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Revision 0

Borehole Summary Report for the Installation of Seven 100-HR-3 Replacement Monitoring Wells, FY2016

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

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Richland, Washington 99352

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J. A. Johanson
GRAM Inc

Date Published
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Assistant Secretary for Environmental Management

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Terms

bgs	below ground surface
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CHPRC	CH2M HILL Plateau Remediation Company
DOW	description of work
DUP	duplicate
Ecology	Washington State Department of Ecology
gpm	gallons per minute
HCl	hydrochloric acid
HEIS	Hanford Environmental Information System
ID	inner diameter
N/A	not applicable
NCO	nuclear chemical operator
NMLS	neutron moisture logging system
NTU	nephelometric turbidity unit
OD	outer diameter
OU	operable unit
ppm	parts per million
QC	quality control
RCT	radiological control technician
RUM	Ringold Formation upper mud
SAP	sampling and analysis plan
SGLS	spectral gamma logging system
SN3	Stoller Newport News Nuclear
TD	total depth
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order* (Ecology et al., 1989)
VOC	volatile organic compound

Metric Conversion Chart

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

1 Introduction

This borehole summary report provides a general overview of the well drilling and construction activities that were performed during the installation of seven monitoring replacement wells at the Hanford Site. All of the wells are located in the 100-HR-3 Groundwater Operable Unit (OU) which underlies the 100-D and 100-H Areas of the Hanford Site. The document controlling installation of the new wells is SGW-59260, *Description of Work for the Installation of Seven Monitoring Wells in 100-D and 100-H Area* (hereafter referred to as the description of work [DOW]). A map of the Hanford Site, for reference, is provided in Figure 1-1.

The wells were drilled, constructed, and developed between January 20, 2016, and March 30, 2016, by Holt Services, Inc. under the direction of CH2M Plateau Remediation Company (CHPRC) for Washington Closure Hanford. Well site geology, well drilling documentation, and construction documentation services were provided by GRAM, Inc. Geophysical logging services were provided by Stoller Newport News Nuclear (SN3).

Installation of the seven new monitoring wells supports Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement), and the wells were installed in compliance with the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) and ROD/R10-96/134, *Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units Interim Remedial Actions, Benton County, Washington.*

The seven wells were replacements for wells that had been decommissioned in support of source area remediation in the 100-D and 100-H Areas. The OU underlying the 100-D and 100-H Areas is the 100-HR-3, which has been contaminated with hexavalent chromium. The purpose for installing the seven new monitoring wells is to continue monitoring after the source area remediation (SGW-59260).

Table 1-1 provides the well names, well identification numbers, Washington State Department of Ecology (Ecology) well tag numbers, and drilling dates for the seven new wells. Well summary sheets, borehole logs, geophysical log data reports, final civil survey reports, and photo logs for each well (if applicable) are presented in Appendix A (for C8729), Appendix B (for C8730), Appendix C (for C8731), Appendix D (for C8732), Appendix E (for C8733), Appendix F (for C8734), and Appendix G (for C8735). Maps of the well locations are provided in Figures 1-2 and 1-3.

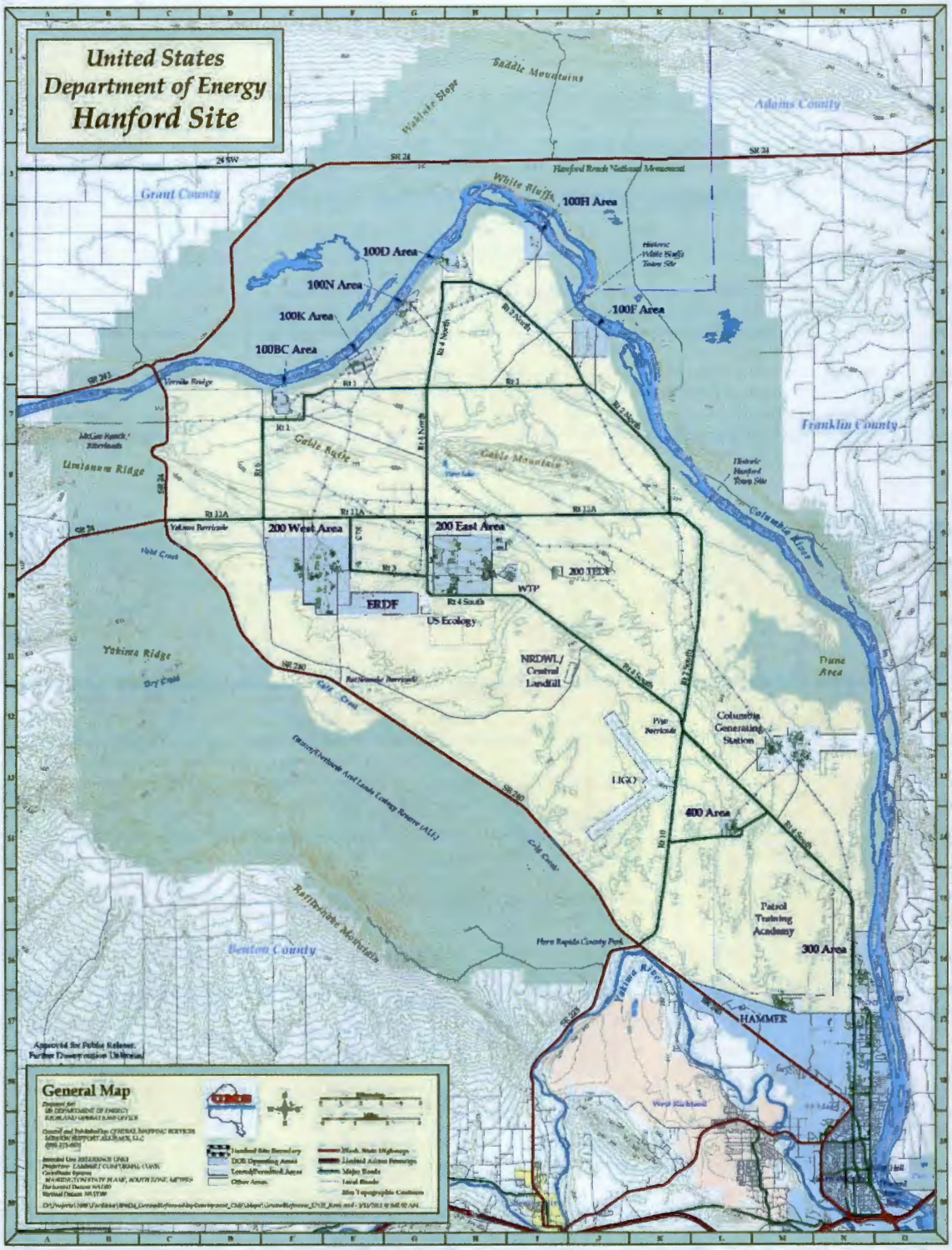

Figure 1-1. Hanford Site with Areas Shown

Table 1-1. Project Well Identification and Drilling Date Summary

Well Number	Well Name	Drilling Date		Ecology Well Tag
		Start	Finish	
C8729	199-D5-149	January 20, 2016	February 9, 2016	BIN 115
C8730	199-D5-150	February 2, 2016	February 18, 2016	BJB 584
C8731	199-D5-151	February 24, 2016	March 8, 2016	BJB 581
C8732	199-D5-152	February 22, 2016	March 8, 2016	BJB 586
C8733	199-H4-87	March 22, 2016	March 28, 2016	BJB 582
C8734	199-H4-88	March 14, 2016	March 23, 2016	BJB 583
C8735	199-H4-89	January 27, 2016	March 30, 2016	BJB 585

Ecology = Washington State Department of Ecology

Figure 1-2. Location of New Monitoring Wells Drilled in the 100-D Area

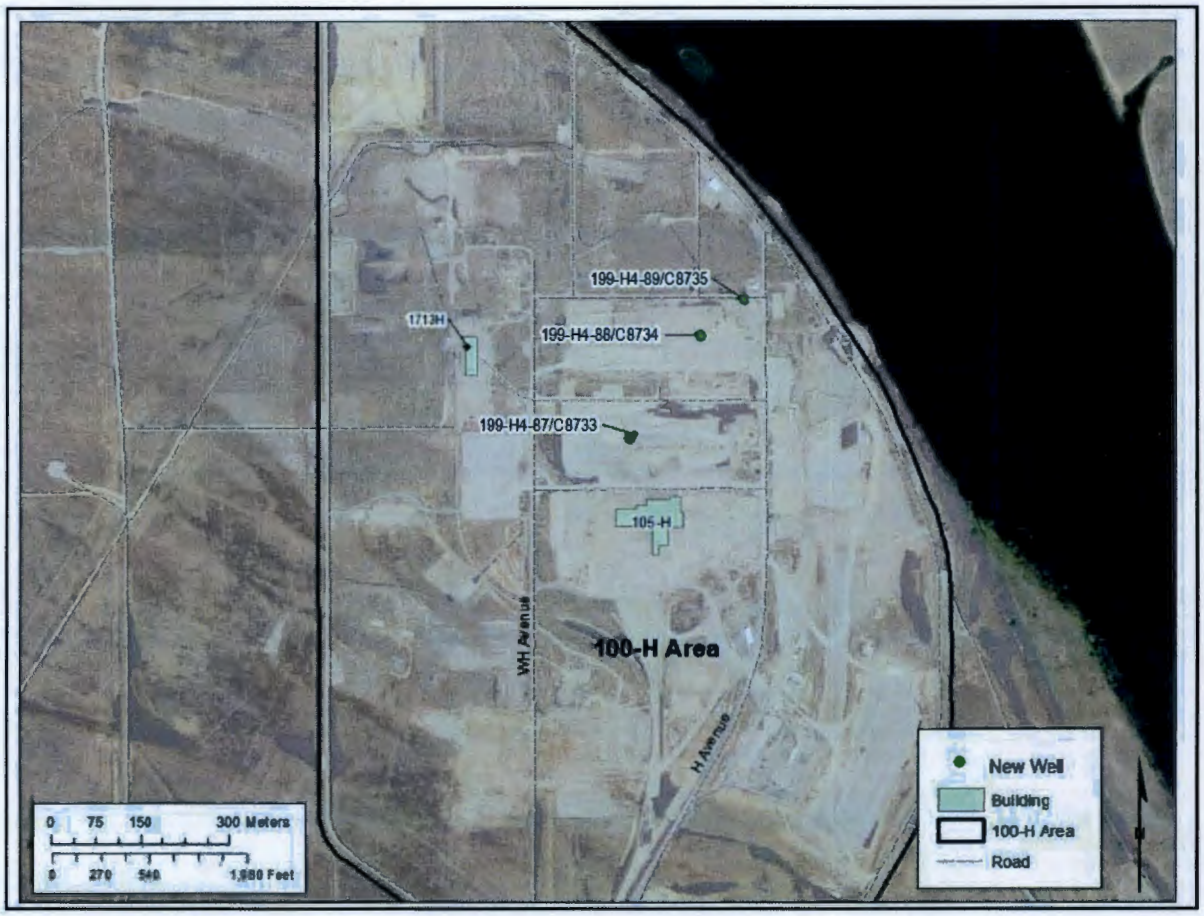

Figure 1-3. Location of New Monitoring Wells Drilled in the 100-H Area

2 Drilling, Sampling, and Well Construction Activities

This section summarizes the field activities associated with wells 199-D5-149 (C8729), 199-D5-150 (C8730), 199-D5-151 (C8731), 199-D5-152 (C8732), 199-H4-87 (C8733), 199-H4-88 (C8734), and 199-H4-89 (C8735).

2.1 General Information

All seven wells were constructed in compliance with WAC 173-160, *Minimum Standards for Construction and Maintenance of Wells*, and the CHPRC construction specifications in SGW-59260. All well drilling and construction activities were documented in the daily field activity reports, and borehole geology was logged in accordance with CHPRC procedures SGRP-PRO-EN-50030 (GRP-EE-02-14.1), *Drilling, Remediating, and Decommissioning Resource Protection Wells, and Geotechnical Soil Borings*; and SGRP-PRO-EN-50025 (GRP-EE-01-7.0), *Geologic Logging*. The sampling activities for this project are outlined in DOE/RL-2012-45, *Sampling and Analysis Plan for Installation of 100-HR-3 Groundwater Operable Unit Replacement Wells* (as amended by TPA-CN-659) (hereafter referred to as the sampling and analysis plan [SAP]).

2.1.1 Drilling, Sampling, and Borehole Logging

The drilling, sampling and borehole logging conducted during the installation of the seven new monitoring wells are discussed in the following subsections.

2.1.1.1 Drilling

The drilling activities of all seven boreholes were drilled with a TSi 150CC[1] track-mounted sonic drill rig operated by Holt Services, Inc. With the exception of borehole C8735, all boreholes were drilled to a total depth (TD) with temporary 10 1/2 in. outer diameter (OD) carbon-steel casing. Borehole C8735 was drilled with temporary 12 in. OD carbon-steel starter casing and was finished with the 10 1/2 in. OD casing. All the boreholes were drilled with an 8 1/2 in. OD shoe on an 8 in. core barrel.

2.1.1.2 Sampling

Sampling was conducted in accordance with the DOW (SGW-59260), the SAP (DOE/RL-2012-45), and CHPRC procedures (SGRP-PRO-EN-50030 [GRP-EE-02-14.1]; SGRP-PRO-EN-50025 [GRP-EE-01-7.0]). Geologic archive grab samples were collected at 5 ft intervals and at major lithology changes throughout each of the boreholes. Archive samples were placed in labeled pint-size glass mason jars and labeled chip tray compartments for storage. Additional grab samples were collected from the aquifer for particle-size distribution samples (hereafter referred to sieve samples) as dictated by the DOW. The sieve samples were collected as composite samples around two depths (as specified in the DOW) to represent the top and bottom of the water table for the 100-D Area wells. The sieve samples were collected as a single collection at the depths specified in the DOW for the 100-H Area wells. Sieve analyses samples were performed to indicate particle-size distribution in accordance with procedure SGRP-PRO-OP-50037 (GRP-EE-05-1.21), *Particle Size Distribution of Soil–Wet Sieve Analysis*.

Three groundwater samples were collected each from the four 100-D Area boreholes during drilling in the saturated zone. Soil samples were collected at six of the seven boreholes during drilling using a split-spoon sampler. Split spoon samples are comprised of four 0.5-ft liners. Liners are labeled A through D; A being the deepest and D being the shallowest. Three split spoons were collected from each

[1] TSi 150CC is a tradename of Terra Sonic International, LLC, Marietta, Ohio.

of the four 100-D Area wells and four split spoons were collected each from two of the 100-H Area wells. No sampling was conducted during drilling at C8735. Split spoon sample pictures located in the appendices may not be truly representative of what was encountered due to camera angle and drilling method. A water sample was collected at each well after final development. In accordance with the SAP, DOW, and procedure SGRP-PRO-SMP-50060 (GRP-FS-04-G-028), *Field Characterization and Treatment Monitoring Activities Groundwater Sampling*, all samples were collected by CHPRC nuclear chemical operators (NCOs).

2.1.1.3 Geophysical Logging

Geophysical logging for all seven boreholes were conducted by the CHPRC subcontractor, SN3. All boreholes were logged using a spectral gamma logging system (SGLS) to identify natural and man-made gamma-emitting radionuclides and a neutron moisture logging system (NMLS) to detect moisture within the vadose zone. Each casing string was logged before downsizing or beginning construction activities.

2.1.2 Health and Safety Screening

Health and safety screening included radiological field screening and air monitoring for volatile chemicals, as discussed below.

2.1.2.1 Radiological Field Screening

Radiological surveys were conducted twice daily during drilling, construction, and development operations: once in the morning, and once in the afternoon. A radiological control technician (RCT) performed radiological surveys of the drill cuttings, geologic samples, temporary casing, and any equipment used downhole or that came in contact with downhole material using standard radiological field screening instruments to detect beta and gamma radiation contamination.

During drilling and well construction activities, radiological contamination was not encountered.

2.1.2.2 Air Monitoring for Volatile Chemicals

Air quality monitoring was performed twice daily, once in the morning and once in the afternoon, to check for volatile organic compound (VOC) contamination. Using a photo ionization detector, areas that were monitored for VOCs included the drillers' breathing zone near the wellhead; at the wellhead or source; any fresh drill cuttings and geologic samples; and any other areas of potential concern.

Varying low levels of VOCs were detected during drilling activities. The only well that received readings above action levels was at C8729. This is discussed in further detail in Section 2.2.

2.1.3 Well Construction and Development

The following subsections provide additional details on the well construction and development activities.

2.1.3.1 Screen and Casing Materials

All of the wells were constructed using 6 5/8 in. OD, 6 in. inner diameter (ID), Schedule 10S, Type 316 stainless-steel blank, screens, and sumps. The screens varied in slot size. The different slot sizes used were six-slot (0.006 in. apertures), 40-slot (0.040 in. apertures), 45-slot (0.045 in. apertures), 50-slot (0.050 in. apertures), and 75-slot (0.075 in. apertures). All wells, with the exception of C8734, used 3 ft sumps placed directly below the screened interval. Well C8734 used a screen with a welded end cap.

The construction materials for each well are discussed in further detail in Section 2.2.

2.1.3.2 Well Completion

The filter pack size used for construction was determined by the sieve samples, geologic borehole logs, and intended well use. Four different filter pack sizes were used for the seven wells: 8-16, 6-9, 10-20, and 20-40 mesh silica sand. Wells C8729, C8731, and C8732 used 8-16 mesh silica sand filter pack. Wells C8730 and C8735 used 10-20 mesh silica sand filter pack. Well C8734 used both 10-20 and 20-40 mesh silica sand filter pack. Well C8733 used 6-9 mesh silica sand filter pack. For all of the wells, the filter pack was settled using the vibration from the sonic rig using its resonator as it back pulled the temporary casing out of the ground. Sufficient sand was added to keep an overlap, as the sand could not be monitored while back pulling the casing.

The annular seals for all seven wells were constructed using 3/8 in. bentonite pellets overlaying the sand filter pack. Above the bentonite pellets, 3/8 in. bentonite chips were placed to approximately 10 ft below ground surface (bgs). For the surface seal, Type I-II Portland cement grout was placed to approximately ground surface. Any remaining unfilled annular space (up to 2 ft) was filled in with high-strength concrete during well pad construction.

The permanent casing was then surrounded by a stainless-steel outer protective monument with a unique Ecology unique well identification number riveted to the monument. A 6 in. thick concrete pad was constructed around the wellhead protective monument. The concrete pad for each well was 4 ft by 4 ft with a brass marker indicating the well name and well identification number embedded into the pad. The monument had a cap that was able to be locked. Four 6 ft long, 3 in. diameter yellow steel posts were placed at the four corners of the concrete pad with a 3 ft stickup as protection for the wellhead.

Ecology unique well numbers are provided in Table 1-1. For construction details, see the construction summaries in Section 2.2.

2.1.3.3 Final Well Development

After construction was completed for wells C8729, C8734, and C8735, final well development began using an electric submersible pump. During construction of wells C8730, C8731, C8732, and C8733, final development was conducted (after the sand pack was added and before the bentonite seal was placed) using an electric submersible pump. Each well only had one development interval where water was pumped while water quality parameters (turbidity, conductivity, pH, and temperature) were taken. Completion of each development interval was indicated when the turbidity read less than 5 nephelometric turbidity units (NTUs) and the remaining water quality parameters stabilized. Development was performed in accordance with procedure SGRP-PRO-OP-50024 (GRP-EE-01-6.3), *Well Development and Testing*. An In-Situ, Inc. LevelTROLL[2] 700 data logger was used to record the drawdown during development and recovery when the pump was turned off. Table 2-1 provides the final water quality data for each well interval, the water level before and after pumping, pumping duration, flow rate, and total gallons removed.

2.1.3.4 Washington State Department of Ecology Well Identification

Each well received a unique Ecology state well identification number that was embossed onto a tag riveted to the protective monument. When the monuments were set all identification tags were set to face approximately toward the north. Ecology identification numbers and their associated well are shown in Table 1-1.

[2] LevelTROLL® is a registered trademark of In-Situ, Inc., Fort Collins, Colorado.

2.2 Well-Specific Information

This section summarizes the drilling, air monitoring, sampling, geophysical logging, construction, and development activities specific to each well. Well development information for all wells is provided in Table 2-1. Well completion, construction, and sample information are summarized for each well is provided in Tables 2-2 through 2-15.

Table 2-1. Well Development Data 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	Temp. (°C)	Total Gallons Pumped
C8729	199-D5-149	2/9/2016	87.90	103.26	115[a]	11.53	5.15	2.12	618	7.94	15.9	10,358.85[d]
C8729	199-D5-149	2/9/2016	87.90	103.26	55[a]	16.95	10[b]	N/A[c]	N/A[c]	N/A[c]	N/A[c]	932.25[d]
C8730	199-D5-150	2/17/2016	83.20	103.37	117	21.45	12.06	3.72	570	7.98	17.5	2,498.80[d]
C8731	199-D5-151	3/7/2016	69.03	88.98	193	29.23	8.20	4.54	569	7.93	13.3	5,723.90[d]
C8732	199-D5-152	3/2/2016	67.89	83.91	223	26.38	4.30	4.78	616	7.77	14.1	4,882.90[d]
C8733	199-H4-87	3/28/2016	46.60	53.60	82	23.53	6.30	3.31	440	7.64	16.4	1,805.00
C8734	199-H4-88	3/23/2016	51.76	56.50	133	0.38	0[e]	2.22	467	7.73	18.0	50.54
C8735	199-H4-89	3/17/2016	42.40	44.00	3	3.3	1.9[f]	N/A[f]	N/A[f]	N/A[f]	N/A[f]	10.00
C8735	199-H4-89	3/30/2016	42.54	46.00	46	0.77	4.32[f]	15.3[f]	397[f]	7.38[f]	17.6[f]	35.42
C8735	199-H4-89	3/30/2016	42.54	47.00	75	0.59	1.12	4.56	398	7.69	19.1	42.00

a. For C8729, 115 minutes was the total pump time for the test. During the final 55 minutes of the test, the flow rate was increased.

b. This was an approximate observed drawdown but was not recorded in the field activity report.

c. When the flow rate was increased, none of the readings were recorded because the turbidity had already dropped below 5 NTU.

d. Total gallons pumped were calculated based on the flow meter during development.

e. While under development, the rugged reader appeared to gain water while developing, and the water never went down during recharge.

f. The well ran dry and the pump was turned off.

bgs = below ground surface
gpm = gallons per minute
N/A = not applicable
NTU = nephelometric turbidity units

2.2.1 Well 199-D5-149 (C8729)

Well 199-D5-149 (C8729) was installed between January 18, 2016, and February 9, 2016. The borehole was drilled to a TD of 112.67 ft bgs.

Drilling was scheduled to start on January 18, 2016, was delayed due to necessary maintenance of the TSi 150CC Terra Sonic drill rig; drilling began instead on January 20, 2016. The temporary casing used was 10 1/2 in. OD carbon-steel box-threaded casing. It was drilled using an 8 1/2 in. OD core barrel bit, advancing the casing to 112.31 ft bgs.

VOCs were detected twice during the drilling process at concentrations exceeding the action levels. A VOC concentration of 60 parts per million (ppm) was found downhole, and a reading of 140 ppm was observed when the drilling contents were emptied into plastic bags on January 20, 2016. Industrial Hygiene staff and their management determined that the heat from drilling was melting the plastic bags and releasing the VOCs; therefore, the plastic bags were removed from use. On January 26, 2016, VOCs again exceeded the action level at 5.6 ppm at the wellhead. Industrial Hygiene management was onsite at the time, and after an inspection, the drillers were released to continue work.

