasts are typically colored olive brown to brown. These rip-up clasts are believed to be older than Hanford sediment and removed (ripped up) and transported into the area during deposition of the Hanford formation gravel.

The base of the Hanford formation generally exhibits a relatively continuous bed of very well sorted, normal graded open framework gravel grading from very-fine pebbles to large-cobbles gravel. This open framework gravel generally is found resting atop a sharp contact with silt belonging to the Ringold Formation. Where Ringold silt is not present at the contact, gravels from both units are mixed together over a 2 to 5 ft gradational contact interval.

A silty sand and silt, fine-grained Ringold subunit identified in PNNL-18340 that overlies the Ringold Unit E gravels in the vicinity of the 316-1 South Process Pond was not encountered throughout the Stage A enhanced attenuation well field. Though stratigraphically equivalent, discontinuous sand lenses were encountered in the top few feet of the Ringold Unit E gravels in some of the deep wells associated with this project.

The Ringold Formation Unit E gravel is present across the well field encountered in wells between 37 and 50.5 ft bgs. The Ringold Formation encountered under the Stage A enhanced attenuation well field typically consists of olive-yellow-brown, semi-consolidated- to well-consolidated, well-rounded, matrix-supported, felsic-dominated, sandy gravels and silty sandy gravels, with 6-in. to 2 ft thick discontinuous beds of gravelly-sand and sand. Gravels typically are moderately-well sorted, very well rounded, ranging in size from fine pebbles to large cobbles. Lithology of the Ringold Formation throughout the well field is composed of greater than 60% well rounded, iron stained, quartzite, intermediate composition porphyritic volcanics, gneiss, and granitoids, and less than 40% basalt, andesite, and andesite lapilli tuff. Mafic clasts are typically less rounded and less altered. Sand fractions in gravels and in sand beds are very-fine to medium-grained, composed of 85% to 95% quartz feldspar with 5% to 15% mafic composition with up to 10% gold and silver muscovite mica. Silt fractions in gravels range from 0% to 20% of bulk composition and are typically olive yellow to tan colored and range from non-clayey to moderately clayey with no- to moderate plasticity. Ringold Formation sediments throughout the well field generally have a low to moderate reaction to hydrochloric acid (HCl).

Of particular interest for this project is the intermittent presence of an oxidized zone and a reduced zone encountered below 44 ft bgs within the Ringold Formation in the Stage A enhanced attenuation well field. The oxidized zone ranges in color from faint brown to yellow to bright orange and does not appear to be associated with any particular strata type. The strongest oxidation appears in wells farthest to the east within and proximal to the former 316-2 North Process Pond and is faint to absent in wells to the west of the former pond. The reduced zone is present immediately below the oxidized zone (where present) and ranges in color from faint blue gray to blue green, and also does not appear to be associated with a specific strata type. Furthermore, the boundary between the oxidized and reduced zone (where the

oxidized zone is present) does not appear to be coincident with any particular sediment texture or type and does not appear to be controlled by any particular sediment type or boundaries between sediment types. The oxidized and reduced zones range in thickness from 4-in. to 6 ft or more with anoxic zones extending to the base of the deepest holes penetrated across the well field at 50 ft.

### **3.3 Well-Specific Geology**

This section provides details of lithologic units encountered in each borehole drilled in the Stage A area. Wells are organized by type. For full lithologic descriptions of geology encountered in each borehole, please refer to the borehole logs included in the appendices.

#### **3.3.1 Ten PRZ Wells: Well Specific Geology**

This section summarizes the geology encountered while drilling the 10 PRZ wells. The colors noted in this section were taken from a Munsell Color<sup>3</sup> chart. The borehole logs are provided in Appendix A.

##### **3.3.1.1 C8930 (399-1-69)**

Well C8930 was drilled to a TD of 40.5 ft bgs on June 17, 2015. Only Hanford formation was encountered in this well.

The gravel drill pad was encountered from 0 to 0.4 ft bgs. Disturbed Hanford formation, and possibly fill, was encountered from 0.4 ft to 12 ft bgs comprised of 2.5Y3/2 very dark grayish brown, unconsolidated, poorly-sorted- to very-poorly-sorted, very fine pebbles to boulders up to 250 mm with a sand matrix. Gravels grade from coarse pebbles to boulders from 8 to 12 ft towards the base of the interval.

Hanford formation was encountered in this well from 12 to 40 ft bgs. Sandy gravel was encountered from 12 to 21 ft bgs consisting of 2.5Y3/2 very dark grayish brown colored moderately-well sorted, very-fine- to medium-pebbles with sparse boulders up to 250 mm with fine to very coarse sand of 95% mafic composition. From 21 to 29 ft bgs slightly silty sandy gravel was encountered composed of poorly sorted fine- to coarse-pebbles of with very fine to medium sand and 10 to 15% non-plastic silt colored 2.5Y3/2 very dark grayish brown. From 29 to 30 ft, a 1 ft layer of slightly clayey coatings on open matrix clasts was encountered. Sandy gravel was encountered from 29 to 34 ft bgs composed of bimodal medium pebbles and small cobbles of 80% mafic composition with very fine to very coarse 90% mafic sand colored 5Y4/2 olive gray. From 34.2 to 39 ft bgs sandy gravel was encountered composed of moderately sorted very-fine- to coarse-pebbles of 90% mafic composition with poorly sorted 95% mafic sand. A slight downward fining sequence was noted through this interval. From 39 to 40.5 ft bgs, silty gravel consisting of poorly sorted very fine pebbles to small cobbles of 95% basalt, 5% felsics with a matrix of non-plastic silt colored 2.5Y4/2 dark grayish brown.

Of particular interest in this well is the presence of a 2-in. thick black bed of moderately sorted clayey silty sandy gravel located from 34 to 34.2 ft bgs composed of medium- to very-coarse pebbles of 99% basalt with very fine to very coarse 99% mafic sand colored 2.5Y2.5/1 (black).

##### **3.3.1.2 C8932 (399-1-71)**

Well C8930 was drilled to a TD of 40 ft bgs on June 16, 2015. Only Hanford formation was encountered in this well.

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<sup>3</sup> Munsell Color 2013 is a copyright of X-Rite, Incorporated. All rights reserved.

The gravel drill pad was noted from 0 to 1 ft bgs. Disturbed Hanford formation was encountered from 1 to 3 ft bgs consisting of 5YR3/2 dark reddish brown, poorly sorted sandy gravel ranging in size from fine pebbles to large cobbles.

Hanford formation was encountered in this well from 3 ft to TD of 40 ft bgs. From 3 to 16 ft bgs, 2.5Y4/3 reddish brown sandy gravel was encountered comprised of poorly sorted fine pebbles to small boulders up to 120 mm with a matrix of slightly silty sand of 40% mafic, 60% felsic composition. From 16 to 30 ft bgs, 7.5Y3/1 very dark gray colored, poorly sorted, sandy gravel is present comprised of 60% very fine pebbles to small cobbles of 40% mafic, 60% felsic gravel with a matrix of 30% fine to coarse sand with up to 10% low plastic silt.

At 17 ft bgs, a 6-inch (in) gravelly clay rip up clast was encountered. From 26.5 to 28 ft bgs, a 1.5 ft diameter rip up clast of silty sandy gravel was encountered composed of 40% gravel, 30% fine to medium sand and 30% medium plastic silt. No color was recorded for these rip up clasts.

From 30 to 40 ft bgs, 7.5Y4/1 dark gray colored, sandy gravel was encountered comprised of poorly sorted very-fine pebbles to small-cobbles up to 120 mm of 60% mafic, 40% felsic gravel with a matrix of 20% fine to very coarse sand with up to 10% silt. Of particular note in this well was the lack of a discernible oxic and anoxic zone.

### **3.3.1.3 C8935 (399-1-73)**

Well C8935 was drilled to a TD of 40.5 ft bgs between June 10, 2015 and June 11, 2015. Only Hanford formation was encountered in this well.

The gravel drill pad was encountered at ground surface to 1 ft bgs. Disturbed Hanford formation was encountered from 1 to 5 ft bgs. This material consisted of unconsolidated, 2.5Y4.1 dark gray colored, very poorly sorted, Hanford formation of 80% basalt gravel up to 120 mm in size with 50/50 mafic/felsic sand.

Hanford formation was encountered from 5 ft to TD at 40.5 ft bgs. Poorly sorted, fine pebble- to small cobble, silty sandy gravel colored 2.5Y5/3 brown was encountered from 5 to 16 ft bgs. From 16 to 18.5 ft bgs, gravel of well-rounded, medium- coarse-pebbles of 99% basalt, colored 2.5Y5/1 black was encountered. A 6-in. thick bed of very well sorted silty gravel containing medium- to coarse-pebbles colored 2.5Y3/1 very dark gray was encountered. From 19 to 25 ft, poorly sorted clayey silty sandy gravel colored 2.5Y4/2 dark grayish brown was encountered comprised of very fine to very coarse pebbles with sparse small cobbles. From 25 to 30 ft bgs, dark gray to dark grayish brown, sandy gravel to silty sandy gravel was encountered. From 30 to 31 ft bgs, gravelly silt was encountered containing up to 60% non-plastic 2.5Y2.5/1 black silt with 30% very-fine- to fine-pebbles of 90% basalt. From 31 to 34 ft bgs, moderately sorted fine-pebble to small-cobble silty sandy gravel was encountered. From 34 to 35 ft bgs, Gravel of fine to medium pebbles of 95% basalt was encountered. From 35 to 40 ft bgs, moderately sorted, silty sandy gravel containing very fine pebbles to small cobbles of 70% basalt, with medium to coarse sand of 85% basalt was encountered.

Of particular interest was the pervasive anoxic zone coloration of sediments from 31 to 40 ft bgs colored GLEY1 3/1 very dark greenish gray. Also of note was the notable lack of oxic yellowish orange coloration above the anoxic zone that was observed in other wells.

Another point of interest is that radiological contamination was encountered between 18.5 ft and 30 ft bgs with an 18,000 dpm beta, gamma spike at the 6-in. black clay coated open matrix gravel bed and drops off to 3,000 dpm beta gamma between 19 ft and 20 ft then continues do drop of towards background between 20 ft and 30 ft bgs. It may be possible that the contamination at 18.5 to 19.5 ft may have been confined to

that bed and was dug downward by drilling. It should also be noted that the horizontal extent of the contamination may be localized to a few feet since contamination was not identified in the adjacent borehole 399-1-72 (C8924) located 4 ft to the east.

#### **3.3.1.4 C8939 (399-1-75)**

Well C8939 was drilled to TD of 40.5 ft bgs on June 9, 2015. Only Hanford formation was encountered in this well.

The gravel drill pad was noted from ground surface to 0.15 ft bgs. Fill material of Hanford formation was encountered from 0.15 ft to 14 ft bgs consisting of poorly sorted sandy gravel with clasts ranging from very-fine pebbles to small cobbles of 60% mafic, 40% felsic composition with fine to medium sand matrix colored 2.5Y3/3 gray. The driller noted having to hold back pressure on the drill head to prevent it from nearly free falling through the sediments as a testament to how loose the sediments were through this sediment.

Hanford formation was encountered in this well from 14 ft to the TD of 40.5 ft bgs. From 14 to 35 ft bgs, sandy gravel was encountered composed of 2.5Y3/1 very dark gray, very poorly sorted, very fine pebbles to large cobbles of 60% mafic, 40% felsic composition with fine to coarse sand of 60% mafic, 40% felsic composition. From 35 to 40.5 ft bgs slightly silty sandy gravel was encountered composed of 2.5Y3/1 very dark gray colored, poorly sorted very fine pebbles to large cobbles of composition similar to the above unit. No significant variation in lithology from the accepted description of the Hanford formation was noted at this borehole.

#### **3.3.1.5 C8941 (399-1-77)**

Well C8941 was drilled to a TD of 40.17 ft bgs on June 30, 2015. Only Hanford formation was encountered in this well.

The gravel drill pad was noted from ground surface to 0.1 ft bgs. Fill or disturbed Hanford formation was encountered from 0.1 to 4 ft bgs composed of 2/5Y3/3 dark olive brown colored sandy gravel consisting of poorly sorted very fine pebbles to large cobbles of 60% mafic, 40% felsic composition with medium sand of 60% mafic, 40% felsic composition. Back fill may extend to 16 ft bgs at this location exhibited by the presence of boulders, and the presence of rip up clasts below 16 ft bgs in this well.

Hanford formation was encountered from 4 to TD of 40.17 ft bgs in this well. From 4 to 16 ft bgs, sandy gravel colored 2.5Y3/3 dark olive brown was encountered composed of very poorly sorted very fine pebbles to large cobbles of 60% mafic, 40% felsic composition with 25% and 30% fine to very coarse sand of 60% mafic, 40% felsic composition. From 16 to 21 ft the same gravels coarsen down ward with maximum clasts ranging up to 250 mm diameter boulders. From 21 to 40.17 ft, 2.5Y3/1 very dark gray colored very-poorly sorted sandy gravel was encountered composed of very fine pebbles to boulders ranging up to 250 mm in diameter with up to 30% poorly sorted mafic dominated sand forming the matrix. At 38 ft bgs, a 1.25 ft lens or bed of near open matrix, very well sorted well rounded gravel of small cobbles was noted with up to 15% clayey silt coating clasts. Color was not noted for this sub-unit.

Of particular notice in this well is the presence of abundant rip up clasts. At 25 ft bgs, a 9-in. diameter rip up clast of 80% silt, 20% fine sand colored 2.5Y4/3 olive brown was encountered. At 28 ft bgs, a 6-in. rip up clast colored 2.5Y5/2 grayish brown was encountered composed of 60% fine sand, 30% sub-round gravel.

### **3.3.1.6 C9450 (399-1-79)**

Well C9450 was drilled to a TD of 40 ft bgs on June 18, 2015. Only Hanford formation was encountered in this well.

The gravel drill pad was encountered from ground surface to 0.5 ft bgs. Natural fill or disturbed Hanford formation was present from 0.5 to 17.5 ft bgs composed of 2.5Y6/1 gray to 2.5Y4/2 dark grayish brown colored sandy gravel consisting of moderately sorted very fine pebbles to small cobbles of 60% felsic, 40% mafic composition with very fine coarse sand of 80% felsic, 20% mafic composition.

Hanford formation was encountered from 17.5 ft to the TD of 40 ft bgs. From 17.5 to 23 ft bgs, sandy gravel was encountered comprised of 65% moderately sorted, rounded- to sub-rounded, very-fine-pebbles to small-cobbles with very fine to coarse sand colored 2.5Y4/2 dark grayish brown. From 23 to 30 ft bgs, gravels of the same makeup fine considerably with improved sorting ranging from very fine- to coarse-pebbles with poorly sorted sand colored 2.5Y4/1 dark gray. From 30 to 40 ft bgs, moderately sorted sandy gravel was encountered composed of very fine- to very-coarse-pebbles with poorly sorted sand colored 2.5Y4/1 dark gray. No unique sub-units were noted in this well.

### **3.3.1.7 C9452 (399-1-81)**

Well C9452 was drilled to a TD of 40.7 ft bgs on June 30, 2015. Only Hanford formation was encountered in this well.

The gravel drill pad was noted from ground surface to 1.5 ft bgs. Natural fill and disturbed Hanford formation was encountered from 1.5 to 3 ft bgs, composed of 2.5Y3/3 very dark olive brown sandy gravel consisting of moderately sorted, very fine pebbles to very coarse pebbles of 60% mafic, 40% felsic composition with poorly sorted sand matrix.

Hanford formation was encountered from 3 ft to TD of 40.7 ft bgs. From 3 to 9 ft bgs, poorly sorted sandy gravel was encountered consisting of very fine pebbles to small boulders of 60% mafic, 40% felsic composition with poorly sorted sand of 60% mafic, 40% felsic composition. From 9 to 21 ft bgs, 2.5Y3/1 very dark gray colored, poorly sorted sandy gravel was encountered composed of similar composition to the above interval, but the with maximum gravel size decreasing to large cobbles. From 21 to 40.7 ft bgs, sandy gravel continued from the above intervals but the modal abundance of gravel ranged from very fine to very coarse pebbles, with 20% large cobbles up to 200 mm in diameter. This interval was noted as 2.5Y3/2 dark grayish brown.

Of interest in this unit, at 28 ft bgs, a 1 ft thick bed or lens of nearly open matrix, well sorted, silty gravel was encountered consisting of 85% gravel and 15% silt. No further details were recorded.

### **3.3.1.8 C9454 (399-1-83)**

Well C9454 was drilled to a TD of 39.98 ft bgs on June 24, 2015. Only Hanford formation was encountered in this well.

The gravel drill pad was noted from ground surface to 0.5 ft bgs. From 0.5 to 3.2 ft bgs, silty sand colored 2.5Y3/2 very dark grayish brown was encountered composed of fine to coarse silty sand of 40% mafic, 60% felsic composition with 5% fine pebbles to small cobbles of 70% mafic, 30% felsic composition. Slightly silty sandy gravel was encountered from 3.2 to 17 ft bgs composed of 54% poorly sorted fine pebbles to large cobbles of 50% mafic, 50% felsic composition with 40% fine to coarse sand colored 2.5Y4/1 dark gray. Sand was encountered from 17 to 28 ft bgs consisting of 2.5Y4/3 dark grayish brown colored, 95% fine to medium sand of 60% mafic, 40% felsic composition with trace silt and up to 3% gravel. From 28 to 39.7 ft bgs, poorly sorted sandy gravel was encountered composed of very fine pebbles

to large cobbles of 70% mafic, 40% felsic composition with poorly sorted sand of 60% mafic, 40% felsic composition. This unit was noted as 7.5YR2.5/1 black in color.

An agglomerated rip up clast of 2.5Y5/1 gray colored micaceous, low plastic silt with 30% moderately sorted angular very fine pebbles to small cobbles of 60% mafic, 40% felsic composition and 10% coarse sand of 60% mafic, 40% felsic composition with no reaction to HCl.

Of particular interest is a 1-in. thick pervasively colored oxic band colored 2.5YR3.4 dark reddish brown noted at 36 ft within the sandy gravel unit.

### **3.3.1.9 C9456 (399-1-85)**

Well C9456 was drilled to a TD of 40.5 ft bgs on June 25, 2015. Only Hanford formation was encountered in this well.

The gravel drill pad was noted from ground surface to 1 ft bgs. From 1 to 2.7 ft bgs, slightly silty sandy gravel was encountered composed of 35% moderately sorted medium pebbles to small cobbles of 70% mafic, 30% felsic composition with fine to coarse sand of 60% mafic, 40% felsic composition with up to 15% 2.5Y3/3 dark olive brown colored silt. Sandy gravel was encountered from 2.7 to 17 ft bgs composed of 50% poorly sorted very fine pebble to large cobbles of 65% mafic, 35% felsic composition with poorly sorted sand of 60% mafic, 40% felsic composition colored 2.5Y4/1 dark gray. From 17 to 40.5 ft bgs, slightly silty sandy gravel was encountered consisting of 45% poorly sorted fine pebbles to very coarse pebbles with 2% large cobbles of 60% mafic, 40% felsic composition with well sorted coarse to very coarse of 60% mafic, 40% felsic composition colored 2.5Y3/1 very dark gray. From 34 ft bgs, and 39 ft bgs, two lenses of very well sorted, almost matrix free well- to sub-rounded gravels of coarse to very coarse pebbles was encountered.

Within the above units, at 18 ft bgs is a 2-in. thick horizon of clayey gravel colored 2.5Y6/4 light yellowish brown with a strong reaction to HCl. No other notes were made on this bed. A 6-in. thick lens of silty sandy gravel was encountered composed of 40% gravel, 40% non plastic silt colored 2.5Y6/4 light yellowish brown with 20% very fine sand.

### **3.3.1.10 C9458 (399-1-87)**

Well C9458 was drilled to ground surface to 40 ft bgs on June 23, 2015. Only Hanford formation was encountered in this well.

The gravel drill pad was noted from ground surface to 0.3 feet bgs. Gravelly sand was encountered from 0.3 to 2.8 ft bgs composed of 70% fine to coarse sand of 40% mafic, 60% felsic composition with 20% moderately sorted very fine pebbles to very coarse pebbles of 70% mafic, 30% felsic composition with up to 10% silt colored 2.5Y3/2 very dark grayish brown. from 2.8 to 23 ft bgs, sandy gravel was encountered composed of very poorly sorted very fine pebbles to boulders of 60% mafic, 40% felsic composition with very fine to coarse sand of 40% mafic, 60% felsic composition with 10% silt colored 2.5Y4/1 dark gray. A 1 ft thick silty gravel lens was encountered from 23 to 24 ft composed of 70% moderately sorted medium pebble to small cobble with coarse sand of 80% mafic, 20% felsic composition colored 2.5Y4/1 dark gray. From 24 to 37 ft bgs, sandy gravel was encountered composed of 45% moderately sorted very fine- to coarse-pebbles of 60% mafic, 40% felsic composition with fine to very coarse sand of 50% mafic, 50% felsic composition with 10% silt colored 2.5Y3/1 very dark gray. Silty gravel was encountered from 37 to 40 ft bgs composed of 75% poorly sorted, well rounded, fine pebbles to small cobbles of 70% mafic, 30% felsic composition with 10% coarse sand of 80% mafic, 20% felsic composition with up to 15% silt.

### **3.3.2 Eleven Aquifer Monitoring Wells: Well Specific Geology**

This section summarizes the geology encountered during the drilling of 11 aquifer monitoring wells. The colors noted in this section were taken from a Munsell Color chart. The borehole logs are provided in Appendix B.

#### **3.3.2.1 C9408 (399-1-65)**

Stratigraphic units identified during the drilling of well C9408 include the Hanford formation and Ringold formation.

Well C9408 was drilled from ground surface to a TD of 49.7 ft bgs. The gravel drill pad at this site extends from ground surface to 0.4 ft bgs. Hanford formation sediments were encountered from 0.4 to 40 ft bgs. Sub-rounded, fine pebble to cobble, sandy gravel colored 2.5Y4/1 dark gray was encountered from 0.4 to 30 ft bgs. From 30 to 38 ft bgs, silty sandy gravel of sub-rounded, fine pebbles to cobbles colored 2.5Y4/1 very dark gray was encountered. From 38 to 40 ft bgs, sandy gravel of sub-rounded, fine pebbles to cobbles colored 2.5Y4/1 very dark gray was encountered. Ringold Formation sediments were encountered from 40 to 49.7 ft bgs. Sub-rounded, fine pebble to cobble, sandy gravel colored 10YR6/6 brownish yellow was encountered from 40 to 44.5 ft bgs. From 44.5 to 49.7 ft bgs, medium to very coarse micaceous sand colored 10YR5/3 to 10YR3/2 brown to very dark grayish brown was encountered.

#### **3.3.2.2 C9409 (399-1-66)**

Stratigraphic units identified during the drilling of well C9409 include the Hanford formation and Ringold Formation.

Well C9409 was drilled from ground surface to a TD of 50.5 ft bgs. Hanford formation sediments were encountered below the drill pad from 0.8 to 37.5 ft bgs. Ringold Formation sediments were encountered from 37.5 to 50.5 ft bgs. The gravel drill pad at this site extends from ground surface to 0.8 ft bgs. Poorly sorted, well rounded, fine pebble to small cobble, sandy gravel colored 2.5Y4/2 dark grayish brown was encountered from 0.8 to 13 ft bgs. From 13 to 19 ft bgs, sandy gravel of moderately to poorly sorted, fine pebbles to coarse pebbles colored 2.5Y2.5/1 black was encountered. From 19 to 23 ft bgs, silty sandy gravel of moderately sorted, well rounded, fine pebbles to coarse pebbles colored 2.5Y3/2 very dark grayish brown was encountered. From 23 to 26 ft bgs, silty gravel of well rounded, medium pebbles to small cobbles colored 2.5Y4/3 very dark grayish brown was encountered. From 26 to 29 ft bgs, sandy gravel of moderately to poorly sorted, fine pebbles to large cobbles colored 2.5Y3/2 very dark grayish brown was encountered. Very poorly sorted, sub-rounded to well-rounded, very fine pebbles to small cobbles, 2.5Y4/2 dark grayish brown, slightly silty sandy gravel was encountered from 29 to 34 ft bgs. Sub-rounded to well rounded, very poorly sorted, medium pebble to small cobble, dark olive gray to strong brown sandy gravel was noted from 34 to 43.5 ft bgs. Dark orange to brown iron oxidation color was noted within the sandy gravel layer below 37.5 ft bgs and appears to coincide with a slight increase in silt content. A thin layer of well-rounded, fine to coarse pebble, silty sandy gravel colored 10YR2/1 black was encountered from 43.5 to 44 ft bgs within the sandy gravels. Sediments were composed of 10YR5/8 yellowish brown, moderately sorted, well-rounded, medium to very coarse pebble sandy gravel with medium to very coarse micaceous sand from 44 to TD at 50.5 ft bgs.

#### **3.3.2.3 C8931 (399-1-70)**

Stratigraphic units identified during the drilling of well C8931 include the Hanford formation.

Well C8931 was drilled from ground surface to a TD of 48.9 ft bgs. The gravel drill pad at this site extends from ground surface to 0.75 ft bgs. Hanford formation sediments were encountered from 0.75 to 48.9 ft bgs. Poorly sorted, sub-rounded to sub-angular, fine pebble to cobble, silty sandy gravel colored

5YR3/2 dark reddish brown was encountered from 0.75 to 3 ft bgs. From 3 to 14 ft bgs, silty sandy gravel of poorly sorted, angular to sub-rounded, fine pebbles to cobbles colored 2.5YR4/3 reddish brown was encountered. From 14 to 32 ft bgs, silty sandy gravel of poorly sorted, angular to round, fine pebbles to cobbles colored 7.5YR3/1 very dark gray was encountered. A possible Ringold Formation rip up clast was observed at 17 ft bgs. Rip up clasts consist of micaceous fine grained sand/silt that is approximately 80% felsic. From 32 to 45 ft bgs, silty sandy gravel of poorly sorted, sub-rounded to well-rounded, pebbles to cobbles colored 7.5YR4/1 dark gray was encountered. From 45 to 48.9 ft bgs, silty sandy gravel of sub-angular to sub-rounded, fine pebbles to cobbles colored 7.5YR3/1 very dark gray was encountered. Silt present from 45 to 48.9 ft bgs shows very low plasticity.

#### **3.3.2.4 C8934 (399-1-72)**

Only Hanford formation was encountered in this borehole.

Well C8934 was drilled from ground surface to 48.1 ft bgs. The gravel drill pad at this site extends from ground surface to 0.5 ft bgs. Poorly sorted sandy gravel was encountered from 0.5 to 5 ft bgs comprised of 60% to 70% sub-rounded fine pebbles to small cobbles and 30% to 40% very fine to coarse sand colored 2.5Y4/2 dark grayish brown. From 5 to 15 ft bgs, mafic dominated poorly sorted sandy gravel was encountered composed of 60% very fine pebbles to small cobbles with 30% poorly sorted sand with 10% silt colored 10YR4/3 brown. From 15 to 19 ft bgs a very well sorted, open framework unit of sandy gravel coarsening downward to gravel was encountered comprised of 75% to 85% sub-rounded very fine pebbles gradually grading to coarse pebbles of 95% basalt with 25% to 15% coarse mafic sand. The bottom 6-in. of this coarsening unit is a silty gravel containing up to 25% clayey silt matrix colored 2.5Y3/4 light olive brown. This 6-in. thick unit is laterally equivalent to the silty gravel layer encountered in well C8935 (399-1-73) that contained radiological contamination as high as 18,000 dpm beta/gamma. Radiological contamination was not detected in the silty gravel layer in this borehole. From 19 to 30 ft bgs a well sorted sandy gravel unit was encountered consisting of well-rounded very fine pebbles to coarse pebbles grading to fine to coarse pebbles of 95% basalt with medium to coarse mafic sand matrix colored 2.5Y4/2 dark grayish brown. From 30 to 40 ft bgs, very poorly sorted sandy gravel was encountered composed of very well rounded very fine pebbles to small cobbles of 80% basalt with medium to very coarse mafic sand matrix colored 2.5Y2.5/1 black. From 40 to 48 ft bgs, well sorted mafic dominated sandy gravel was encountered comprised of 57% to 80% very fine pebbles to coarse pebbles with coarse to very coarse mafic sand matrix. From 44 to 48.1 ft bgs, sediments were stained to a pervasive GLEY2 4/1 dark greenish gray color.

#### **3.3.2.5 C8937 (399-1-74)**

Stratigraphic units identified during the drilling of well C8937 include the Hanford formation and Ringold Formation.

Well C8937 was drilled from ground surface to a TD of 50.07 ft bgs. The gravel drill pad at this site extends from ground surface to 0.15 ft bgs. Hanford formation sediments were encountered from 0.15 to 46 ft bgs. Poorly sorted, sub-angular to sub-rounded, fine pebble to cobble, silty sandy gravel colored 2.5Y3/3 dark olive brown was encountered from 0.15 to 14 ft bgs. From 14 to 34 ft bgs, silty sandy gravel of poorly sorted, sub-angular to sub-rounded, fine pebbles to cobbles colored 2.5Y3/1 very dark gray was encountered. At 18 ft bgs a small carbonate lens about 0.05 ft thick colored 2.5Y8/1 white was identified. At 25 ft bgs a gravel lens about 0.9 ft thick consisting of sub-rounded to well-rounded small cobbles was identified. From 34 to 46 ft bgs, silty sandy gravel of moderately sorted, sub-angular, fine pebbles to cobbles colored 2.5Y3/1 very dark gray was encountered. Ringold Formation sediments were encountered from 46 to 50.07 ft bgs. Sub-rounded to well rounded, fine pebble to cobble, silty sandy gravel colored

2.5Y2.5/1 black was encountered from 46 to 50.07 ft bgs. Silt present from 46 to 50.07 ft bgs shows low plasticity.

### **3.3.2.6 C8940 (399-1-76)**

Stratigraphic units identified during the drilling of well C8940 include the Hanford formation and Ringold Formation.

Well C8940 was drilled from ground surface to a TD of 50.85 ft bgs. The gravel drill pad at this site extends from ground surface to 0.25 ft bgs. Hanford formation sediments were encountered from 0.25 to 47 ft bgs. Poorly sorted, sub-rounded, fine pebble to cobble, sandy gravel colored 2.5Y3/3 dark olive brown was encountered from 0.25 to 8.5 ft bgs. From 8.5 to 21 ft bgs, silty sandy gravel of moderately sorted, sub-angular to sub-rounded, fine pebbles to cobbles colored 2.5Y3/1 very dark gray was encountered. From 21 to 47 ft bgs, silty sandy gravel of very poorly sorted, angular to rounded, fine pebbles to cobbles colored 2.5Y3/1 very dark gray was encountered. At 38 ft bgs a silt/sand lens about 2 ft thick colored 2.5Y5/4 light olive brown was identified. Ringold Formation sediments were encountered from 47 to 50.85 ft bgs. Moderately sorted, sub-rounded cobble, silty sandy gravel colored 2.5Y4/3 to 2.5Y2.5/1 olive brown to black was encountered from 47 to 50.85 ft bgs. Color gradient present from 47 to 50.85 ft bgs appears to be a graded contact between an oxidizing/reducing zone.

### **3.3.2.7 C8942 (399-1-78)**

Stratigraphic units identified during the drilling of well C8942 include the Hanford formation and Ringold Formation.

Well C8942 was drilled from ground surface to a TD of 50.3 ft bgs. The gravel drill pad at this site extends from ground surface to 0.5 ft bgs. Hanford formation sediments were encountered from 0.5 to 41 ft bgs. Sub-rounded, pebble to cobble, sandy gravel colored 2.5Y4/2 dark grayish brown was encountered from 0.5 to 18 ft bgs. From 18 to 21 ft bgs, sandy gravel of sub-rounded, pebbles to small cobbles colored 2.5Y4/3 brown was encountered. From 21 to 31 ft bgs, silty gravel of sub-rounded, fine pebbles to coarse pebbles colored 2.5Y4/2 dark grayish brown was encountered. From 31 to 41 ft bgs, sandy gravel of sub-rounded, fine pebbles to cobbles colored 2.5Y4/1 dark gray was encountered. Ringold Formation sediments were encountered from 41 to 50.3 ft bgs, Low plasticity mud colored 2.5Y3/1 very dark gray was encountered from 41 to 46 ft bgs. From 46 to 50.3 ft bgs, sandy gravel of sub-rounded to rounded, fine pebbles to coarse pebbles colored 2.5Y2.5/1 black was encountered.

### **3.3.2.8 C9451 (399-1-80)**

Stratigraphic units identified during the drilling of well C9451 include the Hanford formation and Ringold Formation.

Well C9451 was drilled from ground surface to a TD of 50.5 ft bgs. The gravel drill pad at this site extends from ground surface to 0.5 ft bgs. Hanford formation sediments were encountered from 0.5 to 50.5 ft bgs. Poorly to moderately sorted, sub-angular to sub-rounded, pebble to cobble, sandy gravel colored 2.5Y3/3 dark olive brown was encountered from 0.5 to 9.8 ft bgs. From 9.8 to 29 ft bgs, silty sandy gravel of poorly sorted, sub-angular to sub-rounded, fine pebbles to coarse cobbles colored 2.5Y3/1 very dark gray was encountered. From 29 to 50.5 ft bgs, silty gravel of angular to rounded, fine pebbles to coarse cobbles colored 2.5Y3/2 brownish black was encountered. Ringold Formation rip up sediments were encountered from 41 to 49 ft bgs. Rip up sediments consists of poorly sorted, sub-angular pebbles to cobbles colored 2.5Y5/6 light olive brown. At 48.5 ft bgs the sediment changed color from 2.5Y5/6 light olive brown to 2.5Y2.5/1 black.

### **3.3.2.9 C9453 (399-1-82)**

Stratigraphic units identified during the drilling of well C9453 include the Hanford formation and Ringold Formation.

Well C9453 was drilled from ground surface to a TD of 51 ft bgs. The gravel drill pad at this site extends from ground surface to 0.2 ft bgs. Hanford formation sediments were encountered from 0.2 to 40.5 ft bgs. Moderately sorted, rounded, pebble, silty sand colored 10YR4/3 brown was encountered from 0.2 to 3 ft bgs. From 3 to 18.2 ft bgs, sandy gravel of moderately sorted, sub-rounded to rounded, cobbles colored 5Y6/1 gray was encountered. From 18.2 to 19.8 ft bgs, well sorted, medium grain sand colored 2.5Y6/1 gray was encountered. From 19.8 to 28.5 ft bgs, sandy gravel of moderately sorted, sub-rounded to well rounded, cobbles colored 2.5Y6/1 gray was encountered. From 28.5 to 40.5 ft bgs, sandy gravel of poorly sorted, sub-rounded to well-rounded cobbles colored 2.5Y5/1 gray was encountered. Ringold Formation sediments were encountered from 40.5 to 51 ft bgs. Moderately sorted, sub-rounded to well rounded, coarse pebble, gravelly silty sand colored 2.5Y6/6 olive yellow was encountered from 40.5 to 41.7 ft bgs. From 41.7 to 51 ft bgs, sandy gravel of well sorted, sub-rounded to well-rounded, fine cobbles colored GLEY2 4/1 dark bluish gray was encountered. Organic material was identified at 44.5 ft bgs. A sand lens was present from 47 to 49 ft bgs.

### **3.3.2.10 C9455 (399-1-84)**

Stratigraphic units identified during the drilling of well C9455 include the Hanford formation and Ringold Formation.

Well C9455 was drilled from ground surface to a TD of 60 ft bgs. The gravel drill pad at this site extends from ground surface to 0.9 ft bgs. Hanford formation sediments were encountered from 0.9 to 40 ft bgs. Sub-angular to sub-rounded, pebble to cobble, silty sandy gravel colored 2.5Y3/3 dark olive brown was encountered from 0.9 to 4 ft bgs. From 4 to 16 ft bgs, silty sandy gravel of poorly sorted, sub-angular to sub-rounded, fine pebbles to cobbles colored 2.5Y3/1 very dark gray was encountered. From 16 to 39 ft bgs, silty sandy gravel of angular to sub-rounded, fine pebbles to cobbles colored 2.5Y3/1 very dark gray was encountered. At 18 ft bgs a carbonate lens about 0.1 ft thick colored 2.5Y8/1 white was identified. Light yellowish brown 2.5Y6/3 clay surrounds gravel clasts from 29 to 29.5 ft bgs. From 39 to 40 ft bgs, gravel of sub-rounded pebbles colored 2.5Y3/1 very dark gray was encountered. Ringold Formation sediments were encountered from 40 to 60 ft bgs. Sub-angular, coarse pebble, silty gravel was encountered from 40 to 41 ft bgs. From 41 to 46 ft bgs, 2.5Y2.5/1 black mud was encountered. Organic material was identified at 43 ft and 45 ft bgs. From 46 to 53 ft bgs, silty sandy gravel of sub-rounded, fine pebbles to cobbles colored 2.5Y2.5/1 black was encountered. From 53 to 58 ft bgs, silty sand of well sorted, sub-rounded, very fine to fine grains colored GLEY1 3/1 very dark gray was encountered. Sub-angular to sub-rounded, poorly sorted, fine pebble to cobble, silty sandy gravel colored 2.5Y2.5/1 black was encountered from 58 to 60 ft bgs.

### **3.3.2.11 C9457 (399-1-86)**

Stratigraphic units identified during the drilling of well C9457 include the Hanford formation and Ringold Formation.

Well C9457 was drilled from ground surface to a TD of 50.1 ft bgs. The gravel drill pad at this site extends from ground surface to 0.25 ft bgs. Hanford formation sediments were encountered from 0.25 to 41 ft bgs. Sub-angular to sub-rounded, fine pebble to coarse pebble, silty sandy gravel colored 2.5Y3/2 very dark grayish brown was encountered from 0.25 to 3.3 ft bgs. From 3.3 to 22 ft bgs, silty sandy gravel of poorly sorted, angular to sub-rounded, fine pebbles to small boulder colored 2.5Y3/1 very dark gray was encountered. Ringold Formation rip up sediments were encountered from 22 to 25 ft bgs. Rip up

sediments consists of mud with low to no plasticity. From 25 to 32 ft bgs, silty sandy gravel of sub-angular to sub-rounded, fine pebbles to cobbles colored 2.5Y3/1 very dark gray was encountered. From 32 to 41 ft bgs, silty sandy gravel of sub-rounded to well-rounded, fine pebbles to cobbles colored 2.5Y3/1 very dark gray was encountered. Ringold Formation sediments were encountered from 41 to 50.1 ft bgs. Poorly sorted, sub-rounded to well-rounded, fine pebbles to cobbles colored 2.5Y4/3 olive brown was encountered from 41 to 49 ft bgs. From 49 to 50.1 ft bgs, silty sandy gravel of sub-rounded to well-rounded, fine pebbles to cobbles colored 2.5Y5/1 black was encountered.

### **3.3.3 Nine Injection Wells: Well Specific Geology**

This section summarizes the geology encountered while drilling the nine injection wells. The colors noted in this section were taken from a Munsell Color chart. The borehole logs are provided in Appendix C.

#### **3.3.3.1 C9460 (399-1-89)**

Well C9460 was drilled from ground surface to a TD of 50.5 ft bgs. Hanford formation and Ringold Formation were encountered in this borehole.

The gravel drill pad was noted from ground surface to 0.25 ft bgs. From 0.25 to 2 ft bgs, disturbed Hanford formation gravels and poorly developed slightly humusy gravelly soil was encountered colored very dark grayish brown 2.5Y3/2.

The Hanford formation was encountered from 2 to 42 ft bgs, characterized by the presence of mafic-dominated sandy gravels and slightly sandy gravels. From 2 to 21 ft bgs, poorly sorted sandy gravel was encountered composed of 60% grading to 55% very fine pebbles to large cobbles with 30% to 40% poorly sorted sand matrix colored very dark gray 2.3Y3/1. From 21 to 38 ft bgs, moderately poor sorted slightly silty sandy gravel was encountered composed of 65% very fine pebbles to small cobbles with 20% poorly sorted sand with up to 15% low plastic silt. A silt lens, colored 10YR6/3 pale brown, appeared in the gravel from 21 to 21.8 ft bgs. From 38 to 42 ft bgs, slightly silty gravelly sand was encountered composed of 60% mafic-dominated coarse sand with 25% well-sorted small cobbles with silt colored 5YR3/1 very dark gray.

Ringold Formation was encountered between 42 ft bgs to TD at 50.5 ft bgs, characterized by felsic-dominated silty sandy gravel. At 42 ft bgs a sharp contact was encountered. From 42 to 50.5 ft bgs, moderately well-sorted silty sandy gravel was encountered composed of 50% to 60% well rounded felsic dominated very fine pebbles to small cobbles with 20% to 30% felsic-dominated fine to medium grained silty sand of moderate plasticity.

An oxic zone pervasively colored 5YR4/2 dark reddish gray was encountered from 42 to 48 ft bgs with a sharp change in color at 48 ft to a pervasive GLEY1 3/1 very dark grey extending to TD.

#### **3.3.3.2 C9461 (399-1-90)**

Well C9461 was drilled from ground surface to 51.03 ft bgs. In this borehole, Hanford formation was encountered from ground surface to 44 ft bgs. Ringold extends from 44 ft bgs to TD in this borehole.

The gravel drill pad was encountered from ground surface to 0.25 ft bgs. Disturbed Hanford formation was encountered from 0.25 ft to 4 ft bgs consisting of poorly sorted gravelly sand composed of 80% mafic dominated medium to coarse sand with 20% poorly sorted mafic dominated very fine pebbles to small cobbles. This interval appeared to gradually grade to the underlying strata.

Hanford formation was encountered from 4 to 44 ft bgs. From 4 to 44 ft bgs, very poorly sorted mafic dominated slightly silty sandy gravel was encountered composed of 45% to 50% very fine pebbles to large cobbles up to 200 mm with 35% to 40% mafic dominated poorly sorted silty sand matrix colored

2.5Y3/1 gray to 2.5Y3/1 very dark gray. Within this unit, at 22 ft bgs, a 1 ft thick lens or bed of well sorted silty gravel with small cobbles was encountered. At 26 ft and at 28 ft bgs, 1-in. thick silt lenses were encountered colored olive brown 2.5Y5/6

From 44 ft to the TD of 51.03 ft bgs there was a notable change from mafic dominated material to felsic dominated material. The silty sandy gravel in the lower portion of the borehole was composed of fine to medium grained sand and poorly sorted, sub-rounded gravels.

An anoxic zone pervasively colored GLEY1 3/2 very dark grayish green was encountered from 44 ft to TD of 51.03 ft bgs with patchy colorations of 2.5Y5.1 black.

### **3.3.3.3 C9462 (399-1-91)**

Well C9462 was drilled to a TD of 50.17 ft bgs. Only Hanford formation was encountered in this borehole.

The gravel drill pad was encountered at ground surface to 0.2 ft bgs. Disturbed Hanford formation was encountered from 0.2 to 4 ft consisting of sandy gravel composed of 80% moderately well sorted mafic, medium pebbles to very coarse pebbles with 20% mafic dominated poorly sorted sand colored 2.5Y3/2 dark olive brown.

From 4 ft to 31 ft bgs, very poorly sorted sandy gravel was encountered composed of mafic dominated 60% fine pebbles to boulders up to 260 mm with 30% mafic dominated poorly sorted sand colored 2.5Y3/1 very dark gray. From 31 to 50.17 ft bgs, moderately poor sorted slightly silty sandy gravel was encountered composed of mafic dominated very fine pebbles to large cobbles with very poorly sorted mafic dominated silty sand colored very dark grayish brown similar to above. Angularity in this unit appeared to increase in roundness with size. From 33 to 35 ft bgs, a large Ringold Formation rip up clast of 80% mica-rich 2.5Y5/4 light olive brown silt with 20% very fine sand was encountered. No oxic or anoxic zone colorations were identified in this borehole.

### **3.3.3.4 C9463 (399-1-92)**

Well C9463 was drilled to a TD of 49.55 ft bgs. Only Hanford formation was encountered in this borehole.

The drill pad was encountered from ground surface to 0.5 ft bgs. From 0.5 ft to 3.2 ft bgs well sorted aeolian sand was encountered colored 2.5Y3/3 dark olive brown. From 3.2 to 49.55 ft bgs the borehole consisted of Hanford formation composed of mafic dominated silts, sands, and gravels colored 2.5Y3/1 very dark gray. There were three silty gravel lenses encountered in this borehole at 28 ft bgs, 38 ft bgs, and 44 ft bgs. The lenses were composed of well-rounded gravels and silt.

### **3.3.3.5 C9464 (399-1-93)**

Well C9464 was drilled from ground surface to a TD of 50.5 ft bgs. Only Hanford formation was encountered in this borehole.

The drill pad was encountered from ground surface to 0.5 ft bgs. From 0.5 to 3.5 ft bgs, well sorted micaceous, aeolian sand was encountered colored brown 10YR4/3. From 3.5 to 16 ft bgs downward coarsening, moderately to very poorly sorted silty sandy gravel was encountered composed of mostly mafic 60% very fine pebbles to large cobbles grading to boulders with a matrix of silty non-plastic mafic dominated, poorly sorted sand colored 2.5Y3/2 very dark grayish brown. From 16 to 35 ft bgs, moderately sorted sandy gravel was encountered composed of mafic dominated 70% very fine pebbles to small cobbles with 20% poorly sorted mafic sand colored similar to above. A very large rip up clast was encountered from 29.5 to 36 ft bgs composed of 100% moderately plastic silt mottled light yellowish

brown and dark grayish brown 2.5Y6/3 and 2.5Y3/2 respectively. A bed of silty gravel was encountered below the rip up clast from 36 to 38 ft bgs composed of 78% poorly sorted fine pebbles to small cobbles of 30% basalt, 70% felsic quartz and intermediate volcanics with 20% very clayey matrix colored 2.5Y4/1 dark gray. From 38 to 47 ft bgs moderately slightly silty sandy gravel was encountered composed of 75% mafic dominated very fine to very coarse pebbles with 15% poorly sorted mafic sand and 15% very plastic silt colored 3.5Y4/1 dark grayish brown.

A second clay lens or rip up clast was encountered in this borehole from 47 ft to the TD of 50.5 ft bgs colored 2.5Y5/3 light olive brown.

### **3.3.3.6 C9465 (399-1-94)**

Well C9465 was drilled to a TD of 50.17 ft bgs. Aeolian sand, Hanford formation, and Ringold Formation were encountered in this borehole. Well sorted, medium grained aeolian sand 2.5Y3/3 dark olive brown was encountered from ground surface to 3.6 ft bgs. At 3.6 ft bgs the sand graded into the underlying Hanford formation

Hanford formation was encountered from 3.6 ft to 43 ft bgs. From 3.6 to 14 ft, moderately poor sorted mafic dominated sandy gravel was encountered composed of 60% fine pebbles to large cobbles with 30% poorly sorted silty sand matrix colored 2.5Y3/1 dark gray. From 14 to 43 ft bgs, moderately poor sorted mafic dominated slightly silty sandy gravel was encountered composed of 55% very fine pebbles to large cobbles with 30% poorly sorted silty sand and 15% silt colored 2.5Y3/1 very dark gray. The Hanford formation has a sharp contact with the underlying Ringold Formation

Ringold Formation was encountered from 43 ft to TD of 50.17 ft bgs in this borehole. This unit was easily differentiated from the overlying Hanford formation by its high felsic sand and distinct color change. This unit is composed of moderately poor sorted slightly silty sandy gravel consisting of 55% well rounded very fine pebbles to small cobbles of 50% mafic, 50% felsic composition with 30% felsic dominated fine to medium sand with low plastic silt. At 57 ft bgs, a 1-in. thick well sorted medium grained sand lens was encountered colored 5YR4/6 yellowish red. This bed exhibits strong oxidation with a gradual transition below 47 ft bgs to an anoxic zone pervasively colored GLEY1 2.5/10Y greenish black.

### **3.3.3.7 C9466 (399-1-95)**

Well C9466 was drilled to 50.5 ft bgs. Hanford formation and Ringold Formation were encountered in this borehole.

Hanford formation was characterized by predominantly mafic silts, sands, and gravels. The drill pad was noted from ground surface to 0.5 ft bgs. The Hanford formation was observed from 0.5 to 39 ft bgs. At 18 ft bgs, a 1 ft thick rip up clast was encountered composed of 2.5Y6/2 yellowish brown colored silty sandy gravels with a very strong reaction to HCl. At 18 ft bgs, a 1 ft thick bed of well sorted, sandy gravel of well-rounded mafic fine to very coarse-pebbles was encountered. At 38 ft bgs, a 1 ft thick lens or bed of well sorted open matrix mafic pebble gravel was encountered. This bed was encountered resting above a sharp contact with underlying Ringold Formation gravels.

Ringold Formation was encountered from 39 to TD of 50.5 ft bgs. This unit was easily differentiated from the Hanford formation by its greater felsic composition, lighter olive yellow color, and more rounded gravels. From 39 to 44 ft bgs, moderately well sorted sandy gravel was encountered composed of 75% very well rounded medium to coarse pebbles of 70% felsic composition with 30% fine to medium felsic sand matrix colored 2.5YR5/1 gray. From 44 to 50.5 ft bgs, moderately sorted slightly silty sandy gravel was encountered composed of 70% very well rounded medium pebbles to small cobbles of 70% felsic

composition with 15% very fine to medium felsic sand and 15% clayey silt colored 10YR6/3 light yellowish brown.

Of particular interest in this borehole was an oxic zone of pervasive 10YR6/8 brownish yellow coloration with decreasing color intensity with depth from 46 to 49 ft bgs with a sharp transition to an anoxic zone at 49 ft with a pervasive coloration of GLEY2 5/1 bluish gray extending to the base of the borehole.

### **3.3.3.8 C9467 (399-1-96)**

Well C9467 was drilled to 50 ft bgs. Hanford formation and Ringold Formation were encountered in this borehole.

Hanford formation was encountered from 3 ft bgs to 44.5 ft bgs. The drill pad was noted from ground surface to 0.5 ft bgs. Disturbed Hanford formation and reworked poorly developed soil was encountered from 0.5 to 3 ft bgs composed of very poorly sorted silty sandy gravel comprised of 40% mafic dominated fine pebbles to small cobbles with poorly sorted silty sand matrix colored 2.5Y5/1 light olive brown. Sandy gravel was encountered from 3 to 13 ft bgs, consisting of 2.5Y5/1 light olive brown, poorly sorted, sub-rounded to rounded cobbles and fine to coarse grained sand. From 13 to 22 ft bgs, moderately poor sorted mafic dominated silty sandy gravel was encountered composed of 50% very fine pebbles to small cobbles with poorly sorted sand matrix colored similar to above. From 22 to 31 ft bgs mafic dominated gravelly sand was encountered composed of 60% poorly sorted sand with 30% very fine pebbles to large cobbles. From 31 to 35 ft bgs, gravelly sand was encountered composed of 60% mafic dominated poorly sorted sand with very fine to fine pebbles colored 2.5Y4/1 dark gray. From 35 to 40 ft bgs, a very well sorted gravel unit of small cobbles was encountered. From 40 to 42 ft bgs, sandy gravel was encountered composed of well sorted normal graded sandy gravel composed of 60% fine- to medium pebbles with 5% clayey silt coating the clasts. This bed rests above a sharp contact with the underlying sandy gravel. From 42 to 44.5 ft bgs, poorly sorted mafic gravelly sand similar, to above units, was encountered.

A rip up clast of very fine felsic sandy silt was encountered from 28 to 30.5 ft bgs.

Ringold Formation was encountered in this borehole from 44.5 ft bgs to the TD of 50 ft bgs. From 44.5 to 48 ft bgs, moderately poor sorted quartz felsic dominated silty sandy gravel was encountered composed of very fine pebbles to small cobbles with 30% micaceous fine sand with 30% slightly clayey silt. From 48 ft to TD of 50 ft bgs, 100% sand was encountered composed of 80% medium felsic sand colored 2.5Y5/4 light olive brown.

An anoxic zone of pervasive GLEY2 3/1 very dark bluish gray coloration was encountered from 44.5 to 48 ft bgs. No orange oxic zone was discernible above the anoxic zone in this borehole.

### **3.3.3.9 C9468 (399-1-97)**

Well C9468 was drilled to 50 ft bgs. Hanford formation and Ringold Formation were encountered in this borehole.

Hanford formation was encountered from ground surface to 39.5 ft bgs. The gravel drill pad was noted from ground surface to 0.5 ft bgs. From 0.5 to 16 ft bgs, unconsolidated, poorly sorted sandy gravel typical of Hanford formation was encountered composed of 50% gravel and 40% sand with up to 10% colored 2.5Y3/2 very dark grayish brown. This unit graded to underlying units. From 16 to 39.5 ft bgs, very poorly sorted, mafic dominated slightly silty sandy gravel was encountered composed of 50% very fine pebbles to large cobbles with 35% poorly sorted sand and up to 15% silt colored 2.5Y3/2 very dark grayish brown. Within this unit at 25 ft bgs, 3-in. thick very well sorted open matrix gravel lens or bed of coarse pebbles was encountered.

Ringold Formation was encountered from 39.5 ft to the borehole TD of 50 ft bgs. From 39.5 to 44.8 ft bgs, felsic-dominated, moderately well sorted gravelly sand was encountered composed of 60% well sorted medium sand of 80% quartz-feldspar with 30% very fine- to coarse-pebble gravel with 10% silt colored 10YR6/3 pale brown. From 44.8 to 50 ft bgs, well sorted slightly silty gravelly sand was encountered composed of 60% felsic dominated well sorted, micaceous medium sand with 25% very-fine- to very coarse pebbles with 15% silt.

A zone of pervasive 2.5Y2.5/1 black coloration was encountered from 48 ft to the TD of 50 ft bgs in this borehole. Carbonized wood chips about 100 mm long by 50 mm wide were encountered in the anoxic zone in the lower 2 ft of this borehole. The color changed from 10YR6/3 pale brown to 2.5Y2.5/1 black. In addition to the color change at 44.8 ft bgs, there was wood in the sediments at approximately 48 ft bgs.

### **3.3.4 Three Post-Injection Characterization Boreholes: Borehole Specific Geology**

This section summarizes the geology encountered while drilling the three post-injection characterization boreholes. The colors noted in this section were taken from a Munsell Color chart. The borehole logs are provided in Appendix D.

#### **3.3.4.1 C9580**

Borehole C9580 was drilled to a TD of 35 ft bgs on January 5, 2016. Only Hanford formation was encountered in this borehole.

Backfill was encountered from ground surface to 5 ft bgs comprised of 10YR3/2 very dark grayish brown, sandy gravel. The sand was very fine to very coarse grained, was very poorly sorted, and was sub-angular to angular. The gravels ranged from small pebbles to small cobbles with a maximum size of 90 mm, and were highly mafic.

Hanford formation was encountered from 5 ft bgs to the total depth of 35 ft bgs. From 5 ft bgs to 10 ft bgs there was sandy gravel. The sand and gravel was mafic dominated, very poorly sorted to poorly sorted. The size range of the sand was fine to very coarse grained, the gravel ranged from 2 mm to 110 mm. At 10 ft bgs there was a 3 ft thick gravelly sand bed. From 13 ft bgs to 32.5 ft bgs there was Hanford gravels. The gravels were poorly sorted and ranged in size from 2 mm to 110 mm and were generally sub-rounded to sub-angular. The overall color noted for this section of the borehole was 5Y5/1 gray. Of note in the section was a silt lens located at 16 ft bgs. The lens was 1 ft thick and was 10YR4/4 dark yellowish brown. The final section of this borehole, from 32.5 ft bgs to 35 ft bgs, was composed of silty gravel.. The maximum size of the gravel was 150 mm, and the color for this segment of the borehole was 2.5Y4/1 very dark gray.

#### **3.3.4.2 C9581**

Borehole C9581 was drilled to a TD of 35 ft bgs on January 6, 2016. Only Hanford formation was encountered in this borehole.

Backfill was encountered from ground surface to 6 ft bgs comprised of 10YR4/2 dark grayish brown, unconsolidated, moderately sorted gravels up to 75 mm in size, with a sand matrix.

Hanford formation was encountered from 6 ft bgs to the total depth of 35 ft bgs. From 6 ft bgs to 19 ft bgs the Hanford formation was characterized by mafic-dominated sandy gravels. The overall color for this section of the borehole was 10YR3/1 very dark gray. There was no notable reaction to HCl in the field, however this could have been due to the low ambient air temperatures. From 19 to 20 ft bgs there was a silty gravel lens. From 20 ft bgs to total depth of 35 ft bgs there was Hanford gravels. The gravels were

poorly sorted and ranged in size from 2 mm to 150 mm and were generally sub-rounded to sub-angular. The overall color noted for this section of the borehole was 2.5Y3/1 very dark gray.

#### **3.3.4.3 C9582**

Borehole C9582 was drilled to a TD of 35 ft bgs between January 6, 2016 and January 11, 2016. Only Hanford formation was encountered in this borehole.

Backfill was encountered from ground surface to 12 ft bgs comprised of 10YR3/2 very dark grayish brown, sandy gravel. The sand was very fine to very coarse grained and was very poorly sorted sub rounded to angular. The gravels ranged from small pebble to small cobble with a maximum size of 140 mm, and were highly mafic.

Hanford formation was encountered from 12 ft bgs to the total depth of 35 ft bgs. From 12 ft bgs to 19 ft bgs there was gravel. The gravel was mafic-dominated and very poorly sorted. The size of the gravel ranged from 2 mm to 160 mm. From 19 to 22 ft bgs there was 3 ft of silty gravel, with trace amounts of very fine to fine grained sand. From 22 to 35 ft bgs there was Hanford gravels. The gravels were poorly sorted, ranged in size from 20 mm to 120 mm, and were generally sub-rounded to angular. The overall color noted for this section of the borehole was 2.5Y3/2 very dark grayish brown. Of note in the section was a silt lens located at 16 ft bgs. The lens was 1 ft thick and was 10YR4/4 dark yellowish brown. The final section of this borehole, from 32.5 to 35 ft bgs, was composed of silty gravel. The maximum size of the gravel was 150 mm and the color for this segment of the borehole was 2.5Y3/2 very dark grayish brown.

## 4 Waste Management

Waste created during the drilling of the 33 boreholes was managed in accordance with DOE/RL-2000-56, *Waste Management Plan for the 300-FF-5 Operable Unit*, and was characterized to the extent necessary to meet the requirements of DOE/RL-2011-41, *Hanford Site Strategy for Management of Investigation Derived Waste*. Investigation derived waste generated throughout the scope of this project included cuttings from both the vadose zone and groundwater saturated zone, purgewater and miscellaneous solid waste such as sampling equipment, plastic, paper, and personal protective equipment.

### 4.1 Drill Cuttings

All drilling cuttings from both the vadose zone and groundwater saturated zone was collect in a tip dumpster and transferred to a ROLL-OFF bin located on site. Two ROLL-OFF bins were used over the course of this project. In addition to drill cuttings, miscellaneous solid waste was also disposed of in the ROLL-OFF bins. This waste was disposed of at the Environmental Restoration Disposal Facility.

### 4.2 Purgewater

Purgewater was collected during well development in accordance with DOE/RL-2009-39, *Investigation-Derived Waste Purgewater Management Action Memorandum*, and DOE/RL-2009-80, *Investigation Derived Waste Purgewater Management Work Plan*. Purge water was transferred directly from the wells to purgewater trucks. Purge water trucks transported and disposed all purge water generated throughout the scope of this project to the Modular tanks facility on site.

## 5 Civil Survey

The well locations were surveyed in accordance with CHPRC procedure SGRP-PRO-SMP-52857 (GRP-EE-01-1.6), *Survey Requirements and Techniques*, on August 10, 2015. Vertical survey data were recorded using *North American Vertical Datum of 1988* (NAVD88) and the horizontal coordinates were recorded using the Washington State Plane (South Zone) *North American Datum of 1983* (NAD83), with the 1991 adjustment for horizontal coordinates. Surveyed locations of the boreholes are presented in Table 5-1, and the reports are located in the Appendices.

**Table 5-1. Civil Survey Summary**

Well ID Number	Well Name	Northing <sup>a</sup> (m)	Easting <sup>a</sup> (m)	Top of Well Vault Elevation <sup>b</sup> (m)
<b>PRZ Monitoring Wells</b>				
C8930	399-1-69	116505.03	594169.73	114.54
C8932	399-1-71	116508.84	594126.33	114.74
C8935	399-1-73	116494.22	594081.69	114.78
C8939	399-1-75	116475.62	594098.69	114.82
C8941	399-1-77	116460.56	594118.72	115.07
C9450	399-1-79	116463.09	594154.88	114.78
C9452	399-1-81	116454.92	594090.90	114.89
C9454	399-1-83	116427.40	594152.48	114.94
C9456	399-1-85	116451.42	594175.50	114.80
C9458	399-1-87	116478.80	594138.62	114.85
<b>Aquifer Monitoring Wells</b>				
C8931	399-1-70	116508.83	594125.04	114.74
C8934	399-1-72	116494.16	594080.16	114.82
C8937	399-1-74	116475.26	594097.65	114.82
C8940	399-1-76	116460.62	594117.79	115.16
C8942	399-1-78	116463.17	594153.70	114.76
C9408	399-1-65	116481.19	594164.48	114.62
C9409	399-1-66	116504.97	594168.41	114.51
C9451	399-1-80	116454.78	594089.52	114.88
C9453	399-1-82	116427.47	594151.78	114.94
C9455	399-1-84	116451.41	594174.47	114.84
C9457	399-1-86	116478.66	594137.74	114.87

**Table 5-1. Civil Survey Summary**

<b>Well ID Number</b>	<b>Well Name</b>	<b>Northing<sup>a</sup> (m)</b>	<b>Easting<sup>a</sup> (m)</b>	<b>Top of Well Vault Elevation<sup>b</sup> (m)</b>
<b>Injection Wells</b>				
C9460	399-1-89	116467.59	594087.17	114.70
C9461	399-1-90	116478.21	594102.77	114.81
C9462	399-1-91	116489.07	594118.24	114.87
C9463	399-1-92	116466.66	594132.82	114.94
C9464	399-1-93	116470.77	594116.97	114.91
C9465	399-1-94	116479.65	594130.8	114.88
C9466	399-1-95	116488.32	594143.85	114.77
C9467	399-1-96	116473.85	594146.20	114.67
C9468	399-1-97	116480.09	594157.77	114.55
<b>Characterization Boreholes</b>				
C9580	N/A	116456.38	594088.67	114.89
C9581	N/A	116462.13	594116.78	115.06
C9582	N/A	116484.01	594161.09	114.59

a. Northing and easting coordinates are based on Washington State Plane Coordinates *North American Datum of 1983* (NAD83).  
 b. *North American Vertical Datum of 1988* (NAVD88) values rounded to 0.01 m. The elevation readings for the characterization boreholes were surveyed from the brass cap after decommissioning.  
 PRZ = periodically rewetted zone

## **6 Well Acceptance**

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

Representatives from CHPRC and Holt Services Inc. (drilling contractor) participated in the acceptance inspection of all 30 wells on August 12, 2015 and of the 3 characterization boreholes on January 23, 2016. Final well acceptance was documented by completion of a checklist and signatures from representatives of the drilling contractor and CHPRC. A Quality Assurance Work Site Assessment will be prepared to document well acceptance.

## 7 References

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SGRP-PRO-OP-50024 (GRP-EE-01-6.3), *Well Development and Testing*

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## Distribution

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## **Appendix A**

### **Well Documentation for PRZ Monitoring Wells**

- Well Summary Sheet
- Borehole Log
- Final Survey Report

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BOREHOLE LOG					Page 1 of 2
Well ID: C9930		Well Name: 399-1-67		Location: 300 Area. N. Process Ponds	
Project: 300 Area U Segregation Remedial Action			Reference Measuring Point: Ground Surface.		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0.0-0.4 : Gravel Pad.	Sonic w/ 5" core barrel (cb.)
0.4-1.2				Sandy Gravel sG. (75-70%G, 25-30%S, <5%M)	
				mod. pr. srt'd. v.f. ph. to v.c. pbl. grading to v. pr. srt'd. c. pbl. - bldr.	
				of 75% bslt./5% felsic Meta. > int. Volc. max: 20mm grading to 250mm	no Recovery
5	9.3	80%		w/ v.f.-v.c. sub-ang. S. of 90% Meta/2% felsic comp. v. unconsolidated.	
				Prob. Fill. 2.5Y 3/4 v. drk. grayish brown slightly moist.	5' g.s.
				wk. rxn. w/ HCl.	
10				8' : gravel coarsen. srt'd. v. pr. srt'd. sub-rnd. - v.w. rnd.	
				of 75% bslt./5% felsic Meta > int. Volc.; matrix of v.f.-v.c.	
				sub-ang. S. trace. m. 2.5Y 3/4 v. drk. grayish brown.	
15	9.3	80%		12.0-21 : slightly silty sandy Gravel (m) sG (70%G-20%S, 5-10%M)	
				mod. w. srt'd. v.f.-m. pbl. w/ ~20% c. pbl. max: 64mm. of 80% bslt./	13' g.s.
				20% felsic int. Volc. > Meta. w/ w. rnd. f.-v.c. S. of 95% Meta/5%	
				felsic. v. unconsolidated. wk. - mod. rxn. w/ HCl. 2.5Y 3/4 v. drk.	
				grayish. brn.	
				15' : mod. srt'd. w. rnd. v.f.-m. pbl. w/ 20% c. pbl. matrix	13' g.s.
				similar to above.	
20	9.3	80%		20' : similar to above. w/ sprs. sm. cbl. of int. Volc. - v.w. rnd.	18.5-30' Redrill.
				21' : sprs. v.w. rnd. bldr. max 250 mm. core by drill.	22-23' g.s. 0% recovery.
				21-23' : silty sandy Gravel m sG (60%G, 20-30%S, 20%M)	
				v. pr. srt'd. (reworked by drill.) v.w. rnd. m. pbl. - sm. cbl. of	
				70%-80% bslt./20-20% felsic Meta > int. Volc. w/ clayey matrix of	25-29' g.s.
				v.f.-v.c. sub-rnd. S. w. clayey silt matrix. mod. plastic. low dilatancy.	
				2.5Y 3/4 v. drk. grayish brown. v. wk. rxn. w/ HCl.	
				23-29 : silty sandy Gravel m sG (60%G, 30%S, 10-15%M)	
				v. pr. srt'd. v.w. rnd. f. pbl. - v.c. pbl. of 80% bslt./20% felsic meta	WT @ 29.30 6/17/15
				int. Volc. max: 60mm. w/ v.f.-m. sub-rnd. S. 90% Meta, 10% felsic.	
				w/ non plastic silt. 2.5Y 3/4 v. drk. grayish brown. prob. normal grading. v. wk. rxn. w/ HCl.	
				29-30 : wet. slightly clayey v. low plastic. coating clasts.	
				29-34 : silty sandy Gravel m sG (75%G, 20%S, 5%M) & slightly silty sandy Gravel (m) sG	
				v. pr. srt'd. sub-ang. - sub-rnd. m. pbl. w/ c. pbl. (bimodal size)	
				of 80% bslt./20% int. Volc. > Meta. w/ v.f.-v.c. sub-ang. S. 90% Meta	30-33' g.s.
				10% felsic v. low plastic silt. - low plastic. 2.5Y 3/4 olive gray. wet.	34' g.s. of black clayey Gravel
				no rxn. w/ HCl.	
				34-34.2 : Black silty sandy Gravel m sG (75%G, 20%	clayey silty Gravel
					more mt. ps.

BOREHOLE LOG					Page 2 of 2
Well ID: C8930		Well Name: 399-1-69		Location: 300 Area N. Process Ponds	
Project: 300 Area U Sequestration RA.			Reference Measuring Point: Ground Surface.		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
30				29-34': Sandy Gravel sG (75%G, 20%S, 5%M)	Sonic w/ 5" x 10' core barrel.
30.5				v. pr. srt'd. sub-ang-subrtd. bimodal size gravel of m. pbl.	
31.0				+ sm. cbl. of 20% int. vol. bslt. / 20% int. vol. meta. w/ v.f.	30-33': g.s.
31.5				v.c.s. sub-ang. s. 90% mafic / 10% felsic v. low plastic - low	
32.0				plastic silt 5Y 2/2 olive gray. wet. no rxn. w/HCl.	
32.5					
33					
34				34-34.2' bgs: silty Gravel (clayey) mG (60%G, 20%S, 20%M)	
34.5				Black (2.5Y 2/5). Pr. srt'd. m. pbl. - v.c. pbl. w. rtd. of 90% bslt.	34-34.2': g.s. - no Red. -
35				1% felsic. w/ v.f. - v.c. sub-ang. s. 95% mafic / 5% felsic w/ v. plastic	
35.5			clayey silt. mod. rxn w/HCl. wet.	35-39': g.s.	
36					
37			34.2-39': sandy Gravel sG (75%G, 25%S)		
37.5			Pr. - mod. srt'd. v. w. rtd. v.f. pbl. - c. pbl. w/ sps. v.c. pbl. max: 40mm		
38			avg: 10-20mm. Downward fining. 40mm-10mm.		
38.5			matrix: c. - v.c. sub-ang. s. of 99% mafic / 1% felsic comp.		
39			2.5Y 2/2 Black. none-trace m.		
39.5			39-40.5': silty Gravel (mG) (75-80%G, 25-20%M)	39-40.5': g.s.	
40			v. pr. srt'd. v. w. rtd. sm. cbl. to v.f. pbl. of 95% bslt, 5% felsic		
			Meta. trace fr. - m. s. of 90% felsic comp. non plastic silt color		
			2.5Y 2/2 dk. grayish brown. Prob. downward fining. wet.		
			no rxn w/HCl 5Y 2/2		

Reported By: A. Lantau	Reviewed By: Kevin Bergstrom
Title: Geo. Tech.	Title: Sr. Geologist
Signature: A. Lantau	Signature: Kevin Bergstrom
Date: 6-17-15	Date: 8/10/15

<b>WELL SUMMARY SHEET</b>		Start Date: 6/16/15		Page <u>1</u> of <u>1</u>		
		Finish Date: 8/6/15				
Well ID: C8932			Well Name: 399-1-71			
Location: 300 Area N of PNNL			Project: 30 Monitoring/Injection Wells in 300-FF-5 OU			
Prepared By: Tessa Clark		Date: 9-28-15	Reviewed By: J.D. MEHRER		Date: 10/28/15	
Signature: <i>Tessa Clark</i>			Signature: <i>J.D. Meherer</i>			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
<b>Surface Completion:</b>						
2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.		0		0.0 - 1.0: Gravel Drill Pad, G		
13 1/2" OD Protective Monument: 0.0' - 0.6' bgs		10		1.0 - 40.0: Silty Sandy Gravel, msG		
<b>Permanent Well:</b>		20				
2.375" OD PVC Blank: 0.45' - 30.43' bgs		30		Depth to Water: 31.20' bgs (6/16/15)		
2.375" OD PVC 0.020-slot Screen: 30.43' - 35.46' bgs		40		Total Depth = 40.00' bgs (6/16/15)		
2.375" OD PVC Blank Casing: 35.46' - 38.20'		50				
<b>Construction Materials:</b>						
Concrete: 0.60' - 1.30' bgs						
Surface Seal: 1.30' - 10.00' bgs						
Bentonite Chips: 10.00' - 24.70' bgs						
Bentonite Pellets: 24.70' - 27.70' bgs						
10/20 Mesh Filter Pack Sand: 27.70' - 40.00' bgs						
All temporary 6" OD casing removed 6/16/15.						
				<b>OD</b> = outside diameter <b>bgs</b> = below ground surface <b>Centralizers</b> : top of sump & bottom of last blank riser.		