Sampling at C8729 included soil samples collected for geologic archive purposes, two sieve analysis samples for particle-size distribution, three split-spoon samples for chemical analysis, three water samples for chemical analysis, and one post-development water sample for chemical analysis. All split spoons and water samples were collected by NCOs. Geologic samples were collected by the field geologist at 5 ft intervals and at lithology changes throughout the borehole. Water was encountered at 85.02 ft bgs on January 21, 2016. Water samples were collected approximately 5 ft and 15 ft into the water table, and at the Ringold upper mud (RUM) interface. Sieve samples were collected as two composite samples with 5 ft grab samples: one for the upper portion of the water table, and one for the bottom portion of the water table above the RUM. Table 2-2 provides sample summary information for this well.

A geophysical survey using SGLS and NMLS was conducted on January 27, 2016, from ground surface to 113 ft bgs through the 10 1/2 in. OD casing. The report by SN3 for C8729 (HGLP-LDR-886) is included in Appendix A.

Well completion operations were initiated on February 1, 2016, with a straightness test that passed throughout the borehole without binding. The well was constructed using 6 in. ID, Schedule 10S, Type 316 stainless-steel blank and sump. A total of 9.99 ft of Type 316 stainless-steel screen with 0.045 in. apertures and 20.01 ft of Type 316 stainless-steel screen with 0.040 in. apertures was used. Stainless-steel centralizers were placed at the bottom of the screen 20 ft up from the bottom of the screen, at the top of the screen, and at 40 ft above the top of the screen. Well construction materials and associated depths are summarized in Table 2-3.

Well development at C8729 was performed on February 9, 2016, in accordance with procedure SGRP-PRO-OP-50024. One development interval was needed for development using a Grundfos[3] 1.5 hp submersible pump. Pumping at an average of 11.53 gallons per minute (gpm), the turbidity dropped to 2.12 NTU before the NCOs collected the post-development water sample. At the end of development, the flow rate was increased to 16.95 gpm to increase stress to the well. A total of 10,358.85 gallons (gal) of water was removed during development. The results for development are summarized in Table 2-1.

[3] Grundfos® is a registered trademark of Grundfos Holding A/S Corporation Denmark, Bjerringbro, Denmark.

Table 2-2. Sample Summary for Well 199-D5-149 (C8729)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
1/21/2016	I-001 C	74.77 – 75.27	Soil	Split spoon	B348Y1
1/21/2016	I-002 C	80.58 – 81.08	Soil	Split spoon	B348Y3
1/21/2016	I-003 C	85.08 – 85.58	Soil	Split spoon	B348Y6
1/21/2016	I-003 C DUP	85.08 – 85.58	Soil	QC	B348Y8
1/21/2016	I-004	89.5	Water	Bail	B34905
1/25/2016	I-005	100.33	Water	Pump	B34908
1/25/2016	I-005 DUP	100.33	Water	QC	B34907
1/25/2016	I-006	105.19	Water	Pump	B34910
2/9/2016	I-007	103.26	Water	Pump	B34FP9, B34FR0, B34FR1

bgs = below ground surface
DUP = duplicate
HEIS = Hanford Environmental Identification System
QC = quality control

Table 2-3. Construction Summary for Well 199-D5-149 (C8729)

Borehole TD (ft bgs)	Static Water Level (ft bgs)	6 in. Diameter, Stainless-Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
112.67	84.90 (2/9/2016)	Stainless-steel blank	+1.76 – 78.27	N/A	Concrete	0.0 – 2.00	N/A
		Stainless-steel screen	78.27 – 98.28	40	Portland cement	2.00 – 10.17	Type I-II
		Stainless-steel screen	98.28 – 108.27	45	Bentonite chips	10.17 – 2.33	3/8 in.
		Stainless-steel sump	108.27 – 11.27	N/A	Bentonite pellets	72.33 – 75.17	3/8 in.
					Colorado silica sand	75.17 – 111.46	10-20
					Natural fill	111.46 – 112.67	N/A

bgs = below ground surface
N/A = not applicable
TD = total depth

2.2.2 Well 199-D5-150 (C8730)

Well 199-D5-150 (C8730) was installed between February 2, 2016, and February 18, 2016. The borehole was drilled to a TD of 111.17 ft bgs.

Drilling began on February 2, 2016, using a TSi 150CC Terra Sonic drill rig. The casing used was 10 1/2 in. OD carbon-steel, box-threaded casing. The casing was advanced to a final depth of 110.15 ft bgs using an 8 1/2 in. OD core barrel bit on February 16, 2016.

There were no concentrations of VOCs that exceeded the action level while drilling and sampling at C8730.

Sampling at C8730 included collecting soil samples for geologic archive purposes, two sieve sample analysis for particle-size distribution, three split-spoon samples for chemical analysis, three water samples for chemical analysis, and a post-development water sample for chemical analysis. All split-spoon samples and water samples were collected by NCOs. Geologic archive soil samples were collected by the field geologist at 5 ft intervals and at lithology changes throughout the borehole. Water was encountered at 84.19 ft bgs on February 4, 2016. Water samples were collected at 5 ft and 15 ft into the water table and at the RUM interface. Sieve samples were collected as composites of 5 ft grab samples for the top half and bottom half of the water table. Sample information is provided in Table 2-4.

A geophysical survey using SGLS and NMLS was performed from surface to 109 ft bgs on February 9, 2016, through the 10 1/2 in. OD casing. The report SN3 for C8730 (HGLP-LDR-888) is included in Appendix B.

Table 2-4. Sample Summary for Well 199-D5-150 (C8730)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
2/3/2016	I-001 B-C	75.67 – 76.17	Soil	Split spoon	B34F67
2/3/2016	I-001 B-C DUP	75.67 – 76.17	Soil	QC	B34F68
2/3/2016	I-002 C	80.04 – 80.54	Soil	Split spoon	B34F69
2/4/2016	I-003 C	86.07 -86.57	Soil	Split spoon	B34F71
2/4/2016	I-004	90.19	Water	Bail	B34F76
2/4/2016	I-004 DUP	90.19	Water	QC	B34F78
2/8/2016	I-005	100.11	Water	Pump	B34F79
2/8/2016	I-006	104.57	Water	Pump	B34F81
2/17/2016	I-007	103.37	Water	Pump	B34FR3, B34FR4, B3FR5

bgs = below ground surface
DUP = duplicate
HEIS = Hanford Environmental Identification System
QC = quality control

A well straightness test was conducted on February 8, 2016, after the TD was achieved. Well construction then began February 16, 2016, using a cable tool rig to lower a 20 ft length of screen. Once the screen was lowered downhole, the sonic rig was set up over the well for the remainder of the construction process. The well was constructed using 6 in. ID, Schedule 10S, Type 316 stainless-steel blank and sump. A total of 30.01 ft of Type 316 stainless-steel screen with 0.040 in. apertures was used. Stainless-steel centralizers were place at the bottom of the screen, 20 ft above the bottom of the screen, at the top of the screen, and 40 ft above the top of the screen. The well construction materials and their associated depths are shown in Table 2-5.

Table 2-5. Construction Summary for Well 199-D5-150 (C8730)

Borehole TD (ft bgs)	Static Water Level (ft bgs)	6 in. Diameter, Stainless-Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
111.17	83.21 (2/17/2016)	Stainless-steel blank	+1.99 – 76.05	N/A	Concrete	0.00 – 1.30	N/A
		Stainless-steel screen	76.05 – 106.06	40	Portland cement	1.30 – 10.25	Type I-II
		Stainless-steel sump	106.06 – 109.05	N/A	Bentonite chips	10.25 – 67.01	3/8 in.
					Bentonite pellets	67.01 – 71.68	3/8 in.
					Colorado silica sand	71.68 – 110.67	10-20
					Natural fill	110.67 – 111.17	N/A

bgs = below ground surface
N/A = not applicable
TD = total depth

Well development at C8730 occurred during well construction on February 17, 2016, in accordance with procedure SGRP-PRO-OP-50024. A Grundfos 1.5 hp submersible pump was used for one interval of development pumping at an average of 21.45 gpm. The turbidity cleared up to 3.72 NTU before development was completed. The NCOs collected a post-development water sample. A total of 2,498.80 gal were removed during development. The development results are summarized in Table 2-1.

2.2.3 Well 199-D5-151 (C8731)

Well 199-D5-151 (C8731) was installed between February 24, 2016, and March 8, 2016. The borehole was drilled to a TD of 97.5 ft bgs.

Drilling began February 24, 2016, using a TSi 150CC Terra Sonic drill rig. The 10 1/2 in. OD carbon-steel, box-threaded casing was advanced to a final depth of 92.23 ft bgs on February 25, 2016. The borehole was drilled using an 8 1/2 in. OD core barrel bit.

There were no concentrations of VOCs that exceeded action levels while drilling or sampling at C8731.

Sampling at C8731 included soil sample collection for geologic archive purposes, two sieve sample analysis for particle-size distribution, three split-spoon samples for chemical analysis, three water samples for chemical analysis, and one post-development water sample for chemical analysis. Split-spoon and water samples were collected by the NCOs. Geologic archive samples were collected by the field geologist at 5 ft intervals and at lithology changes throughout the borehole. Water was encountered at 68.96 ft bgs on February 25, 2016. The water samples were collected at 5 ft and 15 ft into the water table and at the RUM interface, and all of the water samples were bailed due to heaving sands. The sieve samples were collected as composite samples of 5 ft grab samples for the upper water table and lower water table. Sample details are provided in Table 2-6.

Table 2-6. Sample Summary for Well 199-D5-151 (C8731)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
2/24/2016	I-001	60.18 – 61.68	Soil	Split spoon	B34FR7
2/24/2016	I-001 DUP	60.18 – 61.68	Soil	QC	B34FR8
2/24/2016	I-002	63.29 – 63.79	Soil	Split spoon	B34FR9
2/24/2016	I-003	71.25 – 71.75	Soil	Split spoon	B34FT0
2/25/2016	I-004	74.88	Water	Bail	B34FT5
2/25/2016	I-005	85.23	Water	Bail	B34FT7
2/25/2016	I-006	89.48	Water	Bail	B34FV0
3/7/2016	I-007	88.98	Water	Pump	B34FV2, B34FV7, B34H28
3/7/2016	I-007 DUP	88.98	Water	QC	B34FV4, B34FV5, B34FV6

bgs = below ground surface
DUP = duplicate
HEIS = Hanford Environmental Identification System
QC = quality control

A geophysical survey using SGLS and NMLS was conducted from ground surface to 94 ft bgs on February 26, 2016, through the 10 1/2 in. OD casing. The report by SN3 for C8731 (HGLP-LDR-895) is included in Appendix C.

Well construction for C8731 was conducted between March 3, 2016, and March 8, 2016. Construction began on March 3, 2016, with a straightness test that passed through the borehole without binding. The well was constructed using 6 in. ID, Schedule 10S, Type 316 stainless-steel blank and sump. A total of 30.03 ft of Type 316 stainless-steel screen with 0.050 in. apertures was used. Stainless-steel centralizers were placed at the bottom of the screen, 20 ft above the bottom of the screen, at the top of the screen, and 40 ft above the screen. Construction details are provided in Table 2-7.

Development of C8731 occurred during the construction of the well, after the filter pack was added and before the bentonite seal was added on March 7, 2016, in accordance with procedure SGRP-PRO-OP-50024. A Grundfos 2 hp submersible pump was used for development of one interval. Drillers set the pump high initially to clear the water of heavy sediment load and prevent damaging the pump. The pump was then lowered for final development, averaging 29.23 gpm. The turbidity reached

4.54 NTU before the NCOs collected the post-development water sample. A total of 5,723.90 gal of water was removed during development. Development results are summarized in Table 2-1.

Table 2-7. Construction Summary for Well 199-D5-151 (C8731)

Borehole TD (ft bgs)	Static Water Level (ft bgs)	6 in. Diameter, Stainless-Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
97.50	69.03 (3/7/2016)	Stainless-steel blank	+1.94 – 61.06	N/A	Concrete	0.00 – 0.73	N/A
		Stainless-steel screen	61.06 – 91.09	50	Portland cement	0.73 – 10.17	Type I-II
		Stainless-steel sump	91.09 – 94.09	N/A	Bentonite chips	10.17 – 54.00	3/8 in.
					Bentonite pellets	54.00 – 57.48	3/8 in.
					Colorado silica sand	57.48 – 94.08	8-16
					Natural fill	94.08 – 97.50	N/A

bgs = below ground surface
N/A = not applicable
TD = total depth

2.2.4 Well 199-D5-152 (C8732)

Well 199-D5-152 (C8732) was installed between February 10, 2016, and March 8, 2016. The borehole was drilled to a TD of 98.25 ft bgs.

Drilling was scheduled to begin February 10, 2016; however, drilling was delayed due to a stop work on the job site. Drilling began February 22, 2016, using a TSi 150CC Terra Sonic drill rig with 10 1/2 in. OD carbon-steel, box-threaded casing. The casing was advanced to a final depth of 95.08 ft bgs using an 8 1/2 in. OD core barrel bit on February 23, 2016.

No concentrations of VOC exceeded the action level during drilling and sampling.

Sampling at C8732 included soil grab samples for geologic archive purposes, two sieve sample analysis for particle-size distribution, three split-spoon samples for chemical analysis, three water samples for chemical analysis, and one post-development water sample for chemical analysis. The split-spoon and water samples were collected by NCOs. The geologic archive samples were collected by the field geologist at 5 ft intervals and at lithology changes throughout the borehole. Water was encountered at 69.23 ft bgs on February 23, 2016. The water samples were collected at 5 and 15 ft into the water table and at the RUM interface. All three water samples were bailed due to heaving sands. The sieve samples were collected as composite samples of 5 ft grab samples for the upper water table and lower water table. Sample information is provided in Table 2-8.

Table 2-8. Sample Summary for Well 199-D5-152 (C8732)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
2/22/2016	I-001	62.33 – 62.83	Soil	Split spoon	B34JT4
2/22/2016	I-001 DUP	61.33 – 62.83	Soil	QC	B34JT5
2/23/2016	I-002	66.24 – 66.74	Soil	Split spoon	B34JT6
2/23/2016	I-003	71.14 – 71.64	Soil	Split spoon	B34JT7
2/23/2016	I-004	75.00	Water	Bail	B34JV2
2/23/2016	I-005	85.00	Water	Bail	B34JV4
2/23/2016	I-006	90.11	Water	Bail	B34JV6
3/2/2016	I-007	83.91	Water	Pump	B34JV8, B34JV9, B34JW0
3/2/2016	I-007 DUP	83.91	Water	QC	B34JW2, B34JW3, B34JW4

bgs = below ground surface
DUP = duplicate
HEIS = Hanford Environmental Information System
QC = quality control

A geophysical survey using SGLS and NMLS was performed from ground surface to 96 ft bgs on February 25, 2016, through the 10 1/2 in. OD casing. The survey report by SN3 for C8732 (HGLP-LDR-896) is included in Appendix D.

Well construction for C8732 took place between February 29, 2016, and March 8, 2016. A straightness test was preformed and passed through the borehole without binding prior to constructing the well using 6 in. ID, Schedule 10S, Type 316 stainless-steel blank and sump. A total of 30.05 ft of Type 316 stainless-steel screen with 0.050 in. apertures was used. Stainless-steel centralizers were placed at the bottom of the screen, 20 ft above the bottom of the screen, at the top of the screen, and 40 ft above the screen. Construction details are presented in Table 2-9.

Development took place during construction after the sand pack was added and before the bentonite seal was added on March 1, 2016, and March 2, 2016. A Grundfos 1.5 hp submersible pump was used on March 1, 2016, for development. Due to damage sustained during pumping the day before (on March 2, 2016), a new Grundfos 2 hp submersible pump was used to complete one development interval for C8732, pumping approximately 26.38 gpm. The turbidity reached 4.78 NTU before the NCOs collected the post-development water sample. An approximate amount of water removed on March 1, 2016, was determined to be 800 gal. On March 2, 2016, a total of 4,882.90 gal of water was purged during development. Development results are summarized in Table 2-1.

Table 2-9. Construction Summary for Well 199-D5-152 (C8732)

Borehole TD (ft bgs)	Static Water Level (ft bgs)	6 in. Diameter, Stainless-Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
98.25	67.89 (3/2/2016)	Stainless-steel blank	+2.00 – 61.02	N/A	Concrete	0.00 – 1.96	N/A
		Stainless-steel screen	61.02 – 91.07	50	Portland cement	1.96 – 10.08	Type I-II
		Stainless-steel sump	91.07 – 94.07	N/A	Bentonite chips	10.08 – 54.04	3/8 in.
					Bentonite pellets	54.04 – 57.17	3/8 in.
					Colorado silica sand	57.17 – 95.73	8-16
					Natural fill	95.73 – 98.25	N/A

bgs = below ground surface
N/A = not applicable
TD = total depth

2.2.5 Well 199-H4-87 (C8733)

Well 199-H4-87 (C8733) was installed between March 22, 2016, and March 28, 2014. The borehole was drilled to a TD of 64.91 ft bgs.

On March 22, 2016, drilling began and was completed using a TSi 150CC Terra Sonic drill rig using 10 1/2 in. OD carbon-steel, box-threaded casing. The casing was advanced to a final depth of 59.95 ft bgs using an 8 1/2 core barrel bit.

There were no concentrations of VOCs that exceeded action levels while drilling and sampling C8733.

Sampling at C8733 included soil grab samples for archive purposes, two sieve analysis samples for particle-size distribution testing, four split-spoon samples for chemical analysis, and one post-development water sample for chemical analysis. The split-spoon and water samples were collected by NCOs. The geologic archive samples were collected by the field geologist at 5 ft intervals and at lithology changes throughout the borehole. Water was encountered at 47.15 bgs on March 22, 2016. Sieve samples were collected at the top of the water table and above the transition to the RUM. Table 2-10 provides sample information.

A geophysical survey using SGLS and NMLS was conducted from ground surface to 57 ft bgs on March 23, 2016, through the 10 1/2 in. OD casing. The survey report by SN3 for C8733 (HGLP-LDR-902) is included in Appendix E.

Table 2-10. Sample Summary for Well 199-H4-87 (C8733)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
3/22/2016	I-001	30.67 – 31.17	Soil	Split spoon	B34HL8
3/22/2016	I-001 DUP	30.67 – 31.17	Soil	QC	B34HL9
3/22/2016	I-002	35.75 – 36.25	Soil	Split spoon	B34HM0
3/22/2016	I-003	40.74 – 41.24	Soil	Split spoon	B34HM1
3/22/2016	I-004	45.75 – 46.25	Soil	Split spoon	B34HM3
3/28/2016	I-007	54.50	Water	Pump	B34HL0, B34HL1, B34HL2, B34HL3
3/28/2016	I-007 DUP	54.50	Water	QC	B34HK5, B34HK6, B34HK7, B34HK8

bgs = below ground surface
DUP = duplicate
HEIS = Hanford Environmental Information System
QC = quality control

After drilling was completed, a straightness test was conducted on March 22, 2016, and passed through the temporary casing without binding. Well construction for C8733 occurred between March 24, 2016, and March 28, 2016. The well was constructed using 6 in. ID, Schedule 10S, Type 316 stainless-steel blank casing and sump. A total of 20.03 ft of Type 316 stainless-steel screen with 0.075 in. apertures was used. Stainless-steel centralizers were used and placed at the bottom and top of the screen, as well as 20 ft above the screen. Construction materials and associated depths are shown in Table 2-11.

Table 2-11. Construction Summary for Well 199-H4-87 (C8733)

Borehole TD (ft bgs)	Static Water Level (ft bgs)	6 in. Diameter, Stainless-Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
64.91	46.60 (3/28/2016)	Stainless-steel blank	+2.0 – 37.05	N/A	Portland cement	0.00 – 9.80	Type I-II
		Stainless-steel screen	37.05 – 57.08	75	Bentonite chips	9.80 – 29.80	3/8 in.
		Stainless-steel sump	57.08 – 60.08	N/A	Bentonite pellets	29.80 – 33.60	3/8 in.
					Colorado silica sand	33.60 – 64.91	6-9

bgs = below ground surface
N/A = not applicable
TD = total depth

Development occurred on March 28, 2016, in accordance with procedure SGRP-PRO-OP-50024. Development took place during construction, after the sand pack was added, and before the bentonite seal was placed. There was a total of one development interval of no greater than 14 ft for this well. A 1.5 hp submersible pump was used to pump the water at an average rate of 23.53 gpm. The final turbidity recorded was 3.31 NTU before the NCOs collected the post-development water sample. Approximately 1,805 gal of water were removed during development. Results of the well development are summarized in Table 2-1.

2.2.6 Well 199-H4-88 (C8734)

Well 199-H4-88 (C8734) was installed between March 14, 2016, and March 23, 2016. The borehole was drilled to a TD of 59.90 ft bgs.

On March 14, 2016, drilling began with a TSi 150CC Terra Sonic drill rig using 10 1/2 in. OD carbon-steel, box-threaded casing. The casing was advanced to a final depth of 54.80 ft bgs using an 8 1/2 in. OD core barrel bit on March 15, 2016.

There were no concentrations of VOCs that exceeded action level at C8734 during drilling or sampling.

Sampling at C8734 included soil grab samples for archive purposes, two sieve sample analysis for particle-size distribution testing, four split-spoon samples for chemical analysis, and one post-development water sample for chemical analysis. The split-spoon and water samples were collected by NCOs. The geologic archive samples were collected by the field geologist at 5 ft intervals and at lithology changes throughout the borehole. Water was encountered at approximately 52 ft bgs on March 15, 2016. The sieve samples were collected at the top of the water table and above the lithologic transition to the RUM. Information for the samples is provided in Table 2-12.

Table 2-12. Sample Summary to Well 199-H4-88 (C8734)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
3/14/2016	I-001	31.20 – 31.70	Soil	Split spoon	B34HM7
3/14/2016	I-001 DUP	31.20 – 31.70	Soil	QC	B34HM8
3/14/2016	I-002	36.10 – 36.60	Soil	Split spoon	B34HM9
3/14/2016	I-003	41.00 – 41.50	Soil	Split spoon	B34HN1
3/15/2016	I-004	45.00 – 45.50	Soil	Split spoon	B34HN3
3/23/2016	I-007	56.50	Water	Pump	B34HN7, B34HN8, B34HN9, B34HP0
3/23/2016	I-007 DUP	56.50	Water	QC	B34HP2, B34HP3, B34HP4, B34HP5

bgs = below ground surface
DUP = duplicate
HEIS = Hanford Environmental Information System
QC = quality control

A geophysical survey using SGLS and NMLS was conducted from ground surface to 56 ft bgs on March 15, 2016, through the 10 1/2 in. OD casing. The survey report by SN3 for C8734 (HGLP-LDR-900) is included in Appendix F.

Well construction of C8734 occurred between March 17, 2016, and March 21, 2016. A straightness test was conducted on March 17, 2016, and passed through the temporary casing without binding. The well was set using 6 in. ID, Schedule 10S, Type 316 stainless-steel blank casing. A total of 15.00 ft of Type 316 stainless-steel screen with 0.040 in. apertures and a total of 5.09 ft of Type 316 stainless-steel capped screen with 0.006 in. apertures were used. Stainless-steel centralizers were placed at the bottom of the end-capped screen, at the top of the screened interval and one at 20 ft above the screened interval. Construction materials and their associated depths are presented in Table 2-13.

Table 2-13. Construction Summary for Well 199-H4-88 (C8734)

Borehole TD (ft bgs)	Static Water Level (ft bgs)	6 in. Diameter, Stainless-Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
59.90	51.64 (3/23/2016)	Stainless-steel blank	+2.01 – 38.00	N/A	Concrete	0.00 – 0.65	N/A
		Stainless-steel screen	38.00 – 53.00	40	Portland cement	0.65 – 10.08	Type I-II
		Stainless-steel screen with cap	53.00 – 58.09	6	Bentonite chips	10.08 – 30.08	3/8 in.
					Bentonite pellets	30.08 – 34.29	3/8 in.
					Colorado silica sand	34.29 – 52.91	10-20
					Colorado silica sand	52.91 – 59.17	20-40
					Natural fill	59.17 – 59.90	N/A

bgs = below ground surface
N/A = not applicable
TD = total depth

Development occurred on March 23, 2016, in accordance with procedure SGRP-PRO-OP-50024. One development interval of less than 6 ft was conducted using a GeoTech Geosquirt[4] purge pump. The GeoTech Geosquirt is a non-variable pump and purge rate is determined by pump depth. Due to the limited aquifer thickness, the purge rate was 0.38 gpm. The turbidity cleared up to 2.22 NTU before the NCOs took a post-development water sample. The results of well development for this well are provided in Table 2-1.