**BOREHOLE LOG**

Page 1 of 2

Date: June 16, 2015

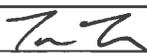
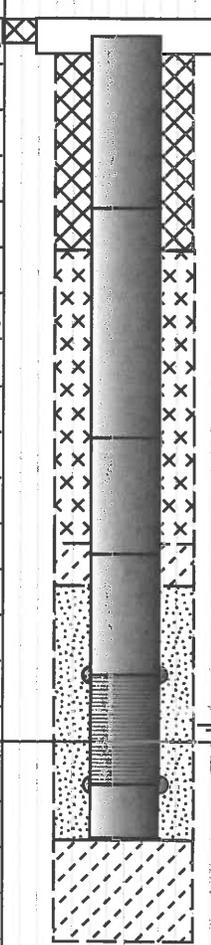
Well ID: C8932 Well Name: 399-1-71 Location: 300 Area N of PANL

Project: PR7 monitoring well Reference Measuring Point: Ground surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0.0 to 1.0 ft Formation Backfill/Drilling pad MSG	Drilling is being conducted w/ 3" casing
g.s				1.00 to 3.00 ft bgs Formation Hanford	4" core barrel
5				10% silt 40% sand 50% Gravel Sand: medium grain, mod sorted sub angular 30% mafic 70% felsic	g.s = Grab Sample
g.s				Gravel 2mm to ~100mm poorly sorted sub angular to round.	0-10 ft drilled slow due to poor soil <del>compaction</del> <sup>consolidation</sup>
10				60% mafic 40% felsic; Damp weak reaction to HCL (dry)	compaction.
g.s				5YR 3/2 dark reddish brown (damp)	
				3.00 ft 16.00 ft bgs (dry) <sup>CK 6/16/15</sup> MSG	Grab Sample
15				Formation Hanford	0'-5'
g.s				10% silt 35% sand 55% Gravel	5-10'
				Sand: Fine to coarse poorly sorted sub angular 40% mafic 60% felsic	10'-15'
				Gravel: 2mm to small boulders	15'-20'
20				Boulder (quartzite) @ 13 to 15 ft bgs causing poor recovery.	20'-25'
g.s				overall gravels are poorly sorted angular to sub round 60% mafic 40% felsic.	25'-30'
				slight reaction to HCL (dry)	30-35'
25				2.5 YR 4/3 reddish brown (damp)	35-40'
30				16.00 ft to 30.00 ft Formation Hanford	
g.s				10% silt 3% sand 100% Gravel	Recovery
				Sand: Fine to coarse poorly sorted sub angular 40% mafic 60% felsic	0'-10' 100%
				Gravel: 2mm to 160mm very poorly sorted. Angular to sub round.	10.00-20.00' 50%
35				when saturated silt has low plasticity @ 17.00 ft Hanf Ringold rip up east in the form of clay around larger gravels.	20.00-30.00 80% 30.00-40.00 0%

Reported By: Candice Burnette Kildall Reviewed By: Kevin Bergstrom  
 Title: Geologist Title: Sr. Geologist  
 Signature: [Signature] Date: 6/16/15 Signature: [Signature] Date: 8/4/15

BOREHOLE LOG					Page <u>2</u> of <u>2</u>
Well ID: <u>C8932</u>		Well Name: <u>399-1-71</u>		Location: <u>300 Area W of PAVL</u>	
Project: <u>PRZ monitoring well</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
				16.00' to 30.00 ft bgs Continued. At 26.50 ft to 28.00 ft bgs there is a large Ringold rip up clast. Clast is composed of: 30% silt 30% Sand (fine to med.) 40% gravel. The clast has medium plasticity	Drilling is being conducted w/ a Terra Sonic 150 cc 6" casing 4" core barrel
				Overall unit color 7.5 YR 3/1 very dark gray lower section moist ~ 25' Slight to no reaction to HCL	
				30.00' to 40.00' bgs Formation: Hanford MSG 10% silt 20% sand 70% Gravel There was zero recovery on the first run description and archive samples were collected from the clean cut. Sand: fine to very coarse, poorly sorted, Angular. 60% mafic 40% felsic Gravel: 2mm to 160mm, poorly sorted sub angular to well rounded - rounding increase w/ size. 7.5 YR 4/1 dark gray (damp) Weak reaction to HCL (damp) Wet	
				TD 40.00 ft bgs 6/16/15 DTW 30.80 ft bgs	
Reported By: <u>Candice Burnette Kildall</u>			Reviewed By: <u>Kevin Bergstrom</u>		
Title: <u>Geologist</u>			Title: <u>Sr. Geologist</u>		
Signature: <u>[Signature]</u>		Date: <u>6/16/15</u>	Signature: <u>[Signature]</u>		Date: <u>8/4/15</u>

<b>WELL SUMMARY SHEET</b>		Start Date: 6/10/15		Page <u>1</u> of <u>1</u>		
Well ID: C8935		Well Name: 399-1-73				
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU				
Prepared By: Tessa Clark		Date: 9-28-15		Reviewed By: J.D. MEHRER		
Signature: 		Signature: 		Date: 10-28-15		
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
<b>Surface Completion:</b>						
2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.		0		0.0 - 1.0: Gravel Drill Pad, G		
13 1/2" OD Protective Monument: 0.0' - 0.6' bgs				1.0 - 5.0: Sandy Gravel, sG		
					5.0 - 16.0: Silty Sandy Gravel, msG	
				10		
<b>Permanent Well:</b>						
2.375" OD PVC Blank: 0.40' - 28.27' bgs					16.0 - 18.5: Gravel, G	
2.375" OD PVC 0.020-slot Screen: 28.27' - 33.27' bgs					18.5 - 19.0 : Silty Gravel, mG	
2.375" OD PVC Blank Casing: 33.27' - 35.90'				20	19.0 - 25.0: Silty Sandy Gravel, msG	
					25.0-26.0: Sandy Gravel, sG	
					26.0-30.0: Silty Sandy Gravel, msG	
		30	30.0 - 31.0: Gravelly Silt, gM			
			Depth to Water: 31.10' bgs (6/11/15)			
<b>Construction Materials:</b>			31.0 - 34.0: Silty Sandy Gravel, msG			
Surface Seal: 0.75' - 10.00' bgs			34.0 - 35.0: Gravel, G			
Bentonite Chips: 10.00' - 22.40 bgs'			35.0 - 40.0: Silty Sandy Gravel, msG			
Bentonite Pellets: 22.40- 24.90' bgs		40	<b>Total Depth = 40.0' bgs (6/16/15)</b>			
10/20 Mesh Filter Pack Sand: 24.90' - 35.90' bgs						
Bentonite Pellets: 35.90-40.00' bgs						
		50				
			<b>OD = outside diameter</b>			
			<b>bgs = below ground surface</b>			
All temporary 6" OD casing removed 6/15/15.			<b>Centralizers: top of sump &amp; bottom of last blank riser.</b>			

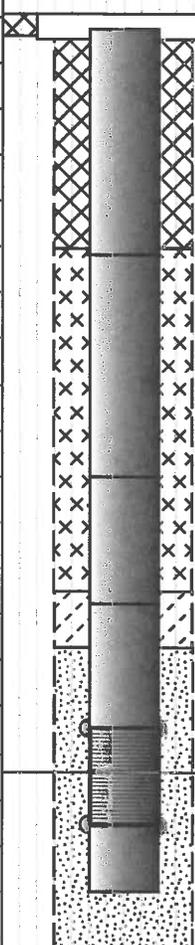
KAB 2-10-15			BOREHOLE LOG		Page 1 of 2
Well ID: C9935 C 8935			Well Name: 399-1-73		Date: 6.10.15
Project: 300 Area U Sequestration / RA			Location: 300 Area N. Process Pond		
Reference Measuring Point: Ground Surface.					
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0-1.0: <sup>max. blows</sup> Gravel Pad. 0-1.0: Gravel Pad	Soil w/10'x5" core barrel (cb)
1.0-5'				1.0-5': Silty Gravel sG (75%G, 20%S, 5%M) v. pr. srt'd. sub-rndd. m. pbl.-sm.cbl. of 80%bst./20% felsic meta. >int. Volc. max clast: 120mm. w/ v.f.-m. sub-ang. S.	0.5-5': grab sample (g.s.) [Symbol] = no Returns.
5				50/50 mafic/felsic S. w/ low cohesion 2.5Y 7/2 drk. gray. wk. rxn w/ HCl.	0.5-5': bas. g.s. to RMA
5-16'				5-16': silty sandy Gravel msG (60-70%G, 30-20%S, 10%M) 0.5-10': v. pr. srt'd. m. pbl.-sm.cbl. of 60-70%bst./40-30% felsic int. v. >meta. max: 70mm w/ v.f.-m. sub-ang. S. of 70% felsic/30% mafic meta. >int. Volc. fine muscovite 2.5Y 7/2 v. drk. gray. no rxn w/ HCl.	5-16': g.s. to RMA
10				10-16': silty sandy Gravel emb. (60%G, 30%S, 10%M) pr. srt'd. v.f. pbl.-sm.cbl. max: 90mm of 60-70%bst./40-30% felsic sub.-w. rndd. clasts. matrix of m.-v.c. ang. S. 2.5Y 8/3 brown no rxn w/ HCl.	10-16': g.s. + Bulk sample to RMA
15				16-18.5' bgs.: Gravel (99%G) ~1%S. v.w. srt'd. v.w. graded matrix suprt'd. m.-crs. pbl. v.w. rndd. of 99%bst./1% felsic. max clast: 20mm. <sup>firmly cemented</sup> Coarsening downward. w/c. ang. S. of 99%bst. 2.5Y 2.5/ black, slightly moist, no rxn w/ HCl.	16-20': bulk sample to RMA
20				18.5-19.0': silty Gravel sG (80-90%G, 10-20%M) v.w. srt'd. v.w. rndd. m.-crs. pbl. of 95%bst./5% felsic w/ clayey silt 2.5Y 3/2 v. drk. gray. no rxn w/ HCl. max clast: 20mm.	20': grab sample to RMA. 18.5-19.0': 1800 dpm Bq, 150 dpm α. Suspected α. Uranium.
25				19-25': silty sandy gravel msG (70%G, 20%S, 10-15%M) pr.-med. srt'd. w. rndd. v.f. pbl.-v.c. pbl. sprs. sm.cbl. max: 120mm. avg. m. pbl. grading to v.c. pbl. of 70%bst./30% felsic meta. >int. Volc. w/ matrix of v.c. p. grading to v.f. S. clayey slightly. 2.5Y 2/2 drk. grayish brown no rxn HCl.	19-20': 3,000 dpm Bq; α non removable
30				25-26': sandy Gravel sG (75%G, 25%S) mod. srt'd.-w. srt'd. v.f.-F. w. rndd. pbl. of 100%bst. w/ c.-v.c. sub-ang. mafic S. 2.5Y 3/2 v. drk. gray no rxn w/ HCl.	20-30': 1500 dpm Bq, α non removable.
30				26-30': silty Sandy Gravel msG (75%G, 15%S, 10-15%M) pr. srt'd. v.w. rndd. v.f. pbl.-sm.cbl. max: 120mm. avg: 20mm. of 60%bst./40% felsic meta. >int. Volc. w/ v.f.-v.crs. sub-ang. S. sprs. mica. ~1% low plastic. 2.5Y 7/2 drk. grayish brown. wk. rxn w/ HCl.	
30					20-40': no grab samples collected due to Rod.

Reported By: A. Lantieri	Reviewed By: Kevin Bergstrom
Title: Geo. Tech.	Title: Sr. Geologist
Signature: A. Lantieri	Signature: Kevin Bergstrom
Date: 6.11.15	Date: 8/6/15





BOREHOLE LOG					Page <u>1</u> of <u>1</u>
Well ID: <u>C8938</u>		Well Name: <u>399-1-75</u>		Location: <u>300 Area W of PNNL</u>	
Project: <u>30 well 300-FF-5 FY15</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0 ft to 0.15 ft bgs Drill Pad / Backfill	PRZ well
0-5		50% recovery			Drilling is being conducted with a
5				0.15' to 14.00 ft bgs sg Formation 5% silt 45% sand 50% Gravel Sand: fine to med. grain mod/poor sorted Angular 60% mafic 40% felsic Gravel: 2mm to 100mm poorly sorted sub round 60% mafic 40% felsic	Terrasonic 15-DCC 6" casing 4" X 10' core barrel
10		100% recovery		Mod to strong reaction to HCL 2.5 V 3/8 Dry	gs = Grab sample
15					
20		70% recovery		14.00 ft bgs to 35.00 ft bgs msx 10% silt 40% Sand 50% Gravel Sand fine to coarse, very poorly sorted. Angular 60% mafic 40% felsic Gravel: 2mm to 150mm, poorly sorted sub round to sub angular 60% mafic 40% felsic	recovery 0-10' ~ 50% 10-20 ~ 60% 20-30 ~ 70% 30-40 ~ 50% 40-40.50 ~ 100%
25				Weak to strong reaction to HCL 2.5 V 3/8 very dark gray moist @ ~ 28 ft bgs. Hanford	
30		100% recovery		35.00 ft bgs to 40.50 ft bgs. TD msx Formation Hanford 15% silt 30% sand 55% gravel Sand very coarse to fine. very poorly sorted. 60% mafic 40% felsic Gravel: 2mm to 175mm, very poorly sorted, Angular to round 60% mafic 40% felsic.	TD 40.50 ft DTW 30.20 ft
35				weak to no Reaction to HCL 2.5 V 3/8 very dark gray Wet	
Reported By: <u>Candice Burnette Kirdall</u>			Reviewed By: <u>Kevin Bergstrom</u>		
Title: <u>Geologist</u>			Title: <u>Sr. Geologist</u>		
Signature: <u>[Signature]</u>		Date: <u>4/29/15</u>	Signature: <u>[Signature]</u>		Date: <u>8/4/15</u>

<b>WELL SUMMARY SHEET</b>			Start Date: 6/30/15		Page <u>1</u> of <u>1</u>	
			Finish Date: 8/6/15			
Well ID: C8941			Well Name: 399-1-77			
Location: 300 Area N of PNNL			Project: 30 Monitoring/Injection Wells in 300-FF-5 OU			
Prepared By: Tessa Clark		Date: 9-28-15	Reviewed By: J.D. MEHRER		Date: 10/28/15	
Signature: 			Signature: 			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
<b>Surface Completion:</b>						
2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.		0		0.0 - 0.1: Gravel Drill Pad, G		
13 1/2" OD Protective Monument: 0.0' - 0.85' bgs				0.1 - 4.0: Sandy Gravel, sG		
					4.0 - 40.17: Silty Sandy Gravel, msG	
				10		
<b>Permanent Well:</b>						
2.375" OD PVC Blank: 0.55' - 30.37' bgs						
2.375" OD PVC 0.020-slot Screen: 30.37' - 35.37' bgs						
2.375" OD PVC Blank Casing: 35.37' - 38.00'				20		
				30		
<b>Construction Materials:</b>			Depth to Water: 32.65' bgs (6/30/15)			
Surface Seal: 0.85'- 10.09' bgs						
Bentonite Chips: 10.09'- 25.00' bgs						
Bentonite Pellets: 25.00' - 27.75' bgs						
10/20 Mesh Filter Pack Sand: 27.75'- 40.17' bgs		40	<b>Total Depth = 40.17' bgs (6/30/15)</b>			
		50				
			<b>OD = outside diameter</b>			
			<b>bgs = below ground surface</b>			
All temporary 6" OD casing removed 6/30/15.			<b>Centralizers: top of sump &amp; bottom of last blank riser.</b>			

BOREHOLE LOG						Page <u>1</u> of <u>2</u>
						Date: <u>June 20, 2015</u>
Well ID: <u>C8941</u>		Well Name: <u>399-1-77</u>		Location: <u>300 Area w. of DNWL</u>		
Project: <u>30 Wells 300-FF-5 FY15</u>				Reference Measuring Point: <u>Ground surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments	
	Type No.	Blows Recovery				
0			0 0 0 0	Ground surface to 0.1 ft bgs Backfill/drill pack	PRZ Well	
g-s			0 0 0 0		Drilling is being conducted with a	
5			0 0 0 0	0.10 ft bgs to 4.00 ft bgs sG Formation	Terrasonic 150CC 6" casing	
g-s			0 0 0 0	5% silt 45% sand 50% gravel Sand: medium grain well sorted	4" x 10' core barrel	
10			0 0 0 0	Sub round. 60% matric 40% felsic Gravel: 2mm to 150mm poorly sorted	g-s = grab sample	
g-s			0 0 0 0	Sub angular 60% matric 40% felsic 2.5 y 3/4 dark olive brown		
15			0 0 0 0	Strong reaction to HCl (100° day HCL was hot) Dry		
g-s			0 0 0 0			
20			0 0 0 0	4.00 ft bgs to 21.00 ft bgs msg Formation: Hanford		
g-s			0 0 0 0	10% silt 35% sand 55% gravel Sand: fine to coarse very poorly sorted sub angular ~60% matric 40% felsic		
25			0 0 0 0	Gravel: 2mm to small boulders one @ ~16 ft bgs. Angular to sub rounded, poorly sorted. 60% matric 40% felsic 2.5 y 3/4	Recovery 0-10 ~100% 10-20 ~75% 20-30 ~80% 30-40 ~50%	
g-s			0 0 0 0	Strong reaction to HCL Dry		
30			0 0 0 0		TD 40.17 ft	
g-s			0 0 0 0	21.00 ft to 40.17 ft bgs msg Formation: Hanford	DTW/ 32.65 ft	
35			0 0 0 0	15% silt 25% sand 60% gravel Sand: fine to very coarse. very poorly sorted. Angular 60% matric 40% felsic Gravel: 2mm to ~175 mm Angular to well rounded		
g-s			0 0 0 0			

Reported By: <u>Candice Burnette Kildall</u>		Reviewed By: <u>Kevin Bergstrom</u>	
Title: <u>Geologist</u>		Title: <u>Sr. Geologist</u>	
Signature: <u>[Signature]</u>	Date: <u>6/30/15</u>	Signature: <u>[Signature]</u>	Date: <u>8/4/15</u>





BOREHOLE LOG					Page <u>1</u> of <u>2</u>
Well ID: <u>C9450</u>		Well Name: <u>399-1-79</u>		Location: <u>300 Area (300-FF-50U) N of PNNL</u>	
Project: <u>31 Wells in 300-FF-50U FY2015</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0-0.5 Gravel Drill Pad	Terra Sonic
				0.5-17.5 60% Gravel, 30% Sand, 10% Silt Sandy Gravel (SG); Gravel: SR, 60% Felsic 40% Mafic, 2mm-10cm; Sand: vf-c, 80% Felsic, 20% Mafic, SR-SA; poorly sorted, 2.5Y4/1 -	6" casing 4" core barrel
5	GS	45%		2.5Y4/2 gray to dark grayish brn, dry to moist, mod rxn w/ HCL	
10	GS				
15	GS	30%			
20	GS			17.5-23' 65% Gravel, 30% Sand, 5% Silt Sandy Gravel (SG); Gravel: R-SR, 2cm-12cm max, avg 2cm, 60% Felsic, 40% Mafic; Sand: SR-SA, 80% Felsic, 20% Mafic, vf-vc; 2.5Y4/2 dark grayish brn, moist, slight rxn w/ HCL.	
25	GS	65%		23.0-30.0 70% Gravel, 20% Sand, 10% Silt Sandy Gravel (SG); Gravel: SR-SA, 60% Felsic, 40% Mafic, 2cm-8cm, 4cm avg. Sand: vf-vc, SR-SA, 80% Felsic, 20% Mafic; 2.5Y4/1 dk gray; moist; no rxn w/ HCL.	
30	GS			30-40' 70% Gravel, 10% Sand, 20% Silt Silty Gravel (mG); Gravel: R-SR, 80% Felsic, 20% Mafic, 2cm-4cm; Sand: 60% Felsic, 40% Mafic, SR-SA, f-vc; 2.5Y4/1 dark gray, poorly sorted, dry to wet; no rxn w/ HCL.	
35	GS	60%			
Reported By: <u>Jennifer Russell</u>			Reviewed By: <u>Kevin Bergstrom</u>		
Title: <u>Geologist</u>			Title: <u>Sr. Geologist</u>		
Signature: <u>Jennifer Russell</u>		Date: <u>6/18/15</u>	Signature: <u>Kevin Bergstrom</u>		Date: <u>8/3/15</u>

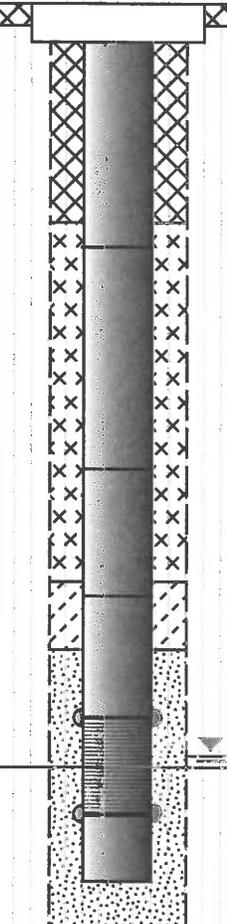
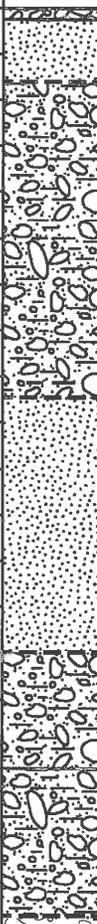




BOREHOLE LOG					Page <u>2</u> of <u>2</u> <i>CE 4180115</i>
Well ID: <u>C9452</u>		Well Name: <u>399-1-81</u>		Location: <u>300 Acres W of PNNL</u>	
Project: <u>30 Wells 300-ft-5 FY15</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				Ground surface to 1.50 ft bgs Drill pad / Backfill	PRZ well
0.5				1.50 ft to 9.00 ft bgs Formation	Drilling is being conducted w/ a Terrasonic 150CC rig
5				5% silt 45% sand 50% gravel Sand: medium to fine grain mod. sorted, sub round to angular. 60% mafic 40% felsic Gravel: 2mm to small boulder Small boulder @ ~3ft bgs sub angular poorly sorted 60% mafic	6" casing 4" x 10' core barrel
9.5				Weak reaction to HCL 2.5 Y 3/3 very dark olive brown Dry	g.s. = Grab sample Grab samples were collected every 5ft and in pint jars and Chip trays
15				9.00 ft bgs to 21.00 ft bgs mslr Formation: Hanford	
20				silt 10% Sand 40% Gravel 50% Sand: fine to coarse, poorly sorted Angular 60% mafic 40% felsic Gravel: 2mm to ~175mm poorly sorted sub round 60% mafic 40% felsic.	Recovery 0'-10' ~60% 10-20' ~90% 20'-30' ~60% 30'-40' ~100%
25				Weak to med. reaction to HCL 2.5 Y 3/1 very dark gray Dry	
30				21.00 ft to 40.70 ft bgs msg Formation: Hanford	TD 40.70 ft DTW 31.50 ft
35				15% silt 30% sand 55% Gravel Sand: coarse to fine very poorly sorted. Angular. 60% mafic 40% felsic Gravel: 2mm to ~200mm (~80% of the gravels are under 50mm) Angular to rounded, rounding increases w/ size	

Reported By: <u>Candice Burnette Wildall</u>	Reviewed By: <u>Kevin Bergstrom</u>
Title: <u>Geologist</u>	Title: <u>Sr. Geologist</u>
Signature:	Signature:
Date: <u>6/29/15</u>	Date: <u>8/3/15</u>



<b>WELL SUMMARY SHEET</b>		Start Date: 6/24/15		Page <u>1</u> of <u>1</u>		
		Finish Date: 8/6/15				
Well ID: C9454		Well Name: 399-1-83				
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU				
Prepared By: Tessa Clark	Date: 9-28-15	Reviewed By: J.D. MELPHER	Date: 10/28/15			
Signature: 		Signature: 				
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
<b>Surface Completion:</b>		0		0.0 - 0.5: Gravel Drill Pad, G		
2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.				0.5 - 3.2: Sand, S		
13 1/2" OD Protective Monument: 0.0' - 0.85' bgs				3.2 - 17.0: Silty Sandy Gravel, msG		
<b>Permanent Well:</b>						
2.375" OD PVC Blank: 0.90' - 30.35' bgs				10		
2.375" OD PVC 0.020-slot Screen: 30.35' - 35.35' bgs					17.0 - 28.0: Sand, S	
2.375" OD PVC Blank Casing: 35.35' - 38.10'				20		
				30		28.0 - 39.7: Silty Sandy Gravel, msG
<b>Construction Materials:</b>						Depth to Water: 33.15' bgs (6/24/15)
Surface Seal: 0.90' - 9.70' bgs						
Bentonite Chips: 9.70' - 25.00' bgs						
Bentonite Pellets: 25.00' - 28.00' bgs						
10/20 Mesh Filter Pack Sand: 28.00' - 39.98' bgs		40		39.7 - 39.98: Gravelly Silt, gm		
				<b>Total Depth = 39.98' bgs (6/24/15)</b>		
		50				
				<b>OD = outside diameter</b>		
				<b>bgs = below ground surface</b>		
All temporary 6" OD casing removed 6/23/15.				<b>Centralizers: top of sump &amp; bottom of last blank riser.</b>		

BOREHOLE LOG					Page <u>1</u> of <u>2</u>
Well ID: <u>C9454</u>		Well Name: <u>399-1-83</u>		Location: <u>300 Area W of PUNL</u>	
Project: <u>31 well 300-FF-5 FY15 (PR2 well)</u>			Reference Measuring Point: <u>Ground surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				Ground surface to 0.50 ft bgs Backfill/drilling pad.	Drilling is being conducted with <sup>activities</sup> a sonic rig Terra Sonic 150 CC
0-5	g.s.	100% Recovery		0.5 ft bgs to 3.20 ft bgs Formation (S)	6" casing 4" x 10' core barrel
5-10	g.s.			5% silt 90% sand 5% gravel. Sand: fine to coarse, poorly sorted Sub angular ~40% mafic 6% felsic Gravel ~4mm to 100mm sub angular 70% mafic 30% felsic Weak reaction to HCL	g.s. = grab sample grab samples collected for archive in 5' intervals
10-15	g.s.	100% recovery		2.5 Y 3/4 very dark grayish brown Dry	H2O Tag @ 33.15 ft bgs TD - 39.98 ft bgs.
15-20	g.s.			3.20 ft bgs to 17.00 ft bgs Formation: Hanford (MSG)	
20-25	g.s.	75% recovery		15% silt 40% sand 45% gravel Sand: fine to coarse, poorly sorted Sub angular 50% mafic 50% felsic Gravel: 2mm to ~150mm poorly sorted Angular to sub round Weak to mod reaction to HCL reaction decreases down unit. 2.54 1/4 dark gray	
25-30	g.s.			17.00 ft bgs to 28.00 ft bgs Formation: Hanford (S)	
30-35	g.s.	50% recovery		2% silt 95% sand 3% gravel Sand: Fine to medium grain, mod sorted Angular 60% mafic 40% felsic No reaction to HCL	
35-39.98	g.s.			2.54 1/2 dark grayish brown Dry	
				28.00 ft to 39.70' bgs Formation: MSG	
				15% silt 30% sand 55% gravel	

Reported By: <u>Candice Burnette Kildall</u>		Reviewed By: <u>Kevin Bergstrom</u>	
Title: <u>Geologist</u>		Title: <u>Sr. Geologist</u>	
Signature: <u>[Signature]</u>	Date: <u>6/24/15</u>	Signature: <u>[Signature]</u>	Date: <u>8/3/15</u>





BOREHOLE LOG						Page <u>1</u> of <u>2</u>
Well ID: <u>C9456</u>		Well Name: <u>399-1-85</u>		Location: <u>300 Area W of PUNL</u>		
Project: <u>31 well installation 300FF-5 FY15</u>				Reference Measuring Point: <u>Ground surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments	
	Type No.	Blows Recovery				
0			000000	Ground surface (0) to 1.00 ft bgs G Drill pad / Backfill	PRZ well	
9.5		80% Recovery	000000	1.00 ft to 2.70 ft bgs MSG Formation	Drilling is being conducted with a Terrasonic 150cc	
5			000000	15% silt 50% sand 35% Gravel Sand: fine to coarse grain, poorly sorted, Angular 40% mafic 60% felsic Gravel: ~10mm to ~120mm, poorly sorted, subround, ~70% mafic 30% felsic	6" casing 4" x 10' core barrel	
9.5		70% Recovery	000000	weak reaction to HCL <del>2.5Y</del> 2.5Y 3/3 dark olive brown Dry	g.s = grab sample grab sample are collected in 5 ft intervals.	
15			000000	2.70 ft to 17.00 ft bgs MSG Formation: Hanford	Recovery	
9.5			000000	10% silt 40% sand 50% Gravel Sand: fine to coarse grain very poorly sorted Angular to subangular ~60% mafic 40% felsic	0-10' = ~80% 10-20' = ~70% 20-30' = ~100% 30-40' = ~60%	
20		100% Recovery	000000	Gravel: 2mm to ~75mm, sub-angular to sub round 65% mafic 35% felsic weak to no reaction to HCL (Dry) 2.5Y 4/1 dark gray Dry	TD 40.50 ft bgs DTW 31.80 ft Bgs	
25			000000	17.00 ft to 40.45 MSG Formation: Hanford		
9.5			000000	15% silt 50% sand 45% Gravel Sand: fine to very coarse. Higher% of sand is coarse to very coarse. Angular very poorly sorted ~60% mafic 40% felsic Gravel: 2mm to 150mm (gravels run small ~2% are over 100µm) Sub angular to well rounded 60% mafic 40% felsic		
30		100% Recovery	000000			
35			000000			

Reported By: Candice Burnette Kildall

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: [Handwritten Signature]

Date: 4/25/15

Signature: [Handwritten Signature]

Date: 8/3/15

BOREHOLE LOG					Page <u>2</u> of <u>2</u>
Well ID: <u>C9456</u>		Well Name: <u>399-1-85</u>		Location: <u>300 Area N of PNNL</u>	
Project: <u>31 well installation 300-FF-5 FY15</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40			5/25/15 TD 40.50'	17.00ft to <u>Continued</u> No reaction to HCL (damp)	PRZ well
				2.5 Y <sup>3</sup> / <sub>4</sub> very dark gray moist.	Drilling was conducted with a
				@ ~ 18.00 ft to 18.20ft bgs Small clay / gravel lens	Terrasonic 150cc rig 6" casing 4"x10' core barrel
				2.5 Y <sup>6</sup> / <sub>4</sub> light yellowish brown No reaction to HCL = mod-strong (Dry) Dampish	
				@ 25.50 ft to 26.00 ft bgs Small lens ~ 40% silt 20% ver fine grain sand 40% gravel mica noted is clay. Low plasticity	
				7.5 Y <sup>1</sup> / <sub>4</sub> light yellowish brown No reaction to HCL	
				@ 32 ft bgs bedding appears gravels concentrate in to two lens:	
				@ ~ 34 ft bgs (0.90 ft)	
				@ ~ 39 ft bgs Average size of gravels is ~ 35 mm Sub round to well round no reaction to HCL No color change	
				Water tagged 6/25/15 @ 33.60ft bgs	
				TD = 40.50 ft bgs	
Reported By: <u>Candice Burnette Kildall</u>			Reviewed By: <u>Kevin Bergstrom</u>		
Title: <u>Geologist</u>			Title: <u>Sr. Geologist</u>		
Signature: <u>[Signature]</u>		Date: <u>6/25/15</u>	Signature: <u>[Signature]</u>		Date: <u>8/3/15</u>



**BOREHOLE LOG**

Date: June 23, 2015

Well ID: C9458 Well Name: 399-1-87 Location: 300 Area N of PNNL

Project: 31 Well 300 FF-5 FY15 PRT Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0.0 to 0.30 ft bgs Drilling pad / Backfill	Drilling is being conducted w/ a Terra Sonic 150 cc 6" casing 4" x 10' core barrel
0-5	g.s.	100% Recovery		0.30 to 2.80 ft bgs Formation (g)S 10% silt sand 70% Gravel 20% Sand: fine to coarse, poorly sorted sub angular 40% matrix 60% felsic Gravel 2mm to ~40mm poorly sorted angular 70% matrix 30% felsic weak to no reaction to HCl (Dry) 2.54 3/2 very dark grayish brown Dry	G.S. = grab sample grab samples collected in five foot intervals for Archive.
5-15	g.s.	50% Recovery		2.80 ft to 23.00 ft Formation: Hanford msg 10% silt 40% <del>Gr</del> Sand 50% Gravel Sand: very fine to coarse, poorly sorted sub angular to angular 40% matrix 60% felsic Gravel: 2mm to small Boulder. poorly sort Angular to sub round 60% matrix 40% felsic (boulder @ 10') weak reaction to HCl (Dry) 2.54 4/1 dark gray Dry	Tag H <sub>2</sub> O @ 32.8' bgs 6/23/15
15-23	g.s.	80% Recovery		23.00' - 24.00' ft bgs Hanford 20% silt 10% Sand 70% gravel Sand: Coarse grained angular 80% matrix 20% felsic Gravel: ~15mm to 100mm poorly sorted sub round. No reaction to HCl 2.54 4/1 dark gray moist	TD 40.00 ft bgs
23-35	g.s.	40% Recovery			

Reported By: Candice Burnette Kildall Reviewed By: Kevin Bergstrom  
 Title: Geologist Title: Sr. Geologist  
 Signature: [Signature] Date: 6/23/15 Signature: [Signature] Date: 8/3/15



<b>SURVEY DATA REPORT</b>				Request No. 154-161		
Project No.	Title 300-FF-5 Wells Final Surveys			File No. 3AT10R28		
Job No. CACN: 303500-JPRC	Prepared By N.P. Fastabend	Date 8/11/15	Reviewer <i>UBM</i>			
<b>DESCRIPTION OF WORK</b>			<b>DISTRIBUTION</b>	<b>SDR</b>	<b>PLOT</b>	<b>DWG</b>
Obtained final coordinates (C/L Casings) and elevations of 30 completed 300-FF-5 flush mount wells located on north side of 300 Area.  Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)			Survey File	OR		
			E.C. Rafuse	1		
			S.J. Trent	1		
			K.M. Whitley	1		
			J.B. Geiger	1		
			B.J. Howard	1		
			A.J. Green	1		
<b>SURVEY RESULTS AND COMMENTS</b>						
<p><b>See Attached Well Survey Data Report Sheets</b></p>						

## WELL SURVEY DATA REPORT

<b>Project:</b> 08/04/15	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC								
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)								
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)								
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C8930 (399-1-69) located on north side of 300 Area.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8930	399-1-69	594169.73	116505.03		Center of Casing
				114.635	"X" on Rim
				114.632	Brass Survey Marker

**Notes:**

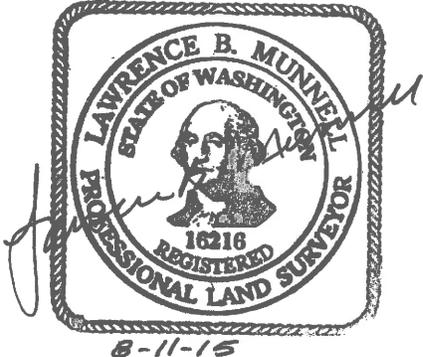
114.540 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
 Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C8932 (399-1-71) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8932	399-1-71	594126.33	116508.84		Center of Casing
				114.838	"X" on Rim
				114.838	Brass Survey Marker

**Notes:**

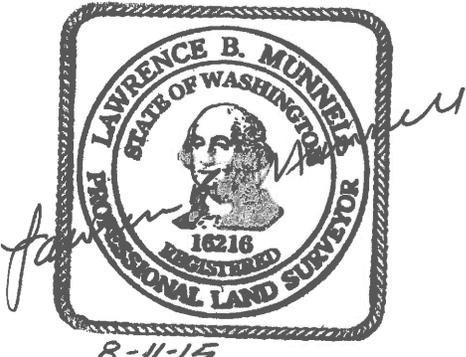
114.738 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

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8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b> 	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC								
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)								
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)								
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C8935 (399-1-73) located on north side of 300 Area.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8935	399-1-73	594081.69	116494.22		Center of Casing
				114.917	"X" on Rim
				114.920	Brass Survey Marker

**Notes:**

114.781 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
 Trimble DiNi 12 Level

**Surveyor Statement:**

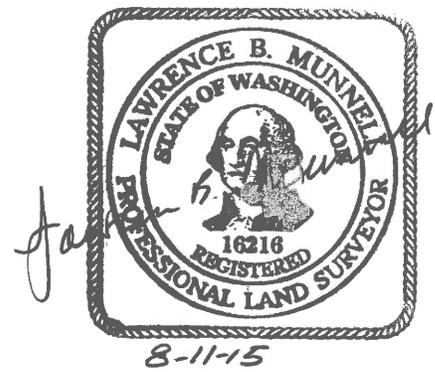
I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC				
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)				
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)				
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend				
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C8939 (399-1-75) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)		<b>Vertical Datum:</b> NAVD88		<b>Units:</b> Meters
<b>Hanford Area Designation:</b> 300A					
<b>Coordinate System:</b> Washington State Plane Coordinates (South Zone)					
<b>Horizontal Control Monuments:</b> Washington State Reference Network					
<b>Vertical Control Monuments:</b> 300-28 (CHPRC) and HSWB-005 (COE)					
<b>Well ID</b>	<b>Well Name</b>	<b>Easting</b>	<b>Northing</b>	<b>Elevation</b>	
C8939	399-1-75	594098.69	116475.62		Center of Casing
				114.922	"X" on Rim
				114.918	Brass Survey Marker
<b>Notes:</b>  <div style="text-align: right; margin-right: 100px;">114.819 Top Inner 2in PVC Casing, North Edge</div> "X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.  Equipment Used: Trimble R8 RTK GPS Trimble DiNi 12 Level					
<b>Surveyor Statement:</b>  I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.					



## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C8941 (399-1-77) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8941	399-1-77	594118.72	116460.56		Center of Casing
				115.254	"X" on Rim
				115.253	Brass Survey Marker

**Notes:**

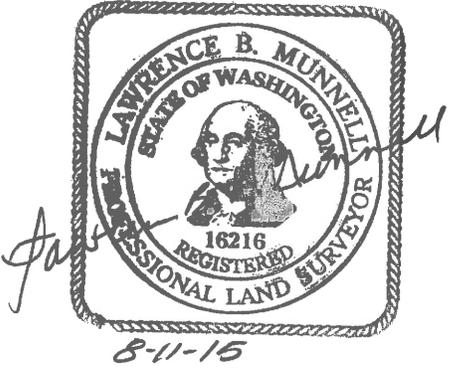
115.071 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9450 (399-1-79) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9450	399-1-79	594154.88	116463.09		Center of Casing
				114.912	"X" on Rim
				114.911	Brass Survey Marker

**Notes:**

114.778 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9452 (399-1-81) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83(91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9452	399-1-81	594090.90	116454.92		Center of Casing
				114.984	"X" on Rim
				114.984	Brass Survey Marker

**Notes:**

114.887 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

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## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9454 (399-1-83) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9454	399-1-83	594152.48	116427.40		Center of Casing
				115.066	"X" on Rim
				115.062	Brass Survey Marker

**Notes:**

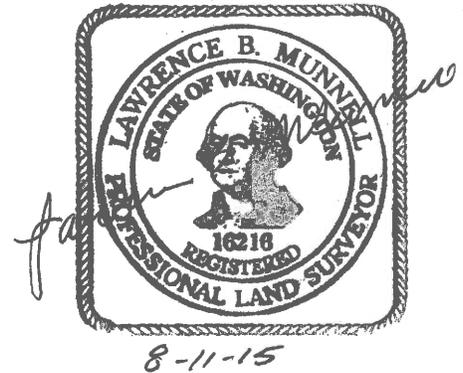
114.939 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

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## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9456 (399-1-85) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9456	399-1-85	594175.50	116451.42		Center of Casing
				114.932	"X" on Rim
				114.931	Brass Survey Marker

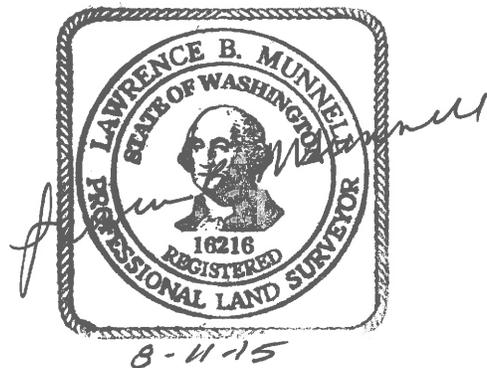
**Notes:**  
114.799 - Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.

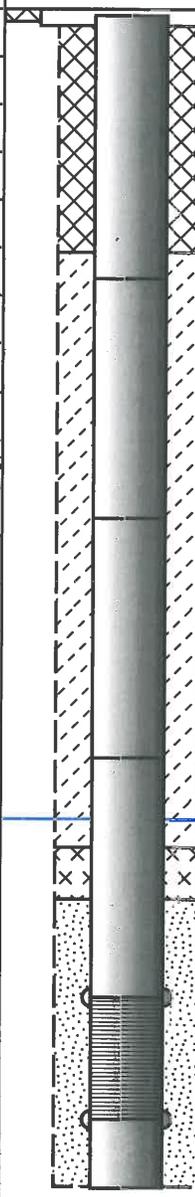


## Appendix B

### Well Documentation for Aquifer Monitoring Wells

- Well Summary Sheet
- Borehole Log
- Final Survey Report

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WELL SUMMARY SHEET		Start Date: 6/15/2015		Page 1 of 1			
		Finish Date: 8/6/2015					
Well ID: C8931		Well Name: 399-1-70					
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU					
Prepared By: Marques Miller		Date: 9/24/15		Reviewed By: J.D. MEHRER			
Signature: <i>[Signature]</i>				Date: 10-28-15			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA					
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description			
<b>Surface Completion:</b>							
2'x2' Flush mount concrete pad w/brass survey marker.		0		0.0' - 0.75': Gravel Drill Pad, G			
13 1/2" OD Protective Monument: 0.0' - 0.60' bgs					0.75' - 48.90': Silty Sandy Gravel, msG		
<b>Permanent Well:</b>							
2.37" OD PVC Blank: 0.30' - 41.25' bgs							
2.37" OD PVC 0.020-slot Screen: 41.25' - 46.25' bgs							
2.37" OD PVC Blank: 46.25' - 48.98' bgs							
<b>Construction Materials:</b>							
Concrete: 0.0' - 1.50' bgs							
Neat Grout: 1.50' - 10.10' bgs							
Bentonite Chips: 10.10' - 34.90' bgs							
Bentonite Seal: 34.90' - 37.10' bgs							
10/20 Mesh Filter Pack Sand: 37.10' - 48.90' bgs							
All temporary 6" OD casing removed 6/16/15.							
						Depth to Water: 33.8' bgs (6/15/15)	
						Total Depth = 48.90' bgs (6/15/15)	
				OD = outside diameter			
				bgs = below ground surface			
				Centralizers: top of sump & bottom of last blank riser.			

**BOREHOLE LOG**

Page 1 of 2

Date: June 16, 2015

Well ID: C8931

Well Name: 399-1-70

Location: 300 Area N of PAV 2

Project: Aquifer monitoring Well

Reference Measuring Point: Ground surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0	Litho	100% recovery		0-0.75 ft Formation: Backfill /drilling pad	Drilling is being conducted w/d Terrasonic 150 cc
5	gs	60% recovery		0.75 ft to 3.00 ft Formation: Hanford msg 10% silt 40% Sand 50% Gravel Sand: medium grain, med. sorted sub angular to angular 30% mafic to ~70% felsic Gravel: 2mm to 100mm poorly sorted sub rounded to sub angular 60% mafic 40% felsic 5YR 3/2 dark reddish brown (damp) Naturally damp. Slight reaction to HCL.	Drill rig 4" core barrel 6" casing. g.s = Grab sample Litho = sample collected at a change in Lithology.
10	gs.			3.00 ft to 14 ft Formation: Hanford msg 10% silt 30% sand 60% g Sand: fine to coarse very poorly sorted sub angular Gravel: 2mm to 10mm, poorly sorted Angular to sub round. 60% mafic 40% felsic 2.5YR 4/3 reddish Brown (damp) Slight reaction to HCL Dry	Grab samples collected @ 0'-5' 5-10' 10-15' 15-20' 20-25' 25-30' 30-35' 35-40' 40-45' 45-48.90'
15	gs.	70% recovery		14.00 ft to 32.00 ft Formation: Hanford msg 10% silt 35% Sand 50% Gravel Sand: fine to very coarse, poorly sorted sub angular 40% mafic 60% felsic Gravel: 2mm to ~140mm poorly sorted, Angular to round. 60% mafic 40% felsic	Litho samples collected @ 3' 38'
20	gs			Recovery 0-10' 100% 10'-20' 60% 20'-30' 70% 30'-40' 50% 40'-48.90' 100% TD 48.90' bgs DTW 33.8' bgs	
25	gs.	50% recovery			
30	Litho				
35	gs				

Reported By: Candice Burnette Kildall

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: [Handwritten Signature]

Date: 6/15/15

Signature: [Handwritten Signature]

Date: 9/8/2015

**BOREHOLE LOG**

Date: June 16, 2015

Well ID: C8931

Well Name: 399-1-70

Location: 300 Area N of PNNL

Project: Aquifer monitoring well

Reference Measuring Point: Ground surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	gs.	100% recovery		14.00 to 32.00 ft Continued: @ ~ 17 ft bgs small compate chips of fine green sand/silt high in felsic (80%) material to include mica. Possible ring old rip up plast.	Drilling is being conducted w/a Terrasonic 150CC 6" casing 4" core barrel
45				gs.	7.5YR 3/1 very dark gray (damp) slight to no reaction to HCL (dry) Damp
50			TD 48.90 6/15/15 Drilled	32.00 ft 45.00 ft bgs Formation Hanford MSG 10% silt 30% sand 60% gravel. Sand: sand is located at the lower end of the sample and is well graded. This is most likely because the vibrations, and from drilling in the water. Sand is fine to coarse sub- angular 50% mafic 60% felsic Gravel: 4mm to 130 mm poorly sorted. sub round to well round. 60% mafic 40% felsic 7.5YR 4/1 dark gray (damp) weak reaction to HCL Wet	2" monitoring well installed 6/16/15 Borehole drilled 6/15/15
				45.00 ft to 48.90 ft bgs Formation: 15% silt Sand 35% 50% gravel sand is very fine to coarse, mica sub round poorly sorted 40% mafic 60% felsic Gravel: 2mm to ~100 mm Subangular to sub rounded 40% mafic 60% felsic Silt has some (very low) plasticity. 7.5YR 3/1 very dark gray (damp) no reaction to HCL Wet	

Reported By: Candice Burnette Kildall

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: [Signature]

Date: 6/16/15

Signature: [Signature]

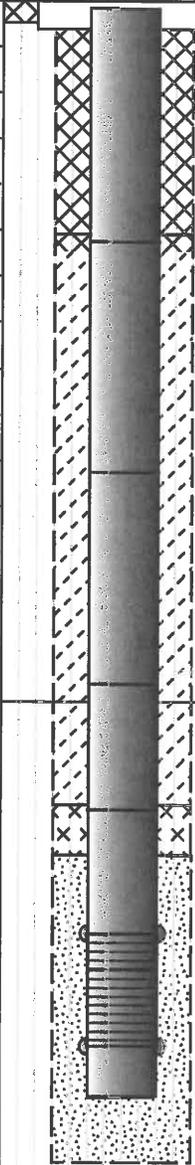
Date: 9/8/2015



BOREHOLE LOG				Page 1 of 2	
Well ID: C8934		Well Name: 399-1-72		Date: 6.9.15	
Project: 300 Area U. Segregation			Location: 300 Area N. of PNH. N. Process Ponds.		
Reference Measuring Point: Ground Surface.					
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0-0.5': Gravel Pad.	Sonic w/10.5" x 5" core barrel
0.5				0.5'-4.0': Silty Gravel. MSG (65-70%G, 30-45%S, <2%M) v.f. pbl. - sm. cbl. sub. rdd. of 60% bslt / 40% felsic meta. > int. Vol. w/ v.f. - v.c. sub. ang. S. of 50% mafic / 50% felsic no rxn. 2.5% dk. gash. brown. wk. rxn w/ HCl. Prob. mixed w/ non-loam soil. Poor recovery.	3': grab sample (g.s.) [Symbol] = no recovery if known.
5				5-15': silty sandy Gravel MSG (60%G, 30%S, 10%M) Poor sort. v.f. pbl. - sm. cbl. of 60% bslt / 40% felsic meta. > int. Vol. Sub-v.w. rdd. clasts max: 100mm. w/ matrix of v.f. - c. sub. ang. S. S. is 70%-50% Qtz felds. sprs. mica. no cohesion. 10% 1/8 brown. moist. mod. rxn. w/ HCl.	5-10': no recovery - Rock blocked stop @ 5' 10-20': 80% recovery - uncertain on origination of frags 13': g.s.
10				15-16': 6"-2' normal graded bedding. Prob. Authmitc. 15-16': Silty Gravel sG (80%G, 40%S) v.w. sort. v.f. - f. pbl. of bslt. w/ m. - v.c. S. 10YR 3/1 blk.	
15				16-18.5': silty gravel grading to Gravel. (95%G, 15%S) v.f. pbl. grading to c. pbl. v.w. rdd. of 95% bslt. 5% felsic w/ sand matrix of m. - v.c. sub. ang. S. of bslt. 10YR 3/1 blk. wk. rxn w/ HCl.	17': g.s. of sG.
20				18.5-19': Silty Gravel bed. mG (75%G, 25%M) gravels similar to above w/ fine matrix of 2.5Y 3/4 lt. olv. brown. 19-20': sG. Silty Gravel sG (70-75%G, 30-35%S) mod. w. sort. v.f. - crs. pbl. v.w. rdd. of 95% bslt / 5% felsic w/ matrix grading from m. - c. ang. S. to v.f. - c. S. silt content increases w/ depth. 2.5Y 1/2 dk. gash. brown no rxn w/ HCl. max clast: 25mm	18.5': g.s. of silty Gravel 20': g.s. of mSG
20				20-30': silty sandy Gravel sG (75%G, 15%S, 10%M) w. sort. v.w. rdd. m. pbl. - v. crs. pbl. of 95% bslt. 15% felsic meta. > int. Vol. w/ matrix of v.f. - crs. ang. S. of 80% mafic, 20% felsic. 2.5Y 1/2 dk. gash. brown. no rxn w/ HCl. max clast: 35mm moist.	20-30': ~100% recovery. 10% stuff.
25				25': mSG. (60-70%G, 30-35%S, 15%M) pr. sort. v.f. pbl. - v.c. pbl. v.w. rdd. of 90% bslt. / 10% felsic meta. w/ v.f. - m. ang. S. 2.5Y 1/2 dk. gash. brown. no rxn w/ HCl. moist	25': g.s. -25-35': 2500 bpm by / O.A.

Reported By: A. Latham	Reviewed By: Kevin Bergstrom
Title: Geo. Tech.	Title: Sr. Geologist
Signature: A. Latham	Signature: K. Bergstrom
Date: 6.9.15	Date: 9/10/2015



<b>WELL SUMMARY SHEET</b>			Start Date: 6/29/2015		Page <u>1</u> of <u>1</u>	
			Finish Date: 8/6/2015			
Well ID: C8937			Well Name: 399-1-74			
Location: 300 Area N of PNNL			Project: 30 Monitoring/Injection Wells in 300-FF-5 OU			
Prepared By: Tessa Clark		Date: 9/25/15	Reviewed By: J.D. MEHRER		Date: 10-28-15	
Signature: 			Signature: 			
CONSTRUCTION DATA			GEOLOGIC/HYDROLOGIC DATA			
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
<b>Surface Completion:</b>						
2'x2' Flush mount concrete pad w/brass survey marker.		0		0.0' - 0.15': Gravel Drill Pad, G		
13 1/2" OD Protective Monument: 0.0' - 0.60' bgs		10		0.15' - 14.0': Silty Sandy Gravel, msG		
<b>Permanent Well:</b>		20				
2.375" OD PVC Blank: 0.30' - 40.17' bgs		30		14.0' - 34.0': Silty Sandy Gravel, msG		
2.375" OD PVC 0.020-slot Screen: 40.17' - 45.17' bgs		40				
2.375" OD PVC Blank: 45.17' - 47.80' bgs		50				
		55		Depth to Water: 30.2' bgs (7/9/15)		
<b>Construction Materials:</b>		60				
Concrete: 0.0' - 1.25' bgs		65		34.0' - 46.0': Silty Sandy Gravel, msG		
Neat Grout: 1.25' - 10.50' bgs		70				
Bentonite Chips: 10.50' - 34.20' bgs		75				
Bentonite Seal: 34.20' - 37.20' bgs		80				
10/20 Mesh Filter Pack Sand: 37.20' - 50.07' bgs		85				
		90		46.0' - 50.50': Silty Sandy Gravel, msG		
		95		<b>Total Depth = 50.50' bgs (6/29/15)</b>		
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BOREHOLE LOG

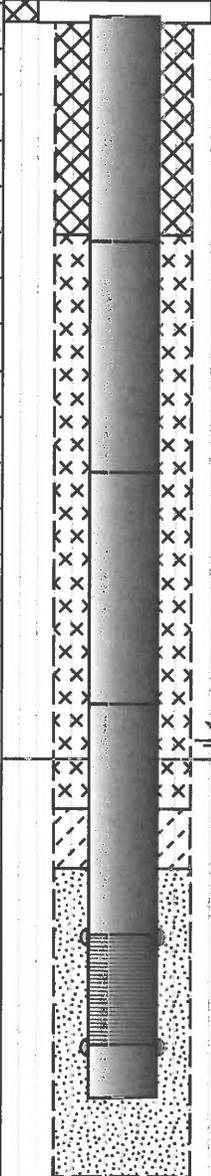
Date: June 29, 2015

Well ID: C8937 Well Name: 399-1-74 Location: 300 Area W of PNNL

Project: 30 well 300-FF-5 FY 15 Reference Measuring Point: Ground surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	g.s.	50% recovery		24.00 ft bgs to 46.00 ft bgs	Aguaifer well
				15% silt 45% sand 40% Gravel	
45	g.s.	50% recovery		Formation: ms	Drilling is being conducted w/ a
				Sand: med to very coarse grain sand	Terrasonic 150 cc
50				Angular poorly sorted 60% matic	6" casing
				40% felsic	4" x 10' core barrel
				Gravel: 2mm to 130mm med. sorted	
				round to sub angular, rounding	
				increases with size. 60% matic 40% felsic	g.s. = grab sample
				No reaction to HCl	
				2.5Y 3/1 very dark gray	
				wet	
				46.00 to 50.50 ft bgs ms	
				Formation:	
				10% silt 40% sand 50% gravel	
				Sand: very fine to med. grain	
				mod. sorting, sub round.	
				40% matic 60% felsic	
				Gravel: 2mm to 100mm	
				sub round to well round.	
				mod. sort.	
				40% matic 60% felsic	
				Clay/silt low plasticity	
				2.5Y 2.5/1 Black	
				wet	
				no reaction to HCl.	
				TD 50.50	
				Water 42.87 bgs 6-29-15	

Reported By: Candice Burnette Kildall Reviewed By: Kevin Bergstrom  
 Title: Geologist Title: Sr. Geologist  
 Signature: [Signature] Date: 6-29-15 Signature: [Signature] Date: 7/9/2015

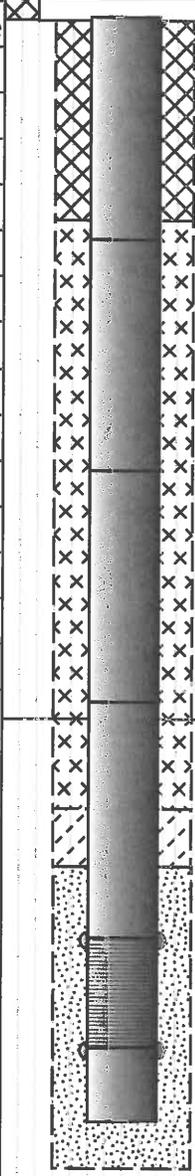
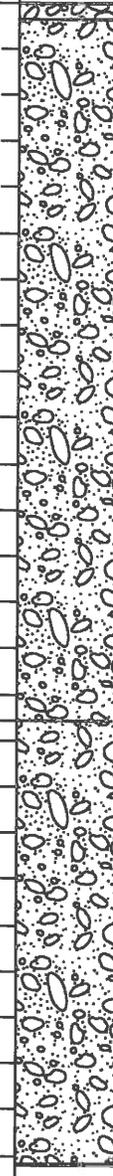
<b>WELL SUMMARY SHEET</b>		Start Date: 7/7/15	Page <u>1</u> of <u>1</u>
		Finish Date: 8/6/15	
Well ID: C8940		Well Name: 399-1-76	
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU	
Prepared By: Tessa Clark	Date: 9-28-15	Reviewed By: J.D. MEHRER	Date: 10-28-15
Signature: 		Signature: 	
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Lithologic Description
<b>Surface Completion:</b>			
2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.		0	0.0 - 0.25: Gravel Drill Pad, G
13 1/2" OD Protective Monument: 0.0' - 0.7' bgs		10	0.25 - 8.5: Sandy Gravel, sG
<b>Permanent Well:</b>		20	8.5 - 21.0: Silty Sandy Gravel, msG
2.375" OD PVC Blank: 0.45 - 40.22' bgs		30	21.0 - 47.0: Silty Sandy Gravel, msG
2.375" OD PVC 0.020-slot Screen: 40.22' - 45.23' bgs		40	Depth to Water: 32.7' bgs (7/15/15)
2.375" OD PVC Blank Casing: 45.23' - 47.85' bgs		50	47.0 - 50.85 Silty Sandy Gravel, msG
<b>Construction Materials:</b>			<b>Total Depth = 50.85' bgs (7/7/15)</b>
Surface Seal: 0.8' - 10.0' bgs			<b>OD = outside diameter</b>
Bentonite Chips: 10.0' - 35.0' bgs			<b>bgs = below ground surface</b>
Bentonite Pellets: 35.0 - 37.92' bgs			<b>Centralizers: top of sump &amp; bottom of last blank riser.</b>
10/20 Mesh Filter Pack Sand: 37.92' - 50.85' bgs			
All temporary 6" OD casing removed 7/13/15.			

BOREHOLE LOG					Page 1 of 2
Well ID: C8940		Well Name: 399-1-76		Location: 300 Area N of PUNL	
Project: 30 well 300FF-5 FY15			Reference Measuring Point: Ground surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				Ground surface to 0.25 ft bgs Drill pad / Backfill	Aquifer well
0-5	gs			0.25 ft bgs to 8.5 ft bgs. Formation: 60% Sand 40% Gravel sg Sand: medium grain well sorted Sub round 60% matrix 40% felsic Gravel: 2mm to ~70mm subround Poorly sorted 60% matrix 40% felsic Weak to no reaction to HCl 2.5Y 3/3 Dark olive brown Dry	Drilling is being conducted w a Terra sonic 150cc 6" casing 4" x 10' core barrel g.s = grab sample Grab samples are collected every 5 ft in pint jars and chip trays.
5-15	gs			8.50 ft bgs to 21.00 ft bgs Formation: Hanford. msg 10% silt 40% sand 50% Gravel Sand: fine to coarse poorly sorted Sub angular 60% matrix 40% felsic Gravel: 2mm to ~105mm mod. sorted Sub round to sub angular. ~60% matrix 40% felsic. 2.5Y 3/1 very dark gray Weak to mod reaction to HCl Dry	Recovery 0'-10' ~90% 10'-20' ~100% 20'-30' ~50% 30'-40' ~40% 40'-50' ~80%
15-25	gs			21.00 ft bgs to 47.00 ft bgs Formation msg 15% silt 40% sand 45% Gravel Sand fine to very coarse. Very poorly sorted Angular to sub angular ~60% matrix 40% felsic. Gravel: 2mm to ~175mm. Very poorly sorted ~75% of the gravel is 50mm or less. Angular to rounded. rounding increase with size.	Split spoon samples SS = split spoon B31MY4 I-001 10'-10.5' B31MY2 I-001B 10.5'-11' B31MY3 I-001B 11'-11.5' B31MY0 I-001B 11.5'-12.0' Sample time 100% Recovery 805 Sample spoon #2 B31N00 I-002A 14'-14.5' B31MY7 I-002B 13.5'-14' B31MY6 I-002C 13.00-13.50 No recovery for I-005 Sample time 0830 70% recovery
25-30	gs				
30-35	gs				

Reported By: Candice Burnette Kildall	Reviewed By: Kevin Bergstrom
Title: Geologist	Title: Sr. Geologist
Signature: <i>[Handwritten Signature]</i>	Signature: <i>[Handwritten Signature]</i>
Date: 7-7-15	Date: 9/9/2015

BOREHOLE LOG					Page <u>2</u> of <u>2</u>
Well ID: <u>C8940</u>		Well Name: <u>399-1-76</u>		Location: <u>300 Area N of PAVIL</u>	
Project: <u>300-FF-5 FY15 30 Wells.</u>			Reference Measuring Point: <u>Ground surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	gs			21.00 ft bgs to 47.00 ft bgs con	Aquifer well
				~100% mafic 40% felsic	
				2.5 Y 3/1 very dark gray wet	g.s = grab sample S.S. = split spoon
45	gs				Split Spoon Sample #3
50	gs			@ ~38 ft bgs there is a fine grain sand/silt lens. the len is ~2 ft thick.	Sample time 0908 40% recovery
				No Plasticity.	
				20% mafic 80% felsic	B31N05 I-00A 16.5-17'
				2.5 F 5/4 light olive brown	B31N03 I-003B 16.' 16.5'
				no reaction to HCL	B31N03 I-005B 21.5-22'
				Damp	B31N14 B31N15 (Dup)
55	gs			47.00 ft bgs to	B31N19 I-006B 24-24.5 B31N20 11
				Formation.	B31N26 J-007A 26.5-27.0
				20% silt 40% sand 40% Gravel	B31N25 I-007B 26-26.5 B31N24 I-007B 26-26.5
				Sand medium grain well sorted	B31N23 I-007C 25.5-26
				sub round. 30% felsic mafic	B31N27 I-007D 25-25.5
				70% felsic ~30% mafic 70%	B31N31 I-008A 29-29.5
				felsic.	B31N30 I-008B 28.5-29
				Gravel: sub round average size ~50mm. mod sorting	B31N29 11
				The ~3ft section appears to be a grade contact between	B31N28 I-008C 28-28.5
				an oxidizing/reducing zone.	B31N27 I-008P 27.5-28
				no reaction to HCL	B31N36 I-009A 31.5-32
				2.5 Y 4/3 olive brown	B31N35 I-009B 31-31.5
				2.5 Y 2.5/1 Black	B31N34 11 B31N33 I-009C 30.5-31
					TD 7/13/15 50.85
					req H <sub>2</sub> O 7/13/15 45.6'

Reported By: <u>Candice Burnette Kildall</u>	Reviewed By: <u>Kevin Bergstrom</u>
Title: <u>Geologist</u>	Title: <u>Sr. Geologist</u>
Signature: <u>[Signature]</u>	Signature: <u>[Signature]</u>
Date: <u>7-7-15</u>	Date: <u>7/9/2015</u>

<b>WELL SUMMARY SHEET</b>		Start Date: 6/22/15		Page <u>1</u> of <u>1</u>	
Well ID: C8942		Well Name: 399-1-78			
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU			
Prepared By: Tessa Clark	Date: 9-28-15	Reviewed By: J.D. MEHRER	Date: 10-28-15		
Signature: 		Signature: 			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA			
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description	
<b>Surface Completion:</b>					
2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.		0		0.0 - 0.5: Gravel Drill Pad, G	
13 1/2" OD Protective Monument: 0.0' - 0.7' bgs		10		0.5 - 50.3: Sandy Gravel, sG	
<b>Permanent Well:</b>		20			
2.375" OD PVC Blank: 0.5 - 40.51' bgs		30			
2.375" OD PVC 0.020-slot Screen: 40.51' - 45.52' bgs		40			
2.375" OD PVC Blank Casing: 45.52' - 48.30' bgs		50			
<b>Construction Materials:</b>					
Concrete: 0.0' - 1.4' bgs					
Surface Seal: 1.4' - 9.8' bgs					
Bentonite Chips: 9.8' - 35.1' bgs					
Bentonite Pellets: 35.1 - 37.8' bgs					
10/20 Mesh Filter Pack Sand: 37.8' - 50.3' bgs					
All temporary 6" OD casing removed 7/13/15.					
					Depth to Water: 31.2' bgs (6/30/15)
					<b>Total Depth = 50.3' bgs (6/22/15)</b>
			OD = outside diameter		
			bgs = below ground surface		
			Centralizers: top of sump & bottom of last blank riser.		

**BOREHOLE LOG**

Page 1 of 2

Date: 6/22/15

Well ID: C8942

Well Name: 399-1-78

Location: 300 Area N of PNNL

Project: 31 Wells 300 FF-5 (FY2015)

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0-0.5 Gravel Drill Pad	Terra Sonic
5	GS	40%		0.5'-18' 70% Gravel, 20% Sand, 10% Silt Sandy Gravel (SG); Gravel: SR, 60% Felsic, 40% Mafic, 2cm-10cm; Sand: Yf-C, SR-SA, 85% Felsic, 15% Mafic; moist; 2.5Y 4/2 dk grayish brn, mod rxn w/ HCL; poorly sorted.	4" core barrel 6" casing
10	GS				
15	GS	25%			
20	GS			18'-21' 60% Gravel, 30% Sand, 10% Silt Sandy Gravel (SG); Gravel: SR, 2cm-6cm, 75% Felsic, 25% Mafic; Sand: f-C, SR-SA, 80% Felsic, 20% Mafic; 2.5Y 4/3 brn; moist; mod rxn w/ HCL	
25	GS	75%		21'-31' 70% Gravel, 10% Sand, 20% Silt Silty Gravel (mG); Gravel: 60% Felsic, 40% Mafic, SR, 8mm-4cm, 2cm avg; Sand: 60% Mafic, 40% Felsic, SA-SR, f-C; 2.5Y 4/2 dk grayish brown; moist; Slight rxn w/ HCL, poorly sorted.	Drillers note drilling more difficult @ ~25' bgs
30	GS			31'- 70% Gravel, 25% Sand, 5% Silt Sandy Gravel (SG); Gravel: 8mm-8cm, SR, 70% Felsic, 30% Mafic; Sand: m-vc, SA-SR, 70% Mafic, 30% Felsic; poorly sorted, wet, 2.5Y 4/2 dk gray; no rxn w/ HCL	
35	GS	50%			

Reported By: Ken Russell

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: Ken Russell

Date: 6/22/15

Signature: Kevin Bergstrom

Date: 9/10/2015





**BOREHOLE LOG**

Date: 6-18-15

Well ID: C9408 9/22/15 Well Name: 399-1-65 Location: 300 Area N of PNNL

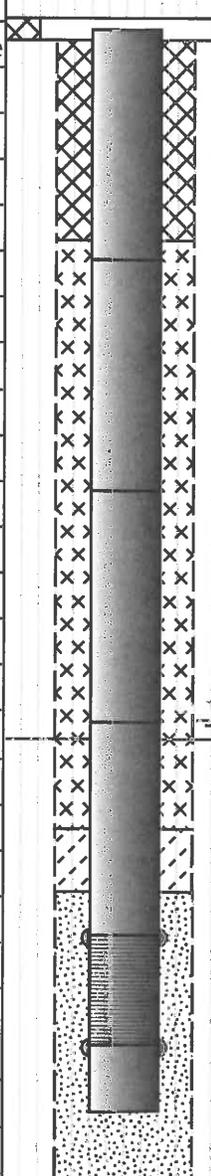
Project: Aquifer Monitoring Well 300-FF-5 Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0'-0.4' Gravel drill pad / Fill	Terrasonic 150 CC
				0.4'-11.4' Sandy Gravel (SG): 60% Gravel, 40% Sand; Gravel: SR, 20% Felsic 80% Mafic, 10cm max; Sand: 40% Felsic 60% Mafic, f-c, SR-SA; poorly sorted; Dark gray 2.5Y4/; mod rxn w/ HCL; dry.	Drill rig 4" core barrel 6" casing
5	GS	70%			
10	GS			Sandy K AB 11.4'-18' Silty Gravel (m <sup>s</sup> G): 70% Gravel, 10% Sand, 20% Silt; Gravel: SR, 70% Felsic 30% Mafic, 2mm-8cm; Sand: vf-c, 70% Felsic, 30% Mafic, SR-SR; poorly sorted; Dark gray 2.5Y4/; no rxn w/ HCL, moist.	Mafic vs 4/18/15
15	GS	80%			
20	GS			KB sandu 18'-30' Silty Gravel (m <sup>s</sup> G): 65% Gravel, 15% Sand; 20% Silt; Gravel: SR, sm pebbles - 8cm max, 4mm avg, 60% Mafic, 40% Felsic; Sand: vf-vc, SR-SA, 60% Mafic, 40% Felsic; 2.5Y4/ Dark gray; sl rxn w/ HCL, poorly sorted; moist	Increased sand Content
25	GS	60%			
30	GS			30'-38' 60% Gravel, 20% Sand, 20% Silt; Silty sandy gravel (m <sup>s</sup> G); Gravel: SR, 2mm-8cm max, 4cm avg.; 70% Mafic, 30% Felsic; Sand: SA-SR, f-c, 70% Felsic, 30% Mafic; no rxn w/ HCL; moist; 2.5Y4/ very dk gray.	vs 4/18/15
35	GS	100%			No GS @ 35' due to elevated rad levels
				38'-40' 70% Gravel, 20% Sand, 10% Silt; Sandy Gravel (SG)	

Reported By: Jan Russell Title: Geologist Signature: Jan Russell Date: 6/19/15

Reviewed By: Kevin Bergstrom Title: Sr. Geologist Signature: K Rm Date: 9/10/2015



<b>WELL SUMMARY SHEET</b>		Start Date: 6/17/15		Page <u>1</u> of <u>1</u>	
		Finish Date: 8/6/15			
Well ID: C9409		Well Name: 399-1-66			
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU			
Prepared By: Tessa Clark		Date: 9-28-15		Reviewed By: J.D. MEHRER	
Signature: <i>Tessa Clark</i>		Signature: <i>J.D. Mehrer</i>		Date: 08-28-15	
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA			
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description	
<b>Surface Completion:</b>					
2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.		0		0.0 - 0.8: Gravel Drill Pad, G	
13 1/2" OD Protective Monument: 0.0' - 0.85' bgs		10		0.8 - 13.0: Silty Sandy Gravel, msG	
<b>Permanent Well:</b>		20		13.0 - 19.0: Sandy Gravel, sG	
2.375" OD PVC Blank: 0.4 - 39.48' bgs		30		19.0 - 23.0: Silty Sandy Gravel, msG	
2.375" OD PVC 0.020-slot Screen: 39.48' - 44.47' bgs		40		23.0 - 26.0: Silty Gravel, mG	
2.375" OD PVC Blank Casing: 44.47' - 47.10' bgs		50		26.0 - 29.0: Silty Sandy Gravel, msG	
				29.0 - 34.0: slightly Silty Sandy Gravel, (m)sG	
<b>Construction Materials:</b>				Depth to Water: 31.15' bgs (7/13/15)	
Concrete: 0.0' - 1.30' bgs				34.0 - 43.5: Sandy Gravel, sG	
Surface Seal: 1.30' - 9.80' bgs				43.5 - 44.0: Silty Sandy Gravel, msG	
Bentonite Chips: 9.80' - 35.10' bgs				44.0 - 50.5: Sandy Gravel, sG	
Bentonite Pellets: 35.10 - 37.95' bgs				<b>Total Depth = 50.1' bgs (6/17/15)</b>	
10/20 Mesh Filter Pack Sand: 37.95' - 50.10' bgs				<b>OD = outside diameter</b>	
				<b>bgs = below ground surface</b>	
				<b>Centralizers: top of sump &amp; bottom of last blank riser.</b>	
All temporary 6" OD casing removed 6/17/15.					