[4] GeoTech Geosquirt™ is a trademark of GeoTech Environmental Equipment, Inc., Denver, Colorado.

2.2.7 Well 199-H4-89 (C8735)

Well 199-H4-89 (C8735) was installed between January 27, 2016, and March 30, 2016. The borehole was drilled to a TD of 56.60 ft bgs.

On January 27, 2016, drilling began with a TSi 150CC Terra Sonic drill rig using 11 15/16 in. OD carbon-steel, box-threaded casing. The casing met refusal during drilling and was only advanced to 35.11 ft bgs using an 8 1/2 in. core barrel bit. On March 10, 2016, the chasing was downsized to 10 1/2 in. OD carbon-steel, box-threaded casing. The casing was advanced to a final depth of 50.15 ft bgs using the same 8 1/2 in. core barrel bit.

There were no concentrations of VOCs that exceeded action levels at C8735 during drilling or sampling.

Sampling a C8735 included soil grab samples for archive purposes, two sieve analysis samples for particle-size distribution testing, and one post-development water sample for chemical analysis. The water sample was collected by NCOs. The geologic archive samples were collected by the field geologist at 5 ft intervals and at lithology changes throughout the borehole. Water was encountered at 42.27 ft bgs on March 10, 2016. One sieve sample was collected at the top of the water table and the second one was collected above the RUM interface. Sample information for the post-development water sample is provided in Table 2-14.

Table 2-14. Sample Summary for Well 199-H4-89 (C8735)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
3/30/2016	I-001	47.00	Water	Pump	B34R30, B34R31, B34R32, B34R33
3/30/2016	I-001 DUP	47.00	Water	QC	B34R35, B34R36, B34R37, B34R38

bgs = below ground surface
DUP = duplicate
HEIS = Hanford Environmental Identification System
QC = quality control

A geophysical survey using SGLS and NMLS was conducted from ground surface to 34 ft bgs on February 1, 2016, through the 11 15/16 in. OD casing. A second geophysical survey using SGLS and NMLS was conducted from 33 ft bgs to 51 ft bgs on March 14, 2016, through the 10 1/2 in. OD. The survey report by SN3 for C8735 (HGLP-LDR-899) is included in Appendix G.

Well construction for C8735 occurred between March 15, 2016, and March 16, 2016. A straightness test was conducted on March 15, 2016, and passed through the temporary casing without binding. The well was constructed using 6 in. ID, Schedule 10S, Type 316 stainless-steel blank casing and sump. A total of 14.98 ft of Type 316 stainless-steel screen with 0.040 in. apertures was used. Stainless-steel centralizers were used at the bottom of the screen, the top of the screen, and 20 ft above the screen. The construction materials and their associated depths are shown in Table 2-15.

Development occurred between March 17, 2016, and March 30, 2016, in accordance with procedure SGRP-PRO-OP-50024. There were a total of two development attempts for the same interval of no more than 7 ft for this well. The first development attempt was on March 17, 2016, using a 0.75 hp Grundfos pump. All attempts to pump water on March 17, 2016, ran the well dry with a slow recharge. A second attempt at development occurred March 30, 2016, using the Geotech Geosquirt purge pump.

At 0.77 gpm, the well ran dry before the turbidity could drop below 5 NTU. After approximately 30 minutes of recharge time, the pump was lowered another 1 ft. At this depth a second pump attempt at 0.59 gpm allowed the turbidity to reach 4.56 NTU, and the NCOs collected the post-development water sample. Approximately 87.42 gal were pumped from the well during development activities. The results from well development are summarized in Table 2-1.

Table 2-15. Construction Summary for Well 199-H4-89 (C8735)

Borehole TD (ft bgs)	Static Water Level (ft bgs)	6 in. Diameter, Stainless-Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
56.60	42.54 (3/30/2016)	Stainless-steel blank	+2.00 – 31.42	N/A	Portland cement	0.00 – 10.10	Type I-II
		Stainless-steel screen	31.42 – 46.37	40	Bentonite chips	10.10 – 24.02	3/8 in.
		Stainless-steel sump	46.37 – 49.35	N/A	Bentonite pellets	24.02 – 27.10	3/8 in.
					Colorado silica sand	27.10 – 50.25	10-20
					Bentonite pellets	50.25 – 53.40	3/8-in
					Natural fill	53.40 – 56.60	N/A

bgs = below ground surface
N/A = not applicable
TD = total depth

3 Geologic Observations

This chapter summarizes the general geology of the 100-HR-3 OU and the individual geology encountered during drilling of each well.

3.1 Geology of the 100-HR-3 Operable Unit

The 100-HR-3 OU lies within the 100-D and 100-H Areas of the Hanford Site. This area is similar to other locations on the Hanford Site, with the two-tiered stratigraphy: the Columbia River Basalt Group, and the overlaying unconsolidated sedimentary deposits (SGW-59260). The principal units found in the 100-D and 100-H Areas include the following (from youngest to oldest):

- Holocene surficial deposits or back fill material
- Pleistocene Hanford formation sediments
- Miocene-Pliocene Ringold Formation sediments
- Columbia River Basalt Group

The generalized surface unit in the local vicinity of the new well locations includes mostly unconsolidated construction fill material.

The Hanford formation consists of Pleistocene-age, cataclysmic flood and interflood deposits comprised mostly of the gravel-dominated facies, which consists of pebble- to cobble-sized clasts within a sand matrix. The gravel-dominated Hanford formation tends to be highly basaltic (WCH-SD-EN-TI-011, *Geology of the Northern Part of the Hanford Site: An Outline of Data Sources and the Geologic Setting of the 100 Areas*).

Disconformably underlying the Hanford formation, the Ringold unit E is composed of fluvial matrix-supported gravels and sands. Ringold unit E tends to be more felsic than the Hanford formation, as well as more rounded. In the 100 Area, the Ringold unit E is directly above the RUM. However, the Ringold Formation unit E is not present in all areas of 100-HR-3 OU, especially across the Horn and at 100-H Area. The RUM is comprised of mostly silt and clay, with a distinct brown to olive-brown coloring. The RUM is a semiconfining layer, forming the base of the unconfined aquifer. It should be noted that the RUM contains some sand and gravel in 100-H area and is much thinner than at 100-D.

The Ringold Formation extends to the Elephant Mountain Member basalt, but drilling did not go past the RUM; therefore, this basalt was not encountered.

3.2 Borehole Geology

This section describes the geologic characteristics and stratigraphic units observed during drilling of the seven boreholes. Borehole geologic logs were prepared in accordance with procedure SGRP-PRO-EN-50025. Each of the borehole logs are presented in Appendices A-G, respectively.

All stratigraphic unit interpretations included in this report were based on field examination of drill cuttings (e.g., lithology, texture, color, and reaction to hydrochloric acid [HCl]). As such, the unit contacts included herein should be considered estimates. Final stratigraphic unit contacts will be determined during the remedial investigation data review and will incorporate the field observations, borehole geophysical logging data, and regional stratigraphic interpretations. The basis for determining the estimated stratigraphic unit contacts is included in the individual borehole summaries in the following subsections.

3.2.1 Well 199-D5-149 (C8729)

Well 199-D5-149 (C8729) is located in the southeastern 100-D Area, approximately 225 ft from the 100-D Area power station. Prominent stratigraphic units encountered while drilling were backfill material, the Hanford formation, the Ringold Formation unit E, and the RUM.

Backfill and the drill pad were encountered from the ground surface to 1.5 ft bgs. The Hanford formation was observed from a depth of 1.5 to 55 ft bgs. The classifications for the Hanford formation included gravelly sand, sandy gravel, and sand. The overall mafic composition of the sand for this formation ranged from 50 to 75 percent. The gravel had an overall mafic composition ranging from 40 to 90 percent. The reaction to 10 percent diluted HCl decreased from strong to weak, between 1.5 and 30 ft bgs. At 35 ft bgs, the reaction to HCl changed in strength from weak, to strong, to moderate. The angularity of the sediment ranged from angular to round. The maximum gravel size was 147 mm (large cobble).

The contact with the underlying Ringold Formation was mostly an indistinct transition at 55 ft bgs. The Ringold Formation extended from 55 to 107 ft bgs. The soil classifications for the Ringold Formation included sandy gravel, gravelly sand, silt, and silty-sandy gravel. The overall felsic composition for the sand of this formation ranged from 50 to 85 percent. The gravel had an overall felsic composition ranging from 20 to 85 percent. The felsic gravels increased with depth of the formation. The reaction to HCl varied throughout the formation, ranging from very weak to very strong. The angularity of the sediment ranged from angular to subround. The maximum gravel size was 135 mm (small cobble). The contact with the underlying RUM was very distinct at 107 ft bgs. The RUM was encountered from 107 ft bgs to a TD of 112.67 ft bgs. The soil classification for the RUM was silt. There was no reaction with the HCl, and the RUM did not have plasticity.

A final static water level was measured at 84.9 ft bgs on February 9, 2016. The borehole log for C8729 is presented in Appendix A.

3.2.2 Well 199-D5-150 (C8730)

Well 199-D5-150 (C8730) is located in the 100-D Area, between the D and DR Reactors (approximately 300 ft to the west). Prominent stratigraphic units encountered while drilling were fill material, the Hanford formation, the Ringold Formation unit E, and the RUM.

The fill material and drill pad were encountered from ground surface to about 10 ft bgs. The Hanford formation was observed from a depth of 10 to 60 ft bgs. The classifications for the Hanford formation included slightly silty gravelly sand, silty-sandy gravel, sandy gravel, and gravelly sand. The overall composition for the sand was mafic, ranging from 65 to 80 percent. The overall composition for the gravel was mafic, ranging from 25 to 95 percent. The felsic gravel increased in the last 10 ft of the formation. The reactions with HCl varied from moderate to strong throughout the formation. The angularity of the sediment ranged from angular to round. The maximum gravel size was 162 mm (large cobble).

The contact with the underlying Ringold Formation was a mostly indistinct transition at 60 ft bgs. The Ringold Formation was encountered from 60 to 106 ft bgs. The classifications for the Ringold Formation included silty-sandy gravel, gravelly sand, sandy gravel, and silty gravel. The overall composition for the sand was felsic, ranging from 20 to 85 percent. The sand was more mafic toward the top of the formation. The overall composition for the gravel was felsic, ranging from 50 to 80 percent. The reactions with HCl ranged from strong to very strong throughout the formation, except when wet. The angularity of the sediment ranged from angular to round. The maximum gravel size was 136 mm (large cobble). The contact with the underlying RUM was very distinct at 106 ft bgs. The RUM was

encountered from 106 ft bgs to a TD of 111.17 ft bgs. The soil classification for the RUM was silt, and there was no HCl reaction. The silt had a low to medium plasticity.

A final static water level was measured at 83.21 ft bgs on February 17, 2016. The borehole log for C8730 is presented in Appendix B.

3.2.3 Well 199-D5-151 (C8731)

Well 199-D5-151 (C8731) is located approximately 225 ft southeast of the power station in the 100-D Area. Prominent stratigraphic units encountered while drilling were fill material, the Hanford formation, the Ringold Formation unit E, and the RUM.

The fill material and drill pad were encountered from ground surface to 30 ft bgs. The Hanford formation extended from 30 to 60 ft bgs. The soil classifications for the Hanford formation included sandy gravel and silty-sandy gravel. The overall composition of the sand was mostly felsic and ranged from 45 to 70 percent, where the overall composition of the gravel was mafic, ranging from 35 to 65 percent. Reactions to HCl ranged from strong to very strong. The angularity of the sediment ranged from angular to subround. The maximum gravel size was 195 mm (large cobble).

The contact with the underlying Ringold Formation was indistinct at approximately 60 ft bgs. The Ringold Formation was encountered from approximately 60 to 91 ft bgs. The soil classifications found in the Ringold Formation included silty-sandy gravel, silty gravel, and sand. The overall composition of the sand was felsic, ranging from 70 to 85 percent. The overall composition of the gravel ranged from 55 to 80 percent felsic. The HCl reactions ranged from moderate to very strong, with the exception of one very weak to almost no reaction at about 5 ft above the RUM contact. The angularity of the sediment ranged from angular to round. The maximum gravel size was 127 mm (large cobble). The contact with the underlying RUM was distinct at 91 ft bgs. The RUM was encountered at 91 ft bgs to a TD of 97.5 ft bgs. The soil classification for the RUM was silt. There was a moderate to strong HCl reaction for the RUM.

A final static water level was measured at 69.03 ft bgs on March 7, 2016. The borehole log for C8731 is provided in Appendix C.

3.2.4 Well 199-D5-152 (C8732)

Well 199-D5-152 (C8732) is located approximately 300 ft southeast of the 100-D Area power station. Prominent units encountered while drilling were fill material, the Hanford formation, the Ringold Formation unit E, and the RUM.

The fill material and drill pad extended from ground surface to approximately 29 ft bgs. The Hanford formation was encountered from 29 to approximately 65 ft bgs. The soil classifications for the Hanford formation included silty-sandy gravel, gravelly sand, and sandy gravel. The overall composition for the sand was mafic, ranging from 40 to 70 percent. The overall composition for the gravel was mafic, ranging from 45 to 80 percent. The sediment reactions to HCl ranged from moderate to very strong. The angularity for the sediment ranged from angular to subround. The maximum gravel size was 112 mm (small cobble).

The contact with the underlying Ringold Formation was indistinct at approximately 65 ft bgs. The Ringold Formation was encountered from approximately 65 to 91.5 ft bgs. The classifications for the Ringold Formation included silty-sandy gravel and sandy gravel. The overall composition for the sand was felsic, ranging from 70 to 85 percent. The overall composition for the gravel was felsic, ranging from 60 to 80 percent. The sediment reactions to HCl ranged from moderate to strong. Within 10 ft of the

contact with the RUM, the reaction to HCl ranged from very weak to no reaction. The angularity for the sediment ranged from angular to round. The maximum gravel size was 144 mm (large cobble). There was distinct contact with the underlying RUM at 91.5 ft bgs. The RUM was encountered at 91.5 ft bgs to a TD of 98.25 ft bgs. There was very weak reaction to no reaction with the HCl, and the RUM had low plasticity.

A final static water level was measured at 67.89 ft bgs on March 2, 2016. The borehole log for C8732 is presented in Appendix D.

3.2.5 Well 199-H4-87 (C8733)

Well 199-H4-87 (C8733) is located approximately 549 ft north-northwest of the H Reactor in the 100-H Area. Prominent stratigraphic units encountered while drilling were fill material, the Hanford formation, the Ringold Formation unit E, and the RUM.

The fill material and drill pad extended from ground surface to approximately 27 ft bgs. The Hanford formation was observed from approximately 27 ft bgs to approximately 55 ft bgs. The classification for the Hanford formation was silty-sandy gravel. The overall composition for the sand was felsic, ranging from 30 to 35 percent. The gravel ranged from 65 to 70 percent mafic composition. The sediment reactions to HCl ranged from weak to strong. The angularity of the sediment ranged from angular to round. The maximum gravel size was 120 mm (small cobble).

The contact with the underlying Ringold Formation was indistinct at approximately 55 ft bgs. The Ringold Formation was encountered from a depth of approximately 55 to 57 ft bgs. The classifications for the Ringold Formation included gravelly sand and sandy gravel. The overall composition of the sand was about 65 percent felsic. The gravel was about 70 percent mafic. There was a reaction to HCl, ranging from very weak to no reaction. The angularity of the sediment ranged from subangular to subround. The maximum gravel size was 180 mm (large cobble). A distinct contact with the underlying RUM was at 57 ft bgs. The RUM was encountered from 57 ft bgs to a TD of 64.91 ft bgs. The classification for the RUM was silt. The reaction to HCL was a strong to very strong.

A final static water level was measured at 46.60 ft bgs on March 28, 2016. The borehole log for C8733 is presented in Appendix E.

3.2.6 Well 199-H4-88 (C8734)

Well 199-H4-88 (C8734) is located approximately 1,056 ft north-northeast of H Reactor in the 100-H Area. Prominent stratigraphic units encountered while drilling were fill material, the Hanford formation unit E, and the RUM.

Fill material and the drill pad were encountered from ground surface to approximately 5 ft bgs. The Hanford formation was observed at a depth from 5 to 53 ft bgs. The soil classification for the Hanford formation was sandy gravel. The overall composition for the sand was mafic, ranging from 60 to 80 percent. The overall composition for the gravel was also mafic, ranging from 60 to 80 percent. Reactions to HCl for the Hanford formation ranged from moderate to very strong. The angularity for the sediment ranged from subangular to round. The maximum gravel size was 150 mm (small cobble).

The contact with the underlying RUM was distinct at 53 ft bgs. The RUM was encountered from 53 ft bgs to a TD of 59.9 ft bgs. The classification for the RUM was silt. The sediment reaction to HCl was very strong.

A final static water level was measured at 51.76 ft bgs on March 23, 2016. The complete borehole log is presented in Appendix F.

3.2.7 Well 199-H4-89 (C8735)

Well 199-H4-89 (C8735) is located approximately 1,320 ft northeast of H Reactor in the 100-H Area. Prominent stratigraphic units encountered while drilling were fill material, the Hanford formation, the Ringold Formation unit E, and the RUM.

The fill material and drill pad extended from ground surface to approximately 15 ft bgs. The Hanford formation was observed from approximately 15 to 45 ft bgs. The soil classifications for the Hanford formation included sandy gravel and silty gravel. The overall composition for the sand was felsic, ranging from 70 to 75 percent. At 35 ft bgs, the sand composition changed from felsic to mafic, ranging from 60 to 70 percent. The overall composition for the gravel was mafic, ranging from 55 to 70 percent. Sediment reactions to HCl ranged from moderate to strong, with the exception of a silty gravel layer observed from 29 to 35 ft bgs, where there was no HCl reaction. The angularity of the sediment ranged from angular to subround. The maximum gravel size was 140 mm (large cobble).

The contact with the underlying Ringold Formation was indistinct at approximately 45 ft bgs. The Ringold Formation was encountered from approximately 45 to 46 ft bgs. The classification for the Ringold Formation included sandy gravel and silty sand. The overall composition of the sand was felsic, ranging from 70 to 85 percent. The overall gravel composition was mafic, ranging from 55 to 80 percent. The sediment reaction to HCl ranged from strong to very strong. The angularity of the sediment ranged from subangular to subround. The maximum gravel size was 125 mm (small cobble). The distinct contact with the underlying RUM was at 46 ft bgs. The RUM was encountered at 46 ft bgs to a TD of 56.50 ft bgs. The classification for the RUM was silt. The sediment reaction to HCl was strong to very strong.

A final static water level was measured at 42.54 ft bgs on March 30, 2016. The borehole log for C8735 is provided in Appendix G.

4 Waste Management

Waste generated during installation of the seven new monitoring wells included drill cuttings, purgewater, and miscellaneous solid waste. Waste was managed in accordance with DOE/RL-97-01, *Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Unit*; DOE/RL-96-17, Rev. 6, *Remedial Design Report/Remedial Action Work Plan for the 100 Area*; and the waste packaging/labeling instruction sheets. Waste generated during drilling activities included drill cuttings, decontamination water, and miscellaneous solid waste.

4.1 Drill Cuttings

Drill cuttings from the vadose zone were collected in designated spoil piles for return-to-earth purposes. Before final well acceptance, all of the drill cuttings contained in the spoil piles had been approved for return to earth and had been spread out across the drill pad. Drill cuttings from below the high-water mark (approximately 10 ft above expected water) were collected, dewatered when necessary, and placed into a designated roll-off box provided by the Environmental Restoration and Disposal Facility. An RCT periodically surveyed the roll-off boxes. Miscellaneous solid waste associated with sampling activities was contained in clear plastic bags and disposed in the roll-off boxes. The roll-off boxes provided for the project were transported to the Environmental Restoration Disposal Facility for disposal at the end of the project. This process is established by CHPRC in procedure SGRP-PRO-OP-50034 (GRP-EE-02-14.5), *Returning Vadose Zone Drill Cuttings/Soils to the Environment.*

4.2 Purgewater

Purgewater was generated during well drilling, sampling, and development activities. All purgewater was collected and contained at the wellhead until it was transported to the Purgewater Modular Storage Units 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.*

5 Civil Survey

The well locations for C8729, C8730, C8731, and C8732 were surveyed on March 17, 2016, and the remaining well locations for C8733, C8734, and C8735 were surveyed on April 7, 2016, in accordance with procedure SGRP-PRO-SMP-52857 (GRP-EE-01-1.6), *Survey Requirements and Techniques*. The equipment used to collect the coordinates was a Trimble[5] R8 RTK GPS and a Trimble DiNi 12 Level. The Washington State Plane (south zone) *North American Datum of 1983* (NAD83), with the 1991 adjustment, was used to record the horizontal coordinates; *North American Vertical Datum of 1988* (NAVD88) was used to record the vertical survey data. The locations of the surveyed boreholes are identified in Table 5-1. Each of the survey reports are presented in Appendices A through G, respectively.

Table 5-1. Civil Survey Summary

Well Number	Well Name	Northing[a] (m)	Easting[a] (m)	Brass Survey Marker Elevation[b] (m)	Top of Casing[b,c] Elevation (m)
C8729	199-D5-149	151461.82	573327.62	143.918	144.669
C8730	199-D5-150	151401.85	573429.42	143.883	144.648
C8731	199-D5-151	151391.88	573312.03	139.210	139.970
C8732	199-D5-152	151349.10	573300.18	139.013	139.791
C8733	199-H4-87	152667.79	577736.16	129.250	130.017
C8734	199-H4-88	152833.59	577850.51	130.917	131.698
C8735	199-H4-89	152893.98	577923.32	128.198	128.984

a. Northing and easting coordinates are based on Washington State Plane coordinates of *North American Datum of 1983* (NAD83).

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

c. Protective casing.

[5] Trimble® is a registered trademark of Trimble Navigation Limited, Westminster, Colorado.

6 Well Acceptance

The final step of the well installation process is well acceptance. Well acceptance represents confirmation that the wells meet the requirements outlined in the scope of work. This also indicates the contractual completion of the finished wells.

Well inspections for the five wells were conducted by representatives from CHPRC and Holt Services, Inc. Wells C8729, C87230, C8731, and C8732 were walked down on March 31, 2016. The remaining wells (C8733, C8734, and C8735) were walked down on April 6, 2016. Representatives of the drilling contractor and CHPRC documented the final well acceptance by providing signatures. To document the well acceptance, a quality assurance work site assessment was created.

7 References

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Appendix A

Borehole Documentation for C8729

- Well Summary Sheet for C8729
- Borehole Log for C8729
- Log Data Report for C8729
- Final Survey Report for C8729
- Photo Log for C8729

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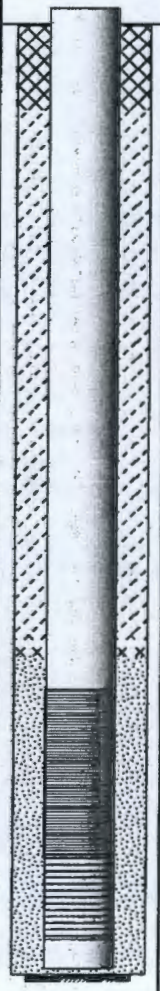
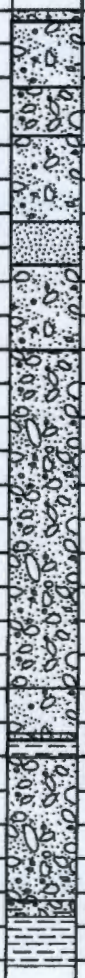
WELL SUMMARY SHEET		Start Date: 1/18/16 Finish Date: 2/9/16	Page 1 of 1
Well ID: C8729		Well Name: 199-D5-149	
Location: 100D SE of Power Station		Project: HR-3 Replacement Wells	
Prepared by: Julie Johanson	Date: 4/4/16	Reviewed by: [illegible]	Date: 4-13-16
Signature: Julie Johanson		Signature: [illegible]	

CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram		Graphic Log	Lithologic Description
Surface Completion: 4'x4'x6" Concrete Pad with brass survey marker and 6 9/16" protective monument (3.00' ags)		0		0-1.5: Sandy Gravel (sG) 1.5-9: Gravelly Sand (gS)
Well Completion material: High Strength Concrete 0.0' bgs - 2.00' bgs				9-15: Sandy Gravel (sG) 15-25: Gravelly Sand (Gs)
Type I/II Portland Cement 2.00' bgs - 10.17' bgs		20		
Granular Bentonite 3/8" 10.17' bgs - 72.33' bgs				25-30: Sand (S) 30-40: Gravelly Sand (gS)
3/8" Bentonite Pellets 72.33' bgs - 75.17' bgs		40		40-80: Sandy Gravel (sG)
8-16 Colorado Silica Sand 75.17' bgs - 111.46' bgs				
Natural Fill 111.46' bgs - 112.67' bgs		60		
Permanent Well: 6" ID Stainless Steel Blank 1.76' ags - 78.27' bgs				
6" ID Stainless Steel 0.040 Slot Screen 78.27' bgs - 98.28' bgs		80		80-85: Gravelly Sand (gS)
6" ID Stainless Steel 0.045 Slot Screen 98.28' bgs - 108.27' bgs				85-86.2: Sandy Gravel (sG) 86.2-88: Silt (M)
6" ID Stainless Steel Sump 108.27' bgs - 111.27' bgs				88-105: Sandy Gravle (sG)
		100		
All temporary casing completely removed from ground on 2/2/2016				105-107: Silty Sandy Gravel (msG) 107-112.67: Silt (M) [RUM]
ags = above ground surface bgs = below ground surface				

A-6003-643 (03/03)

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BOREHOLE LOG

Page 1 of 3
Date: 1-20-16

Well ID: C8729 | Well Name: 199-D5-149 | Location: 100D SE of power station

Project: HR-3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0-1.5': Sandy Gravel (sG) [fill + pad] 5% silt, 20% sand; 75% gravel; max 45 mm; moist; poorly sorted; sub angular to angular; 65%m/35%f; weak-mod. HCl rxn; 2.5Y 3/2 very dark grayish brown	Sonic Rig Fill to ~9' bgs
5	G.S.			1.5-9: Gravelly Sand (gS) @5' bgs: 5% silt, 75% v.fn.-v.crs. sand, 20% v.fn.-sm. cob.; max 84 mm; moist; poorly sorted; sub rnd.-sub ang; 60%m/40%f; strg HCl rxn; 2.5Y 3/3 dark olive brown. Increasing in silt	Archive @ 5' bgs
	G.S.				
10	SMS 1-20-16			9-15: Sandy Gravel (sG) 25% silt, 65% v.fn.-v.crs sand (med); 30% v.fn.-sm. cob.; max 63 mm; poorly sorted; moist; sub ang-sub rnd.; 75%m/25%f (sand); g: 75%m/25%f; med HCl rxn; 5Y 2.5/1 black	Archive @ 9' bgs Hanford @ 9' bgs
15	G.S.			15-25: Gravelly Sand (gS) 10% silt, 75% v.fn.-v.crs sand (med); 15% v.fn. peb.-sm. cob; max 95 mm; poorly sorted; slightly damp; sub ang.-rnd.; s: 75%m/25%f, g: 65%m/35%f; weak-mod. HCl rxn; 2.5Y 3/1 very dark gray	Archive @ 15' bgs
20	G.S.			@20' bgs: 10% silt, 80% v.fn.-v.crs. sand (med); 10% v.fn. peb.-med. peb.; max 28 mm, mod. sorted, damp; s: 75%m/25%f; g: 60%f/40%m; 2.5Y 4/1 dark gray	Archive @ 20' bgs
25	G.S.			25-30: Sand (S) 5% silt, 95% v.fn.-v.crs. sand (med.-crs.); max 2 mm; mod.-well sorted; sub ang-sub rnd.; slightly moist; s: 75%m/25%f; weak HCl rxn; 2.5Y 4/1 dark gray	Archive @ 25' bgs
30	G.S.			30-40: Gravelly Sand (gS) 5% silt, 85% v.fn.-v.crs. sand (med.-crs.); 10% v.fn. peb-sm. cob; max 58 mm; slightly moist; mod.-poorly sorted; sub ang.-sub rnd.; s: 75%m/25%f; g: 85%m/15%f; weak HCl rxn; 2.5Y 4/1 dark gray.	Archive @ 30' bgs
35	G.S.			@35' bgs: 5% silt, 80% v.fn.-v.crs sand (crs); 15% v.fn. peb.-lg. cob.; max 140 mm; poorly sorted, weak-mod HCl rxn; 2.5Y 4/2 dark grayish brown	Archive @ 35' bgs

Reported By: Julie Johanson | Reviewed By: Sarah Springer
Title: Geologist | Title: geologist
Signature: Julie Johanson | Date: 1-20-16 | Signature: Sarah Springer | Date: 05-03-16

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 3
Date: 1-20-16

Well ID: C8729 | Well Name: 199-D5-149 | Location: 100D SE of power station.

Project: HR-3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	G.S.			40-40: Sandy Gravel (SG) 10% silt, 40% v.fn.-v.crs. sand, 50% v.fn.-v.crs. peb; max 46mm; dry; poorly sorted, sang.-subrnd.; s: 70%m/30%f; g: 80%m/20%f; strg. HCl rxn; 2.5Y 4/1 dark gray	Sonic Rig Archive @ 40' bgs.
45	G.S.			@ 45' bgs: <10% silt, <20% v.fn.-v.crs. sand (med); 70% v.fn.-v.crs. peb.; max 55 mm; slightly moist; s: 75%m/25%f, g: 90%m/10%f; 2.5Y 3/2 very dark grayish brown.	Archive @ 45' bgs
50	G.S.			@ 50' bgs: 5% silt, 30% v.fn.-v.crs. sand(crs); 65% v.fn. peb. - lg. cob.; max 147mm; slightly moist-dry; s: 70%m/30%f, g: 80%m/20%f; weak HCl rxn; 2.5Y 3/2 very dark grayish brown	Archive @ 50' bgs
55	G.S.			@ 55' bgs: 5% silt, 25% v.fn.-v.crs sand (crs); 70% v.fn. peb. - sm. cob.; max 80mm; moist, s: 30%m/80%f, g: 75%m/25%f; med. HCl rxn; 2.5Y 3/2 very dark grayish brown.	Archive @ 55' bgs
60	G.S.			@ 60' bgs: 10% silt, 30% v.fn.-v.crs. sand (med.-crs.), 60% v.fn. peb. - sm. cob.; max 120mm, slightly moist; s: 80%m/80%f, g: 70%m/30%f; v. strg. HCl rxn, 2.5Y 3/2 very dark grayish brown	Archive @ 60' bgs Ringold @ ≈ 60' bgs
65	G.S.			@ 65' bgs: 10% silt, 25% v.fn.-v.crs. sand (med.), 65% v.fn. peb. - sm. cob.; max 112 mm; s: 45%m/55%f; g: 80%m/20%f; v. strg. HCl rxn, 2.5Y 4/3 olive brown	Archive @ 65' bgs
70	G.S.			@ 70' bgs: 10% silt, 25% v.fn.-v.crs. sand (med.-crs.), 65% v.fn. peb.-sm. cob.; max 75 mm; slightly moist-dry; s: 35%m/65%f, g: 75%m/25%f; v. weak HCl rxn; 2.5Y 4/3 olive brown	Archive @ 70' bgs
75	G.S.			@ 75' bgs: 10% silt, 25% v.fn.-v.crs. sand (med.-crs.); 65% v.fn. peb.-sm. cob.; max 80 mm; dry; s: 30%m/70%f; g: 65%f/35%m; med.-strg. HCl rxn; 2.5Y 5/3 light olive brown	Archive @ 75' bgs; Sample: T-001 (split spoon) 74.77'-75.27' bgs HEIS# B34841, B34842; 1-21-16

Reported By: Julie Johanson | Reviewed By: Sarah Springer

Title: Geologist | Title: geologist

Signature: Julie Johanson | Date: 1-21-16 | Signature: Sarah Springer | Date: 05-03-16

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 4
Date: 1-21-16

Well ID: C8729 | Well Name: 199-D5-149 | Location: 100D SE of power station.

Project: HR-3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description (Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl)	Comments (Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level)
80	G.S.				Sonic Rig
	S.S. I-002 1-21-16			80-85 : Gravelly Sand (gS)	Archive @ 80' bgs.
				10% silt, 65% v.fn.-v.crs. sand (med.), 25% v.fn.-v.crs.	Sample I-002 (S.S.) 1-21-16
				peb.; max 50 mm; slightly moist-dry; angular-sub rnd;	HETS# B34843, B34844;
				poorly sorted; s: 90%f/10%m, g: 85%f/15%m; mod.-	80.58'-81.08' bgs
85	G.S.			strg. HCl rxn; 2.5Y 4/3 olive brown	H_2O @ 85.02' bgs (1-21-16)
	S.S. I-003 I-003 DUP 1-21-16			85-86.2: Sandy Gravel (sG)	Archive @ 85' bgs
				5% silt; 65% v.crs.-v.fn sand (crs.); 30% v.fn. peb.-	Sample I-003, I-003 DUP (S.S.) 1-21-16
				sm. cob.; max 101 mm; moist, poorly sorted, sub ang-	HETS# B34846, B34847; Dup: B34848,
				sub rnd; s: 90%f/10%m, g: 80%f/20%m; mod. HCl rxn;	B34866; 85.08'-85.58' bgs
90	G.S. H_2O 1-21-16 I-004	Sieve Sample 85'-95'		10YR 4/3 brown	Archive @ 86.2' bgs
				86.2'-88 : Silt (M)	Archive @ 88' bgs
				~~98% silt/clay; 2% v.fn.-v.crs. sand~~ SMF 1-21-16; 100% silt/clay;	H_2O Sample I-004 # HETS# B34905
				moist-wet; well sorted; v.strg. HCl rxn; 2.5Y 5/4	Field screen: 0.003 mg/L Cr(VI)
				light olive brown; weak plasticity.	90.02' bgs 1-21-16
95	G.S.			88-105 : Sandy Gravel (sG)	DTW: ~~95.02' bgs~~ SMF 1-21-16 84.99' bgs
				70% v.fn.-v.crs. sand (crs.), 30% v.fn. peb.-sm. cob.; max	Archive @ 95' bgs
				88 mm; wet, poorly sorted; ~~strong~~ SMF 1-21-16 sub ang.-sub rnd.; s: 85%f/15%m;	
				g: 70%f/30%m; v.strg. HCl rxn; 10YR 4/2 dark	
				grayish brown	
100	G.S.			~~@ 95' bgs: 25% v.fn.-v.crs. sand (crs.)~~ SMF 1-21-16	
	H_2O I-005 I-005 DUP 1-25-16	Sieve Sample 95'-105'		95' bgs :	Archive @ 100' bgs
				10% silt, 20% v.fn.-v.crs. sand (crs); 70% v.fn. peb.-	H_2O Sample I-005 # HETS B34908
				sm. cob.; max 88 mm; wet, poorly sorted, sub. angular-sub	Cr(VI): 0.003 mg/L, I-005 DUP HETS#
				rnd. s: 55%f/45%m, g: 60%f/40%m; weak-mod. HCl	B34907 Cr(VI) 0.001 mg/L; 100.32' bgs
105	G.S			rxn; 2.5Y 3/2 very dark grayish brown	1-25-16 @ 1327
	H_2O I-006 1-26-16			@ 100' bgs: 10% silt, 15% v.fn.-v.crs. sand (med);	Archive @ 105' bgs
				75% v.fn. peb.-sm cob; max 135 mm; strg. HCl rxn; 2.5Y	H_2O Sample I-006 HETS# B34910;
				4/2 dark grayish brown	Cr(VI) 0.011 mg/L; 105.19' bgs; 1-26-16 @
				105-107: Silty Sandy Gravel (mSG)	1041
110	G.S.	JMS 1-26-16		50% silt, 40% v.fn.-v.crs. sand, 40% g v.fn. peb.-sm. cob; max	
				98 mm; wet; poorly sorted; sub. ang.-sub rnd; s: 65%f/35%m;	Archive @ 110' bgs
				g: 60%m/40%f; weak-mod. HCl rxn; 2.5Y 4/2 dark	
				grayish brown	TD: 112.67' bgs
				107-112.67: Silt (m) [RUM]	
115				100% silt/clay; slightly moist; well sorted, No HCl	
				rxn; moist: 5YR 4/2 dark reddish gray; dry: 7.5YR	
				7/2 pinkish gray; @ 110' bgs; No plasticity.	

Reported By: Julie Johanson | Reviewed By: Sarah Springer

Title: Geologist | Title: geologist

Signature: Julie Johanson | Date: 1-26-16 | Signature: Sarah Springer | Date: 05-03-16

A-6003-642 (03/03)

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Stoller Newport News Nuclear

199-D5-149 (C8729)
Log Data Report

Borehole Information

Log Date	2016-01-27	Filename	C8729_HG-NM_2016-01-27	Site	100-D
Coordinates (WA St Plane)		DTW[1] (ft)	90	DTW Date	01/27/16
North (m)	East (m)	Drill Date	TOC[2] Elevation	Total Depth (ft)	Type
N/A	N/A	10/21/15	N/A	112.31	Sonic

Casing Information

Casing Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	0.1	10 1/2	9 5/8	0.25 – 0.42	-0.1	112.31

Borehole Notes

The logging engineer measured depth to water with an e-tape.

Zero reference is ground surface.

This borehole was drilled by a sonic method, using internal-upset casing in 5-ft lengths. This result is a significant reduction in count rate for both the gamma log and neutron moisture log at each casing joint. The sonic drill casing, through which log data were collected, was manufactured by Terra Sonic International. A telephone conversation with the manufacturer's representative indicated that the 10.5-inch casing has a nominal wall thickness of 0.25 in. At the end of each 5-ft length, an inset with either a box (female) or pin (male) thread is welded inside the pipe. When the box and pin are screwed together, the total length of the insert is 13.5 inches. This consists of 5 inches on the pin side of the joint, and 8.5 inches on the box side. Over this distance, wall thickness is 0.42 in. Both inserts are tapered for an additional 4.5 inches to avoid an edge on the inside of the casing.

Logging Equipment Information

Logging System	Gamma 1L	Type	HPGe SGLS[3]
Effective Calibration Date	10/29/2015	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-130, Rev. 0	Logging Procedure	SGRP-PRO-OP-53010, Rev. 0

Logging System	Gamma 1H	Type	NMLS[4]
Effective Calibration Date	10/21/15	Serial No.	H310700352
Calibration Reference	HGLP-CC-131, Rev. 1	Logging Procedure	SGRP-PRO-OP-53016, Rev. 0

[1] depth to water inside casing
[2] top of casing
[3] Spectral Gamma Logging System
[4] Neutron Moisture Logging System

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SGLS Log Run Information

Log Run	1	2 Repeat			
HEIS Number	1013093	1013094			
Date	1/27/16	1/27/16			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0.0	80			
Finish Depth (ft)	113.0	91			
Count Time (sec)	100	100			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	AL292CAB	AL292CAB			
Start File	AL292000	AL292114			
Finish File	AL292113	AL292125			
Post-Verification	AL292CAA	AL292CAA			
Depth Return Error (in.)	N/A	high ½"			
Comments	No fine gain adjustments made	No fine gain adjustments made			

NMLS Log Run Information

Log Run	3	4 Repeat			
HEIS Number	1013095	1013096			
Date	1/27/16	1/27/16			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0.0	80			
Finish Depth (ft)	90	90			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	NA	N			
MSA Interval (ft)	0.25	0.25			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	AH237CAB	AH237CAB			
Start File	AH237000	AH237361			
Finish File	AH237360	AH237401			
Post-Verification	AH237CAA	AH237CAA			
Depth Return Error (in.)	N/A	HIGH 1"			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on both sondes.

Pre- and post-survey verification measurements met the acceptance criteria for the established systems.

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Analysis Notes

Analyst	R G McCain	Date	02/24/15
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53052, Rev. 0		

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as AL20151029_CC-130 for the SGLS, using an efficiency function and corrections for casing and dead time as determined during annual response checks.

NMLS data are reported in counts per second.

The internal upsets in casing thickness at 5-ft intervals significantly affect both gamma and moisture log response, with the result being a distinctive "saw tooth" pattern in the log results after conventional casing correction has been applied. This was corrected by calculating an "effective casing thickness" for each measurement point and calculating a casing correction based on this value. Log detectors respond to material both above and below the actual measurement point, so the first step is to determine a sensitivity function describing the variation in detector sensitivity as a function of depth above and below the measurement point. For the gamma log, the sensitivity range was assumed to be within +/- 1 ft of the measurement point. For the moisture log, the sensitivity range was estimated to be within +/- 0.5 ft of the measurement point. The sensitivity function was then used to create an estimated "effective thickness" based on distance from the nearest casing joint above the measurement point.

For both the gamma and moisture log, a depth offset was estimated to align the measurement points and the casing joints. This allows the effective thickness to be estimated for all measurement points. For measurement points that fall between casing joints, the effective thickness is equal to the nominal casing wall thickness (0.25 in.), but for measurement points at or near a casing joint the effective thickness may be greater, up to a maximum or 0.42 in. for a point at the casing joint and thus well inside the internal upset region.

For the gamma log, a corrected activity was calculated by using a casing correction calculated from the effective casing thickness at each measurement point.

For the moisture log, an empirical correction factor was determined by examining the log over an interval of relatively stable moisture content. For measurement points well within the interval between casing joints (nominal casing thickness = 0.25 in.), the correction factor is assumed to be 1.0. For measurement points within a casing joint (casing thickness = 0.42 in.), the correction factor is estimated to be 1.18. Correction factors for intermediate effective thickness values are interpolated.

Most log plots show both "raw" and "corrected" values. Raw values are those computed for a constant casing thickness. Corrected values are those computed from the effective casing thickness.

The HGU[5] is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Model Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

Results and Interpretations

No manmade radionuclides were detected in the borehole. MDLs are plotted for Cs-137 and Pu-239, based on characteristic gamma lines at 662 and 375 keV, respectively.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content. Below the casing change at around 44 ft, there appear to be thick intervals (>10 ft) of relatively higher and lower average soil moisture content occasionally punctuated with thinner horizons (< 5 ft) of higher moisture content.

The KUT and moisture repeat plots indicate that the respective systems were working properly.

[5] Hanford Gamma Unit

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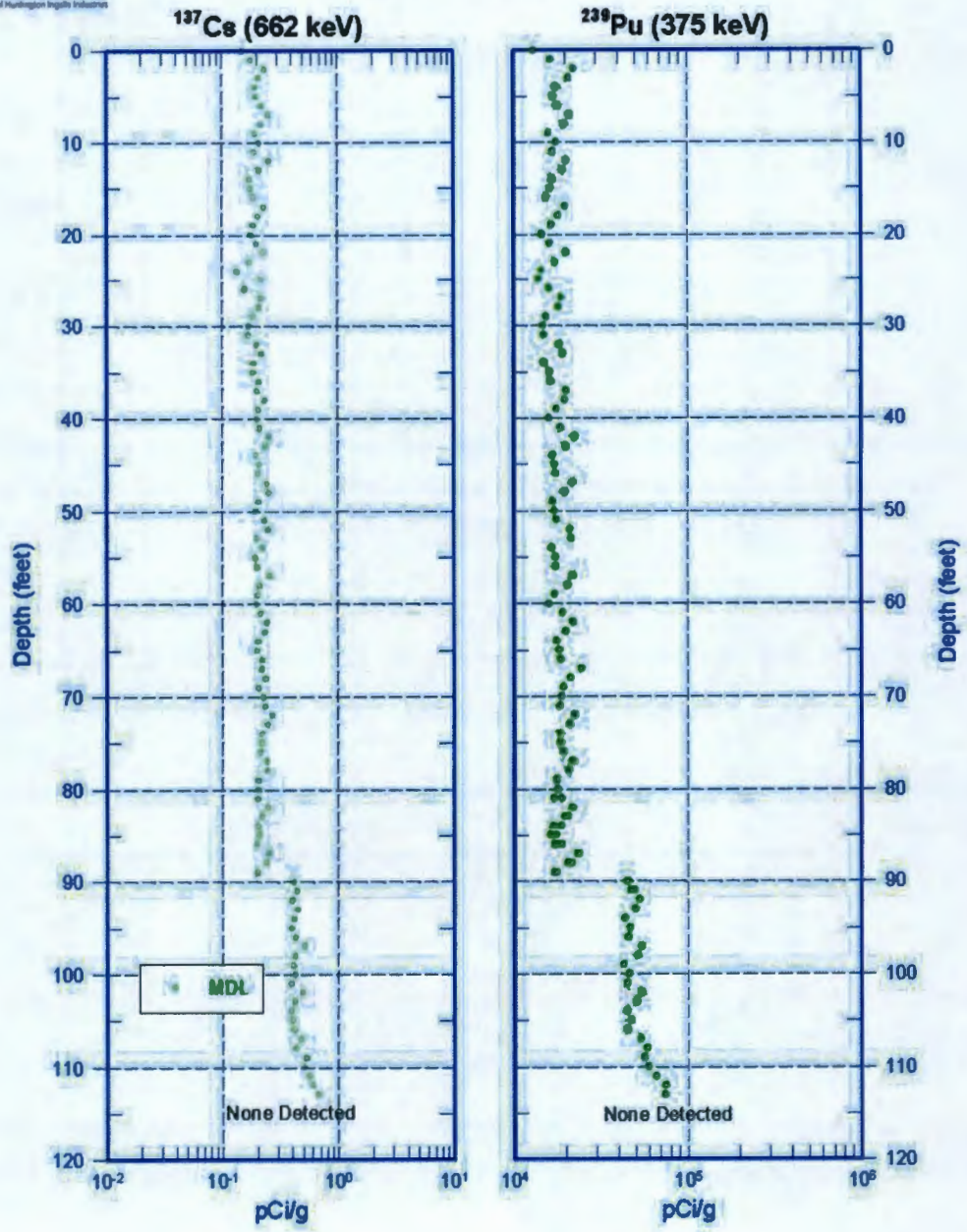
List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-120 ft)
Natural Gamma Logs (0-120 ft)
Combination Plot (0-120 ft)
Total Gamma & Moisture (0-120 ft)
Total Gamma & Hanford Gamma Unit (0-120 ft)
Repeat Section of Natural Gamma Logs (80-91 ft)
Moisture Repeat Section (80-90 ft)