**BOREHOLE LOG**

Page 1 of 2

Date: 6-17-15

Well ID: C9409

Well Name: 399-1-66

Location: 300 Area N. Process Ponds

Project: 300 Area U sequestration Remedial Action

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0.0-0.8': Gravel Pad.	Sonic w/ 5" x 11" core barrel.
0.8-13'				0.8-13': silty sandy gravel sG (70%G, 20%S, 10%M) v. pr. srt'd. v. w. rtd. v.f. pbl. - sm. cbl. of 20-75% bsth/20% mafic Meta > int. Volc. w/ fm. v.c. sub-ang. S. 70% mafic, 30% felsic. moist. 2.5Y 7/2 v. drk graysh. brown. mod. rxn w/ HCl. unconsolidated.	5': g.s. (grab sample)
5	g.s.	60%		• 5': v. pr. srt'd. similar to above. max elast: 70 mm. non plastic. matrix silts continuous. moist	
10	g.s.			• 11-13': Normal grading pbb. sp. cont. (70%G, 20%S, 10%M) 11': g.s. v.f. pbl. - sm. cbl. v. w. rtd. of 20% bsth/20% felsic. w/ v.f. v.c. sub-ang. S. 2.5Y 7/2 v. drk grayish brown. non plastic. non cohesive. moist. max elast: 120 mm. no rxn w/ HCl.	
15	g.s.	20%		13-17': sandy Gravel sG (75%G, 25%S) trace - 5%M mod. - pr. srt'd. bi-modal size: v.f. - m. pbl. w/ ~20% v.c. pbl. of 95% bsth/5% felsic. Meta > int. Volc. w/ m-v.c. sub-ang. S. of 79% mafic. 1% felsic. 2.5Y 7/2 black. no rxn w/ HCl.	15': g.s.
20	g.s.			• 13-18': bi-modal fractions: 20% fm. m. pbl. / 20% v.c. pbl. • 18-19': bi-modal fractions: 20% v.f. pbl. / 20% v.c. pbl.	20': g.s.
20	g.s.			19'-23': silty sandy Gravel mG (60%G, 20%S, 20%M) v.f. - c. pbl. v. w. rtd. - mod. srt'd. of 20% bsth/20% felsic w/ v.f. - m. ang. S. 2.5Y 7/2 v. drk. grayish brown. non plastic. mod. consolidated.	
25	g.s.	20%		• 19.5': 3cm silt lense w/ 20% 2.5Y 7/2 v. drk. gray mottled w/ 20% 7.5YR 5/6 strong brown. faint stringers of strong brown apparent non plastic. - most of unit ground to dry powder. -	23': g.s.
25	g.s.			25-26': silty Gravel mG (80%G, 20%M, trace S) v. w. graded. m. pbl. - sm. cbl. of v. w. rtd. of 20% bsth/20% mafic 80% bsth/20% mafic. w/ v.f. S. + 2.5Y 7/3 v. drk grayish brown silt. - non mod. plastic	28': g.s.
30	g.s.			• 23': 2" layer w/ silt colored matrix of 7.5Y 7/6 strong brown. • base of unit * 6-17-15	
30	g.s.			26-29': silty sandy Gravel sG (70%G, 20%S, 10%M) mod. srt'd. grading to v. pr. srt'd. w. graded bed. of v.f. - m. pbl. grading to v.f. - lg. cbl. max range: from 4mm to 150 mm. w/ v.f. - v. crs. S. of 95% bsth/5% felsic int. Volc. > Meta. 2.5Y 7/2 v. drk. grayish brown. moist. mod. rxn w/ HCl.	

Reported By: A. Lantieri Reviewed By: BA WILLIAMS  
 Title: Geo. Tech. Title: SR. GEOLOGIST  
 Signature: Aaron Lantieri Date: 6-17-15 Signature: [Signature] Date: 9/22/15

**BOREHOLE LOG**

Date: 6.17.15

Well ID: C9409

Well Name: 399-1-66

Location: 300 Area N. Process Ponds

Project: 300 Area U Sequestration Remedial Action

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
30				29-34': slightly silty sandy gravel sG (75%G, 15%S, 10%M). v. pr. srt'd. sub-w. rdd. v.f. pbl.-sm.cbl. max: 120mm of 75% bslt/25-20% felsic int. Volc. Meta. w/ v.f.-v.c. sub-rdd. S. of 95% Modic comp. pr. consolidated. non plastic matrix. silt.	Sonic w/ 5" x 1' core barrel.
35				25Y 1/2 drk. drk. grayish brown. - no black silty gravel bed @ 31.1' in adjacent well. 37'-37.5': sandy Gravel sG (78%G, 12% S) trace m.	33' g.S.
40				pr. srt'd. v.f. pbl.-sm.cbl. sub-w. rdd. of 75% bslt/25% felsic Meta. > int. v. trace S.S. i/w/ c.-v.c. sub-rdd S. of 95% bslt/5% felsic 5Y 1/2 drk olive gray. wet. wk. rxn w/ HCl weathy. no visible bed-forms. (approx. 6.17.15) (approx. 5.17.15)	35' g.S.
45				37.5-43.5': sandy Gravel sG (60%G 35%S, 5%M) v. pr. srt'd. m. pbl.-sm.cbl. of 95% bslt > and. / 5% felsic-Qtzite. max: 120mm w/ s/ps. bldr of bslt. 400mm+. avg: c.pbl. v.w. rdd. 20-30mm. matrix of v.f.-m. felsic Qtz-felds. S. sub-ang.	42' g.S.
50				7.5Y 5/6 strong brown. abnt. fa. mica. non plastic. 37.5-39': v. deep orange brown rust colored matrix. darker orange seems to be associated w/ slight increase in silt content ~10-5% no rxn w/ HCl.	44.5' g.S.
				43.5-44': silty sandy Gravel sG (60%G, 30%G, 10%M) Black 10YR 3/6 black silty sand matrix supported pebble gravel bed- or silty sand conglomerate. i. v.w. rdd. fa.-m. pbl. of bslt. w/ v.f.-m. S. no rxn. w/ HCl. non plastic.	48' g.S.
				44-47': sandy Gravel sG (78%G 12% S) (75%G, 25% S) mod. srt'd. v.w. rdd. m. pbl.-v.c. pbl. of 99% bslt. > and. / 1% Qtzite. w/ m.-c. ang. felsic S. abnt. mica. 95% Qtz-felds. 10YR 5/6 yellowish brown. clasts Fe oxidized-stained. no rxn w/ HCl wet. unconsolidated. trace m. no visible bed-forms.	T.D. @ 50.0'
				47-50.5': sandy Gravel sG (75%G, 25% S) mod. srt'd. v.w. rdd. m.-c. pbl. of 95% bslt. > and. / 5% Qtz. w/ m.-c. ang. felsic S. 95% Qtz-felds. 2.5Y 7/4 lt. olv. brn. no rxn. w/ HCl. unconsolidated. same as unit above but no oxide.	DTW @ 51.15' bgs

Reported By: <u>A. Lantz</u>	Reviewed By: <u>RA WILLIAMS</u>
Title: <u>Geo. Tech.</u>	Title: <u>SR. GEOLOGIST</u>
Signature: <u>A. Lantz</u>	Signature: <u>[Signature]</u>
Date: <u>6.17.15</u>	Date: <u>9/22/15</u>



**BOREHOLE LOG**

Page 1 of 2

Date: July 14, 2015

Well ID: C9451

Well Name: 399-1-80

Location: 300 Area N of PNNL

Project: 300FFS 30 Well installation FY15

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				Ground surface to 0.50 ft bgs Drill pad / Backfill	Aquifer
0-5	g.s.				Drilling is being conducted w/ a
5	g.s.			0.5 ft bgs to 9.80 ft bgs. sg Formation	Terrasonek 150CC 7" casing 4" core
				45% Sand 55% Gravel Sand: med. to coarse grain, mod sorted ~ 60% mafic 40% felsic sub angular.	S.S = Split Spoon
10				Gravel: 10mm to 150mm sub angular to sub round. to mod to poorly sorted 60% mafic 40% felsic	Grain samples are collected in 5ft intervals
	I-001 g.s.			2.5 Y 3/3 Dark olive brown weak reaction to HCL	Split Spoons I-001D B31N62
15	I-002 g.s.			Dry	I-001C B31N63
	I-003 g.s.				I-001B B31N65, B31N64
	I-004 g.s.				I-001A B31N66
20	I-005 g.s.			9.80 to 29.00 ft bgs. msG Formation	I-002D No Recovery I-002C No Recovery
	I-006 g.s.			10% silt 45% Sand 45% Gravel Sand fine to very coarse. mod sort. sub angular to angular 60% mafic 40% felsic	I-002B B31N70 B31N69
	I-007 g.s.				I-002A B31N71
	I-008 g.s.				I-002D B31N72
	I-009 g.s.				I-003C B31N73
25	I-010 g.s.			Gravel: 2mm to 200mm sub angular to sub round. poorly sorted. 60% mafic 40% felsic	I-005B B31N74 B31N75
	I-011 g.s.				I-003B B31N76 (DUP)
	I-012 g.s.				I-003A B31N77
	I-013 g.s.				I-004D B31N78
	I-014 g.s.			2.5 Y 3/1 very dark gray damp / Dry	I-004C B31N79
30	I-015 g.s.				I-004B B31N80 B31N81
	I-016 g.s.				I-004A B31N82
	I-017 g.s.				I-005D No Recovery
	I-018 g.s.			29.00 ft bgs to 50.50 ft bgs Formation	I-005C B31N84
	I-019 g.s.			10% silt 20% Sand 70% gravel Sand: fine to coarse, Angular poorly sorted 60% mafic 40% felsic	I-005B B31N85 B31N86
35					I-005A B31N87
					I-006A B31N90 B31N91
					I-007A B31N96 B31N97
					I-008D No recovery
					I-008C B31N80
					I-008B B31N81 B31N82

Reported By: Candice Burnett Kildall

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: [Handwritten Signature]

Date:

Signature: [Handwritten Signature]

Date: 9/9/2015

BOREHOLE LOG					Page <u>2</u> of <u>2</u>
Well ID: <u>C9451</u>		Well Name: <u>399-1-80</u>		Location: <u>300 Area North of PNA</u>	
Project: <u>300-FF-5 30 well installation FY15</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	g-5			<u>29.00 ft to 51 ft Conti</u> <u>Gravel: 2mm to 800mm ~80%</u> <u>of the gravels are between</u> <u>2mm and 10mm. Angular to</u> <u>round. Rounding increase with</u> <u>size. 60% mafic 40% felsic</u> <u>2.5 y 3/2</u> <u>wet</u> <u>No reaction to HCL</u>	<u>Aquifer Well</u>  <u>Drilling is</u> <u>being conducted</u> <u>with a terrasonic</u> <u>150 cc vig</u> <u>7" casing</u> <u>4 1/10" core barrel</u>
45		g-5			
50				<u>41.00 ft to 49 (rip up?)</u> <u>Formation</u> <u>15% silt 40% Sand 45 % Gravel</u> <u>Sand: med. grain well to med</u> <u>sorted sub angular ~40% mafic</u> <u>60% felsic</u> <u>Gravel: ~10mm to 150mm sub</u> <u>angular poorly sorted</u> <u>35% mafic 65% felsic</u> <u>No reaction to HCL</u> <u>Wet. 2.5 y 5/6 light olive brown</u> <u>silt has low plasticity</u> <u>@ 48.5 ft bgs the is</u> <u>a color change 2.5 y 2.5/1 black</u> <u>most likely a reducing zone.</u>	<u>Split spoon Sample Con:</u> <u>T-009A-B 3/1N57 B 3/1N56</u> <u>T-009B No recovery</u> <u>T-009C No recovery</u> <u>T-009D No recovery</u>
				<u>TD 50-50' (7-14-15) ft bgs</u> <u>DWT 31.78 ft bgs</u>	

Reported By: <u>Candice Burnette Vidall</u>		Reviewed By: <u>Kevin Bergstrom</u>	
Title: <u>Geologist</u>		Title: <u>Sr. Geologist</u>	
Signature: <u>[Signature]</u>	Date: <u>7/14/15</u>	Signature: <u>[Signature]</u>	Date: <u>9/9/2015</u>

<b>WELL SUMMARY SHEET</b>		Start Date: 6/24/2015		Page <u>1</u> of <u>1</u>		
Well ID: C9453		Well Name: 399-1-82				
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU				
Prepared By: Marques Miller		Date: 9/24/15		Reviewed By: <b>J.D. MEHRER</b>		
Signature: <i>Marques Miller</i>		Signature: <i>J.D. Meherer</i>		Date: 10-28-15		
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
<b>Surface Completion:</b>						
2'x1.95' Flush mount concrete pad w/brass survey marker.		0		0.0' - 0.2': Gravel Drill Pad, G		
13 1/2" OD Protective Monument: 0.0' - 0.85' bgs				0.2' - 3.0': Silty Sand, mS		
					3.0' - 18.20': Sandy Gravel, sG	
				10		
<b>Permanent Well:</b>						
2.37" OD PVC Blank: 0.50' - 40.50' bgs						
2.37" OD PVC 0.020-slot Screen: 40.50' - 45.55' bgs						
2.37" OD PVC Blank: 45.55' - 48.30' bgs						
				20	18.20' - 19.80': Sand, S	
					19.80' - 40.50': Sandy Gravel, sG	
				30	Depth to Water: 31.40' bgs (6/30/15)	
<b>Construction Materials:</b>						
Concrete: 0.0' - 1.80' bgs						
Neat Grout: 1.80' - 10.0' bgs						
Bentonite Chips: 10.0' - 32.10' bgs						
Bentonite Seal: 32.10' - 35.60' bgs						
10/20 Mesh Filter Pack Sand: 35.60' - 51.0' bgs						
		40	40.50' - 41.70': Gravelly Silty Sand, gmS			
			41.70' - 51.0': Sandy Gravel, sG			
		50	<b>Total Depth = 51.0' bgs (6/24/15)</b>			
			<b>OD = outside diameter</b>			
			<b>bgs = below ground surface</b>			
			<b>Centralizers: top of sump &amp; bottom of last blank riser.</b>			
All temporary 6" OD casing removed 6/24/15.						

**BOREHOLE LOG**

Page 1 of 2

Date: 6.24.15

Well ID: C9453

Well Name: 399-1-82

Location: N of PNNL 300 Area

Project: 30 Well 300-FF-5 FY15

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0'-0.2' bgs well pad gravel	Aquifer well
0.2				0.2' - 3' bgs Silty Sand (MC): 40% m, 60% S, 5% G. Sand: med grain, med sorted, sub ang, 30% mafic, 70% felsic. Gravel: max 80 mm clast, rounded, med sorted, 70% mafic, 30% felsic. 10 YR 7/8 dry. weak RXN HCl.	Drilling was conducted with a Terrasonic 150 CC 6" casing 4" x 10' core barrel
3				3' - 18.2' bgs Sandy Gravel (SG): 50-60% S, 40-50% G, 5-10% M. Sand: med-coarse, med sorted, ang-sub ang, 70-80% mafic, 20-30% felsic. Gravel: max 100mm clast, rounded-sub rdd, med sorted, 50-60% mafic, 40-50% felsic. 5 Y 0/1 Dry. Mod RXN HCl @ 8.7' bgs. No RXN otherwise.	g.s = grab sample grab samples well collected in 8" intervals and @ lithology changes.
18.2				18.2' - 19.8' bgs Sand (S): med grain, ang-sub ang, well sorted, 30-40% mafic 60-70% felsic. 2.5 Y 6/1 Dry. weak RXN HCl. sandy Gravel (SG)	
19.8				19.8' - 28.5' bgs Gravelly Sand (GS): 70% S, 30% G, 5-10% M. Sand: med-coarse grain, med sorted, ang-sub ang, 70% mafic, 30% felsic. Gravel: 140mm max clast, well rdd-sub rdd, med sorted, 50-60% mafic, 40-50% felsic. 2.5 Y 6/1 Dry. NO RXN HCl.	TD 50.50 DTW 32.30
28.5				28.5' - 40.5' bgs Sandy Gravel (SG): 40% S, 60% G, 5% M. Sand: med-coarse grain, med sorted, ang-sub ang, 60-70% mafic, 30-40% felsic. Gravel: Max 130 mm clasts, well rdd-sub rdd, poor sorted, 60-65% mafic, 40-35% felsic, 2.5 Y 5/1. No RXN HCl. Wet starting @ 39' bgs.	

Reported By: MARJORIS MILLER Candice Kiddall Reviewed By: Kevin Bergstrom  
 Title: Geologist / Geologist Title: Sr. Geologist  
 Signature: [Signature] Date: 6.24.15 Signature: [Signature] Date: 9/10/2015

**BOREHOLE LOG**

Page 2 of 2

Date: 6.24.15

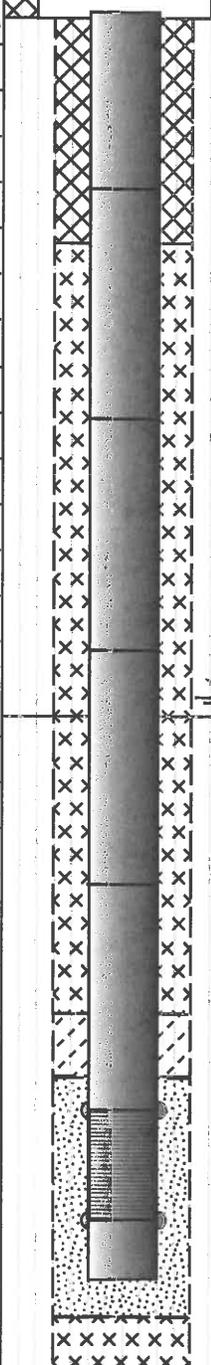
Well ID: C 94 53 Well Name: 399-1-82 Location: N & PNNL 300 Area

Project: 30 well, 300-FF-5 FY 2015 Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40			S.D. 	Coarsely Silty Sand (GS)	Aquifer well
40.5 - 41.7	gs			bgs Silty Sand (GS) (mat): 30% M, 50% S, 20% G, Sand: fine-med grain, mod sorted, ang-sub ang, 40% mafic, 60% felsic. Gravel: max 50mm clast, well sorted, well rdd-sub rdd, mod sorted, 50-60% felsic, 40-50% mafic. 2.5 y b/b wet. No PXN Hcl wet.	Drilling was conducted with a Terra Seismic 1500C 6" casing 4"x10" core barrel
45	gs			41.7' - 50' bgs Sandy Gravel (SG): 60% S, 40% G. Sand: med-grain well sorted, sub ang, 20-25% mafic, 75-80% felsic. Gravel: max 70mm clast, well rdd-sub rdd, well sorted, 30-40% mafic, 60-70% felsic. Clay 2 4/5 b wet. No PXN Hcl wet. Organics @ 44.5' bgs.	gs - grab sample
50				47' - 49' bgs sand lens.	

Reported By: MARQUES MILLER / Candice Kildan Reviewed By: Kevin Bergstrom  
 Title: Geologist / Geologist Title: Sr. Geologist  
 Signature: [Signature] Date: 6-24-15 Signature: [Signature] Date: 7/10/2015

24 mm 6.24.15

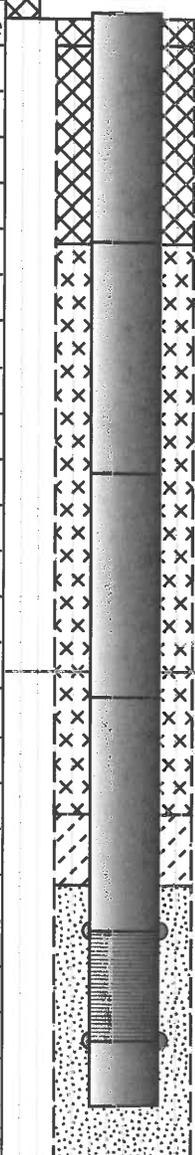
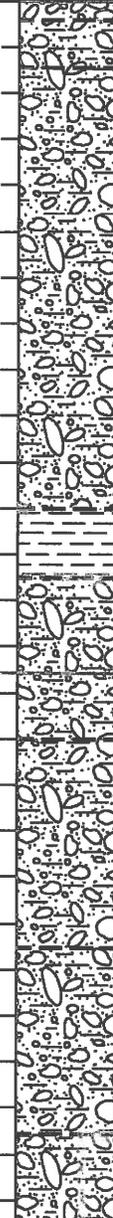
WELL SUMMARY SHEET		Start Date: 6/25/15		Page 1 of 1			
		Finish Date: 8/6/15					
Well ID: C9455		Well Name: 399-1-84					
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU					
Prepared By: Tessa Clark		Date: 9-28-15		Reviewed By: J.D. MEHRER			
Signature: <i>Tessa Clark</i>		Signature: <i>J.D. Mehrer</i>		Date: 10-28-15			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA					
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description			
<b>Surface Completion:</b>							
2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.		0		0.0 - 0.9: Gravel Drill Pad, G			
13 1/2" OD Protective Monument: 0.0' - 0.75' bgs				0.9 - 39.0: Silty Sandy Gravel, msG			
<b>Permanent Well:</b>		10					
2.375" OD PVC Blank: 0.40 - 48.01' bgs							
2.375" OD PVC 0.020-slot Screen: 48.01' - 53.02' bgs							
2.375" OD PVC Blank Casing: 53.02' - 55.66' bgs				20			
<b>Construction Materials:</b>							
Concrete: 0.0' - 1.6' bgs							
Surface Seal: 1.6' - 10.2' bgs							
Bentonite Chips: 10.2' - 42.0' bgs							
Bentonite Pellets: 42.0' - 44.7' bgs							
10/20 Mesh Filter Pack Sand: 44.7' - 57.0' bgs							
Bentonite Pellets: 47.0' - 60.0' bgs							
All temporary 6" OD casing removed 6/25/15.				30	Depth to Water: 32.8' bgs (7/14/15)		
				40	39.0 - 40.0: Gravel, G		
					40.0 - 41.0: Silty Gravel, mG		
					41.0 - 46.0: Silt, M		
					46.0 - 53.0: Silty Sandy Gravel, msG		
				50			
					53.0 - 58.0: Silty Gravel, mG		
					58.0 - 60.0: Silty Sandy Gravel, msG		
					<b>Total Depth = 60.00' bgs (7/14/15)</b>		
<b>OD</b> = outside diameter							
<b>bgs</b> = Below Ground Surface							
<b>Centralizers:</b> top of sump & bottom of last blank riser.							

BOREHOLE LOG					Page 1 of 3
Well ID: C9455		Well Name: 399-1-84		Location: 300 Area W of PNNL	
Project: 30 Wells 300-FF-5 FY 15			Reference Measuring Point: Ground Surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				Ground surface to 0.9'	Aquifer
				Backfill / Drill Pad	
0-5	g-s	100% recovery			Drilling is being conducted with a
5	g-s			090 ft to 4.00 ft bgs MSG	Sam's rig
				15% silt 40% sand 45% Gravel	6" casing
				Formation:	4" x 10' core barrel
				Sand: fine to coarse, poorly sorted	
				sub-angular 60% mafic 40%	
				felsic	
10	g-s			Gravel: 10mm to 100mm sub angular	
				to sub-round 60% mafic 40% felsic	
				Weak to moderate reaction to HCL	
				2.5 Y 3/8 dark olive brown	
				Dry	
15	g-s	60% recovery		4.00 ft to 16.00 ft bgs MSG	Recovery
				Formation: Hanford	0-10' = 100%
				16% silt 35% sand 55% Gravel	10-20' = 60%
				Sand: fine to coarse poorly sorted	20-30' = 90%
				Angular 60% mafic 40% felsic	30-40' = 60%
20	g-s			Gravel: 2mm to 150mm, poorly	40-50' = 100%
				sorted sub angular to sub-round	50-60' = 100%
				60% mafic 40% felsic	
				Weak to mod reaction to HCL	
				2.5 Y 3/1 very dark gray	
				Dry	
25	g-s	90% recovery			
				16.00 ft to 39 ft bgs MSG	TD: 60.06 ft bgs
				Formation: Hanford	DTW: 32.00 ft bgs
				10% silt 50% sand 40% Gravel	
30	g-s			Sand: fine to very coarse, poorly	
				sorted Angular 60% mafic 40% felsic	
				Gravel CR 4/25/15	
				Gravel: 2mm to 170mm (~90% of	
				the gravels are under 50mm)	
				Angular to sub round, rounding	
				increase w/ size.	
				60% mafic 40% felsic	
35	g-s	60% recovery		Weak reaction to HCL (dAMP)	

Reported By: Candie Burnett Kildall	Reviewed By: Kevin Bergstrom
Title: Geologist	Title: Sr. Geologist
Signature: <i>[Signature]</i>	Signature: <i>[Signature]</i>
Date: 6/25/15	Date: 9/9/2015

BOREHOLE LOG					Page <u>2</u> of <u>3</u>
Well ID: <u>C 9455</u>		Well Name: <u>399-1-84</u>		Location: <u>300 Area N of PNNI</u>	
Project: <u>30 Wells 300-FF-5 FY 15</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	gs	100% Recovery		16.00ft to 39.00 Continued	Aquifer well
				2.5 Y <sup>3/4</sup> very dark gray.	
45	gs	100% Recovery		@ ~ 18.00 ft bgs is 0.10' of carbonate chunks - strong reaction to HCl. Dry. 2.54 8/1 white.	Drilling is being conducted with a Terrasonic 150 cc 6" casing 4" x 10' core barrel
50	gs			@ 29.00 ft to 29.50 ft bgs there is 2.54 6/3 light yellowish brown clay surround the gravels.	
55	gs	100% Recovery		@ 39 ft to 40 ft Gravel bed/lens average size of the gravel = 35 mm. sub round no color change.	
60	gs			40ft to 41.00 ft bgs mG Formation: 40% silt 10% sand 50% Gravel Sand: very fine grain rounded mica, 20% matc 80% felsic Gravel: Average 50mm sub angular 40% matc 60% felsic.	
				41ft to 46.00 ft bgs <sup>OK</sup> <sub>6/5</sub> (m) Formation: 100% silt small wood flecks found @ ~ 43' and 45' moist to dry - (hard compact poss. bgs from drilling method) 2.54 2 3/4 black No reaction to HCl	
				46.00ft to 53.00 ft bgs mSLr Formation 40% silt 25% sand 30% Gravel Sand: fine to med grain; poorly sorted sub angular (mica) 40% matc 60% felsic Gravel: 2mm to ~100mm	
Reported By: <u>Candice Burnette Kildall</u>			Reviewed By: <u>Kevin Bergstrom</u>		
Title: <u>Geologist</u>			Title: <u>Sr. Geologist</u>		
Signature: <u>[Signature]</u>		Date: <u>6/25/15</u>	Signature: <u>[Signature]</u>		Date: <u>9/9/2015</u>



<b>WELL SUMMARY SHEET</b>		Start Date: 6/22/15		Page <u>1</u> of <u>1</u>		
		Finish Date: 8/6/15				
Well ID: C9457		Well Name: 399-1-86				
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU				
Prepared By: Tessa Clark	Date: 9-28-15	Reviewed By: J.D. MEHRER	Date: 10-28-15			
Signature: 		Signature: 				
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
<b>Surface Completion:</b>						
2'x2'x 0.75' bgs Flush mount concrete pad w/brass survey marker.		0		0.0 - 0.25: Gravel Drill Pad, G		
13 1/2" OD Protective Monument: 0.0' - 0.75' bgs		10		0.25 - 3.3: Silty Sandy Gravel, msG		
<b>Permanent Well:</b>		20		3.3 - 22.0: Silty Sandy Gravel, msG		
2.375" OD PVC Blank: 0.50- 40.39 bgs		30		22.0 - 25.0: Silt, M		
2.375" OD PVC 0.020-slot Screen: 40.39' - 45.39' bgs		40		25.0 - 32.0: Silty Sandy Gravel, msG		
2.375" OD PVC Blank Casing: 45.39' - 48.02 bgs		50		32.0 - 41.0: Silty Sandy Gravel, msG		
<b>Construction Materials:</b>						
Concrete: 0.0' - 2.0' bgs						
Grout Surface Seal: 2.0' - 10.5' bgs						
Bentonite Chips: 10.5' - 35.1' bgs						
Bentonite Pellets: 35.1 - 38.0' bgs						
10/20 Mesh Filter Pack Sand: 38.0' - 50.1 bgs						
All temporary 6" OD casing removed 6/22/15.						
<b>OD = outside diameter</b>						
<b>bgs = Below Ground Surface</b>						
<b>Centralizers: top of sump &amp; bottom of last blank riser.</b>						
				Depth to Water: 29.14' bgs (7/20/15)		
				<b>Total Depth = 50.10' bgs (6/23/15)</b>		

BOREHOLE LOG					Page <u>1</u> of <u>3</u>
Well ID: <u>C9457</u>		Well Name: <u>399-1-86</u>		Location: <u>300 Area N of PNNL</u>	
Project: <u>31 wells in 300-FF-5DU FY2015</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0			0.0	Ground surface to 0.25'	Drilling was
			0.0	Backfill / Drilling pack.	conducted
			0.0		w/ Terra Sonic 150CC
9.5			0.0	0.25' to 3.30'	6" casing
			0.0	Formation (msg)	4" core barrel
5			0.0	10% silt 40% sand 50% G	
			0.0	Sand: fine to coarse, very poorly sorted	g.s = grab sample
			0.0	sub angular ~40% mafic 60% felsic	
9.5			0.0	Gravel: 2mm to ~40mm, sub	Grab samples and
			0.0	angular to sub round.	chip trays samples
10			0.0	60% mafic to 40% felsic	were collected
			0.0	Weak reaction to HCl	every 5' for
			0.0	2.5 Y 3/2 very dark gray sh brown.	archive.
			0.0	Dry	
15			0.0	3.30' to 22.00ft bgs	
			0.0	Formation: Hanford (msg)	
			0.0	10% silt 35% sand 55% Gravel	
			0.0	Sand: fine to coarse very poorly	
			0.0	sorted sub angular 40% mafic	
20			0.0	60% felsic	
			0.0	Gravel: 2mm to small boulder	
			0.0	poorly sorted; angular to sub round	
			0.0	70% mafic ~30% felsic	
			0.0	@ ~11 ft 0.5 ft of mod.	
25			0.0	sorted sub round gravel lens	
			0.0	average size ~15mm (possible	
			0.0	artifact of drilling method.)	
			0.0	weak to no reaction to HCl	
			0.0	2.5 Y 3/1 very dark gray	
30			0.0	Dry	
			0.0	22.00 ft to 25.00 ft (m)	
			0.0	Ringold rip up clast	
			0.0	90% silt 0% sand 10% Gravel	
			0.0	Low plasticity to no plasticity.	
35			0.0	gravels are poorly sorted subangular	
			0.0	~80% mafic and located @ the	
			0.0	margin of the clast	

Reported By: <u>Candice Burnette Kildall</u>	Reviewed By: <u>Kevin Bergstrom</u>
Title: <u>Geologist</u>	Title: <u>Sr. Geologist</u>
Signature: <u>[Signature]</u>	Signature: <u>[Signature]</u>
Date: <u>6/23/15</u>	Date: <u>9/9/2015</u>

**BOREHOLE LOG**

Page 2 of 3

Date: June 23, 2015

Well ID: C9457 Well Name: 399-1-86 Location: 300 Area N of PNNL

Project: 31 well 300 FF-5 FY 15 Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	g.s.	100% recovery		25.00 ft bgs to 32 ft bgs (MSG) 10% silt 45% S 45% G (Hanford) Sand fine to very coarse, very poorly sorted Angular 70% matic 50% felsic Gravels: 2mm to ~100mm	Drilling is being conducted w/ a Terra Sonic 150 cc v.g 6" casing 4" x 10' core barrel
45				Sub angular to sub rounded size increases down unit ~70% matic 30% felsic No reaction to HCL 2.5Y 3/1 very dark gray moist	g.s = grab sample collected is 5 ft intervals for Archive.
50	TD 49.8 ft	bgs		32.00 - 41.00' Formation: Hanford (MSG) 15% silt 10% sand 75% gravel Sand: fine to coarse poorly sorted angular ~60% matic 60% felsic Gravel ~2mm to 100mm sub round to well round 70% matic 30% felsic No reaction to HCL 2.5Y 3/1 very dark gray moist	Water tagged: 42.00 ft bgs 6/23/15
				41' to 49' Formation (MSG) 15% silt 40% sand 45% Gravel Sand: fine to coarse, poorly sorted sub angular 30% matic 70% felsic large mica flakes Gravel 2mm to 130mm sub round to well round, poorly sorted lots (20% chert) overall 30% matic 70% felsic 2.5Y 4/3 olive brown No reaction to HCL Wet	