199-D5-149 (C8729)
Manmade Radionuclides



Zero Reference - Ground Surface

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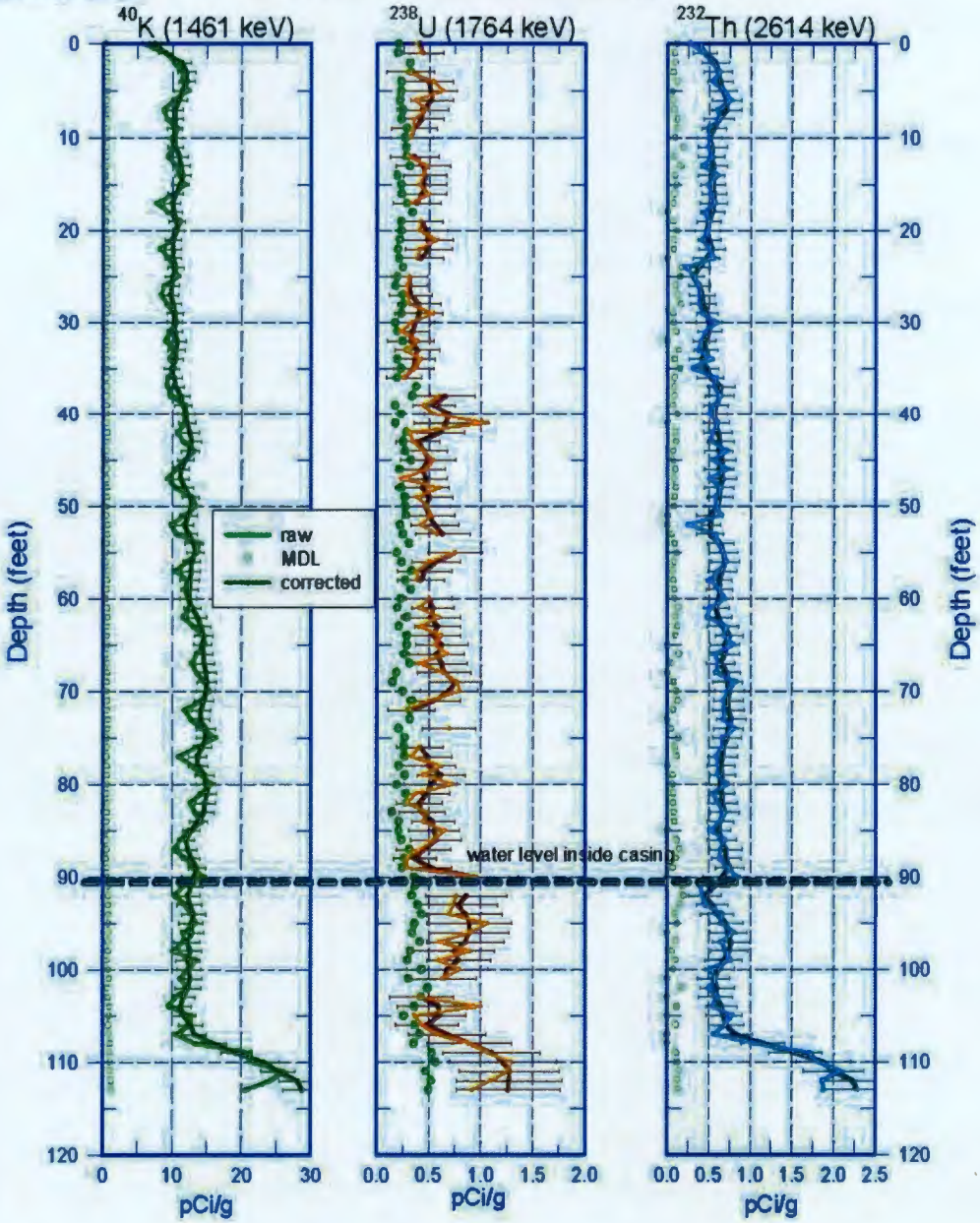
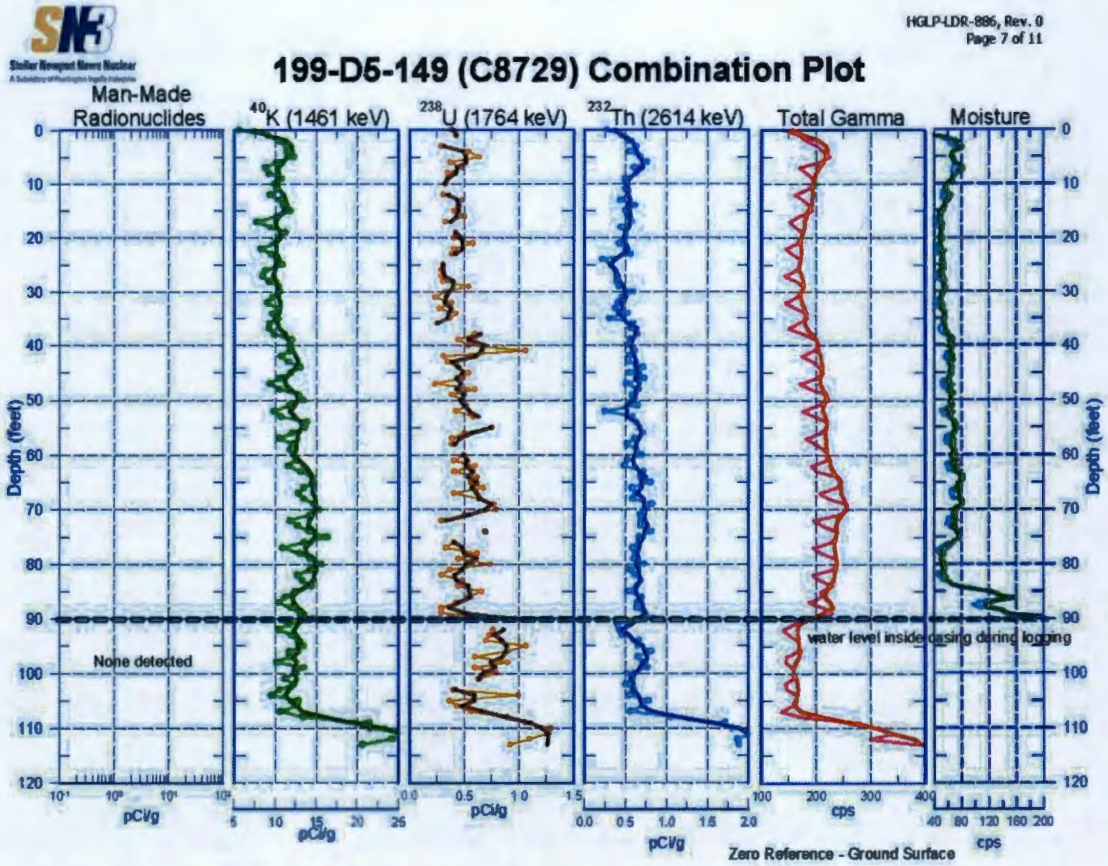
199-D5-149 (C8729)
Natural Gamma Logs

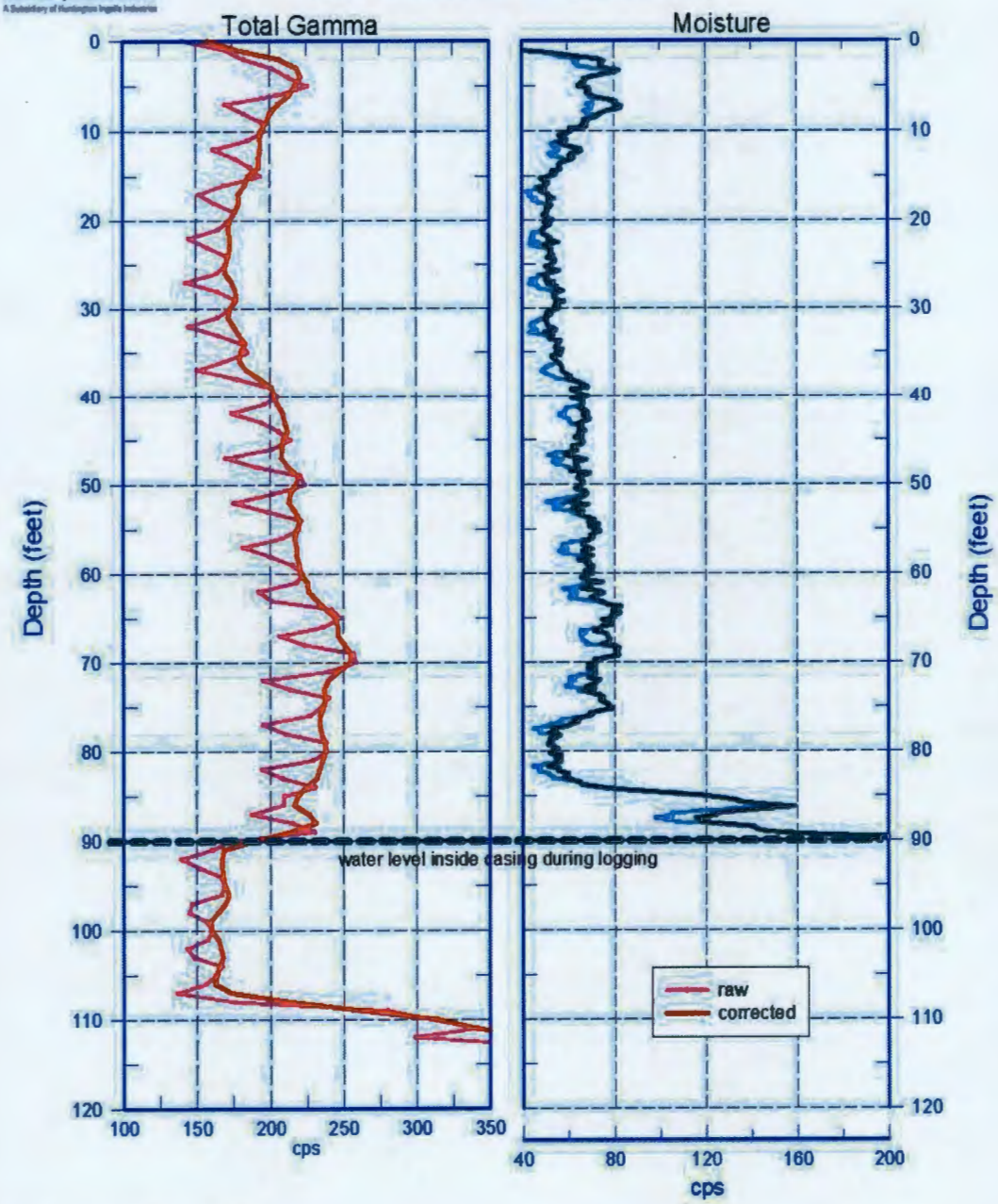


Zero Reference - Ground Surface


HGLP-LDR-886, Rev. 0
Page 7 of 11
199-D5-149 (C8729) Combination Plot
Man-Made Radionuclides
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Total Gamma
Moisture
Depth (feet)
None detected
water level inside casing during logging
pCi/g
cps
Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

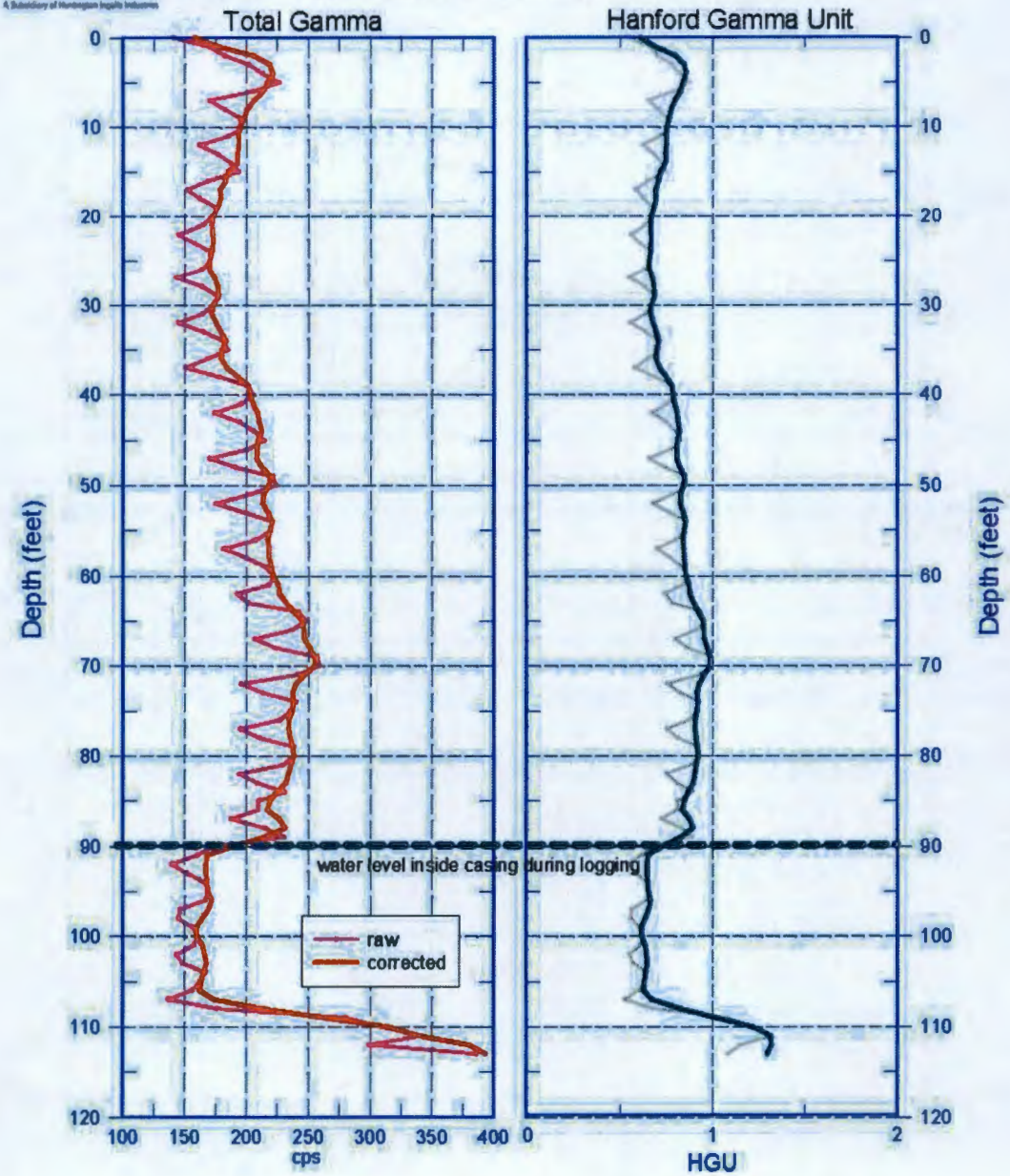
199-D5-149 (C8729)
Total Gamma & Moisture



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

199-D5-149 (C8729)
Total Gamma & Hanford Gamma Unit

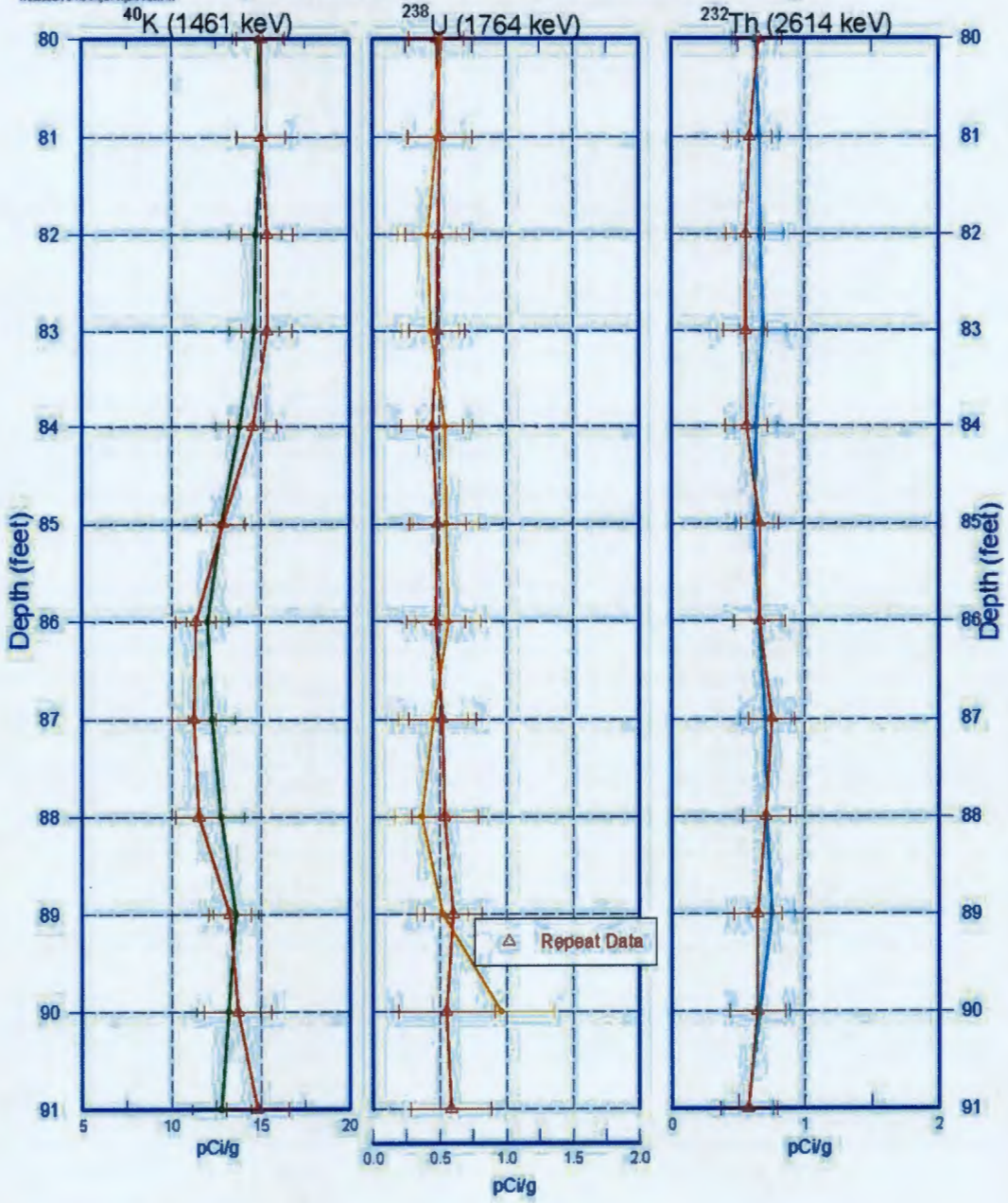


Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

199-D5-149 (C8729)

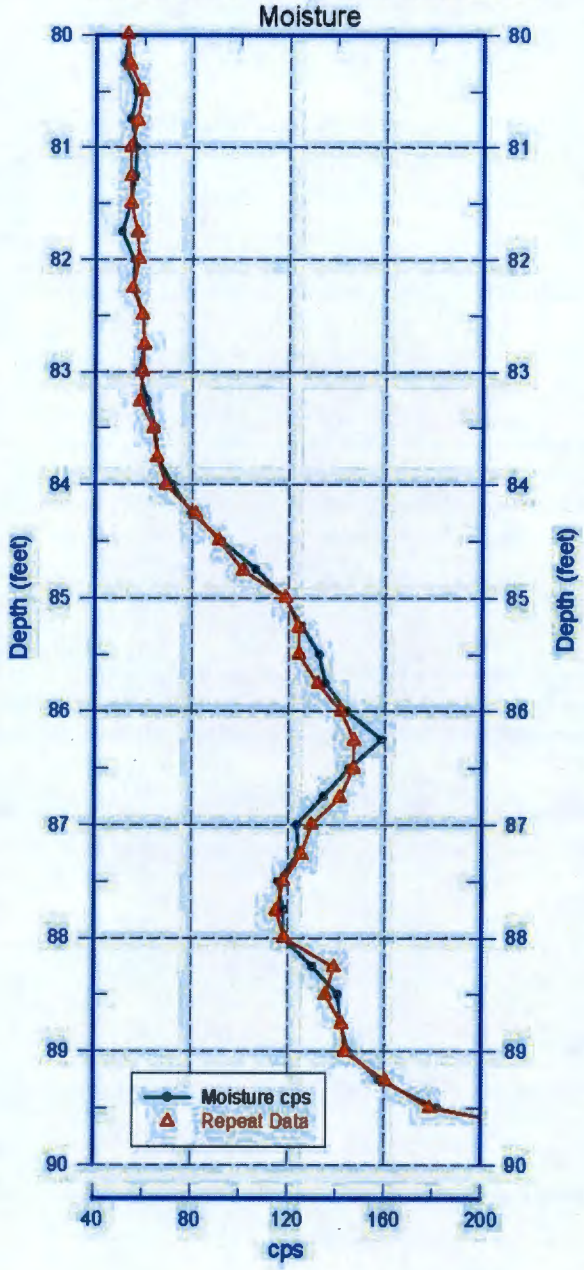
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

Stellar Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

199-D5-149 (C8729)
Moisture Repeat Section



Zero Reference - Ground Surface

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WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 03/10/16	Requestor: Ed Rafuse (CHPRC)
Date of Survey: 03/17/16	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of 100D Replacement Well C8729 (199-D5-149).	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 100D

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
D-6 (CHPRC) and D-9 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C8729	199-D5-149	573327.62	151461.82		Center of Casing
				144.669	"X" on Rim
				143.918	Brass Survey Marker

Notes:

144.288 Top Inner Casing, North Edge

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.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

3-17-16

A-6003-659 (04/03)

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Split Spoon Sample Photos C8729

Soil Sample at 75 ft bgs

75 ft Bottom of Liner A

75 ft Bottom of Liner B

Soil Sample at 80 ft bgs

Rocks removed from 80 ft Soil Sample

80 ft Bottom of Liner A

80ft Bottom of Liner C

Soil Sample at 85 ft bgs

85 ft Bottom of Liner A

85 ft Bottom of Liner B

85 ft Bottom of Liners B & C

85 ft Top of Liners B & C

85 ft Transition through Liners B & C

85 ft Bottom of Liner C

85 ft Top of Liner C

Appendix B

Borehole Documentation for C8730

- Well Summary Sheet for C8730
- Borehole Log for C8730
- Log Data Report for C8730
- Final Survey Report for C8730
- Photo Log for C8730

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WELL SUMMARY SHEET

Start Date: 2/2/16
Finish Date: 2/18/16
Page 1 of 1

Well ID: C8730	Well Name: 199-D5-150
Location: W ~100 yrds between D & DR Reactors	Project: HR-3 Replacement Wells
Prepared by: Julie Johanson — Date: 4/4/16	Reviewed by: J.D. MEHRER, Environmental Scientist — Date: 9-13-16
Signature: Julie Johanson	Signature:

CONSTRUCTION DATA

Surface Completion:

4'x4'x6" Concrete Pad with brass survey marker and 6 9/16" protective monument (3.00' ags)

Well Completion material:

High Strength Concrete
0.0' bgs - 1.30' bgs

Type I/II Portland Cement
1.30' bgs - 10.25' bgs

Granular Bentonite 3/8"
10.25' bgs - 67.01' bgs

3/8" Bentonite Pellets
67.01' bgs - 71.68' bgs

10-20 Colorado Silica Sand
71.68' bgs - 110.67' bgs

Natural Fill
110.67' bgs - 111.17' bgs

Permanent Well:

6" ID Stainless Steel Blank
1.99' ags - 76.05' bgs

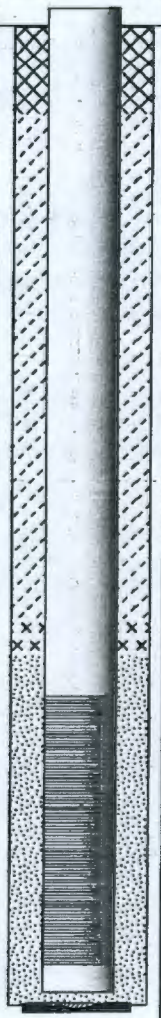
6" ID Stainless Steel 0.040 Slot Screen
76.05' bgs - 106.06' bgs