Reported By: Candice Burnette Kildall Reviewed By: Kevin Bergstrom

Title: Geologist Title: Sr. Geologist

Signature: [Signature] Date: 6/23/15 Signature: [Signature] Date: 9/9/2015



<b>SURVEY DATA REPORT</b>				Request No. 154-161		
Project No.	Title 300-FF-5 Wells Final Surveys			File No. 3AT10R28		
Job. No. CACN: 303500-JPRC	Prepared By N.P. Fastabend	Date 8/11/15	Reviewer <i>UBM</i>			
<b>DESCRIPTION OF WORK</b>			<b>DISTRIBUTION</b>	<b>SDR</b>	<b>PLOT</b>	<b>DWG</b>
Obtained final coordinates (C/L Casings) and elevations of 30 completed 300-FF-5 flush mount wells located on north side of 300 Area.  Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)			Survey File	OR		
			E.C. Rafuse	1		
			S.J. Trent	1		
			K.M. Whitley	1		
			J.B. Geiger	1		
			B.J. Howard	1		
			A.J. Green	1		
<b>SURVEY RESULTS AND COMMENTS</b>						
<p><b>See Attached Well Survey Data Report Sheets</b></p>						

## WELL SURVEY DATA REPORT

<b>Project:</b> Date Requested: 08/04/15 Date of Survey: 08/10/15 Fluor Hanford Point of Contact:	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC <b>Requestor:</b> Edward Rafuse (CHPRC) <b>Surveyor:</b> Lawrence B. Munnell (CHPRC) <b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C8931 (399-1-70) located on north side of 300 Area.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8931	399-1-70	594125.04	116508.83		Center of Casing
				114.822	"X" on Rim
				114.822	Brass Survey Marker

**Notes:**

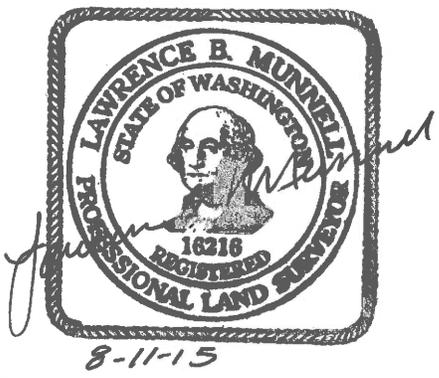
114.743 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
 Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b> 08/04/15	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC								
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)								
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)								
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C8934 (399-1-72) located on north side of 300 Area.	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8934	399-1-72	594080.16	116494.16		Center of Casing
				114.912	"X" on Rim
				114.915	Brass Survey Marker

**Notes:**

114.824' Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
 Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C8937 (399-1-74) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83(91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8937	399-1-74	594097.65	116475.26		Center of Casing
				114.917	"X" on Rim
				114.923	Brass Survey Marker

**Notes:**

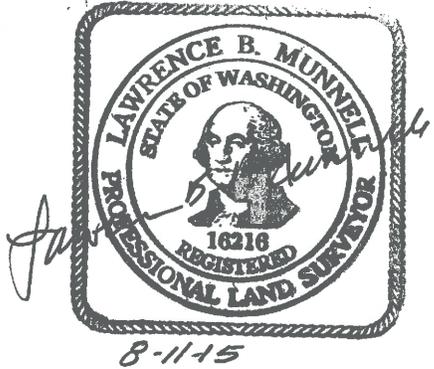
114.822 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b> 08/04/15	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC								
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)								
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)								
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C8940 (399-1-76) located on north side of 300 Area.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8940	399-1-76	594117.79	116460.62		Center of Casing
				115.231	"X" on Rim
				115.233	Brass Survey Marker

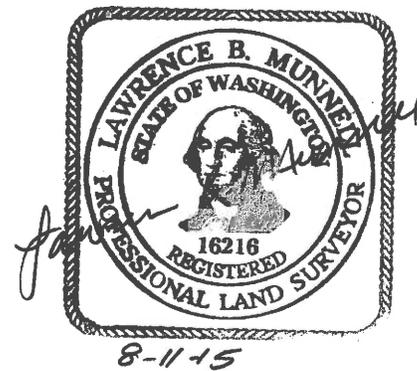
**Notes:**  
115.106 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
 Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C8942 (399-1-78) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C8942	399-1-78	594153.70	116463.17		Center of Casing
				114.895	"X" on Rim
				114.900	Brass Survey Marker

**Notes:**

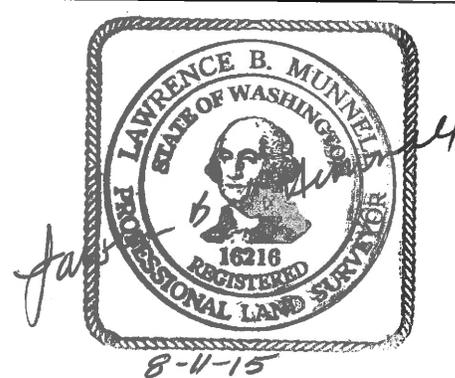
114.763 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9408 (399-1-65) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9408	399-1-65	594164.48	116481.19		Center of Casing
				114.692	"X" on Rim
				114.689	Brass Survey Marker

**Notes:**

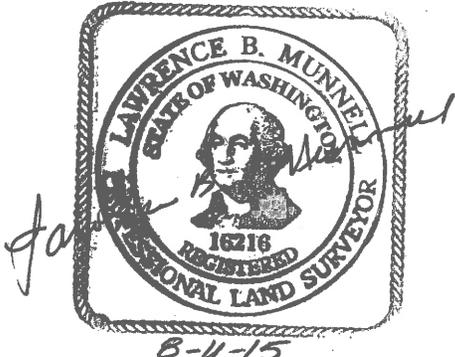
114.617 - Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9409 (399-1-66) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9409	399-1-66	594168.41	116504.97		Center of Casing
				114.629	"X" on Rim
				114.632	Brass Survey Marker

**Notes:**

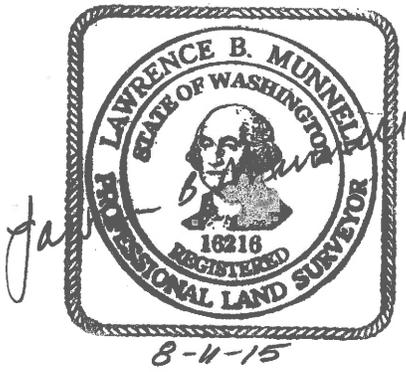
114.514 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9451 (399-1-80) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9451	399-1-80	594089.52	116454.78		Center of Casing
				114.977	"X" on Rim
				114.979	Brass Survey Marker

**Notes:**

114.881' Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9453 (399-1-82) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83(91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9453	399-1-82	594151.78	116427.47		Center of Casing
				115.064	"X" on Rim
				115.067	Brass Survey Marker

**Notes:**

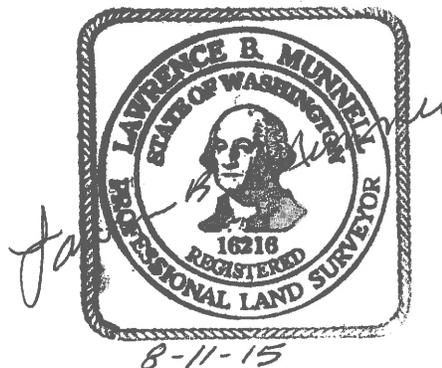
114.943 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



## WELL SURVEY DATA REPORT

<b>Project:</b> Date Requested: 08/04/15 Date of Survey: 08/10/15 Fluor Hanford Point of Contact:	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC <b>Requestor:</b> Edward Rafuse (CHPRC) <b>Surveyor:</b> Lawrence B. Munnell (CHPRC) <b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9455 (399-1-84) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91) <b>Vertical Datum:</b> NAVD88 <b>Units:</b> Meters <b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9455	399-1-84	594174.47	116451.41		Center of Casing
				114.943	"X" on Rim
				114.951	Brass Survey Marker

**Notes:**

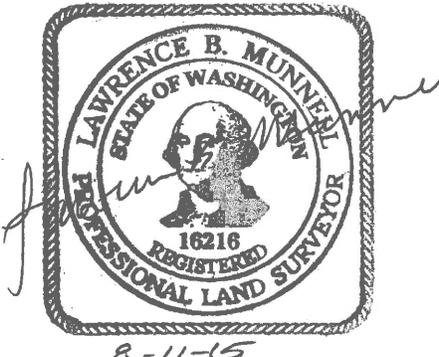
114.836 · Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
 Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9457 (399-1-86) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9457	399-1-86	594137.74	116478.66		Center of Casing
				114.970	"X" on Rim
				114.974	Brass Survey Marker

**Notes:**

114.865 Top Inner 2in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



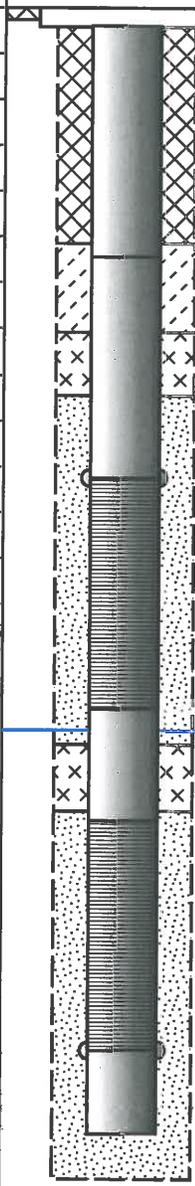
8-11-15

## Appendix C

### Well Documentation for Injection Wells

- Well Summary Sheet
- Borehole Log
- Final Survey Report

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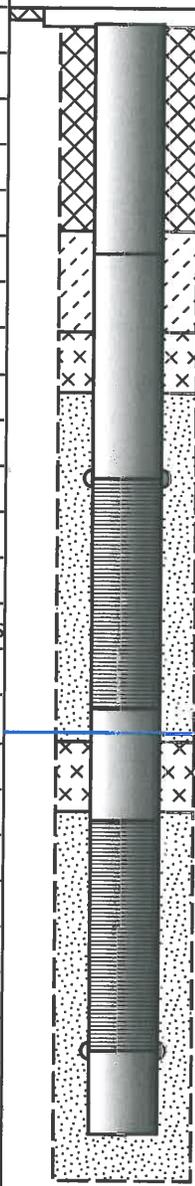
WELL SUMMARY SHEET		Start Date: 6/8/2015		Page <u>1</u> of <u>1</u>		
		Finish Date: 8/4/2015				
Well ID: C9460		Well Name: 399-1-89				
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU				
Prepared By: Marques Miller		Date: 9/17/15		Reviewed By: J.D. MEHRER		
Signature: <i>Marques Miller</i>				Signature: <i>J.D. Mehrer</i>		
				Date: 10-28-15		
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
<b>Surface Completion:</b>		0		0.0' - 0.25': Gravel Drill Pad, G		
2'x2' Flush mount concrete pad w/brass survey marker.				0.25' - 2.0': Silty Sandy Gravel, msG		
13 1/2" OD Protective Monument: 0.0' - 0.78' bgs					2.0' - 21.0': Sandy Gravel, sG	
<b>Permanent Well:</b>				10		
6.75" OD PVC Blank: 0.70' - 20.39' bgs						
6.75" OD PVC 0.050-slot Screen: 20.39' - 30.39' bgs						
6.75" OD PVC Blank: 30.39' - 35.39' bgs				20	21.0' - 38.0': Silty Sandy Gravel, msG	
6.75" OD PVC 0.050-slot Screen: 35.39' - 45.39' bgs						
6.75" OD PVC Blank: 45.39' - 48.90' bgs						
<b>Construction Materials:</b>				30	Depth to Water: 31.37' bgs (8/4/15)	
Concrete: 0.0' - 1.0' bgs						
Neat Grout: 1.0' - 10.20' bgs						
Bentonite Chips: 10.20' - 14.10' bgs						
Bentonite Seal: 14.10' - 16.89' bgs				40	38.0' - 42.0': Slightly Silty Gravelly Sand, (m)gs	
8/16 Mesh Filter Pack Sand: 16.89' - 31.99' bgs						
Bentonite Seal: 31.99' - 34.92' bgs						
8/16 Mesh Filter Pack Sand: 34.92' - 50.90' bgs				50	42.0' - 50.90': Silty Sandy Gravel, msG	
All temporary 10 3/4" OD casing removed 7/16/15.						
					<b>Total Depth = 50.90' bgs (7/16/15)</b>	
					<b>OD = outside diameter</b>	
					<b>bgs = below ground surface</b>	
					<b>Centralizers: top of sump &amp; bottom of last blank riser.</b>	

BOREHOLE LOG					Page 1 of 3
C9460		399-1-84		Date: 6/8/15	
Well ID: <del>399-1-84 KAS</del>		Well Name: C9460 KAS		Location: 300 Area N of PNUL	
Project: 30 well expansion			Reference Measuring Point: ground surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0	Litho	100% recovery		0' to 0.25' backfill (drill pad)	Terrasonic 150cc
0.25	gs			0.25' to 2.00 ft bgs	4'x10' core barrel
				Formation:	16" casing
				15% silt 30% sand 55% gravel	
5	gs			Sand: fine to coarse, sub rounded	g.s = grab sample
				40% matric 60% felsic Poorly sorted	
	Litho			Gravel: 2 mm to ~125 mm sub round	Litho = change
	gs			to sub angular 7% matric 30% felsic	in Litholog
10				2.5Y <sup>3/2</sup> very dark grayish brown (damp)	
				Strong reaction to HCL (dry)	
		90% recovery			Grab samples
					were collected
					over 9' interval
				2.00' to 9.00 ft bgs	
15	gs			Formation:	Litho samples
				10% silt 30% sand 40% Gravel	were collected
				Sand: fine to coarse, poorly sorted	@ the contacts
				sub angular 30% matric 70% felsic	
				Gravel: 2 mm to +200 mm (small cobbles)	Sieve samples
20	Litho			Poorly sorted, Angular to sub round	were collected
	gs			rounding increases w/ size	in 10' intervals
				60% matric 40% felsic	started @ 25' bgs
				2.5Y <sup>3/1</sup> very dark gray (damp)	
				mod. reaction to HCL (dry)	
25					
		100% recovery			
					TD 50.50' (7/15/15)
					DIW 30.76' (7/16/15)
				9.00' to 21.00' bgs	
30				Formation:	
				5% silt 40% sand 55% Gravel	
				Sand: Very coarse to coarse grain	
				mod to well sorted, sub round	
				40% matric 60% felsic	
				Gravel: 2 mm to 140 mm poorly sorted	
				sub to well rounded. 60% matric	
35				40% felsic	
				2.5Y <sup>3/1</sup> very dark gray (damp)	
				mod to weak reaction to HCL (dry)	

Reported By: Candie Kildall		Reviewed By: Kevin Bergstrom	
Title: Geologist		Title: Sr. Geologist	
Signature: <i>[Handwritten Signature]</i>	Date: 4/10/15	Signature: <i>[Handwritten Signature]</i>	Date: 9/10/2015

BOREHOLE LOG					Page <u>2</u> of <u>3</u>
Well ID: <u>399-1-89</u>		Well Name: <u>C 9460</u>		Location: <u>300 Area N of PNAK</u>	
Project: <u>30 well expansion</u>			Reference Measuring Point: <u>ground surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	<u>35' to 45'</u> <u>95</u> <u>100% recovery</u> <u>48'</u> <u>95</u> <u>3' sand sample 1st 3 45' to 50'</u> <u>95</u> <u>55'</u>		0.0	<u>21.00' to 38.00' ft bgs</u>	
			0.2	<u>Formation</u>	
			0.0	<u>15% silt 20% sand 65% gravel</u>	
			0.0	<u>Sand: very fine to coarse grain, poorly sorted, sub angular 60% matric 40% felsic</u>	
45			0.0	<u>Gravel: 2mm to ~100mm sub round to round poorly sorted 60% matric 40% felsic</u>	
			0.0	<u>Silt/clay w/ low plasticity</u>	
			0.0	<u>silty / coarse gravel lens at 21.50 to 21.75' bgs (tan color 10YR 4/3 pale brown)</u>	
50			0.0	<u>Sample color 2.5Y 3/2 very dark grayish brown (damp)</u>	
			0.0	<u>Weak reaction to HCL (dry)</u>	
55			0.0	<u>Wet</u>	
			0.0	<u>38.00' to 42.00 ft bgs</u>	
			0.0	<u>Formation:</u>	
			0.0	<u>15% silt 60% sand 25% Gravel</u>	
			0.0	<u>Sand: coarse grain, mod sorted sub round 40% matric 60% felsic</u>	
			0.0	<u>Gravels: larger ~100mm to small cobbles sub angular to sub rounded 40% matric 60% felsic</u>	
			0.0	<u>5YR 3/1 very dark gray (damp)</u>	
			0.0	<u>weak to no reaction to HCL (dry)</u>	
			0.0	<u>Wet</u>	
			0.0	<u>Sharp contact.</u>	
			0.0	<u>42.00 to 48.00 ft bgs</u>	
			0.0	<u>Formation</u>	
			0.0	<u>20% silt 20% sand 60% gravel</u>	
			0.0	<u>Sand fine grain, well sorted sub rounded 35% matric 60% felsic</u>	
			0.0	<u>notable mica present.</u>	
			0.0	<u>Gravel: 2mm to 100mm sub round to well round. 40% matric 60% felsic (continued on pg 3)</u>	
Reported By: <u>Candice Burnette Kildall</u>				Reviewed By: <u>Kevin Bergstrom</u>	
Title: <u>Geologist</u>				Title: <u>Sr. Geologist</u>	
Signature: <u>Candice Burnette Kildall</u>			Date: <u>6/10/15</u>	Signature: <u>Kevin Bergstrom</u>	
				Date: <u>9/10/2015</u>	

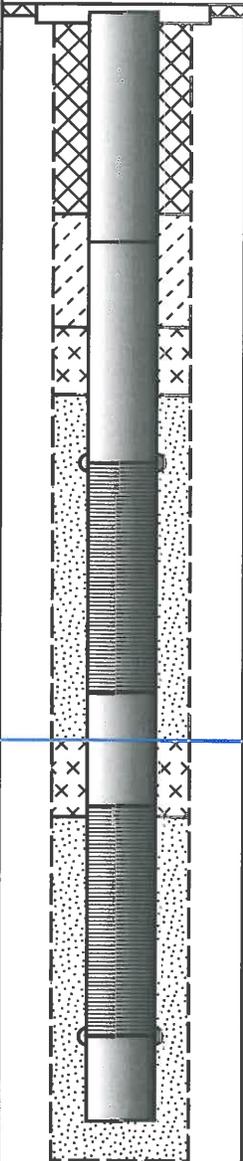


WELL SUMMARY SHEET		Start Date: 7/16/2015		Page 1 of 1			
		Finish Date: 8/4/2015					
Well ID: C9461		Well Name: 399-1-90					
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU					
Prepared By: Marques Miller		Date: 9/17/15		Reviewed By: J.D. MEHRER			
Signature: <i>Marques Miller</i>				Signature: <i>J.D. Mehrer</i>			
				Date: 10-28-15			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA					
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description			
<b>Surface Completion:</b>							
1.88'x1.90' Flush mount concrete pad w/brass survey marker.		0		0.0' - 0.25': Gravel Drill Pad, G			
13 1/2" OD Protective Monument: 0.0' - 0.85' bgs					0.25' - 4.0': Sandy Gravel, sG		
					4.0' - 51.03': Silty Sandy Gravel, mSG		
				10			
<b>Permanent Well:</b>							
6.75" OD PVC Blank: 0.70' - 20.42' bgs							
6.75" OD PVC 0.050-slot Screen: 20.42' - 30.43' bgs							
6.75" OD PVC Blank: 30.43' - 35.43' bgs							
6.75" OD PVC 0.050-slot Screen: 35.43' - 45.44' bgs							
6.75" OD PVC Blank: 45.44' - 48.95' bgs							
				30		Depth to Water: 31.65' bgs (8/4/15)	
<b>Construction Materials:</b>							
Concrete: 0.0' - 1.20' bgs							
Neat Grout: 1.20' - 9.87' bgs							
Bentonite Chips: 9.87' - 14.10' bgs							
Bentonite Seal: 14.10' - 16.83' bgs							
8/16 Mesh Filter Pack Sand: 16.83' - 31.95' bgs							
Bentonite Seal: 31.95' - 34.90' bgs							
8/16 Mesh Filter Pack Sand: 34.90' - 51.03' bgs							
		50		<b>Total Depth = 51.03' bgs (7/20/15)</b>			
				<b>OD = outside diameter</b>			
				<b>bgs = below ground surface</b>			
				<b>Centralizers: top of sump &amp; bottom of last blank riser.</b>			
All temporary 10 3/4" OD casing removed 7/20/15.							

BOREHOLE LOG						Page 1 of 2
Well ID: C9461		Well Name: 399-T 90		Location: 300 Area W of DNVI		Date: July 16, 2015
Project: 300-FF-5 Borewell FY15				Reference Measuring Point: Ground Surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments	
	Type No.	Blows Recovery			Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				Ground surface to 0.25 ft Backfill / drill pad	Injection well	
0-5	gs			0.25 ft to 4.00 ft bgs SG Formation	Drill Auger being conducted with a Terrasonic 150cc	
5				80% sand 20% Gravel Sand: medium grain & mod sort. sub angular 60% matrix 40% felsic	8" x 10' Core barrel 10" casing	
5-10	gs			Gravel: 2mm to ~75mm, sub to well rounded poorly sorted mod reaction to HCl	g.s = grab sample	
10				70% matrix 30% felsic 2.5 Y 3/3 dark olive	Drilling is slow from ~8' bgs to	
10-15	gs			Dry		
15				4.00 ft to 14.00 ft bgs MSG Formation	recovery 0-10' 100% 10-20' 60% 20-30' 100%	
15-20	gs			15% silt 40% sand 45% gravel Sand: fine to coarse very poorly sorted angular to sub angular	grab sample are taken in 5ft intervals. The samples are collected in pint jars and chip trays.	
20				60% matrix 40% felsic Gravel 2mm to 200mm, very poorly sorted sub round to round. ~60% matrix 40% felsic		
20-25	gs			Graded taper upper contact sharp lower contact mod - to - weak reaction to HCl going down unit.		
25				2.5 Y 3/1 Gray (dry)		
25-30	gs			Dry		
30				14.00 ft to 44.00 ft MSG Formation		
30-35	gs			15% silt 35% sand 50% Gravel Sand fine to very coarse mod sorted angular 70% matrix 30% felsic		
35				Gravel: see pg 2		

Reported By: Candice Burnett Kildall	Reviewed By: Kevin Bergstrom
Title: Geologist	Title: Sr. Geologist
Signature: <i>[Signature]</i>	Signature: <i>[Signature]</i>
Date: 7/20/15	Date: 9/10/2015



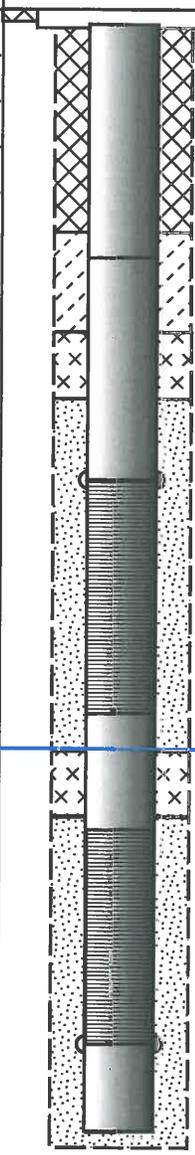
WELL SUMMARY SHEET		Start Date: 7/20/2015		Page <u>1</u> of <u>1</u>			
		Finish Date: 8/4/2015					
Well ID: C9462		Well Name: 399-1-91					
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU					
Prepared By: Marques Miller		Date: 9/16/15		Reviewed By: J.D. MEHRER			
Signature: <i>Marques Miller</i>				Signature: <i>J.D. Mehrer</i>			
				Date: 10-28-15			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA					
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description			
<b>Surface Completion:</b>							
1.88'x1.84' Flush mount concrete pad w/brass survey marker.		0		0.0' - 0.2': Gravel Drill Pad, G			
13 1/2" OD Protective Monument: 0.0' - 0.74' bgs					0.2' - 4.0': Gravelly Sand, gS		
					4.0' - 31.0': Sandy Gravel, sG		
				10			
<b>Permanent Well:</b>							
6.75" OD PVC Blank: 0.35' - 19.98' bgs							
6.75" OD PVC 0.050-slot Screen: 19.98' - 29.98' bgs							
6.75" OD PVC Blank: 29.98' - 34.98' bgs							
6.75" OD PVC 0.050-slot Screen: 34.98' - 44.97' bgs							
6.75" OD PVC Blank: 44.97' - 48.54' bgs							
				30		31.0' - 50.17': Silty Sandy Gravel, msG	
<b>Construction Materials:</b>						Depth to Water: 32' bgs (8/4/15)	
Concrete: 0.0' - 1.0' bgs							
Neat Grout: 1.0' - 9.15' bgs							
Bentonite Chips: 9.15' - 14.08' bgs							
Bentonite Seal: 14.08' - 17.08' bgs							
8/16 Mesh Filter Pack Sand: 17.08' - 32.0' bgs							
Bentonite Seal: 32.0' - 35.33' bgs							
8/16 Mesh Filter Pack Sand: 35.33' - 50.17' bgs							
		40					
		50		<b>Total Depth = 50.17' bgs (7/21/15)</b>			
				<b>OD = outside diameter</b>			
				<b>bgs = below ground surface</b>			
				<b>Centralizers: top of sump &amp; bottom of last blank riser.</b>			
All temporary 10 3/4" OD casing removed 7/21/15.							

BOREHOLE LOG						Page 1 of 2
Well ID: 29462		Well Name: 399-1-91		Location: 300 Area N of PNNL		Date: July 20, 2015
Project: 30well installation 300-FF-5 FY15			Reference Measuring Point: Ground Surface			
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments	
	Type No.	Blows Recovery			Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				Ground Surface to 0.20 ft bgs Drill Pad / Backfill	Injection Well	
0-5	g.s.	~70% recovery		0.20 ft to 4.00 ft bgs Formation silt 0% sand 8% Gravel 20% Sand: medium grain mod to well sorted sub round, 60% mafic 40% felsic	Drilling is being conducted with a Terrasonic CC150 8" x 10' core barrel 10" casing.	
5-10	g.s.	~60% recovery		Gravel: 10 mm to 30 mm mod sorting Sub round to well rounded 80% mafic 20% felsic	g.s = grab sample Grab samples are collected in 5' intervals	
10-15	g.s.	~60% recovery		weak to no reaction to HPL Graded contacts top + bottom 2.5 Y 3/3 dark olive brown		
15-20	g.s.	~60% recovery		4.00 ft bgs to 31.00 ft bgs sg Formation: 10% silt 30% sand 60% Gravel	Recovery 0-10 ~70% 10-20 ~60% 20-30 ~100% 30-40 ~80% 40- ~100%	
20-25	g.s.	~100% recovery		Sand fine to coarse, poorly sorted sub angular to angular 70% mafic 30% felsic		
25-30	g.s.	~100% recovery		Gravel: 2mm to small boulders Very poorly sorted angular to well rounded, rounding increases with size.		
30-35	g.s.	~80% recovery		mod reaction going to weak reaction down unit. graded contacts upper and lower		
35-40	g.s.	~80% recovery		2.5 Y 3/1 very dark gray		
40-50.17	litro	~80% recovery		31.00 ft bgs to 50.17' bgs NSG Formation 15% silt 25% sand 60% Gravel	TD = 50.17' bgs DWT = 7-21-95 DTW = 40.90' bgs	
50.17	g.s.	~80% recovery		Sand fine to very coarse, very poorly sorted, angular 70% mafic 30% felsic		

Reported By: Candice Burnette Kildall	Reviewed By: Kevin Bergstrom
Title: Geologist	Title: Sr. Geologist
Signature:	Signature:
Date: 7/20/15	Date: 9/10/2015

BOREHOLE LOG					Page <u>2</u> of <u>2</u>
Well ID: <u>C9462</u>		Well Name: <u>399-1-91</u>		Location: <u>300 Area N of ANN</u>	
Project: <u>300 Well installation 300-ff-5</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	g.s	~100% recovery		31.00 ft bgs to 50.17' bgs MSB Continued	Injection well
45				Grauel: 2mm to ~200mm Poorly sorted ~80% of the gravels are less than 100mm the smaller gravels tend to be angular with round increasing with size 100% mafic 40% felsic Silt: tends to concentrate around the larger gravels No reaction to HCL	Drilling is being conducted with a Terra sonic 150CC 8" X 10' core barrel 10" casing  g.s = grab sample
50			50.17'	2.5 Y 3/2 very dark grayish brown @ 33.00 ft Bgs to 35 ft bgs There is a <sup>DM?</sup> Ringold Rip up clast. The clast is composed of 80% silt 20% felsic (very mica rich) Very fine grain sand. Very low plasticity. No reaction to HCL 2.5 Y 5/4 light olive brown	

Reported By: <u>Candice Burnette Kibball</u>	Reviewed By: <u>Kevin Bergstrom</u>
Title: <u>Geologist</u>	Title: <u>Sr. Geologist</u>
Signature: <u>[Signature]</u>	Signature: <u>[Signature]</u>
Date: <u>7-21-15</u>	Date: <u>9/10/2015</u>

WELL SUMMARY SHEET		Start Date: 7/23/2015		Page 1 of 1			
		Finish Date: 5/13/2015					
Well ID: C9463		Well Name: 300-1-92					
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU					
Prepared By: Marques Miller		Date: 9/16/15		Reviewed By: J.D. MEHRER			
Signature: <i>Marques Miller</i>				Signature: <i>J.D. MEHRER</i>			
				Date: 10-28-15			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA					
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description			
<b>Surface Completion:</b>							
1.85'x1.90' Flush mount concrete pad w/brass survey marker.		0		0.0 - 0.5: Gravel Drill Pad, G			
13 1/2" OD Protective Monument: 0.0' - 0.75' bgs					0.5 - 3.2: Sand, S		
					3.2 - 49.5: Silty Sandy Gravel, mSG		
				10			
<b>Permanent Well:</b>							
6.75" OD PVC Blank: 0.7' - 20.3' bgs							
6.75" OD PVC 0.050-slot Screen: 20.3' - 30.3' bgs							
6.75" OD PVC Blank: 30.3' - 35.3'							
6.75" OD PVC 0.050-slot Screen: 35.3' - 45.3' bgs							
6.75" OD PVC Blank: 45.3' - 48.8' bgs							
				30		Depth to Water: 32.15' bgs (8/5/15)	
<b>Construction Materials:</b>							
Concrete: 0.0' - 2.3' bgs							
Neat Grout: 2.3' - 9.92' bgs							
Bentonite Chips: 9.92' - 14.0' bgs							
Bentonite Seal: 14.0' - 16.92' bgs							
8/16 Mesh Filter Pack Sand: 16.92' - 32.1' bgs							
Bentonite Seal: 32.17' - 35.0' bgs							
8/16 Mesh Filter Pack Sand: 35.0' - 49.5' bgs							
		40					
				<b>Total Depth = 49.5' bgs (7/23/15)</b>			
		50					
				<b>OD = outside diameter</b>			
				<b>bgs = below ground surface</b>			
				<b>Centralizers: top of sump &amp; bottom of last blank riser.</b>			
All temporary 10 3/4" OD casing removed 7/23/15.							

BOREHOLE LOG						Page 1 of 2
Well ID: <b>C9463</b>		Well Name: <b>399-1-97</b>		Location: <b>300 Area N of BNNL</b>		
Project: <b>30 Well 300-FF-5 FY15</b>				Reference Measuring Point: <b>Ground Surface</b>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments	
	Type No.	Blows Recovery				
0			0.0' - 0.5'	Backfill / Drill pad.	Injection Well	
g.s		~100%	0.5' to 3.20 ft bgs	(S) Formation	Drilling is being conducted with a TerraSonic 150 cc 10" casing 8"x10" core barrel	
5			100% Sand	Med to well sorted medium grain sub round. ~40% mafic 60% felsic		
g.s			2.5Y 3/3 dark olive brown	No reaction to HCL	g.s = grab sample grab samples are collected every 5' and placed in pint jars and chip trays	
10			Dry, Graded contact upper/lower			
		~80%	3.20' to 18.00 ft bgs	(MSC) Formation		
15			10% silt 40% Sand 50% Gravel	Sand: fine to coarse poorly sorted sub angular 60% mafic 40% felsic	Recovery 0'-10' ~100% 10'-20' ~80%	
			Gravel: 2mm to 250mm. Angular to sub round. very poorly sorted	2.5Y 3/1 Very dark gray	20'-30' ~75% 30'-40' ~70%	
20			Dry, Graded contacts upper/lower	Strong reaction to HCL @ top of unit weak to no at bottom of unit.	40'-50' ~50%	
g.s		~75%	18.00' to 49.55' bgs	(MSC) Formation		
			15% silt 25% sand 60% Gravel	Sand: med. to very coarse, very poorly sorted Angular 60% mafic 40% felsic		
25			Gravel: 2mm to ~100 mm	Gravels tend to be less than 50mm very poorly sorted. Angular with rounding increasing with size	TD 49.55 ft DTW 34.65 ft	
30		~70%				
35						
g.s						

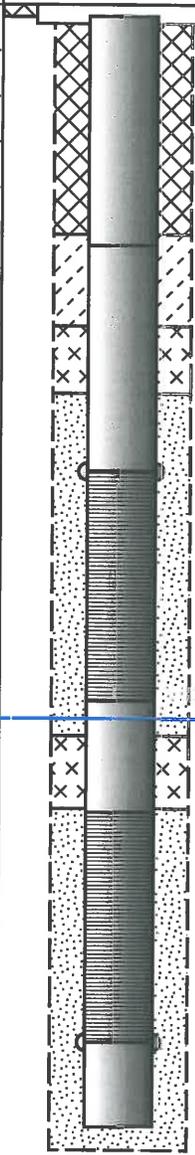
Reported By: <b>Candice Burnette Kiddall</b>	Reviewed By: <b>Kevin Bergstrom</b>
Title: <b>Geologist</b>	Title: <b>Sr. Geologist</b>
Signature: <i>[Signature]</i>	Signature: <i>[Signature]</i>
Date:	Date: <b>9/10/2015</b>

BOREHOLE LOG					Page <u>2</u> of <u>2</u>		
Well ID: <u>C9403</u>		Well Name: <u>399-1-92</u>		Location: <u>300 Area W of PNA</u>			
Project: <u>30 Wells 300-FF-5 &amp; FY15</u>				Reference Measuring Point: <u>Ground surface</u>			
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments		
	Type No.	Blows Recovery					
40	gs  ~50%	0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	P 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0	18.00' to 49.55' continued 2.543/1 very dark gray wet No reaction to HCl	Injection well  Drilled w/ a Terrasonic 150 cc 10" casing 8" core barrel		
45				@ 28.00 ft to 28.50 80% G 20% m There is a gravel lens. / silty Gravel 35mm to 60mm well round			
50				@ 38.00 to 40.00' 80% G 20% m silty gravel lens gravel ~35mm to 60mm well rounded			
				@ 44.00 ft to 44.50 ft silty gravel lens 80% G 20% m gravel ~40 to 80 mm well rounded			
Reported By: <u>Candice Burnette Kildall</u>			Reviewed By: <u>Kevin Bergstrom</u>				
Title: <u>Geologist</u>			Title: <u>Sr. Geologist</u>				
Signature: <u>[Signature]</u>		Date:	Signature: <u>[Signature]</u>		Date: <u>9/10/2015</u>		







WELL SUMMARY SHEET			Start Date: 7/21/2015		Page <u>1</u> of <u>1</u>		
			Finish Date: 8/6/2015				
Well ID: C9465		Well Name: 399-1-94					
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU					
Prepared By: Marques Miller	Date: 9/16/15	Reviewed By: J.D. MEHRER		Date: 10-28-15			
Signature: <i>Marques Miller</i>		Signature: <i>J.D. Meherer</i>					
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA					
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description			
<b>Surface Completion:</b>							
2'x2' Flush mount concrete pad		0		0.0' - 0.1': Gravel Drill Pad, G			
w/brass survey marker.				0.1' - 3.6': Sand, S			
13 1/2" OD Protective Monument:					3.6' - 14.0': Sandy Gravel, sG		
0.0' - 0.80' bgs							
<b>Permanent Well:</b>							
6.75" OD PVC Blank: 0.55' - 20.24' bgs							
6.75" OD PVC 0.050-slot Screen:						14.0' - 49.82': Silty Sandy Gravel, msG	
20.24' - 30.24' bgs							
6.75" OD PVC Blank:							
30.24' - 35.24' bgs							
6.75" OD PVC 0.050-slot Screen:							
35.24' - 45.23' bgs							
6.75" OD PVC Blank: 45.23' - 48.80' bgs							
<b>Construction Materials:</b>							
Concrete: 0.0' - 1.05' bgs							
Neat Grout: 1.05' - 10.0' bgs							
Bentonite Chips: 10.0' - 14.0' bgs							
Bentonite Seal: 14.0' - 16.92' bgs							
8/16 Mesh Filter Pack Sand:							
16.92' - 31.83' bgs							
Bentonite Seal: 31.83' - 35.0' bgs							
8/16 Mesh Filter Pack Sand:							
35.0' - 49.82' bgs							
All temporary 10 3/4" OD casing removed 7/22/15.							
				Total Depth = 49.82' bgs (7/21/15)			
				OD = outside diameter			
				bgs = below ground surface			
				Centralizers: top of sump & bottom of last blank riser.			
				Depth to Water: 31.16' bgs (8/5/15)			

BOREHOLE LOG					Page 1 of 2
Well ID: <b>C9465</b>		Well Name: <b>399-1-94</b>		Location: <b>300 Area N of PNAAL</b>	
Project: <b>30 Well 300 FF 5 FY15</b>			Reference Measuring Point: <b>Ground Surface</b>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				Ground surface to 0.10 ft bgs Back fill / drill pad	Injection well
0-9.5	g.s	~100%			Drilled by a Terrasonix-150 cc
0.10 ft to 3.60 ft bgs				(S) Formation	g-s = grab sample
5				Sand 98% gravel 2%	
				Sand: med grain, well sorted	
9.5				Sub round ~40% mafic 60% felsic	
				Gravel: ~15 mm to 30 mm angular	Recovery
10				90% mafic 10% felsic	0-10 ~100%
				Dry	10-20 60%
9.5				Weak to no reaction to HCl	20-30 50%
				2.54 3/8 dark olive brown	30-40 75%
				Graded upper/lower contact	40- 100%
15					
9.5				3.60 ft to 14.00 ft bgs	
				Formation	
				Silt 10% Sand 30% Gravel 60%	
20				Sand: fine to coarse poorly sorted	
				Sub round: 60% mafic 40% felsic	
9.5				Gravel: 2mm to Large Cobble, angular	
				to sub round, poorly sorted	
				~60% mafic 40% felsic	
25				Dry	
				2.54 3/8 Dark gray	
9.5				Strong to med reaction to HCl	
				Graded contact upper/lower.	
30					
9.5				14.00 ft to 43.00 ft bgs	
				Formation	
				15% silt 30% Sand 55% Gravel	TD = 50.17
				Sand: fine to very coarse, very poorly	DTW = 35.65'
				sorted. Angular. (~70% of the sand	
35				is coarse to very coarse) 60% mafic	
				40% felsic.	
				Gravel: 2mm to large cobble, poorly	
				sorted. Angular to round.	

Reported By: <b>Candice Burnette Kildall</b>		Reviewed By: <b>Kevin Bergstrom</b>	
Title: <b>Geologist</b>		Title: <b>Sr. Geologist</b>	
Signature: <i>Candice Kildall</i>	Date: <b>7-21-15</b>	Signature: <i>Kevin Bergstrom</i>	Date: <b>9/10/2015</b>

BOREHOLE LOG					Page <u>2</u> of <u>2</u>
Well ID: <u>C9465</u>		Well Name: <u>399-1-94</u>		Location: <u>300 Area N of PNNL</u>	
Project: <u>30 wells 300-FF-5 FY15</u>				Reference Measuring Point: <u>Ground Surface</u>	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	gs	2 100%		14.00 ft to 43.00 ft Continued	
45				rounding increases with size Wet, No reaction to HCl 2.57 3/11 very dark gray graded upper / sharp lower contact.	
50	gs	1		43.00 ft to 50.17 ft bgs Formation 15% silt 30% sand 55% Gravel. Sand: fine to med. grain well sorted sub to well rounded 20% mafic 80% felsic Gravel: 2mm to 100mm med. sorting sub round. 50% mafic 50% felsic Wet, No reaction to HCl Silt has low plasticity GHE 2.5/10 y greenish black  @47ft there is a 1' sand lens. lens is med grain well sorted, round ~100% felsic. BYR 1/6 yellowish red.	
Reported By: <u>Candice Bannette Kiddall</u>			Reviewed By: <u>Kevin Bergstrom</u>		
Title: <u>Geologist</u>			Title: <u>Sr. Geologist</u>		
Signature: <u>[Signature]</u>		Date: <u>7-21-15</u>	Signature: <u>[Signature]</u>		Date: <u>9/10/2015</u>

WELL SUMMARY SHEET		Start Date: 6/4/2015		Page <u>1</u> of <u>1</u>		
		Finish Date: 8/6/2015				
Well ID: C9466		Well Name: 399-1-95				
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU				
Prepared By: Marques Miller		Date: 9/17/15		Reviewed By: J.D. MEHRER		
Signature: <i>Marques Miller</i>				Signature: <i>J.D. Meherer</i>		
				Date: 10-28-15		
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
<b>Surface Completion:</b>		0		0.0' - 0.5': Gravel Drill Pad, G		
2'x2' Flush mount concrete pad w/brass survey marker.				0.5' - 6.0': Silty Sandy Gravel, msG		
13 1/2" OD Protective Monument:					6.0' - 19.0': Sandy Gravel, sG	
0.0' - 0.80' bgs						
<b>Permanent Well:</b>				10		
6.75" OD PVC Blank: 0.0' - 20.92' bgs						
6.75" OD PVC 0.050-slot Screen:						
20.92' - 30.92' bgs						
6.75" OD PVC Blank:				20	19.0' - 29.5': Silty Sandy Gravel, msG	
30.92' - 35.92' bgs						
6.75" OD PVC 0.050-slot Screen:						
35.92' - 45.91' bgs						
6.75" OD PVC Blank: 45.91' - 49.44' bgs						
				30	29.5' - 33.0': Gravelly Silty Sand, gmS	
<b>Construction Materials:</b>					Depth to Water: 31.30' bgs (8/6/15)	
Concrete: 0.0' - 2.80' bgs					33.0' - 38.0': Sandy Gravel, sG	
Neat Grout: 2.80' - 10.16' bgs						
Bentonite Chips: 10.16' - 14.50' bgs					38.0' - 39.0': Gravel, G	
Bentonite Seal: 14.50' - 16.80' bgs				40	39.0' - 44.0': Sandy Gravel, sG	
8/16 Mesh Filter Pack Sand:						
16.80' - 31.96' bgs			44.0' - 50.30': Silty Sandy Gravel, msG			
Bentonite Seal: 31.96' - 35.0' bgs						
8/16 Mesh Filter Pack Sand:						
35.0' - 50.30' bgs		50	<b>Total Depth = 50.30' bgs (7/27/15)</b>			
			<b>OD = outside diameter</b>			
			<b>bgs = below ground surface</b>			
All temporary 10 3/4" OD casing removed 7/27/15.			<b>Centralizers: top of sump &amp; bottom of last blank riser.</b>			

**BOREHOLE LOG**

Page 1 of 2

Date: 6/4/15

Well ID: C9466

Well Name: 399-1-95

Location: 300 Area N of PNNL

Project: 300-FF-5

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0-0.5': Gravel Pad. Crushed aggregate.	Sonic Core barrel: 4 3/8" x 5" inch.
0.5				0.5-3.0': Silty Sandy Gravel msG (60%G, 25%S, 15%M)	10' core barrel (c.b.)
3.0				Poor srt'd. v.f. pbl. - sm. cbl. sub-ang. w. rnd. max 75mm. w/ v.f.-v.c. sub-rnd. S. 75% meta/5% felsic. silt: 10YR 1/2 H. brownish gray. Dry. unconsolidated. wk. rxn w/ HCl.	Grab Sample (G.S.) @ 2'
5				3.0-6.0': silty sandy Gravel msG (40%G, 40%S, 20%M)	5.0' : g.s.
6.0				v.Pr. srt'd. sub-rnd. w. rnd. m.-v.c. pbl. abnt. lrg. cbl. bsl't.	
7.0				w/v.f.-c. sub-rnd. S. silt color 2.5Y 1/2 Dk grayish brown. low dilatancy. low plastic. Comp: 80% bsl't. / 20% felsic meta > Volc.	
8.0				wk rxn w/ HCl.	9.0' : g.s.
10				6.0-17.0': silty sandy Gravel (msG) (60%G, 30%S, 10%M)	
11.0				mod.-pr. srt'd. w.-sub-rnd. v.f. pbl. - sm. cbl. max: 70mm. avg: 40mm. of 60% bsl't. / 40% felsic meta. > int. Volc. w/ v.f.-m. sub-rnd. S.	
12.0				silt: 10YR 1/2 dk gray. moist. no plastic. wk. rxn w/ HCl.	
15				-16': prob. coarsening downward. From 11-17' avg. clast from 40mm to 70mm.	15' : g.s.
17.0				17.0-18.0': Rip up clast of silty gravel (SG) (30%G, 20%M, 50%S) 10% S.	
18.0				2.5Y 1/2 H. yellowish brown matrix of cemented sandy silt w/ gravel.	
18.5				mod. plastic. v. weathered basalt w/ clay clinds. v. st. rxn w/ HCl.	18.5' : g.s.
20				19-22': Sandy Gravel SG (70%G, 30%S, 5%M)	
20.0				mod. w. srt'd. v.f.-v.c. pbl. w.-v.w. rnd. of 80% bsl't. / 20% meta.	20' : g.s.
21.0				fr. consolidated. wk rxn w/ HCl. w/ m.-v.c. avg. S. 10YR 1/2 v. drk. brown.	
22.0				19-23.0': silty sandy Gravel msG (70%G, 15%S, 15%M)	22' : Top of Periodically reworked zone (PRZ)
23.0				mod. srt'd. v. w. rnd. v.f.-v.c. pbl. of 80% bsl't. / 10% meta. > int. v.	(PRZ)
23.5				w/ v.f.-v.c. sub-ang. S. Silt is slight clayey mod. plastic. low dilatancy.	
24.0				10YR 1/2 v. drk. brown. no rxn w/ HCl. - wk. rxn w/ HCl	
24.5				23-24': silty sandy Gravel msG (70%G, 20%M, 10%S)	
25				v. poor srt'd. v.f. pbl. - v.c. pbl. max: 64mm v.w.-sub-rnd. of 85% bsl't. / 15% int. Volc. + etc. w/ v.f.-m. sub-ang. S. + plastic. slight clayey silt. color 10YR 1/2 v. drk. grayish brown w/ 1% matrix 10YR 1/2 yellowish brown. mod. imbrication.	23.5' : g.s.
27.0				24.0-27.5': Silty sandy Gravel msG (60%G, 20%S, 20%M)	27' : g.s. 26-36' : sieve #1
28.0				mod. srt'd. grading to poor srt'd. v.f.-m. pbl. -> v.f. pbl. sm. cbl. of 85% bsl't. / 15% felsic meta. w/ mod. clayey, mod. plastic silt. + v.f.-v.c. sub-ang. S. 10YR 1/2 v. drk. grayish brown. no rxn w/ HCl.	
29.0				27.5-33.0': Gravelly silty Sand. msG (15%G, 15%S, 20%M, 70%S)	
30				v.Pr. srt'd. unconsolidated. sub w. rnd. v.f.-v.c. S. w/ 2.5Y 1/2 gray nonplastic M. w/ v.f. pbl. - sm. cbl. of 75% bsl't. / 5% qtz > meta. no rxn w/ HCl. slightly moist. - moist.	31.29' : Water Table (7.23.15)

Reported By: A. Lantieri  
 Title: Geog. Tech.  
 Signature: A. Lantieri  
 Date: 7/30/15

Reviewed By: Kevin Bergstrom  
 Title: Sr. Geologist  
 Signature: Kevin Bergstrom  
 Date: 9/10/2015

**BOREHOLE LOG**

Page 2 of 2

Date: 6.4.15

Well ID: C9466

Well Name: 399-1-95

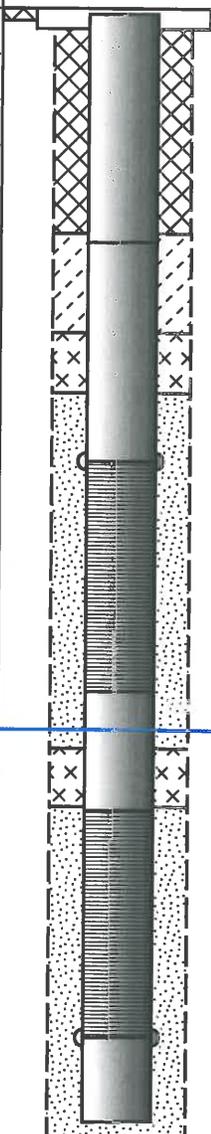
Location: 300 Area N of PNNL

Project: 300-FF-5

Reference Measuring Point: Ground surface.

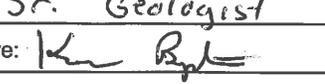
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
35	2.5			33-38.0': Silty sandy Gravel <sup>K<sub>sp</sub></sup> (70-75% G, 20-30% S, 5-10% M) mod. srt'd. v.w.rndd. v.f.-v.c. pbl. of 98% bslt. ~2% Meta. w/ v.f.-v.c. sub-ang-sub-rndd. D. mod. plastic, mod. dilatent. clayey silt. 2.5Y 7/1 Gray. Grades to fine gravels below. 38-39': Gravel G (90% G, 10-5% S) trace m.	Sonit w/ 5' core barrel x 10' long. 36' i.g.s. 36-46': Sieve #2
40	2.5			v.w. srt'd. v.f.-m. pbl. v.w.rndd. of 98% bslt. 4% Meta. w/f.-v.c. sub-rndd. mafic D. 2.5Y 7/1 Gray. sharp contact below. 39-44': Sandy Gravel sG (75% G, 20-30% S, 0-5% M) mod. srt'd. v.w.rndd. m.-v.c. pbl. of 70% felsic Meta. > Qtz	42' i.g.s.
45	2.5			int. v. tuff / 30-20% bslt. + And. in matrix of m.-crs. sub-ang D. of Qtz: felds. w/ abnt. muscovite mica. 2.5Y 5/6 H. yellowish brown. no rxn w/ HCl. grades to gravelly silt: 53-54'	46' i.g.s. Sieve #3: 46-50.5'
	2.5			44-50.5': gravelly Silt. s.M. at 6.4.15 44-50.5': silty sandy Gravel m sG (70% G, 10-15% S, 15% M)	48' sieve grab. (s.a.)
50	2.5			44-49': poorly srt'd. m.pbl. - sm.cbl. max: 70mm. v.w. - sub-rndd. G. of 70% felsic Meta. > int. volcanics > Qtz / 30% bslt. in matrix v.f.-m. sub-ang. D. w/ intercalated layers 2-4" of m.-c. D. of 90% felds. Qtz. w/ abnt. mica. Ox. staining from 44-46. color 10YR 6 brownish yellow. Silt of v. plastic-clayey-sticky, mod. dilatency. no rxn w/ HCl 46-49' color: 2.5Y 6 yellowish brown. no rxn w/ HCl 46-49': sorting improves to mod-w. srt'd. K. m.-c. pbl. 49-50.5': Color change to GLE 2 5/1 bluish gray. "Anoxic zone" no rxn w/ HCl.	50.5': i.g.s. @ TD.

Reported By: <u>A. Lantieri</u>	Reviewed By: <u>Kevin Bergstrom</u>
Title: <u>Geo. Tech.</u>	Title: <u>Sr. Geologist</u>
Signature: <u>[Signature]</u>	Signature: <u>[Signature]</u>
Date: <u>7.30.15</u>	Date: <u>9/10/2015</u>

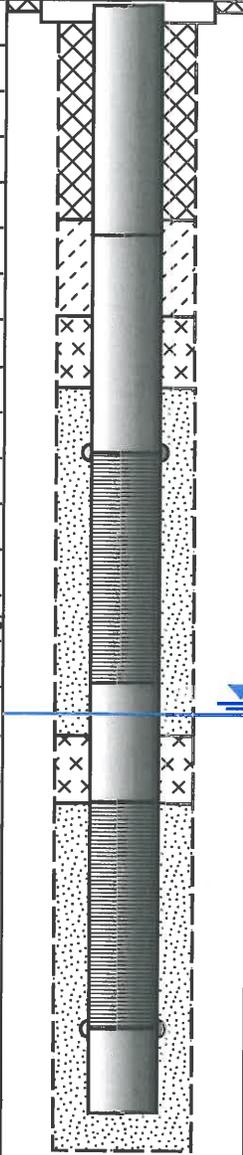
WELL SUMMARY SHEET		Start Date: 6/4/2015		Page 1 of 1			
		Finish Date: 8/5/2015					
Well ID: C9467		Well Name: 399-1-96					
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU					
Prepared By: Marques Miller		Date: 9/17/15		Reviewed By: J.D. MEHRER			
Signature: <i>Marques Miller</i>				Signature: <i>J.D. Mehrer</i>			
				Date: 10-28-15			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA					
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description			
<b>Surface Completion:</b>							
1.95'x1.88' Flush mount concrete pad w/brass survey marker.		0		0.0' - 0.5': Sandy Gravel, sG			
13 1/2" OD Protective Monument: 0.0' - 0.95' bgs				0.5' - 3.0': Silty Sandy Gravel, msG			
<b>Permanent Well:</b>					3.0' - 13.0': Sandy Gravel, sG		
6.75" OD PVC Blank: 0.20' - 19.88' bgs				10		13.0' - 22.0': Silty Sandy Gravel, msG	
6.75" OD PVC 0.050-slot Screen: 19.88' - 29.88' bgs							
6.75" OD PVC Blank: 29.88' - 34.88' bgs				20		22.0' - 31.0': Slightly Silty Gravelly Sand, (m)gs	
6.75" OD PVC 0.050-slot Screen: 34.88' - 44.87' bgs							
6.75" OD PVC Blank: 44.87' - 48.38' bgs				30		Depth to Water: 31.35' bgs (8/5/15)	
<b>Construction Materials:</b>						31.0' - 35.0': Sandy Gravel, sG	
Concrete: 0.0' - 2.80' bgs						35.0' - 40.0': Gravel, G	
Neat Grout: 2.80' - 9.94' bgs							
Bentonite Chips: 9.94' - 14.10' bgs				40		40.0' - 42.0': Silty Sandy Gravel, msG	
Bentonite Seal: 14.10' - 16.70' bgs						42.0' - 44.5': Sandy Gravel, sG	
8/16 Mesh Filter Pack Sand: 16.70' - 32.18' bgs						44.5' - 48.0': Silty Sandy Gravel, msG	
Bentonite Seal: 32.18' - 34.83' bgs						48.0' - 49.38': Sand, S	
8/16 Mesh Filter Pack Sand: 34.83' - 49.38' bgs				50		<b>Total Depth = 49.38' bgs (7/23/15)</b>	
All temporary 10 3/4" OD casing removed 7/23/15.						OD = outside diameter	
						bgs = below ground surface	
						Centralizers: top of sump & bottom of last blank riser.	

BOREHOLE LOG					Page <u>1</u> of <u>4</u>
Well ID: <u>C9467</u>		Well Name: <u>399-1-96</u>		Location: <u>N of PNNL 300 FF -5</u>	
Project: <u>300 FF -5 FV15</u>			Reference Measuring Point: <u>Ground surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
5	gs		0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3 2.4 2.5 2.6 2.7 2.8 2.9 3.0	0.0 (Ground surface) to 0.50 ft bgs	Drilling is being
				Formation: unknown Backfill SG	Conducted w/ a sonic
10	gs		3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 4.0 4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8 4.9 5.0 5.1 5.2 5.3 5.4 5.5 5.6 5.7 5.8 5.9 6.0 6.1 6.2 6.3 6.4 6.5 6.6 6.7 6.8 6.9 7.0 7.1 7.2 7.3 7.4 7.5 7.6 7.7 7.8 7.9 8.0 8.1 8.2 8.3 8.4 8.5 8.6 8.7 8.8 8.9 9.0 9.1 9.2 9.3 9.4 9.5 9.6 9.7 9.8 9.9 10.0	5% silt 20% sand 75% Gravel	rig
				Sand: fine to coarse. 8% Matric. sub round	6" borehole
15	gs		10.0 10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8 10.9 11.0 11.1 11.2 11.3 11.4 11.5 11.6 11.7 11.8 11.9 12.0 12.1 12.2 12.3 12.4 12.5 12.6 12.7 12.8 12.9 13.0 13.1 13.2 13.3 13.4 13.5 13.6 13.7 13.8 13.9 14.0 14.1 14.2 14.3 14.4 14.5 14.6 14.7 14.8 14.9 15.0	Gravel: Angular, 70% matric 30% felsic	Borehole was
					drilled and sampled
20	gs		15.0 15.1 15.2 15.3 15.4 15.5 15.6 15.7 15.8 15.9 16.0 16.1 16.2 16.3 16.4 16.5 16.6 16.7 16.8 16.9 17.0 17.1 17.2 17.3 17.4 17.5 17.6 17.7 17.8 17.9 18.0 18.1 18.2 18.3 18.4 18.5 18.6 18.7 18.8 18.9 19.0 19.1 19.2 19.3 19.4 19.5 19.6 19.7 19.8 19.9 20.0	0.50 ft bgs to 3.00 ft bgs	then backfill w/
				Formation: Hanford (MSG)	sand. (6/4/15)
30	gs		20.0 20.1 20.2 20.3 20.4 20.5 20.6 20.7 20.8 20.9 21.0 21.1 21.2 21.3 21.4 21.5 21.6 21.7 21.8 21.9 22.0 22.1 22.2 22.3 22.4 22.5 22.6 22.7 22.8 22.9 23.0 23.1 23.2 23.3 23.4 23.5 23.6 23.7 23.8 23.9 24.0 24.1 24.2 24.3 24.4 24.5 24.6 24.7 24.8 24.9 25.0 25.1 25.2 25.3 25.4 25.5 25.6 25.7 25.8 25.9 26.0 26.1 26.2 26.3 26.4 26.5 26.6 26.7 26.8 26.9 27.0 27.1 27.2 27.3 27.4 27.5 27.6 27.7 27.8 27.9 28.0 28.1 28.2 28.3 28.4 28.5 28.6 28.7 28.8 28.9 29.0 29.1 29.2 29.3 29.4 29.5 29.6 29.7 29.8 29.9 30.0	20% silt 40% sand 40% Gravel	
				Sand: fine to coarse. Angular to sub	1-10'
35	gs		30.0 30.1 30.2 30.3 30.4 30.5 30.6 30.7 30.8 30.9 31.0 31.1 31.2 31.3 31.4 31.5 31.6 31.7 31.8 31.9 32.0 32.1 32.2 32.3 32.4 32.5 32.6 32.7 32.8 32.9 33.0 33.1 33.2 33.3 33.4 33.5 33.6 33.7 33.8 33.9 34.0 34.1 34.2 34.3 34.4 34.5 34.6 34.7 34.8 34.9 35.0	ang. Poorly sorted 40% matric 60% felsic	Low recovery
				Gravel: 2mm to ~120mm, sub round	~60' of the core
40	gs		35.0 35.1 35.2 35.3 35.4 35.5 35.6 35.7 35.8 35.9 36.0 36.1 36.2 36.3 36.4 36.5 36.6 36.7 36.8 36.9 37.0 37.1 37.2 37.3 37.4 37.5 37.6 37.7 37.8 37.9 38.0 38.1 38.2 38.3 38.4 38.5 38.6 38.7 38.8 38.9 39.0 39.1 39.2 39.3 39.4 39.5 39.6 39.7 39.8 39.9 40.0	to round. Rounding increase in relation	barrel. Driller
				to size. ~70% matric 30% felsic	notes low down/up
45	gs		40.0 40.1 40.2 40.3 40.4 40.5 40.6 40.7 40.8 40.9 41.0 41.1 41.2 41.3 41.4 41.5 41.6 41.7 41.8 41.9 42.0 42.1 42.2 42.3 42.4 42.5 42.6 42.7 42.8 42.9 43.0 43.1 43.2 43.3 43.4 43.5 43.6 43.7 43.8 43.9 44.0 44.1 44.2 44.3 44.4 44.5 44.6 44.7 44.8 44.9 45.0	strong reaction to HCL	Pressure.
				2.5Y 5/1 light olive brown (damp for color)	
50	gs		45.0 45.1 45.2 45.3 45.4 45.5 45.6 45.7 45.8 45.9 46.0 46.1 46.2 46.3 46.4 46.5 46.6 46.7 46.8 46.9 47.0 47.1 47.2 47.3 47.4 47.5 47.6 47.7 47.8 47.9 48.0 48.1 48.2 48.3 48.4 48.5 48.6 48.7 48.8 48.9 49.0 49.1 49.2 49.3 49.4 49.5 49.6 49.7 49.8 49.9 50.0		10'-20'
					Low recovery
55	gs		50.0 50.1 50.2 50.3 50.4 50.5 50.6 50.7 50.8 50.9 51.0 51.1 51.2 51.3 51.4 51.5 51.6 51.7 51.8 51.9 52.0 52.1 52.2 52.3 52.4 52.5 52.6 52.7 52.8 52.9 53.0 53.1 53.2 53.3 53.4 53.5 53.6 53.7 53.8 53.9 54.0 54.1 54.2 54.3 54.4 54.5 54.6 54.7 54.8 54.9 55.0	3.00 ft bgs to 13.00 ft bgs	Low recovery
				Formation: Hanford (SG)	~70%
60	gs		55.0 55.1 55.2 55.3 55.4 55.5 55.6 55.7 55.8 55.9 56.0 56.1 56.2 56.3 56.4 56.5 56.6 56.7 56.8 56.9 57.0 57.1 57.2 57.3 57.4 57.5 57.6 57.7 57.8 57.9 58.0 58.1 58.2 58.3 58.4 58.5 58.6 58.7 58.8 58.9 59.0 59.1 59.2 59.3 59.4 59.5 59.6 59.7 59.8 59.9 60.0	5% silt 40% sand 55% Gravel	Low/up/down
				Sand: medium to coarse grain	pressure
65	gs		60.0 60.1 60.2 60.3 60.4 60.5 60.6 60.7 60.8 60.9 61.0 61.1 61.2 61.3 61.4 61.5 61.6 61.7 61.8 61.9 62.0 62.1 62.2 62.3 62.4 62.5 62.6 62.7 62.8 62.9 63.0 63.1 63.2 63.3 63.4 63.5 63.6 63.7 63.8 63.9 64.0 64.1 64.2 64.3 64.4 64.5 64.6 64.7 64.8 64.9 65.0	sub round. Mod sort 60% matric	20'-30'
				Gravel: 2mm to ~8mm sub angular	100% recovery
70	gs		65.0 65.1 65.2 65.3 65.4 65.5 65.6 65.7 65.8 65.9 66.0 66.1 66.2 66.3 66.4 66.5 66.6 66.7 66.8 66.9 67.0 67.1 67.2 67.3 67.4 67.5 67.6 67.7 67.8 67.9 68.0 68.1 68.2 68.3 68.4 68.5 68.6 68.7 68.8 68.9 69.0 69.1 69.2 69.3 69.4 69.5 69.6 69.7 69.8 69.9 70.0	to sub round. Poorly sorted 60% matric	30'-40'
				40% felsic.	~50% recovery
75	gs		70.0 70.1 70.2 70.3 70.4 70.5 70.6 70.7 70.8 70.9 71.0 71.1 71.2 71.3 71.4 71.5 71.6 71.7 71.8 71.9 72.0 72.1 72.2 72.3 72.4 72.5 72.6 72.7 72.8 72.9 73.0 73.1 73.2 73.3 73.4 73.5 73.6 73.7 73.8 73.9 74.0 74.1 74.2 74.3 74.4 74.5 74.6 74.7 74.8 74.9 75.0	Natural moisture present	drilling / clean cut
				Mod to strong reaction to HCL (dry)	was slow.
80	gs		75.0 75.1 75.2 75.3 75.4 75.5 75.6 75.7 75.8 75.9 76.0 76.1 76.2 76.3 76.4 76.5 76.6 76.7 76.8 76.9 77.0 77.1 77.2 77.3 77.4 77.5 77.6 77.7 77.8 77.9 78.0 78.1 78.2 78.3 78.4 78.5 78.6 78.7 78.8 78.9 79.0 79.1 79.2 79.3 79.4 79.5 79.6 79.7 79.8 79.9 80.0	2.5Y 4/2 Dark grayish brown (damp)	
85	gs		80.0 80.1 80.2 80.3 80.4 80.5 80.6 80.7 80.8 80.9 81.0 81.1 81.2 81.3 81.4 81.5 81.6 81.7 81.8 81.9 82.0 82.1 82.2 82.3 82.4 82.5 82.6 82.7 82.8 82.9 83.0 83.1 83.2 83.3 83.4 83.5 83.6 83.7 83.8 83.9 84.0 84.1 84.2 84.3 84.4 84.5 84.6 84.7 84.8 84.9 85.0	13.00 ft to 22.00 ft	40'-50'
				Formation: Hanford (MSG)	100% recovery
90	gs		85.0 85.1 85.2 85.3 85.4 85.5 85.6 85.7 85.8 85.9 86.0 86.1 86.2 86.3 86.4 86.5 86.6 86.7 86.8 86.9 87.0 87.1 87.2 87.3 87.4 87.5 87.6 87.7 87.8 87.9 88.0 88.1 88.2 88.3 88.4 88.5 88.6 88.7 88.8 88.9 89.0 89.1 89.2 89.3 89.4 89.5 89.6 89.7 89.8 89.9 90.0	20% silt 30% sand 50% Gravel	g.s = grab sample
				Sand: coarse to fine, mod to poorly	TD 49.38 (7-23/15)
95	gs		90.0 90.1 90.2 90.3 90.4 90.5 90.6 90.7 90.8 90.9 91.0 91.1 91.2 91.3 91.4 91.5 91.6 91.7 91.8 91.9 92.0 92.1 92.2 92.3 92.4 92.5 92.6 92.7 92.8 92.9 93.0 93.1 93.2 93.3 93.4 93.5 93.6 93.7 93.8 93.9 94.0 94.1 94.2 94.3 94.4 94.5 94.6 94.7 94.8 94.9 95.0	sorted sub angular 60% matric	DTW 34.26 (7/23/15)
				40% felsic	
99	gs		95.0 95.1 95.2 95.3 95.4 95.5 95.6 95.7 95.8 95.9 96.0 96.1 96.2 96.3 96.4 96.5 96.6 96.7 96.8 96.9 97.0 97.1 97.2 97.3 97.4 97.5 97.6 97.7 97.8 97.9 98.0 98.1 98.2 98.3 98.4 98.5 98.6 98.7 98.8 98.9 99.0	Gravels: 2mm to 140mm	

BOREHOLE LOG					Page <u>2</u> of <u>4</u>
Well ID: <u>C9467</u>		Well Name: <u>399-1-96</u>		Location: <u>N of PNNL</u>	
Project: <u>300-FF-5</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
45	gs		0-0 0-0 0-0 0-0	sub round poorly sorted, gravels tend to be larger in the lower segment. 60% matric. 40% felsic	Borehole was drilled + cased 7-23-15 w/ 10" casing 8" core barrel
	gs		0-0 0-0 0-0	Some clay present and surrounding the <del>gravel</del> gravels in the unit weak plasticity.	
50			50 TD 6/4/15	strong (very) reaction to HCL (dry) 2.5 7/8 dark grayish brown (damp) Natural moisture present	
				22.00 ft bgs to 31 ft bgs (mrgs) Formation: (MSB) 10% silt 60% Sand 30% Gravel	
				Sand: very fine to coarse grain sub angular, med sorted. 70% matric to 30% felsic	
				Gravel: 2mm to 180mm, sub angular to round. 45% matric. 35% felsic	
				2.5 7/8 very dark gray (damp) weak to no reaction to HCL (dry)	
				The bottom .5 ft is mostly silt this section of the sample was dry most likely an artifact of drilling not a lens.	
				* Possible rip up clast between 28 and 30.50 ft bgs. Clast are composed of very fine grain felsic sand and light colored silt. Clasts collected in grab sample.	
				Segment contained natural moisture	
				31.00 ft to 35 ft bgs Formation (SG)	
				5% silt 60% sand 35% Gravel	
				Sand: coarse to fine grain, sub rounded well sorted 70% matric 30% felsic	
Reported By: <u>Candice Kiddall</u>			Reviewed By: <u>Kevin Bergstrom</u>		
Title: <u>Geologist</u>			Title: <u>Sr. Geologist</u>		
Signature: <u>[Signature]</u>		Date: <u>6/4/15</u>	Signature: <u>[Signature]</u>		Date: <u>9/10/2015</u>

BOREHOLE LOG					Page <u>3</u> of <u>4</u>
Well ID: <u>C9467</u>			Well Name: <u>399-1-69</u>		Date: <u>June 4, 2015</u>
Project: <u>300FF-5</u>			Location: <u>N of PNM L</u>		
Reference Measuring Point: <u>Ground Surface</u>					
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
				<u>31 ft to 35 ft Continued.</u> <u>(Gravel: 2mm to 40mm</u> <u>some small cobbles (2) Poorly sorted</u> <u>sub round to round.</u> <u>weak to No reaction to HCl (Dry)</u> <u>2.5 y 7/11 dark gray (damp)</u> <u>moist/wet</u> <u>Sharp contact</u>	
				<u>35ft to 40 ft bgs</u> <u>Formation: G</u> <u>5% silt 95% Gravel</u> <u>Gravel: Average size ~80mm</u> <u>sub round to rounded, well sorted</u> <u>70% mafic 30% felsic</u> <u>2.5 y 7/11 dark gray (damp)</u> <u>Slight reaction to HCl (dry)</u> <u>Wet</u> <u>Sharp contact</u>	
				<u>40 ft bgs to 42 ft bgs</u> <u>Formation: msG</u> <u>10% silt 30% Sand 60% Gravel</u> <u>Sand: Fine to coarse, sub angular</u> <u>mod. sort 60% mafic 40% felsic</u> <u>Gravel: 20mm to 40mm sub round</u> <u>to round. 60% mafic 40% felsic</u> <u>Weak to No reaction to HCl (dry)</u> <u>2.5 y 7/11 dark gray (damp)</u> <u>Wet</u>	
				<u>42.00 ft to 44.50 ft bgs</u> <u>Formation SG</u> <u>5% silt 60% Sand 35% Gravel</u> <u>Sand: medium grain, well sorted</u> <u>sub round 20% mafic 80% felsic</u> <u>~10% mica</u>	
Reported By: <u>Candice Kiddall</u>			Reviewed By: <u>Kevin Bergstrom</u>		
Title: <u>Geologist</u>			Title: <u>Sr. Geologist</u>		
Signature: 		Date: <u>6/4/15</u>	Signature: 		Date: <u>9/10/2015</u>