6" ID Stainless Steel Sump
106.06' bgs - 109.05' bgs

All temporary casing completely removed from ground on 2/18/2016

ags = above ground surface
bgs = below ground surface

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 20, 40, 60, 80, 100

Graphic Log

Lithologic Description

- 0-10: Sandy Gravel (sG)
- 10-15: Slightly Silty Gravely Sand ([m]gS)
- 15-20: Silty Sandy Gravel (msG)
- 20-25: Sandy Gravel (sG)
- 25-35: Silty Sandy Gravel (msG)
- 35-40: Gravelly Sand (gS)
- 40-60: Sandy Gravel (sG)
- 60-65: Silty Sandy Gravel (msG)
- 65-70: Gravelly Sand (gS)
- 70-80: Silty Sandy Gravel (msG)
- 80-85: Sandy Gravle (sG)
- 85-95: Silty Sandy Gravel (msG)
- 95-106: Silty Gravel (mG)
- 106-111.17: Silt (M) [RUM]

A-6003-643 (03/03)

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BOREHOLE LOG

Page 1 of 3
Date: 2-2-16

Well ID: C8730 | Well Name: 199-D5-150 | Location: W. ~100 yrds. between D + DR reactor

Project: HR-3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0-10 : Sandy Gravel (sG) @ 5' bgs: 5% silt; 60% v.fn.-v.crs. sand (crs.), 35% v.fn. peb.-sm. cob.; max 92 mm; moist, poorly sorted, sub rnd.-sub ang.; s: 80%f/20%m, g: 60%m/40%f; mod.-strg. HCl rxn; 10YR 4/3 brown	Sonic. Fill to ~10'
5	G.S.				Archive @ 5' bgs.
10	G.S.				Hanford FM @ ~10'
				10 - 15 : Slightly Silty Gravelly Sand (msgS) 15% silt, 60% v.fn.-v.crs. sand (med.-crs.), 25% v.fn. peb.-lg. cob.; max 160 mm; moist, poorly sorted, ang.-sub rnd.; s: 70%m/30%f, g: 90%m/10%f; mod. HCl rxn; 10YR 3/2 very dark grayish brown	Archive @ 10' bgs
15	G.S.			15 - 20 : Silty Sandy Gravel (msG) 30% silt, 50% v.fn.-v.crs. sand (med.), 20% v.fn.-v.crs. peb.; max 58 mm; moist, poorly sorted, ang.-sub rnd.; s: 75%m/25%f, g: 90%m/10%f; strg. HCl rxn, 10YR 4/2 dark grayish brown	Archive @ 15' bgs
20	G.S.			20 - 25 : Sandy Gravel (sG) 5% silt, 35% v.fn.-v.crs. sand (crs.), 60% v.fn. peb.-sm. cob.; max 122 mm; moist, poorly sorted, sub ang.-sub rnd.; s: 70%m/30%f, g: 95%m/5%f; strg. HCl rxn; 10YR 4/2 dark grayish brown	Archive @ 20' bgs.
25	G.S.			25 - 35 : Silty Sandy Gravel (msG) 15% silt; 25% v.fn.-v.crs. sand (med.-crs.), 60% v.fn. peb.-sm. cob.; max 110 mm, slightly moist; poorly sorted, ang.-sub. rnd.; s: 80%m/20%f, g: 85%m/15%f; mod.-strg. HCl rxn; 10YR 4/3 brown	Archive @ 25' bgs.
30	G.S.			@ 30' bgs: 10% silt; 25% v.fn.-v.crs. sand (crs.); 65% v.fn. peb.-sm. cob.; max 125 mm; s: 60%m/40%f, g: 70%m/30%f; mod. HCl rxn; 10YR 4/2 dark grayish brown	Archive @ 30' bgs.
35	G.S.			35' - 40 : Gravelly Sand (gS) 5% silt, 70% v.fn.-v.crs. sand (crs.), 25% v.fn. peb.-sm. cob; max 114 mm; moist, poorly sorted; ang.-sub. rnd.; s: 70%m/30%f, g: 70%f/30%m; mod.-strg. HCl rxn; 10YR 2/2 very dark brown	Archive @ 35' bgs

Reported By: Julie Johanson | Reviewed By: Sarah Springer

Title: Geologist | Title: geologist

Signature: Julie Johanson | Date: 2-2-16 | Signature: Sarah Springer | Date: 05-03-16

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 3
Date: 2-2-16

Well ID: C8730 | Well Name: 199-D5-150 | Location: W. ~100 yrds. between D+DR reactor

Project: HR-3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	G.S.				Sonic
				40 - 60: Sandy Gravel	Archive @ 40' bgs
				10% silt, 55% v.fn.-v.crs. sand (med.-crs.), 35% v.fn.peb.-sm.cob, max 130 mm, moist, poorly sorted, ang.-sub rnd., s: 70%m/30%f, g: 55%m/45%f; mod.-strg. HCl rxn; 10YR 3/2 very dark grayish brown	
45	G.S.			@ 45' bgs: 10% silt, 60% v.fn.-v.crs. sand (med.-crs.), 30% v.fn.peb - lg. cob.; max 162 mm; moist, poorly sorted, ang.-rnd.; g: 70%f/30%m, s: 70%m/30%f; mod.-strg. HCl rxn. 10YR 3/2 very dark grayish brown	Archive @ 45' bgs.
50	G.S.			@ 50' bgs: 10% silt, 45% v.fn.-v.crs. sand (crs.-v.crs.); 45% v.fn.peb.-sm.cob.; max 77 mm; sub ang.-sub rnd.; s: 65%m/35%f, g: 70%f/30%m; mod. HCl rxn; 10YR 3/1 very dark gray	Archive @ 50' bgs.
55	G.S.			@ 55' bgs: 10% silt, 50% v.fn.-v.crs sand (crs.-v.crs.), 40% v.fn.peb.-sm.cob.; max 67 mm; ang.-sub rnd.; s: 65%m/35%f, g: 75%f/25%m; mod.-strg. HCl rxn; 10YR 3/2 very dark grayish brown.	Archive @ 55' bgs
60	G.S.			60 - 65: Silty Sandy Gravel (msG)	Archive @ 60' bgs.
				25% silt, 30% v.fn.-v.crs. sand, 45% v.fn.peb.-sm.cob.; max 82 mm, dry; poorly sorted, sub.rnd.-ang.; s: 70%f/30%m; g: 70%f/30%m; strg. HCl rxn; 10YR 6/2 light brownish gray; silt mostly rock dust from breaking up cobbles during drilling. Sand mineralogy may be off due to rock dust	Ringold @ ~60' bgs
65	G.S.			65 - 70: Gravelly Sand (gS)	Archive @ 65' bgs.
				5% silt, 75% v.fn.-v.crs. sand (crs.-v.crs.), 20% v.fn.peb.-lg. cob.; max 136 mm, moist, poorly sorted, ang.-sub rnd., s: 80%m/20%f, g: 60%f/40%m; strg. HCl rxn; 10YR 3/2 very dark grayish brown	
70	G.S.			70 - 80: ~~Silty~~ Silty Sandy Gravel (msG)	Archive @ 70' bgs
				15% silt, 50% v.fn.-v.crs. sand (crs.), 35% v.fn.peb.-sm.cob.; max 65 mm, slightly moist, poorly sorted, ang.-sub rnd., s: 75%m/25%f, g: 65%f/35%m; v. strg. HCl rxn; 10YR 4/2 dark grayish brown	
75	G.S. 2-2-16			@ 75' bgs: 15% silt, 20% v.fn.-v.crs. sand, 65% v.fn.-v.crs. peb (v.fn.-f.); max 51 mm; s: 65%m/35%f; g: 55%m/45%f; v. strg. HCl rxn; 10YR 3/2 very dark grayish brown	Archive @ 75' bgs. Sample I-001 HRZ3 B34F67, DUP: B34F68; S.S.; 1300, 2-3-16, 75.67'-76.67' bgs

Reported By: Julie Johanson | Reviewed By: Sarah Springer

Title: Geologist | Title: geologist

Signature: Julie Johanson | Date: 2-3-16 | Signature: [signature] | Date: 05-03-16

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 3
Date: 2-3-16

Well ID: C8730
Well Name: 199-D5-150
Location: 2-3-16 ~100 yards between D+DR reactors.
Project: HR-3 Replacement Wells.
Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
80	G.S. I-002 2-3-16				Sonic Rig
				80-85: Sandy Gravel (sG)	Archive @ 80' bgs
				10% silt, 50% v.fn.-v.crs. sand(crs.), 40% v.fn. peb.-lg. cob.; Max 136mm; moist; poorly sorted; ang.-rnd.; s: 85%f/15%m; g: 75%f/25%m; v. strg. HCl rxn; 10YR 4/3 brown	Ringold @ ~80' bgs; Split Spoon Sample I-002 HE25# B34F69; 2-3-16 @ 1355; 80.04'-80.54' bgs
85	G.S. I-003 2-4-16	Seive Sample 85'-95'		85-95: Silty Sandy Gravel (msG)	Archive @ 85' bgs
				15% silt, 35% v.fn.-v.crs. sand(v.crs.), 50% v.fn. peb.-sm. cob.; max 118mm; wet, poorly sorted, sub ang.-sub rnd.; s: 75%f/25%m; g: 80%f/20%m; v. strg. HCl rxn; 10YR 4/3 brown	Split Spoon Sample I-003 HE25# B34F71; 2-4-16 @ 0915; 86.07'-86.57' bgs
90	G.S. H2O I-004 2-4-16			@ 90' bgs: 20% silt, 35% v.fn.-v.crs. sand(crs.), 45% v.fn. peb-sm. cob.; max 91mm; ang.-sub.rnd.; s: 80%f/20%m; g: 75%f/25%m; strg.-v. strg. HCl rxn, 10YR 5/2 grayish brown	OTW: 89.84' bgs (2-4-16); Archive @ 90' bgs; H2O Sample I-004 HE25# B34F76 DUP: B34F78; 2-4-16 @ 1320; 90.19' bgs Cr(VI) 0.012 mg/L + 0.013 mg/L respectively.
95	G.S.	Seive Sample 95'-105'		95-106: Silty Gravel (mG)	
				@ 95' bgs: 20% silt, 15% v.fn.-v.crs. sand, 65% v.fn. peb.-sm. cob.; max 112mm; ang.-sub rnd.; s: 60%f/40%m; g: 80%m/20%f; v. strg. HCl rxn, when dry. No HCl rxn when wet 10YR 5/1 gray (silt)	Archive @ 95' bgs; JMS 2-4-16 H2O Sample I-004 HE25# B34F76; DUP: B34F78; JMS 2-4-16
100	G.S. H2O I-005 2-4-16			@ 100' bgs: 25% silt, 20% v.fn.-v.crs. sand(v.fn.-fn.); 55% v.fn. peb.-sm.cob.; max 94mm; ang.-rnd.; s: 65%f/35%m; g: 50%m/50%f; strg. HCl rxn when dry; No HCl rxn when wet; 10YR 5/1 gray	Archive @ 100' bgs; H2O Sample I-005 HE25# B34F79, 100.11' bgs 2-4-16 @ 0935; Cr(VI): 0.196 mg/L
105	H2O I-006 2-4-16 G.S.				
	G.S.			@ 105' bgs: 35% silt, 34% sand v.fn.-v.crs.(crs.), 30% v.fn. peb.-sm.cob.; max 69mm, sub-ang.-sub rnd; s: 70%f/30%m; g: ~50%m/50%f; strg. HCl rxn; 10YR 3/3 dark brown	Archive @ 105' bgs; Archive @ 106' bgs; H2O Sample I-006 HE25# B34F81; 104.57' bgs 2-4-16 @ 1315, Cr(VI): ~0.004 mg/L
110				106-111.17: Silt (M) [RUM]	
				100% silt, wet-moist, well sorted; No HCl rxn, 10YR 5/3 brown; med.-low plasticity.	TD @ 111.17' bgs
115					

Reported By: Julie Johanson
Title: Geologist
Signature: Julie Johanson
Date: 2-8-16

Reviewed By: Sarah Springer
Title: geologist
Signature: Sarah Springer
Date: 05-03-16

A-6003-642 (03/03)

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199-D5-150 (C8730)
Log Data Report

Borehole Information

Log Date	2016-02-09	Filename	C8730_HG-NM_2016-02-09	Site	100-D
Coordinates (WA St Plane)		DTW[1] (ft)	89.1	DTW Date	02/09/16

North (m)	East (m)	Drill Date	TOC[2] Elevation	Total Depth (ft)
N/A	N/A	10/21/15	N/A	111.17

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	Sonic Geoprobe	0.3	10 1/2	9 5/8	0.25 – 0.42	-0.3	110.15

Borehole Notes

The logging engineer measured depth to water with an e-tape.

Zero reference is ground surface. There is a void space around the outside of the casing from top of casing to 2.8 ft. This appears to be related to the effects of ground vibration from the sonic drilling method.

This borehole was drilled by a sonic method, using internal-upset casing in 5-ft lengths. This results in a significant reduction in count rate for both the gamma log and neutron moisture log at each casing joint. The sonic drill casing, through which log data were collected, was manufactured by Terra Sonic International. A telephone conversation with the manufacturer's representative indicated that the 10.5-in. casing has a nominal wall thickness of 0.25 in. At the end of each 5-ft length, an insert with either a box (female) or pin (male) thread is welded inside the pipe. When the box and pin are screwed together, the total length of the insert is 13.5 in. This consists of 5 in. on the pin side of the joint, and 8.5 in. on the box side. Over this distance, wall thickness is 0.42 in. Both inserts are tapered for an additional 4.5 in. to avoid a sharp edge on the inside of the casing.

Logging Equipment Information

Logging System	Gamma 1L	Type	HPGe SGLS[3]
Effective Calibration Date	10/29/2015	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-130, Rev. 0	Logging Procedure	SGRP-PRO-OP-53010, Rev. 0

Logging System	Gamma 1H	Type	NMLS[4]
Effective Calibration Date	10/21/15	Serial No.	H310700352
Calibration Reference	HGLP-CC-131, Rev. 1	Logging Procedure	SGRP-PRO-OP-53016, Rev. 0

[1] depth to water inside casing
[2] top of casing
[3] Spectral Gamma Logging System
[4] Neutron Moisture Logging System

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SGLS Log Run Information

Log Run	1	2 Repeat			
HEIS Number	1018145	1018146			
Date	2/9/16	2/9/16			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0.0	80			
Finish Depth (ft)	109.1	91			
Count Time (sec)	100	100			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	AL294CAB	AL294CAB			
Start File	AL294000	AL294110			
Finish File	AL294109	AL294121			
Post-Verification	AL294CAA	AL294CAA			
Depth Return Error (in.)	N/A	0			
Comments	Fine gain adjustments made after files 050, 078, 097	No fine gain adjustments made			

NMLS Log Run Information

Log Run	3	4 Repeat			
HEIS Number	1018147	1018148			
Date	2/9/16	2/9/16			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0.0	80.0			
Finish Depth (ft)	89.0	89.0			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	NA	N			
MSA Interval (ft)	0.25	0.25			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	AH239CAB	AH239CAB			
Start File	AH239000	AH239357			
Finish File	AH239356	AH239353			
Post-Verification	AH239CAA	AH239CAA			
Depth Return Error (in.)	N/A	HIGH 1 1/2"			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on both sondes.

Pre- and post-survey verification measurements met the acceptance criteria for the established systems.

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Analysis Notes

Analyst	R G McCain	Date	03/23/15
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53052, Rev. 0		

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as C8730_AL20151029_CC-130_corr for the SGLS, using an efficiency function and corrections for casing and dead time as determined during annual response checks.

NMLS data are reported in counts per second.

The internal upsets in casing thickness at 5-ft intervals significantly affect both gamma and moisture log response, with the result being a distinctive "saw tooth" pattern in the log results after conventional casing correction has been applied. This was corrected by calculating an "effective casing thickness" for each measurement point and calculating a casing correction based on this value. Log detectors respond to material both above and below the actual measurement point, so the first step is to determine a sensitivity function describing the variation in detector sensitivity as a function of depth above and below the measurement point. For the gamma log, the sensitivity range was assumed to be within +/- 1 ft of the measurement point. For the moisture log, the sensitivity range was estimated to be within +/- 0.5 ft of the measurement point. The sensitivity function was then used to create an estimated "effective thickness" based on distance from the nearest casing joint above the measurement point.

For both the gamma and moisture log, a depth offset was estimated to align the measurement points and the casing joints. This allows the effective thickness to be estimated for all measurement points. For measurement points that fall between casing joints, the effective thickness is equal to the nominal casing wall thickness (0.25 in.), but for measurement points at or near a casing joint the effective thickness may be greater, up to a maximum or 0.42 in. for a point at the casing joint and thus well inside the internal upset region.

For the gamma log, a corrected activity was calculated by using a casing correction calculated from the effective casing thickness at each measurement point.

For the moisture log, an empirical correction factor was determined by examining the log over an interval of relatively stable moisture content. For measurement points well within the interval between casing joints (nominal casing thickness = 0.25 in.), the correction factor is assumed to be 1.0. For measurement points within a casing joint (casing thickness = 0.42 in.), the correction factor is estimated to be 1.18. Correction factors for intermediate effective thickness values are interpolated.

Most log plots show both "raw" and "corrected" values. Raw values are those computed for a constant casing thickness. Corrected values are those computed from the effective casing thickness.

The HGU[5] is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Model Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

Results and Interpretations

Cs-137 was detected at two isolated points in the borehole: 59 ft and 82 ft. In both cases the reported concentration is very close to the MDL and error is high, so neither instance is considered definitive. MDLs are plotted for Cs-137 and Pu-239, based on characteristic gamma lines at 662 and 375 keV, respectively.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content. The moisture log is relatively consistent over most of the borehole. A sharp increase occurs at about 82 ft, with the water level inside the casing at 89 ft. The geologist report noted that water was tagged at 83.84 ft during drilling.

The KUT and moisture repeat plots indicate that the respective systems were working properly.

[5] Hanford Gamma Unit

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List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-120 ft)
Natural Gamma Logs (0-120 ft)
Combination Plot (0-120 ft)
Total Gamma & Moisture (0-120 ft)
Total Gamma & Hanford Gamma Unit (0-120 ft)
Repeat Section of Natural Gamma Logs (80-91 ft)
Moisture Repeat Section (80-90 ft)

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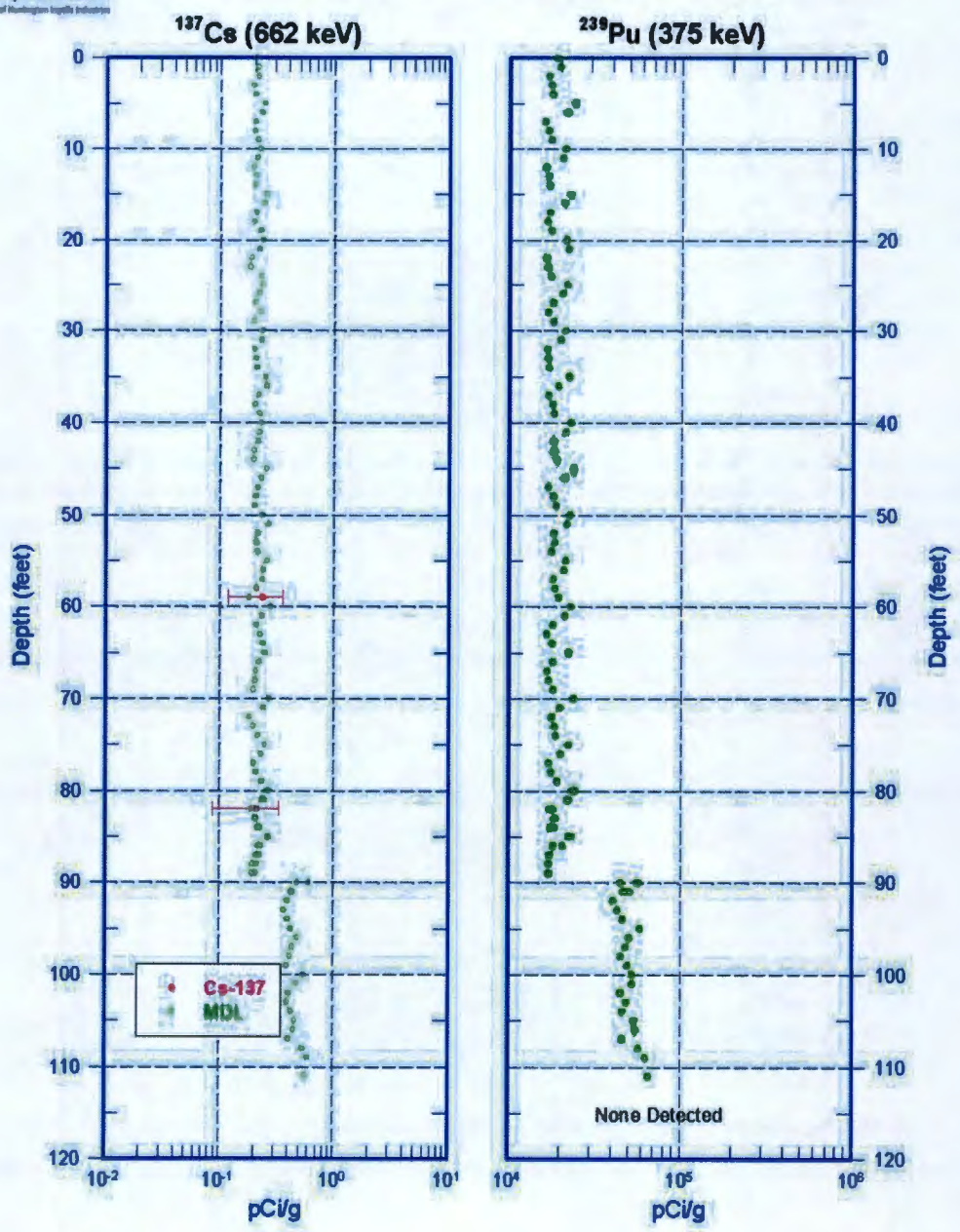
199-D5-150 (C8730)
Manmade Radionuclides



Zero Reference - Ground Surface

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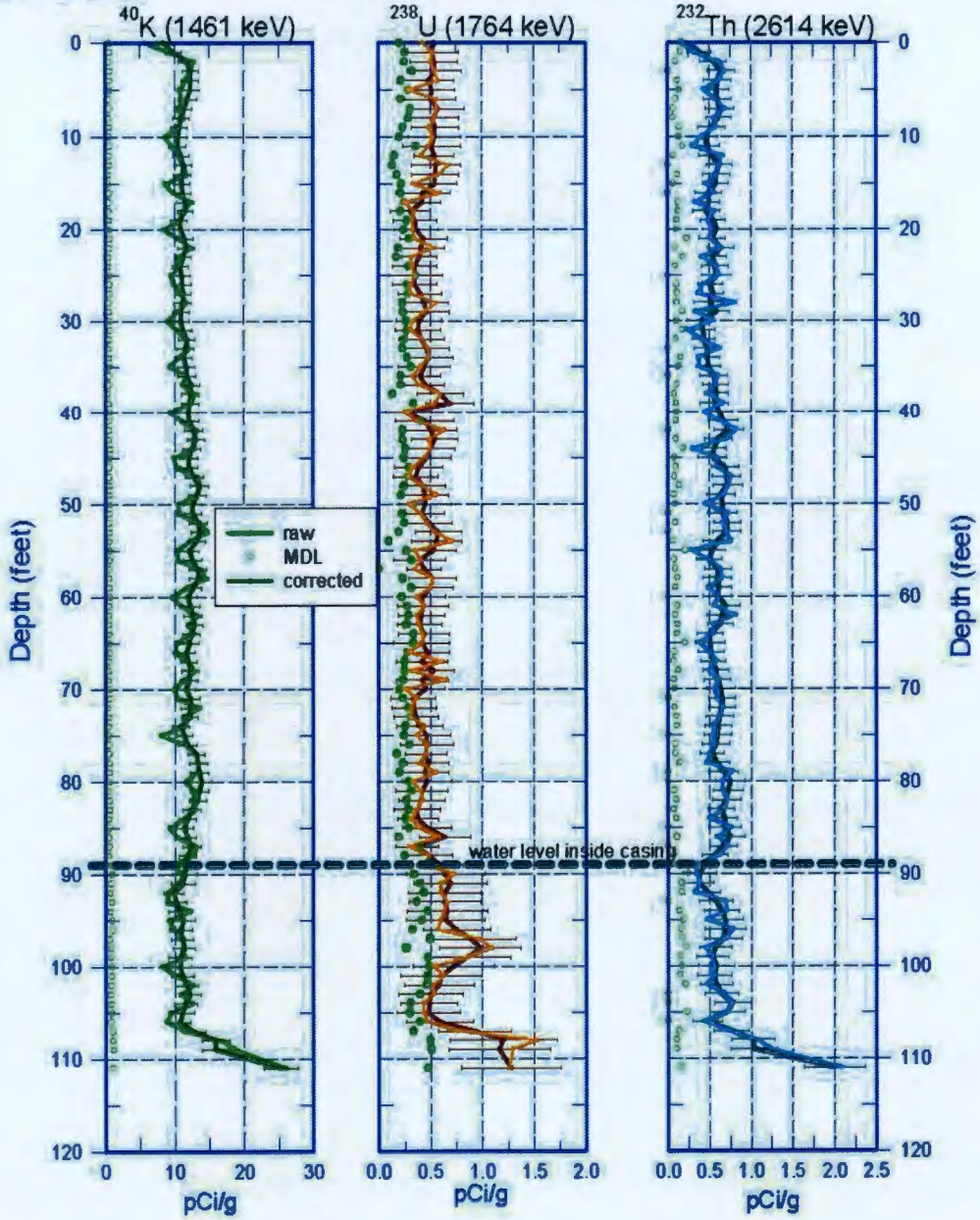
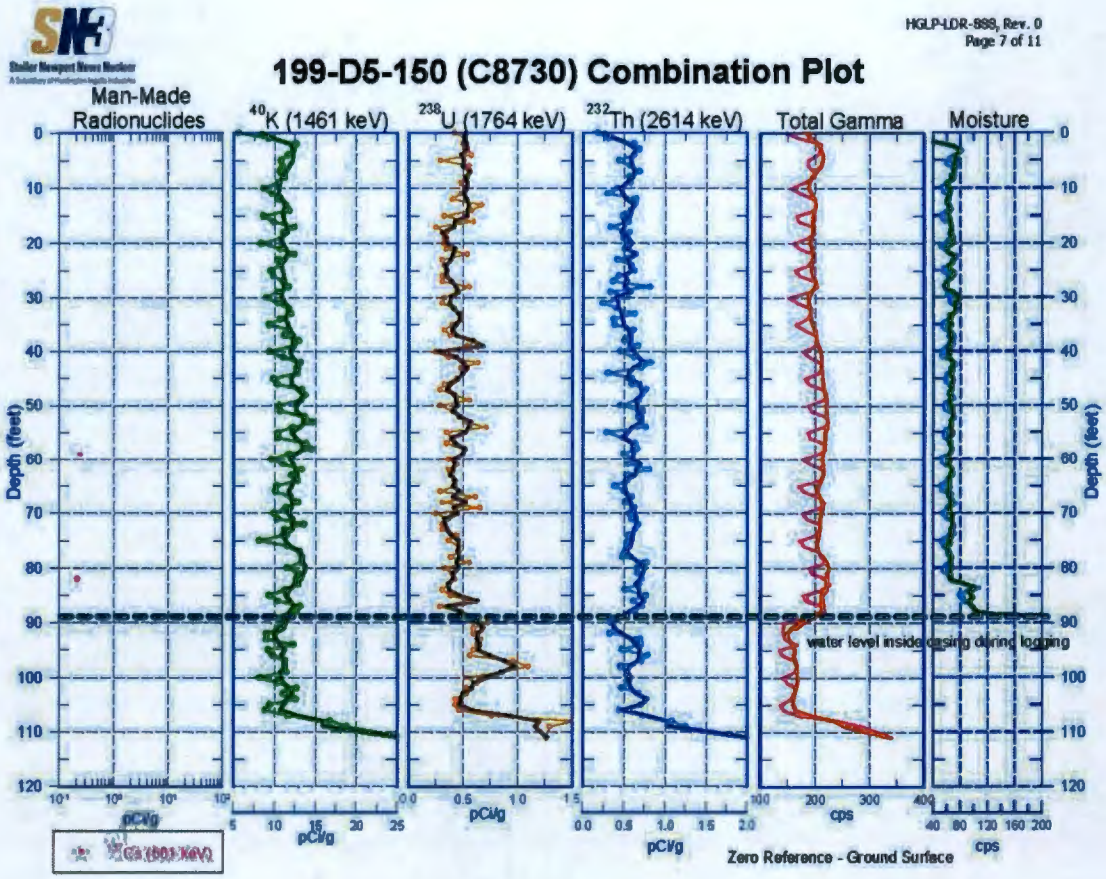
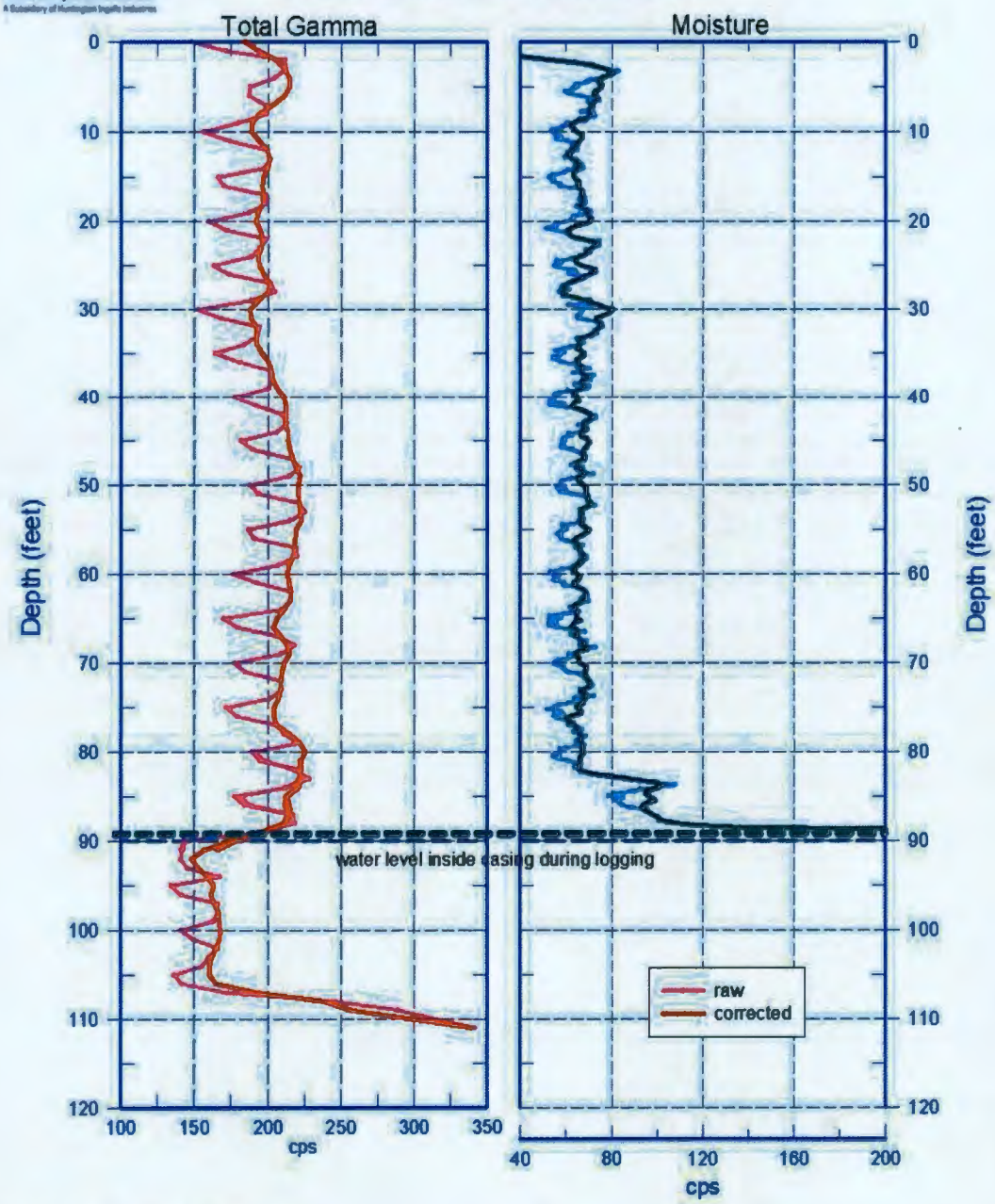
199-D5-150 (C8730)
Natural Gamma Logs



Zero Reference - Ground Surface


HGLP-LDR-899, Rev. 0
Page 7 of 11
199-D5-150 (C8730) Combination Plot
Man-Made Radionuclides
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Total Gamma
Moisture
Depth (feet)
pCi/g
cps
water level inside casing during logging
Zero Reference - Ground Surface

199-D5-150 (C8730)
Total Gamma & Moisture



Zero Reference - Ground Surface

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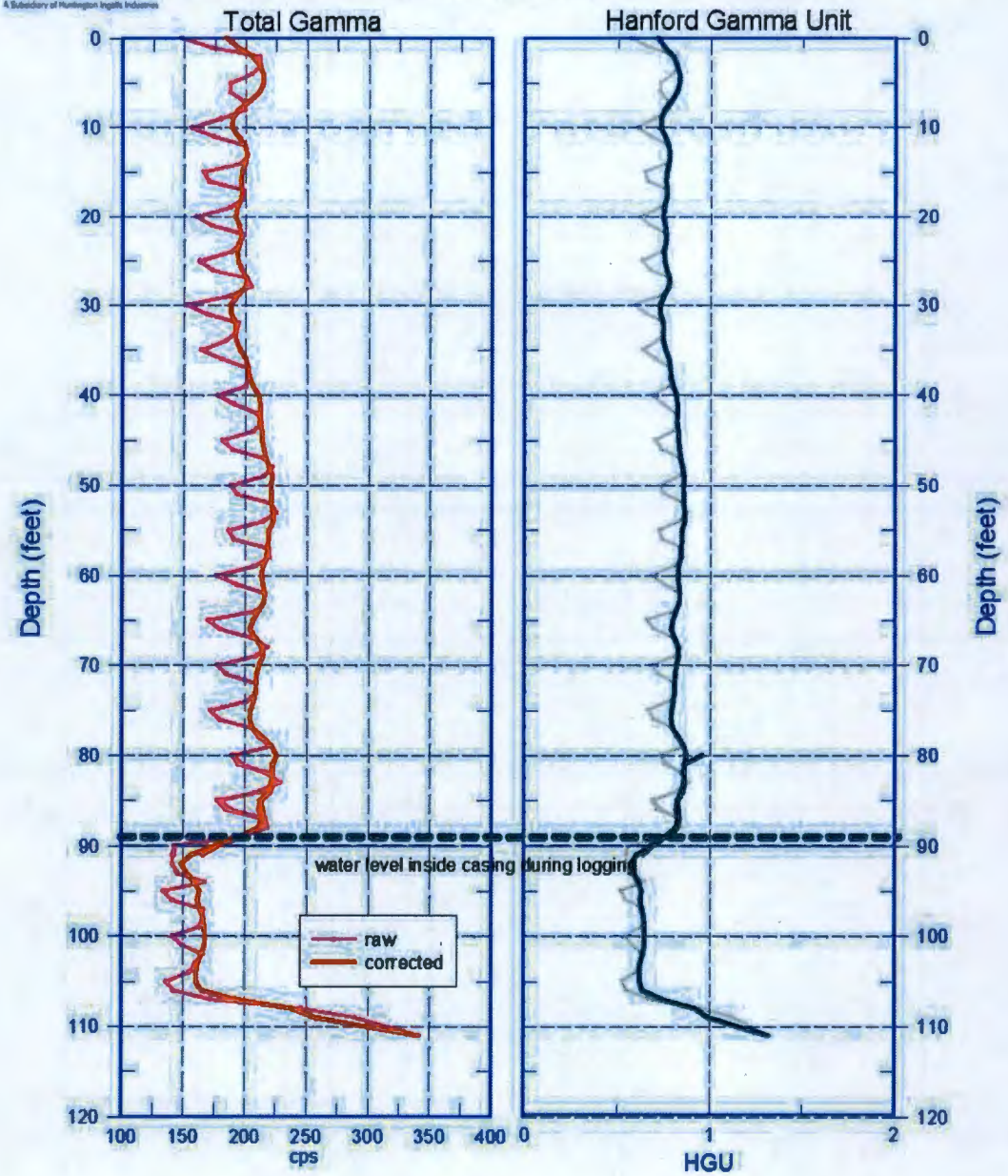
199-D5-150 (C8730)
Total Gamma & Hanford Gamma Unit



Zero Reference - Ground Surface

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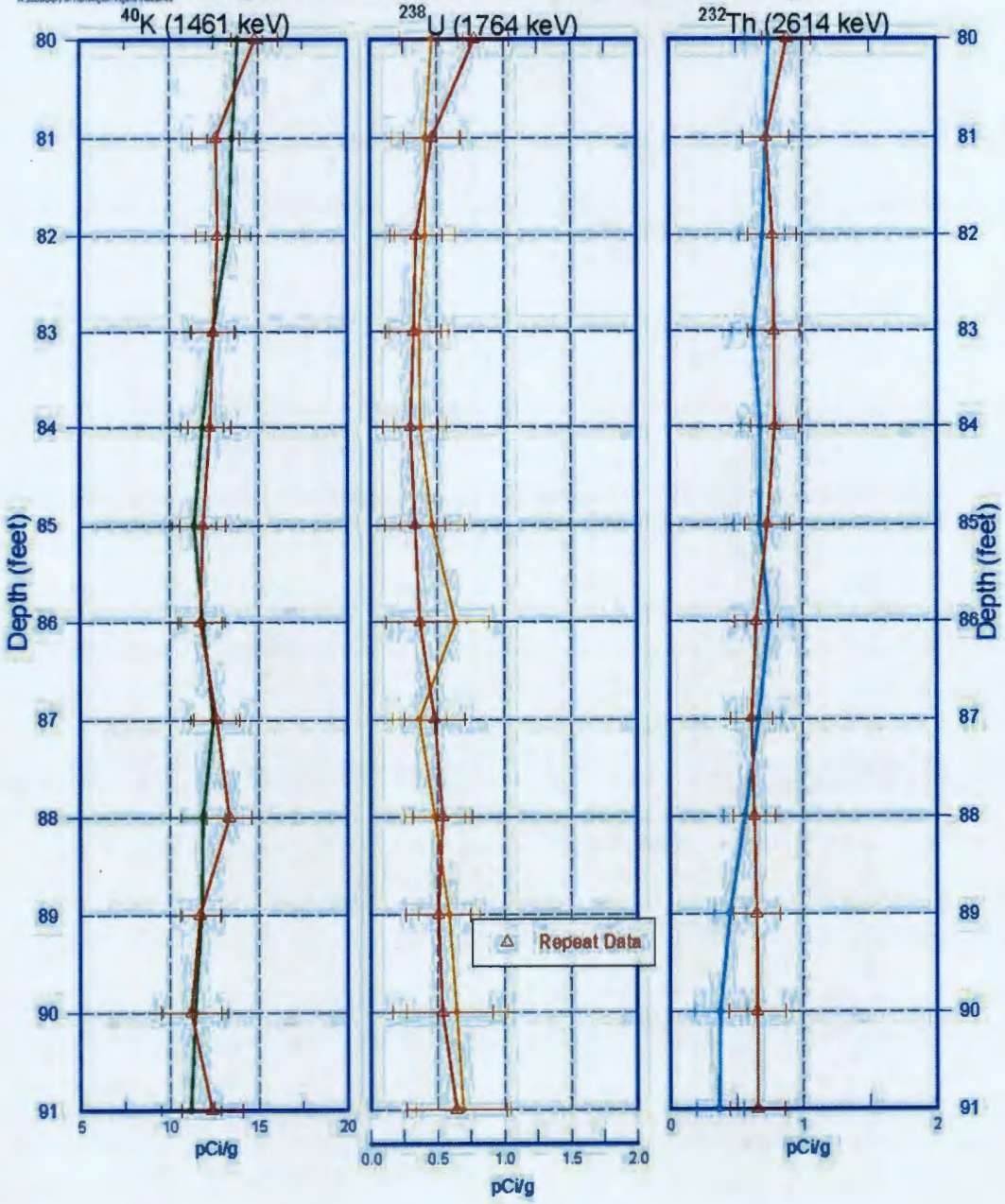
A Subsidiary of Huntington Ingalls Industries

199-D5-150 (C8730)

Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

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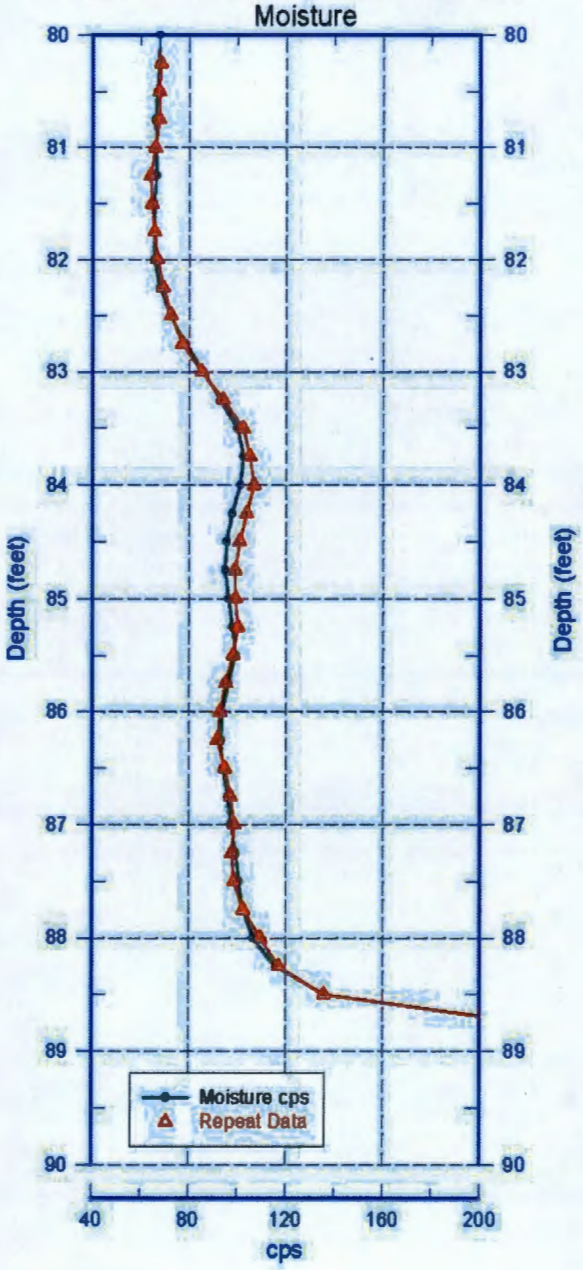
199-D5-150 (C8730)
Moisture Repeat Section



Zero Reference - Ground Surface

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WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend **Company:** CHPRC
Date Requested: 03/10/16	**Requestor:** Ed Rafuse (CHPRC)
Date of Survey: 03/17/16	**Surveyor:** Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	**Survey Co. Point of Contact:** Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of 100D Replacement Well C8730 (199-D5-150).	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Meters **Hanford Area Designation:** 100D

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
D-6 (CHPRC) and D-9 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C8730	199-D5-150	573429.42	151401.85		Center of Casing
				144.648	"X" on Rim
				143.883	Brass Survey Marker

Notes:

144.353' Top Inner Casing, North Edge

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.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

3-17-16

A-6003-659 (04/03)

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Split Spoon Sample Photos C8730

Soil Sample at 75 ft bgs

75 ft Top of Liners A & B

Soil Sample at 80 ft bgs

80 ft Bottom of Liner A

80 ft Bottom of Liner B

Soil sample at 85 ft bgs

85 ft Bottom of Liner A

85 ft Bottom of Liner B

Appendix C

Borehole Documentation for C8731

- Well Summary Sheet for C8731
- Borehole Log for C8731
- Log Data Report for C8731
- Final Survey Report for C8731
- Photo Log for C8731

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WELL SUMMARY SHEET

Start Date: 2/24/16
Finish Date: 3/8/16
Page 1 of 1

Well ID: C8731	Well Name: 199-D5-151
Location: 100D ~75 yrds SE of power station	Project: HR-3 Replacement Wells
Prepared by: Julie Johanson Date: 4/4/16	Reviewed by: J.D. MEHRER Environmental Scientist Date: 4-13-16
Signature: Julie Johanson	Signature:

CONSTRUCTION DATA

Surface Completion:

4'x4'x6" Concrete Pad with brass survey marker and 6 9/16" protective monument (3.00' ags)

Well Completion material:

High Strength Concrete
0.0' bgs - 0.73' bgs

Type I/II Portland Cement
0.73' bgs - 10.17' bgs

Granular Bentonite 3/8"
10.17' bgs - 54.00' bgs

3/8" Bentonite Pellets
54.00' bgs - 57.48' bgs

8-16 Colorado Silica Sand
57.48' bgs - 94.08' bgs

Natural Fill
94.08' bgs - 97.50' bgs

Permanent Well:

6" ID Stainless Steel Blank
1.94' ags - 61.06' bgs

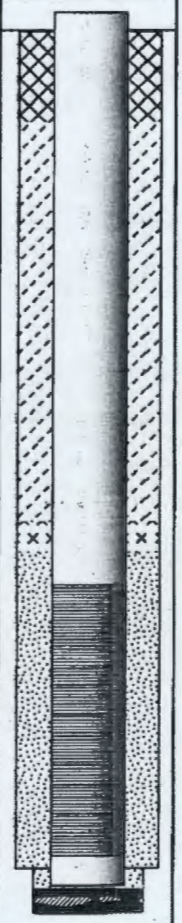
6" ID Stainless Steel 0.050 Slot Screen
61.06' bgs - 91.09' bgs

6" ID Stainless Steel Sump
91.09' bgs - 94.09' bgs

All temporary casing completely removed from ground on 3/8/2016

ags = above ground surface
bgs = below ground surface

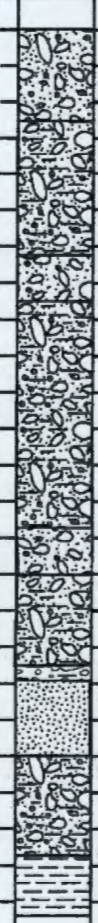
Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 20, 40, 60, 80, 100

Graphic Log



Lithologic Description

0-10: Sandy Gravel (sG)
10-25: Silty Gravely Sand (mgS)
25-30: Sandy Gravel (sG)
30-55: Silty Sandy Gravel (msG)
55-60: Sandy Gravel (sG)
60-70: Silty Sandy Gravel (msG)
70-71.5: Silty Gravel (mG)
71.5-80: Sand (S)
80-91: Silty Sandy Gravel (msG)
91-97.50: Silt (M) [RUM]

A-6003-643 (03/03)

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BOREHOLE LOG

Page 1 of 3
Date: 2-24-16

Well ID: C8731 | Well Name: 199D5-151 | Location: 100D ~75 yards SE of powers station