WELL SUMMARY SHEET		Start Date: 7/27/2015		Page 1 of 1		
		Finish Date: 8/6/2015				
Well ID: C9468		Well Name: 399-1-97				
Location: 300 Area N of PNNL		Project: 30 Monitoring/Injection Wells in 300-FF-5 OU				
Prepared By: Marques Miller		Date: 9/17/15		Reviewed By: J.D. MEHRER		
Signature: <i>Marques Miller</i>				Signature: <i>J.D. Meherer</i>		
				Date: 10-28-15		
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
<b>Surface Completion:</b>						
1.88'x1.90' Flush mount concrete pad w/brass survey marker.		0		0.0' - 0.5': Gravel Drill Pad, G		
13 1/2" OD Protective Monument: 0.0' - 1.0' bgs					0.5' - 16.0': Sandy Gravel, sG	
<b>Permanent Well:</b>				10		
6.75" OD PVC Blank: 0.20' - 19.90' bgs						
6.75" OD PVC 0.050-slot Screen: 19.90' - 29.90' bgs						16.0' - 39.5': Silty Sandy Gravel, msG
6.75" OD PVC Blank: 29.90' - 34.90' bgs				20		
6.75" OD PVC 0.050-slot Screen: 34.90' - 44.90' bgs						
6.75" OD PVC Blank: 44.90' - 48.42' bgs						
				30		Depth to Water: 31.05' bgs (8/6/15)
<b>Construction Materials:</b>						
Concrete: 0.0' - 1.0' bgs						
Neat Grout: 1.0' - 9.76' bgs						
Bentonite Chips: 9.76' - 13.87' bgs						
Bentonite Seal: 13.87' - 16.90' bgs						
8/16 Mesh Filter Pack Sand: 16.90' - 32.0' bgs						
Bentonite Seal: 32.0' - 34.92' bgs						
8/16 Mesh Filter Pack Sand: 34.92' - 50.0' bgs						
		40		39.5' - 44.80': Sandy Gravel, sG		
				44.80' - 50.0': Gravelly Silty Sand, gmS		
		50				
				<b>Total Depth = 50.0' bgs (7/28/15)</b>		
				<b>OD = outside diameter</b>		
				<b>bgs = below ground surface</b>		
All temporary 10 3/4" OD casing removed 7/28/15.				<b>Centralizers: top of sump &amp; bottom of last blank riser.</b>		

BOREHOLE LOG					Page 1 of 2
Well ID: <u>19468</u>		Well Name: <u>399-1-97</u>		Location: <u>300 Area W of PNML</u>	
Project: <u>30 wells 300 off 5</u>		Reference Measuring Point: <u>Ground surface</u>		Date: <u>July 27, 2015</u>	
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0.00 ft (ground surface) to 0.50 ft Drill pad / backfill	Injection well
0-5	gs	2 50% recovery		0.50 ft to 16.00 ft bgs Formation: 10% silt 40% Sand 50% Gravel Sand: fine to medium grain. mod. sorting, sub angular ~60% mafic 40% felsic Gravel: 2 mm to ~200 mm Angular to round, very poorly sorted. ~60% mafic 40% felsic very weak reaction to HCL 2.5 Y 3/2 very dark grayish brown Dry	Drilling is being conducted with an air hammer 150 CC g.s = grab sample. Grab samples are collected every 5 ft and placed in pint jars and chip trays.
5-10	gs	70% recovery		graded contacts upper/lower	
10-15	gs	90% recovery		16.00 ft to 39.50 ft bgs (m)G Formation: 15% silt 35% Sand 50% Gravel Sand: fine to very coarse, very poorly sorted. Angular. the majority ~60% of the sand is coarse to very coarse, ~60% mafic 40% felsic Gravel: 2 mm to ~150 mm. Some larger cobble (less than 1%) sub round to well round for gravel over ~50mm. Gravels are very poorly sorted w/ the majority >50 mm smaller gravels tend to be more angular.	Recovery: 0-10 50% 10-20 70% 20-30 90% 30-40 75% 40-50% 100%
15-20	gs	75% recovery		well reaction to HCL moist to wet 2.5 Y 3/2 very dark grayish brown	
20-25	gs			@ 25.00 ft to 25.30 ft there is a gravel lens average size ~50mm well rounded	TD 50.00 ft bgs DWT 36.85 ft bgs.
25-30	gs			@ 28.00 ft to 28.70 ft there is	

Reported By: Candice Burnette Kildall  
 Title: Geologist  
 Signature: [Signature] Date: 7/28/15

Reviewed By: BA WILLIAMS  
 Title: SR. GEOLOGIST  
 Signature: [Signature] Date: 9/22/15

**BOREHOLE LOG**

Page 2 of 2

Date: July 28, 2015

Well ID: C9468

Well Name: 399-1-97

Location: 300 Area W of PUNA

Project: 30 wells 300-FF-5 FY15

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		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
	Type No.	Blows Recovery			
40				a silty (~20) gravel lens gravels a ~5mm well rounded no silt has low to med. plasticity	Injection well Drilling is being conducted with a terrasonic 150 cc
45				38.00 to 38.50 ft there is a gravel lens ~75mm gravels, well rounded.	10" casing 8" X 10' core barrel
50				39.50 ft to 44.80 ft bgs sg Formation <sup>clay matrix</sup> Ringold 10% mb 60% s 30% gravel sand: med grain, well sorted rounded. ~20% mafic 80% felsic Gravel: 2mm to 30mm, med/poor sorting sub round to well round 40% mafic 60% felsic No reaction to HCL 10YR 6/3 Pale brown wet: graded upper / Sharp lower contact	g.s = grab sample
				44.80 to 50.00 ft bgs (gms) 15% silt 40% sand 25% gravel Sand: well sorted med grain rounded. Large flakes of mica 20% mafic 80% felsic Gravel: 2mm to 20mm sub-round ~40% mafic to 60% felsic Wood found in the last <del>foot</del> <sup>7-20/15</sup> two feet: chunks are ~100mm X 50mm No reaction to HCL 2.5Y 2.5/1 black wet	wood found @ ~48 ft bgs. Some of the chunk were collected and placed in a pint jar with the Archive samples.

Reported By: Candice Burnette Kildall

Reviewed By: RD Williams

Title: Geologist

Title: SR. Geologist

Signature: Candice Kildall

Date: 7/28/15

Signature: [Signature]

Date: 7/28/15

<b>SURVEY DATA REPORT</b>				Request No. 154-161		
Project No.	Title 300-FF-5 Wells Final Surveys			File No. 3AT10R28		
Job. No. CACN: 303500-JPRC	Prepared By N.P. Fastabend	Date 8/11/15	Reviewer <i>UBM</i>			
<b>DESCRIPTION OF WORK</b>			<b>DISTRIBUTION</b>	<b>SDR</b>	<b>PLOT</b>	<b>DWG</b>
Obtained final coordinates (C/L Casings) and elevations of 30 completed 300-FF-5 flush mount wells located on north side of 300 Area.  Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)			Survey File	OR		
			E.C. Rafuse	1		
			S.J. Trent	1		
			K.M. Whitley	1		
			J.B. Geiger	1		
			B.J. Howard	1		
			A.J. Green	1		
<b>SURVEY RESULTS AND COMMENTS</b>						
<p><b>See Attached Well Survey Data Report Sheets</b></p>						

### WELL SURVEY DATA REPORT

<b>Project:</b> 08/04/15	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC								
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)								
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)								
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9460 (399-1-89) located on north side of 300 Area.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9460	399-1-89	594087.17	116467.59		Center of Casing
				114.842	"X" on Rim
				114.839	Brass Survey Marker

**Notes:**

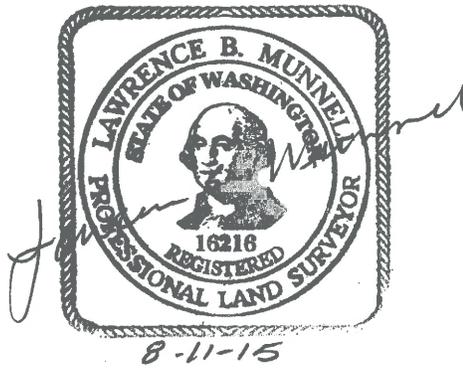
114.698 Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
 Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b> 08/04/15	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC								
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)								
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)								
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9461 (399-1-90) located on north side of 300 Area.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9461	399-1-90	594102.77	116478.21		Center of Casing
				114.942	"X" on Rim
				114.949	Brass Survey Marker

**Notes:**

114.812. Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
 Trimble DiNi 12 Level

**Surveyor Statement:**

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8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9462 (399-1-91) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9462	399-1-91	594118.24	116489.07		Center of Casing
				115.012	"X" on Rim
				115.014	Brass Survey Marker

**Notes:**

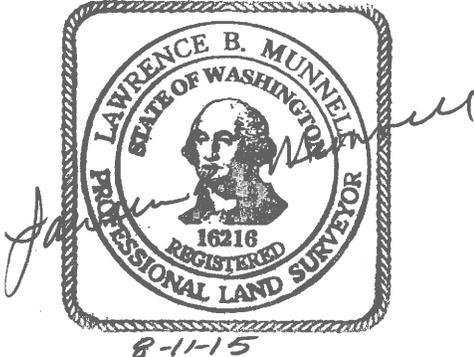
114.874' Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

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8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b> 08/04/15	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC								
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)								
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)								
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9463 (399-1-92) located on north side of 300 Area.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9463	399-1-92	594132.82	116466.66		Center of Casing
				115.070	"X" on Rim
				115.071	Brass Survey Marker

**Notes:**

114.943 Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
 Trimble DiNi 12 Level

**Surveyor Statement:**

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8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b> 08/04/15	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC								
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)								
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)								
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9464 (399-1-93) located on north side of 300 Area.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9464	399-1-93	594116.97	116470.77		Center of Casing
				115.047	"X" on Rim
				115.050 *	Brass Survey Marker

**Notes:**

114.911' Top Inner 6in PVC Casing, North Edge

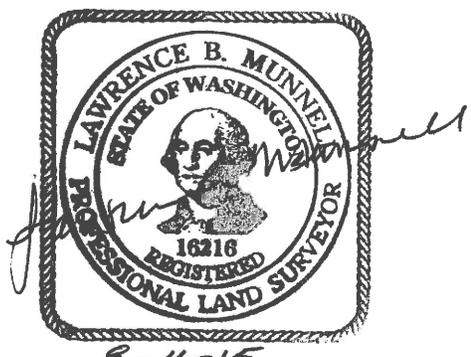
"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

Equipment Used: Trimble R8 RTK GPS  
 Trimble DiNi 12 Level

\* BRASS MARKER LOOSE - UBM

**Surveyor Statement:**

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8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b> 08/04/15	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC								
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)								
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)								
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9465 (399-1-94) located on north side of 300 Area.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9465	399-1-94	594130.80	116479.65		Center of Casing
				115.033	"X" on Rim
				115.032	Brass Survey Marker

**Notes:**

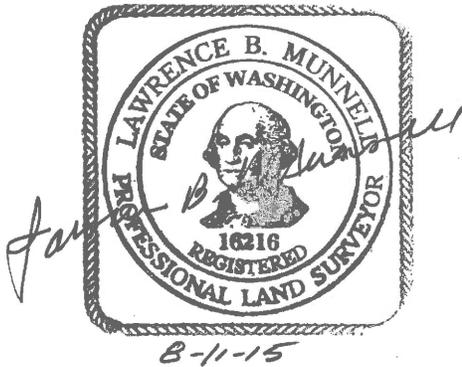
114.882 Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
 Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9466 (399-1-95) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9466	399-1-95	594143.85	116488.32		Center of Casing
				114.833	"X" on Rim
				114.834	Brass Survey Marker

**Notes:**

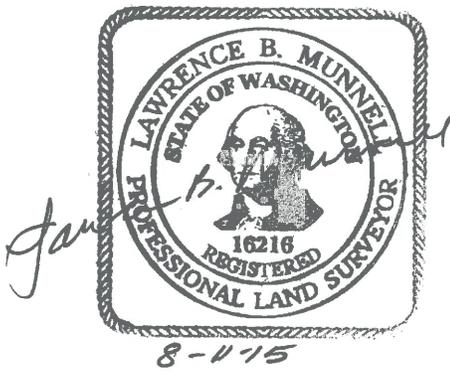
114.707, Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



8-11-15

## WELL SURVEY DATA REPORT

<b>Project:</b>	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9467 (399-1-96) located on north side of 300 Area.	<b>Horizontal Datum:</b> NAD83 (91)
	<b>Vertical Datum:</b> NAVD88
	<b>Units:</b> Meters
	<b>Hanford Area Designation:</b> 300A

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
Washington State Reference Network

**Vertical Control Monuments:**  
300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9467	399-1-96	594146.20	116473.85		Center of Casing
				114.836	"X" on Rim
				114.838	Brass Survey Marker

**Notes:**

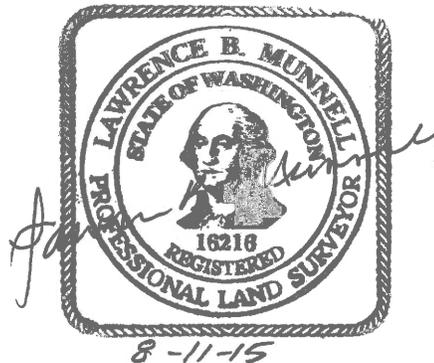
114.673 Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
Trimble DiNi 12 Level

**Surveyor Statement:**

I, Lawrence B. Munnell, a Professional Land Surveyor registered in the State of Washington (Registration No. 16216), hereby certify this report is based on a field survey performed by me, or under my direct supervision.



## WELL SURVEY DATA REPORT

<b>Project:</b> 08/04/15	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC								
<b>Date Requested:</b> 08/04/15	<b>Requestor:</b> Edward Rafuse (CHPRC)								
<b>Date of Survey:</b> 08/10/15	<b>Surveyor:</b> Lawrence B. Munnell (CHPRC)								
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtain final survey coordinates (C/L Casing) and elevations of Well C9468 (399-1-97) located on north side of 300 Area.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 300-28 (CHPRC) and HSWB-005 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9468	399-1-97	594157.77	116480.09		Center of Casing
				114.759	"X" on Rim
				114.762	Brass Survey Marker

**Notes:**

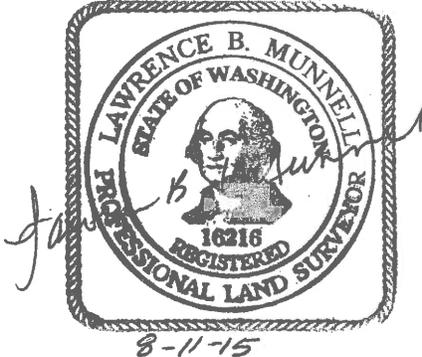
114.546' Top Inner 6in PVC Casing, North Edge

"X" on Rim elevation taken on north edge rim of outer 12" steel handhole casing.

**Equipment Used:** Trimble R8 RTK GPS  
 Trimble DiNi 12 Level

**Surveyor Statement:**

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8-11-15

## Appendix D

### Well Documentation for Post-Injection Boreholes

- Well Summary Sheet
- Borehole Log
- Final Survey Report

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**WELL SUMMARY SHEET**

Start Date: 1/5/2016

Page 1 of 2

Finish Date: 1/7/2016

Well ID: C9580

Well Name: N/A

Location: N portion of 300 Area Industrial Complex

Project: 300-FF-5 OU Characterization Boreholes

Prepared By: K. Wilson

Date:

Reviewed By: **J.D. MEHRER**

Date:

Signature:



2/18/16

Signature: Environmental Scientist

2-29-16

**CONSTRUCTION DATA**

**GEOLOGIC/HYDROLOGIC DATA**

Depth in Feet

Graphic Log

Lithologic Description

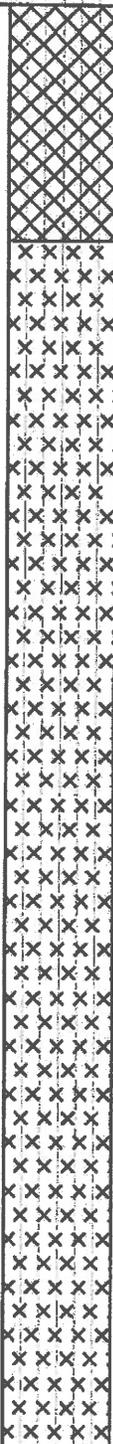
**Surface Completion:**

Brass marker placed into concrete at ground surface

**Materials used in construction:**

Concrete surface seal  
Ground Surface - 4.9' bgs

3/8" Bentonite Chips  
4.9' - 35.0' bgs



0

5

10

15

20

25

0' to 10' bgs: Sandy Gravel (sG)

10' to 13' bgs: Gravelly Sand (gS)

13' to 16' bgs: Gravel (G)

16' to 17' bgs: Silt (M)

17' to 32.5' bgs: Gravel (G)



**BOREHOLE LOG**

Page 1 of 2

Date: 1/5/16

Well ID: L9580

Well Name: N/A

Location: 300 Area

Project: 300-FF-5

Reference Measuring Point: ground surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0'-5' bgs: <u>Sandy Gravel (SG)</u> S=60% very fine (vf) - very coarse (vc) sand, 80% mafic, 20% felsic, subangular to angular, moderately sorted; 40% G v.f. pebble to small cobble max 90mm, 90% mafic subrounded (subrnd) to angular (ang), very poorly sorted (vps); trace silt; no rxn to HCl; overall sorting poor; color 10YR 3/2 very dark grayish brown, damp	Sonic 6" wire barrel approx 28°F G.S. = grab sample S.S. = split spoon G.S. 0'-5' bgs
5				5'-10' bgs: <u>Sandy Gravel (SG) cont'd</u> S=70% fine (F) to vc sand, 90% mafic subangular (subang) to ang, poorly sorted; G=30% vf - small cobbles max = 110mm 90% mafic, subrnd to ang, vps; color 2.5Y 3/1 very dark grey, damp, no rxn to HCl	G.S. 5'-10' bgs
10				10'-13' bgs: <u>Gravelly Sand (GS)</u> 80% vf to vc sand, 90% mafic, subang to ang, vps; 20% vf pebbles to small cobbles max = 120 mm, 60% mafic, subrnd to ang, color 5Y 3/1 very dark gray, damp, no rxn to HCl	G.S. 10'-13' bgs @ 1116 I-001: 20'-22.5' bgs 22.0' bgs A=0% recovery B=0% recovery, C=0% recovery D=100% recovery HEIS# = B3401, dup B3408
15				13'-16' bgs: <u>Gravel (G)</u> 95% coarse to small cobble Gravels, max = 110 mm, subang to ang, 60% mafic vps; trace vf sand, trace silt = 5%; color 5Y 5/1 gray, damp, no rxn to HCl; overall sorting very poor	I-002: 22.5'-24.5' bgs 24.5' bgs A=0% recn, B=0% recn, C=0% recn, D=100% recn, HEIS# = B347D3, B347D2, Blank B347D4
20				16'-17' bgs: <u>Silt (M)</u> 100% silt, color 10YR 4/4 dark yellowish brown, damp, no rxn to HCl	G.S. 13'-16' bgs I-003: 25.0'-27.0' bgs 27.0' bgs A=0% recn, B=0% recn, C=0% recn, D=100% recn, HEIS# = B347D8, B347D9
25				17'-20' bgs: <u>Gravel (G)</u> 95% coarse to small cobble Gravels, max = 85 mm, subang to ang, 90% mafic vps, trace silt and vf sand, color 5Y 5/1 gray, damp, no rxn to HCl; overall vps. → @ 25' bgs @ 22.5' silt content increases to 10% → @ 25' silt content increases to 15% overall decrease in G size, max = 50mm	G.S. 16'-17' bgs G.S. 17'-20' bgs I-004: 27.5'-29.5' bgs 29.5' bgs A=0% recn, B=0% recn, C=0% recn, D=100% recn, HEIS# = B347F1, B347F3, B347F4 G.S. 20'-25' bgs G.S. 25'-30' bgs

Reported By: Katie Wilson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: Katie Wilson

Date: 1/5/16

Signature: Kevin Bergstrom

Date: 1/28/2016

**BOREHOLE LOG**

Date: 1/5/16

Well ID: C9580

Well Name: N/A

Location: 300 Area

Project: 300-FF5

Reference Measuring Point: ground surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
30	G.S. 3-005 A-D 11/10	100	[Hand-drawn log symbols]	Gravel cot'd: color change to 10YR <sup>3/1</sup>	Sonic
				very dark gray @ 30' bgs. Silt content @ 20% to 32.5' bgs.	6" core barrel approx. 28°F
35	G.S. 3-006 A-D 11/10	100	[Hand-drawn log symbols]	32.5' bgs - 35' bgs: Silty Gravel (m6)	G.S. = grab sample
				75% G, 25% m; G = f to small gravels max = 150mm, color is 2.5Y 4/1 dark grey	G.S. 30' - 32.5' bgs
				wet, very poorly sorted, angular to subangular	G.S. 32.5' - 30' bgs
				no rxn to HCl; Gravels are 70% med.	
				Trace very fine sand	
					TDP 35.0' bgs
					SS = split spoon
					F-005: 30.0' - 32.0' bgs
					A = 0% recovery, B = 10% recovery, C = 100% recovery, D = 100% recovery.
					HEIS# = B347F6, B347F7, B347F8, B347F9
					F-006: 32.5' - 34.5' bgs
					A = 0% recovery, B = 100% recov., C = 100% recov., D = 100% recov.
					HEIS# = B347H1, B347H2, B347H3, B347H4, B347H5

Reported By: K. Wilson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: [Handwritten Signature]

Date: 1/5/16

Signature: [Handwritten Signature]

Date: 4/28/2016

**WELL SUMMARY SHEET**

Start Date: 1/7/2016

Page 1 of 2

Finish Date: 1/7/2016

Well ID: C9581

Well Name: N/A

Location: N portion of 300 Area Industrial Complex

Project: 300-FF-5 OU Characterization Boreholes

Prepared By: K. Wilson

Date:

Reviewed By: **J.D. MEHRER**

Date:

Signature: *K. Wilson*

2/8/16

Signature: *J.D. Mehrer*

2-29-16

**CONSTRUCTION DATA**

**GEOLOGIC/HYDROLOGIC DATA**

Depth in Feet

Graphic Log

Lithologic Description

**Surface Completion:**

Brass marker placed into concrete at ground surface

**Materials used in construction:**

Concrete surface seal

Ground Surface - 5.15 bgs

3/8" Bentonite Chips

5.15' - 35.0' bgs

0

5

10

15

20

25

0' to 19' bgs: Sandy Gravel (sG)

19' to 20' bgs: Silty Gravel (mG)

20' to 35.0' bgs: Gravel (G)



BOREHOLE LOG					Page 1 of 2
Well ID: C9581		Well Name: N/A		Location: N of PNNL	
Project: 300 FF-5 Characterization Borehole			Reference Measuring Point: Ground surface		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0-6 ft bgs Formation: (Backfill) (SG) 2% silt 30% Sand 70% Gravel.	Sonic drill rig 1" core barrel temp 33°F
5	g.s.			Sand: fine to med grain med. sorting subround ~ 40% matc 60% felsic Gravel: 1mm to 75mm very poorly sorted sub round. 70% matc 30% felsic	g.s = grab sample grab samples are collected over 5' interval and @ lithology changes.
10	litw			6.0 - 9.0 ft bgs Formation: Han Ford (SG) 2% silt 28% Sand 70% Gravel	s.s = split spoon 32.90 ft = HQ0
15	g.s.			Sand: fine to med grain. poor to mod sorting. sub-round 60% matc 40% felsic Gravel: 2mm to 100mm. very poorly sorted Sub angular to sub round.	S.S samples I-061 Depth 20.00' - 22.50' Recovery 100%
20	litw			80% matc 20% felsic No reaction to HCL 10YR 3/1 (some moisture) very dark gray	temp 80°F HEIS B34716 B34718 B34717 B34719
25	g.s.			9.0 - 10.0 ft bgs. Formation (SG) 10% silt 20% Sand 70% Gravel	I-002 depth 22.50 - 25.00 Recovery 100%
30	g.s.			med. grain sands. mod sorting sub-angular 50% matc 50% felsic No reaction to HCL Gravel: 2mm to 75mm. poorly sorted sub angular to sub round. 70% matc	temp 84°F HEIS B347K2 B347K3 B347K4 I-003
35	g.s.			30% felsic 10YR 4/6 dark yellow brown. 10.0 ft bgs to 19.00 ft bgs Formation: Han Ford (SG) 2% silt 28% Sand 70% Gravel	depth 25.00 - 27.50 Recovery 100% temp 84°F HEIS B347K8, B347K9 B347K7 B347L0 B347L1 I-004
				Sand: fine to med grain poor to mod sorting sub-round 60% matc 40% felsic Gravel: 2mm to 100mm very poorly sorted Sub angular to subround.	depth 27.50 - 30.00' Recovery 75% temp 84°F HEIS B347I2 B347I3 B347L4 B347L5
				very weak reaction to HCL 10YR 3/1 (dry) very dark gray	I-005 depth 30.00 - 32.50 Recovery 0
Reported By: Candice Burette Kildall			Reviewed By: Kevin Bergstrom		
Title: Geologist			Title: Sr. Geologist		
Signature:		Date: 1/7/16	Signature:		Date: 1/28/2016



**WELL SUMMARY SHEET**

Start Date: 1/7/2016

Page 1 of 2

Finish Date: 1/11/2016

Well ID: C9582

Well Name: N/A

Location: N portion of 300 Area Industrial Complex

Project: 300-FF-5 OU Characterization Boreholes

Prepared By: K. Wilson

Date:

Reviewed By: **J.D. MEHREZ**

Date:

Signature: *K. Wilson*

2/8/16

Signature: *J.D. Mehez*

2-29-16

**CONSTRUCTION DATA**

**GEOLOGIC/HYDROLOGIC DATA**

Depth in Feet

Graphic Log

Lithologic Description

**Surface Completion:**

Brass marker placed into concrete at ground surface

**Materials used in construction:**

Concrete surface seal

Ground Surface - 4.85 bgs

3/8" Bentonite Chips

4.85' - 35.0' bgs

0

0' to 12' bgs: Sandy Gravel (sG)

5

10

12' to 19' bgs: Gravel (G)

15

20

19' to 22' bgs: Silty Gravel (mG)

25

22' to 35.0' bgs: Gravel (G)

WELL SUMMARY SHEET			Start Date: 1/7/2016		Page <u>2</u> of <u>2</u>		
			Finish Date: 1/11/2016				
Well ID: C9582			Well Name: N/A				
Location: N portion of 300 Area Industrial Complex			Project: 300-FF-5 OU Characterization Boreholes				
Prepared By: K. Wilson		Date:	Reviewed By: <u>J.D. MEPPER</u>		Date:		
Signature: <u>Kate Wilson</u>		<u>2/8/16</u>	Signature: <u>[Signature]</u>		<u>2-25-16</u>		
CONSTRUCTION DATA			GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description			
Temporary Casing/Hole diameter: 7.25" OD: 0' bgs - 35.0' bgs		30		22' - 35.0' bgs: Gravel (G)			
				DTW: 31.4 bgs (1/11/16)			
All temporary casing removed 1/11/2016		35		Total Depth: 35.0' bgs			
OD = outside diameter							
bgs = below ground surface							
DTW = Depth to Water							

**BOREHOLE LOG**

Page 1 of 2

Date: 11/11/16

Well ID: C9582

Well Name: NA

Location: N. portion of 300 Area

Project: 300-FF-5

Reference Measuring Point: ground surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				<u>0'-12' bgs: Sandy Gravel (SG)</u>	<u>Sonic</u>
				<u>60% G, very fine (vf) to very coarse (vc) pebbles, avg = 20mm, small cobbles, max = 70mm, 100% mafic, angular (ang) to subrounded (subrnd), very poorly sorted (vps); 35% S, vf to vc, 90% mafic, subround to ang, poorly sorted; moist; trace silt; 10YR 3/2 very dark greyish brown; no rxn to HCl.</u>	<u>6" core barrel</u>
				<u>→ @ 5'-10' bgs, max cobble increase to 100mm</u>	<u>weather approx 35° F</u>
				<u>no rxn to HCl, damp</u>	<u>g.s. = grab sample</u>
				<u>→ 10'-12' bgs, continue Sandy Gravel, increase silt content to 5% max</u>	<u>g.s. 0'-5' bgs</u>
				<u>cobble = 140mm, no rxn to HCl, damp</u>	<u>g.s. 5'-10' bgs</u>
				<u>12'-19' bgs: Gravel (G)</u>	<u>g.s. 10'-12' bgs</u>
				<u>80% G, vf to vc pebbles, small cobbles, max = 110mm, 90% mafic, subrnd to ang, vps; 10% S, vf to vc, subang to ang, 80% mafic; 10% silt; silt coating on rocks; moist, 2.5Y 3/1</u>	<u>g.s. 12'-14' bgs</u>
				<u>very dark grey, no rxn to HCl, overall vps</u>	<u>g.s. 14'-15' bgs</u>
				<u>→ from 14'-14.5' bgs, silt content increases to 15%, sand is coarse to vc; 10YR 4/1</u>	<u>g.s. 14.5'-18' bgs</u>
				<u>dark grey, moist, no rxn to HCl, although one chip (~3mm) of caliche is found, max G = 130mm</u>	<u>g.s. 18'-19' bgs</u>
				<u>→ 14.5'-18' bgs: overall cobble size decrease to max = 80mm, average = 20mm, slight orange-ish tint to silt, moist, no rxn to HCl</u>	<u>g.s. 19'-20' bgs</u>
				<u>→ 18'-19' bgs: color change to 2.5Y 4/1 dark grey, moist; max G size = 110mm, silt content @ 15%, no rxn to HCl.</u>	<u>g.s. 20'-22' bgs</u>
				<u>19'-22' bgs: Silty Gravel (mG)</u>	<u>g.s. 22'-27' bgs</u>
				<u>75% G, vf to vc pebbles, max cobble = 90mm</u>	<u>g.s. 27'-32' bgs</u>
				<u>subrnd to ang, vps; 50% mafic; silt = 25%; trace vf-vc S; overall sorting = vps; moist; 10YR 4/3 brown, no rxn to HCl</u>	
				<u>→ 20'-22' bgs, color change to 2.5Y 4/2 dark greyish brown, no rxn to HCl, moist</u>	
				<u>22'-35' bgs: Gravel (G)</u>	
				<u>80% G, vf to vc pebbles, max cobble = 120mm, vps, 70% mafic, subrnd to ang; 20% S, c to vc, ang, vps; 80% mafic; trace silt; moist, no rxn to HCl, 2.5Y 3/2 v dark greyish brown</u>	

Reported By: K. Wilson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: Katie Wilson

Date: 11/11/16

Signature: Kevin Bergstrom

Date: 1/28/2016



<b>SURVEY DATA REPORT</b>				Request No. 162-026		
Project No.	Title 300-FF-5 Boreholes C9580, C9581 & C9582 Final Surveys			File No. 3AT10R28		
Job. No. CACN: 303500- JPRC	Prepared By N.P. Fastabend	Date 1/20/16	Reviewer <i>AE. MOSCA</i> 			
DESCRIPTION OF WORK			DISTRIBUTION	SDR	PLOT	DWG
Obtained final coordinates and elevations of brass cap markers in concrete for completed 300-FF-5 Boreholes C9580, C9581 and C9582 located on north side of 300 Area.  Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)			Survey File	OR		
			S.E. Imhoff	1		
			K.M. Whitley	1		
			J.L. Smoot	1		
			J.B. Geiger	1		
			B.J. Howard	1		
			A.J. Green	1		
SURVEY RESULTS AND COMMENTS						
<p style="font-size: 1.2em; font-weight: bold;">See Attached Well Survey Data Report Sheets</p>						

## WELL SURVEY DATA REPORT

<b>Project:</b> 01/12/16	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC								
<b>Date Requested:</b> 01/12/16	<b>Requestor:</b> Steve Imhoff (CHPRC)								
<b>Date of Survey:</b> 01/20/16	<b>Surveyor:</b> Neil P. Fastabend (CHPRC)								
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtained final survey coordinates and elevation of Brass Cap Marker in concrete for completed 300-FF-5 Borehole C9580 located on north side of 300 Area.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 Washington State Reference Network

Well ID	Well Name	Easting	Northing	Elevation	
					Center of Casing
					"X" on Rim
C9580	C9580	594088.67	116456.38	114.86	Brass Survey Marker

**Notes:**

Equipment Used: Trimble R8 RTK GPS

**Surveyor Statement:**

## WELL SURVEY DATA REPORT

<b>Project:</b> 01/12/16	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC								
<b>Date Requested:</b> 01/12/16	<b>Requestor:</b> Steve Imhoff (CHPRC)								
<b>Date of Survey:</b> 01/20/16	<b>Surveyor:</b> Neil P. Fastabend (CHPRC)								
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtained final survey coordinates and elevation of Brass Cap Marker in concrete for completed 300-FF-5 Borehole C9581 located on north side of 300 Area.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 Washington State Reference Network

Well ID	Well Name	Easting	Northing	Elevation	
					Center of Casing
					"X" on Rim
C9581	C9581	594116.78	116462.13	115.09	Brass Survey Marker

**Notes:**

Equipment Used: Trimble R8 RTK GPS

**Surveyor Statement:**

## WELL SURVEY DATA REPORT

<b>Project:</b> 01/12/16	<b>Prepared By:</b> Neil P. Fastabend <b>Company:</b> CHPRC								
<b>Date Requested:</b> 01/12/16	<b>Requestor:</b> Steve Imhoff (CHPRC)								
<b>Date of Survey:</b> 01/20/16	<b>Surveyor:</b> Neil P. Fastabend (CHPRC)								
<b>Fluor Hanford Point of Contact:</b>	<b>Survey Co. Point of Contact:</b> Neil P. Fastabend								
<b>Description of Work:</b> Obtained final survey coordinates and elevation of Brass Cap Marker in concrete for completed 300-FF-5 Borehole C9582 located on north side of 300 Area.	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;"><b>Horizontal Datum:</b></td> <td>NAD83 (91)</td> </tr> <tr> <td><b>Vertical Datum:</b></td> <td>NAVD88</td> </tr> <tr> <td><b>Units:</b></td> <td>Meters</td> </tr> <tr> <td><b>Hanford Area Designation:</b></td> <td>300A</td> </tr> </table>	<b>Horizontal Datum:</b>	NAD83 (91)	<b>Vertical Datum:</b>	NAVD88	<b>Units:</b>	Meters	<b>Hanford Area Designation:</b>	300A
<b>Horizontal Datum:</b>	NAD83 (91)								
<b>Vertical Datum:</b>	NAVD88								
<b>Units:</b>	Meters								
<b>Hanford Area Designation:</b>	300A								

**Coordinate System:** Washington State Plane Coordinates (South Zone)

**Horizontal Control Monuments:**  
 Washington State Reference Network

**Vertical Control Monuments:**  
 Washington State Reference Network

Well ID	Well Name	Easting	Northing	Elevation	
					Center of Casing
					"X" on Rim
C9582	C9582	594161.09	116484.01	114.59	Brass Survey Marker

**Notes:**

Equipment Used: Trimble R8 RTK GPS

**Surveyor Statement:**