Project: HR-3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool; Sampler Size, Water Level
0				0-10: Sandy Gravel (sG)	Sonic Rig ~~Archive @ 2-24-16~~
				@5' bgs: 10% silt, 55% v.fn.-v.crs. sand, 35% v.fn. peb.-sm. cob.; max 101 mm; moist, poorly sorted, ang.-sub. rnd.; s: 85%m/15%m, g: 80%m/20%f; strg.-v.strg. HCl rxn; 2.5Y 2.5/1 black	Fill from ground surface to ~30' bgs
5	G.S.				Archive @ 5' bgs
10	G.S.			10-25: Silty Sandy Gravel (sG)	Archive @ 10' bgs
				20% silt, 25% v.fn.-v.crs. sand; 50% v.fn. peb.-sm. cob.; max 92 mm, moist, poorly sorted, ang.-sub. rnd.; s: 60%m/40%f, g: 65%m/35%f, mod.-strg. HCl rxn; 2.5Y 3/2 very dark grayish brown;	
15	G.S.			@15' bgs: 15% silt, 30% v.fn.-v.crs. sand; 50% v.fn. peb.-sm. cob.; max 91 mm; s: 50%m/20%f, g: 80%m/20%f, mod.-strg. HCl rxn, 2.5Y 3/1 very dark gray	Archive @ 15' bgs
20	G.S.			@20' bgs: 20% silt, 45% v.fn.-v.crs sand (fn.), 35% v.fn. peb.-sm. cob.; max 97 mm, slightly moist, sub ang.-sub. rnd.; s: 90%m/10%f, g: 85%m/15%f; weak HCl rxn; 10YR 3/1 very dark gray	Archive @ 20' bgs
25	G.S.			SMD 2-24-16 S25-30: Sandy Gravel (sG)	Archive @ 25' bgs
				10% silt, 55% v.fn.-v.crs. sand (crs.-v.crs.), 35% v.fn. peb.-sm. cob.; max 103 mm, moist, poorly sorted, sub. ang.-sub. rnd.; s: 55%f/45%m, g: 65%m/35%f; mod.-strg. HCl rxn; 2.5Y 3/1 very dark gray	
30	G.S.			30-55: Silty Sandy Gravel (msG)	Hanford @ ~30' bgs Archive @ 30' bgs
				20% silt, 40% v.fn.-v.crs. sand (crs.-v.crs.), 40% v.fn. peb.-lg. cob.; max 195 mm, moist, poorly sorted, s: 55%f/45%m, g: 60%m/40%f; strg.-v.strg. HCl rxn, 2.5Y 3/2 very dark grayish brown; sub ang.-sub. rnd.	
35	G.S.			@35' bgs: 20% silt, 35% v.fn.-v.crs. sand, 45% v.fn. peb.-sm. cob.; max 101 mm, s: 60%f/40%m, g: 60%m/40%f; strg.-v.strg. HCl rxn, 2.5Y 4/2 dark grayish brown	Archive @ 35' bgs

Reported By: Julie Johanson | Reviewed By: Sarah Springer

Title: Geologist | Title: Geologist

Signature: Julie Johanson | Date: 2-24-16 | Signature: Sarah Springer | Date: 05-03-16

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 3
Date: 2-24-16

Well ID: C8731 | Well Name: 199-D5-151 | Location: 100D ~75 yards SE of power station
Project: HR-3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	G.S.			30-55 : Silty Sandy Gravel (msG)	Sonic Rig
				@40' bgs: 15% silt, 45% v.fn.-v.crs. sand (med.-crs.), 40% v.fn. peb.-sm. cob.; max 114mm; ang.-sub.rnd., moist, poorly sorted; s: 70%f/30%m, g: 65%m/35%f; strg.-v.strg. HCl rxn, 10YR 4/3 brown	Ringold @ ~40' bgs Archive @ 40' bgs
45	G.S.			@45' bgs: 20% silt, 35% v.fn.-v.crs. sand, 45% v.fn. peb.-sm. cob.; max 78mm; sub ang.-rnd.; s: 70%f/30%m, g: 55%m/45%f; v.strg. HCl rxn, 2.5Y 4/2 dark grayish brown, silty conglomerate nodules, v.strg. HCl rxn; 2.5Y 5/3 light olive brown	Archive @ 45' bgs
50	G.S.			@50' bgs: 15% silt; 50% v.fn.-v.crs. sand, 35% v.fn. peb.-sm. cob.; max 97mm, ang.-sub.rnd.; slightly moist-dry; s: 55%m/45%f, g: 65%f/35%m; v.strg. HCl rxn; dry; 2.5Y 6/2 light brownish gray.	Archive @ 50' bgs.
55	G.S.			55-60 : Sandy Gravel (sG)	Archive @ 55' bgs
				10% silt, 5% v.fn.-v.crs. sand (v.crs.), 40% v.fn. peb.-sm. cob.; max 79mm, moist, poorly sorted, sub ang.-sub.rnd.; s: 55%m/45%f, g: 50%m/50%f; v.strg. HCl rxn; 2.5Y 3/1 very dark gray; silt nodules, v.strg. HCl rxn; 10YR 4/4 dark yellowish brown	
60	G.S.			60-70 : Silty Sandy Gravel (msG)	Archive @ 60' bgs Split Spoon Sample I-001, HETS# 834FR7, I-001 DUP HETS# 834FR8 2-24-16 @ 1342; 60.18'-61.85' bgs
	S.S. I-001 2-24-16			15% silt, 45% v.fn.-v.crs. sand, 40% v.fn. peb.-sm. cob.; max 62mm; slightly moist-dry; poorly sorted; ang.-sub.rnd.; s: 70%f/30%m, g: 70%f/30%m; v.strg. HCl rxn; 2.5Y 6/2 light brownish gray	
65	G.S.			@65' bgs: 25% silt, 30% v.fn.-v.crs. sand, 45% v.fn. peb.-sm. cob.; max 80mm; moist-wet; ang.-rnd.; s: 70%f/30%m; g: 55%f/45%m; mod.-strg. HCl rxn; 2.5Y 5/3 light olive brown	Archive @ 65' bgs. Split Spoon Sample I-002 HETS# 834FR9 2-24-16 @ 1440 65.29-66.81' bgs Soil had odor
	S.S. I-002 2-24-16				
70	G.S.			70-71.5 : Silty Gravel (mG)	DTW: 69.23' bgs (2-24-16) Archive @ 70' bgs.
	S.S. I-003 2-24-16	Active Sample 70-80'		35% silt, 15% v.fn.-v.crs. sand (v.fn.-fn.), 50% v.fn. peb.-sm. cob.; max 66mm; wet; poorly sorted; sub ang.-sub.rnd.; g: 65%f/35%m, s: ~70%f/30%m; mod.-strg. HCl rxn, 2.5Y 5/3 light olive brown; mod.-high plasticity	Split Spoon Sample I-003 HETS# 834FT0 2-24-16 @ 1520; 70.25'-72.78' bgs
75	G.S. H_2O I-004 2-25-16			71.5'-80 : Sand (S)	DTW: 68.96' bgs (static 2-25-16) Archive @ 75' bgs
				@75' bgs: 45% v.fn.-v.crs. sand (crs.), 55% sm. cob.; max 80mm; wet, well sorted, subang.-sub.rnd.; s: 80%f/20%m, g: felsic; mod. HCl rxn; 2.5Y 5/3 light olive brown	H_2O Sample I-004 HETS# 834FT5; 2-25-16 @ 0939; 74.88' bgs; Cr(VI) 0.001 ppb

Reported By: Julie Johanson | Reviewed By: Sarah Springer
Title: Geologist | Title: Geologist
Signature: Julie Johanson | Date: 2-25-16 | Signature: Sarah Springer | Date: 05-03-16

A-6003-842 (03/03)

BOREHOLE LOG

Page 3 of 3
Date: 2-25-16

Well ID: C8731 | Well Name: 199-D5-151 | Location: 100D ~75 yards SE of power station

Project: HR-3 Replacement Wells. | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
80	G.S.	Stove Sample 80-80			Sonic Rig
		Stove Sample 80-90		80 - 91 : Silty Sandy Gravel (msG) 30% silt, 40% v.fn.-v.crs sand (med.-crs.); 40% v.fn. peb.-lg. cob.; max 127mm, wet, poorly sorted; sub ang.-sub rnd.; s: 85%f/15%m ~ 20% mica, g: 80%f/20%m; strong HCl rxn; 2.5Y 4/3 olive brown	Archive @ 80' bgs
85	G.S.			@85' bgs: 15% silt, 45% v.fn.-v.crs. sand (med.-crs.); 40% v.fn. peb.-sm. cob.; max 100 mm; sub ang.-rnd.; s: 75%f/25%m; g: 80%f/20%m; v. weak-no HCl rxn; 2.5Y 4/2 dark grayish brown	Archive @ 85' bgs. H_2O Sample I-005 H2O5 B34FT7; 2-25-16 @1313; 85.23' bgs; Cr(VI) 0.004 mg/L
	H_2O I-006 2-25-16				
	H_2O I-006 2-25-16 Ch. S.				
90	G.S.			@90' bgs: 20% silt, 45% v.fn.-v.crs. sand (crs.), 35% v.fn. peb.-sm. cob.; max 70 mm; ang.-sub. rnd.; s: 75%f/25%m; g: 80%f/20%m; med.-strg. HCl rxn; 2.5Y 4/1 dark gray	Archive @ 90' bgs H_2O Sample I-006 H2O6 B34FV0; 2-25-16 @ 1218; 89.48' bgs; Cr(VI) 0.025 mg/L
95				91 - 97.50 : Silt (M) [RUM] 100% silt; moist, well sorted, med.-strg. HCl rxn; 10YR 5/3 brown	Archive @ 91' bgs TD: @ 97.50' bgs
100					
105					
110					
115					

Reported By: Julie Johanson | Reviewed By: Sarah Springer

Title: Geologist | Title: Geologist

Signature: Julie Johanson | Date: 2-25-16 | Signature: Sarah Springer | Date: 05-03-16

A-6003-642 (03/03)

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199-D5-151 (C8731)
Log Data Report

Borehole Information

Log Date	2016-02-26	Filename	C8731_HG-NM_2016-02-26	Site	100-D
Coordinates (WA St Plane)		DTW[1] (ft)	69.95	DTW Date	02/26/16

North (m)	East (m)	Drill Date	TOC[2] Elevation	Total Depth (ft)
N/A	N/A	2/25/16	N/A	92.23

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	Sonic	0.3	10 1/2	9 5/8	0.25 – 0.42	-0.15	97.50

Borehole Notes

The logging engineer measured depth to water with an e-tape. Drill depth and casing depth were provided by the wellsite geologist. Zero reference is ground surface.

This borehole was drilled by a sonic method, using internal-upset casing in 5-ft lengths. This result is a significant reduction in count rate for both the gamma log and neutron moisture log at each casing joint. The sonic drill casing, through which log data were collected, was manufactured by Terra Sonic International. A telephone conversation with the manufacturer's representative indicated that the 10.5-in. casing has a nominal wall thickness of 0.25 in. At the end of each 5-ft length, an insert with either a box (female) or pin (male) thread is welded inside the pipe. When the box and pin are screwed together, the total length of the insert is 13.5 in. This consists of 5 in. on the pin side of the joint, and 8.5 in. on the box side. Over this distance, wall thickness is 0.42 in. Both inserts are tapered for an additional 4.5 in. to avoid a sharp edge on the inside of the casing.

Logging Equipment Information

Logging System	Gamma 5 Tb	Type	HPGe SGLS[3]
Effective Calibration Date	2/23/16	Serial No.	54-TP13441B
Calibration Reference	HGLP-CC-136, Rev. 0	Logging Procedure	SGRP-PRO-OP-53010, Rev. 0

Logging System	Gamma 5 Pb	Type	NMLS[4]
Effective Calibration Date	04/15/2015	Serial No.	H34055445
Calibration Reference	HGLP-CC-131, Rev. 1	Logging Procedure	SGRP-PRO-OP-53016, Rev. 0

SGLS Log Run Information

Log Run	1	2 Repeat			
HEIS Number	1018151	1018152			
Date	2/26/16	2/26/16			
Logging Engineer	Felt/Meisner	Felt/Meisner			
Start Depth (ft)	0.0	56			
Finish Depth (ft)	94.0	65			

[1] depth to water inside casing
[2] top of casing
[3] Spectral Gamma Logging System
[4] Neutron Moisture Logging System

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Log Run	1	2 Repeat			
Count Time (sec)	100	100			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C8731FTB20160 226AV00CAB1	C8731FTB20160 226AV00CAB1			
Start File	AD000000	BD005600			
Finish File	AD009400	BD006500			
Post-Verification	BV00CAA1	BV00CAA1			
Depth Return Error (in.)	N/A	high 3"			
Comments	No fine gain adjustments made	No fine gain adjustments made			

NMLS Log Run Information

Log Run	3	4 Repeat			
HEIS Number	1018149	1018150			
Date	2/26/16	2/26/16			
Logging Engineer	Felt	Felt			
Start Depth (ft)	0.0	40.0			
Finish Depth (ft)	69.51	47.0			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	NA	N			
MSA Interval (ft)	0.25	0.25			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C8731FTB20160 226AV00CAB1	C8731FTB20160 226AV00CAB1			
Start File	AD000000	BD004000			
Finish File	AD006951	BD004700			
Post-Verification	BV00CAA1	BV00CAA1			
Depth Return Error (in.)	N/A	HIGH 1"			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on both sondes.

Pre- and post-survey verification measurements met the acceptance criteria for the established systems.

Analysis Notes

Analyst	R G McCain	Date	04/07/16
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53052, Rev. 0		

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as

C8730_AL20151029_CC-130_corr for the SGLS, using an efficiency function and corrections for casing and dead time as determined during annual response checks.

NMLS data are reported in counts per second.

The internal upsets in casing thickness at 5-ft intervals significantly affect both gamma and moisture log response, with the result being a distinctive "saw tooth" pattern in the log results after conventional casing correction has been applied. This was corrected by calculating an "effective casing thickness" for each measurement point and calculating a casing correction based on this value. Log detectors respond to material both above and below the actual measurement point, so the first step is to determine a sensitivity function describing the variation in detector sensitivity as a function of depth above and below the measurement point. For the gamma log, the sensitivity range was assumed to be within +/- 1 ft of the measurement point. For the moisture log, the sensitivity range was estimated to be within +/- 0.5 ft of the measurement point. The sensitivity function was then used to create an estimated "effective thickness" based on distance from the nearest casing joint above the measurement point.

For both the gamma and moisture log, a depth offset was estimated to align the measurement points and the casing joints. This allows the effective thickness to be estimated for all measurement points. For measurement points that fall between casing joints, the effective thickness is equal to the nominal casing wall thickness (0.25 in.), but for measurement points at or near a casing joint the effective thickness may be greater, up to a maximum or 0.42 in. for a point at the casing joint and thus well inside the internal upset region.

For the gamma log, a corrected activity was calculated by using a casing correction calculated from the effective casing thickness at each measurement point.

For the moisture log, an empirical correction factor was determined by examining the log over an interval of relatively stable moisture content. For measurement points well within the interval between casing joints (nominal casing thickness = 0.25 in.), the correction factor is assumed to be 1.0. For measurement points within a casing joint (casing thickness = 0.42 in.), the correction factor is estimated to be 1.2. Correction factors for intermediate effective thickness values are interpolated, using a simple linear function.

Most of the sonic drill casing was in 5-ft lengths. From the character of the total gamma and moisture logs, it is apparent that casing joints occur at 5-ft intervals at approximately 7, 12, 17... ft. In this borehole, however, three 10-ft sections were apparently used. When the correction is applied for casing joints, anomalous spikes in the log data are observed at 57, 67, and 77 ft. These were determined to be the result of the *absence* of a casing joint at those depths. Ed Rafuse of CHPRC confirmed that the drillers do have a few 10-ft casing lengths. Therefore the casing joint corrections at 57, 67, and 77 ft were "removed" by manually setting the casing wall thickness to 0.25 in. at these depths.

Most log plots show both "raw" and "corrected" values. Raw values are those computed for a constant casing thickness. Corrected values are those computed from the effective casing thickness.

The HGU[5] is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Model Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

Results and Interpretations

No manmade radionuclides were detected. The KUT profile shows relatively little variability. A "dip" in the K-40 and total gamma profile at 70 ft suggests a washout zone at the top of groundwater. An apparent increase in the 609-keV Bi-214 line relative to the 1764 keV Bi-214 line below 70 ft indicates the presence of radon inside casing, most likely dissolved in groundwater.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content.

The KUT and moisture repeat plots indicate that the respective systems were working properly.

[5] Hanford Gamma Unit

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List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-120 ft)
Natural Gamma Logs (0-120 ft)
Combination Plot (0-120 ft)
Total Gamma & Moisture (0-120 ft)
Total Gamma & Hanford Gamma Unit (0-120 ft)
Repeat Section of Natural Gamma Logs (55-65 ft)
Moisture Repeat Section (40-50 ft)

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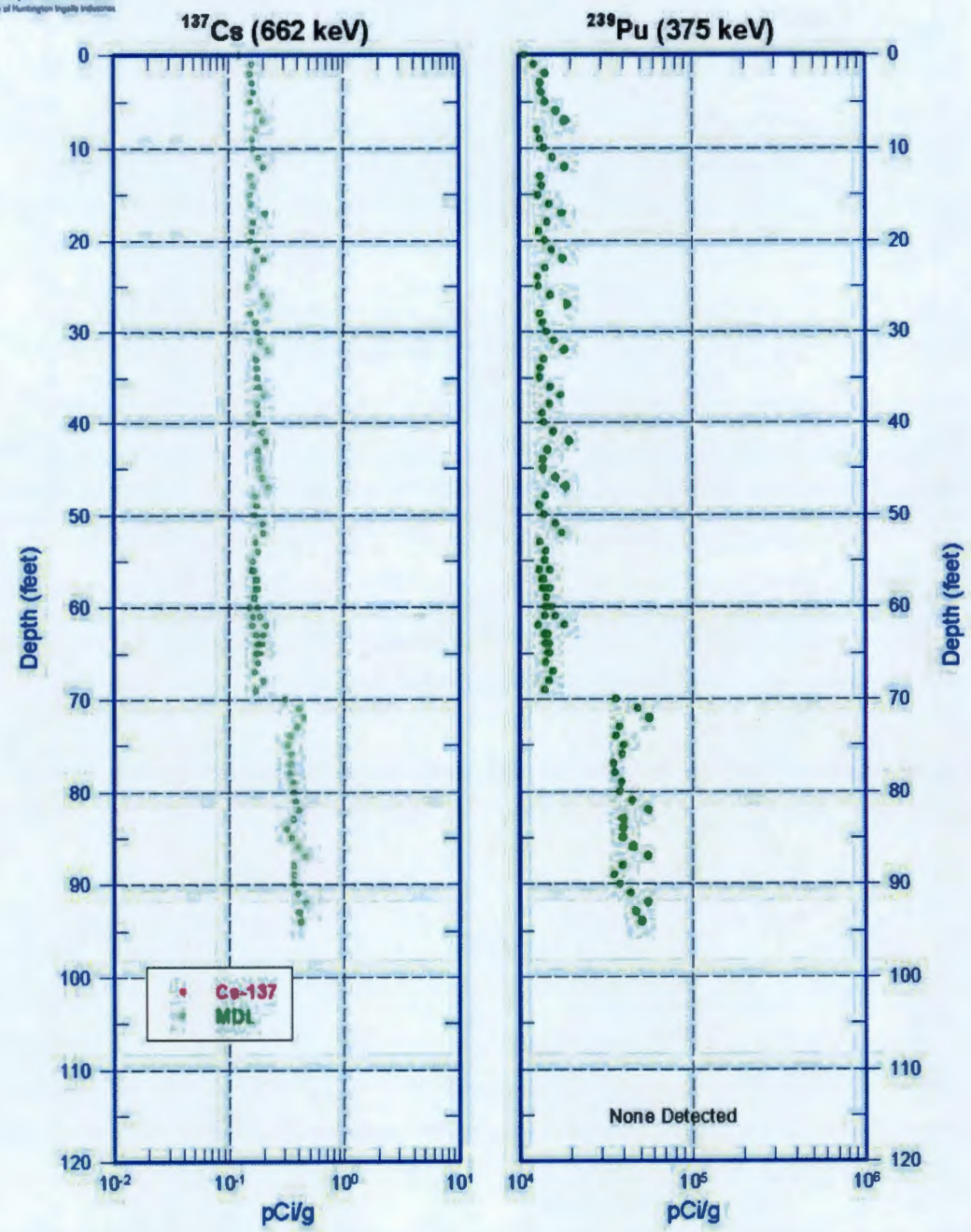
199-D5-151 (C8731)
Manmade Radionuclides



Zero Reference - Ground Surface

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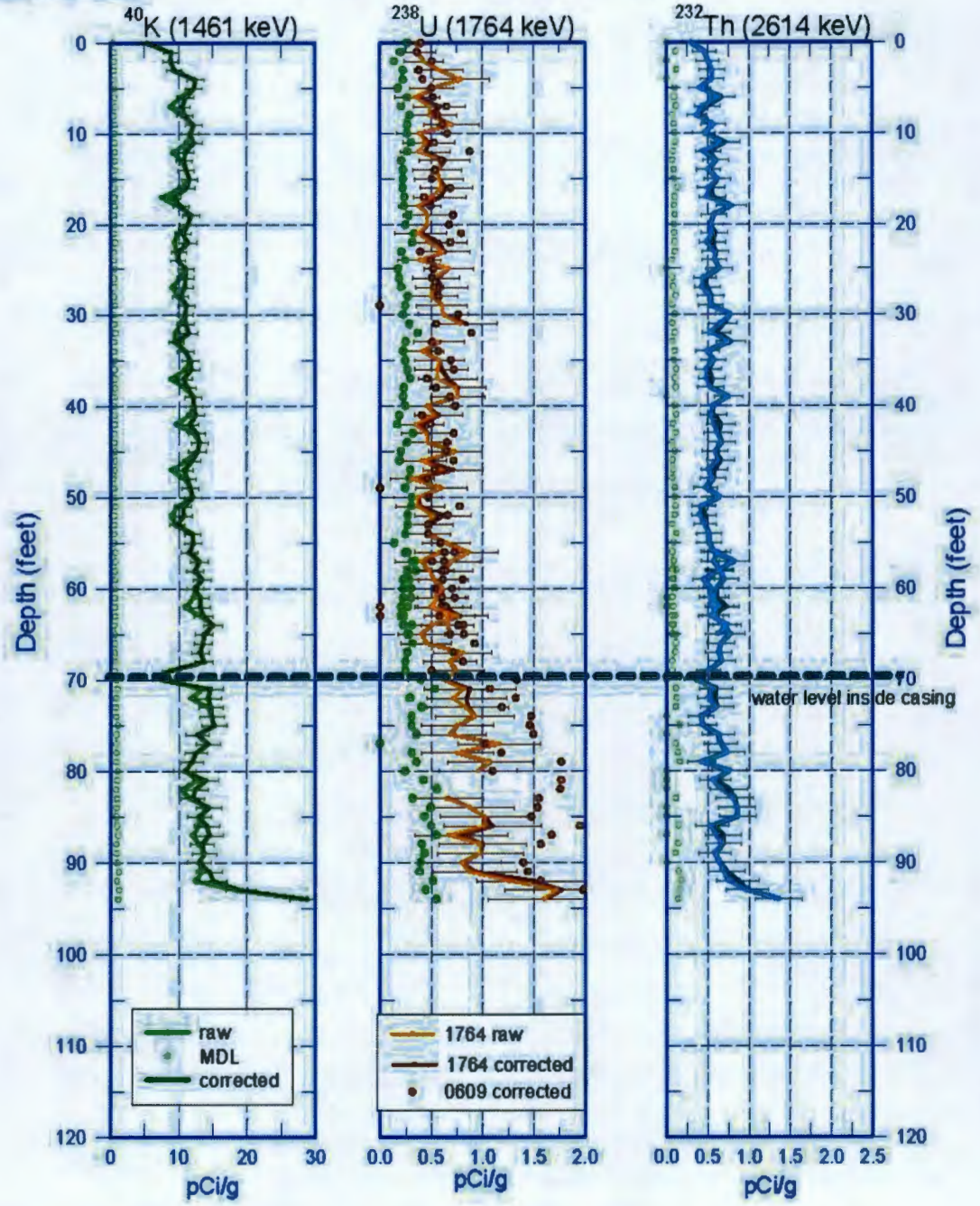
199-D5-151 (C8731)
Natural Gamma Logs



Zero Reference - Ground Surface

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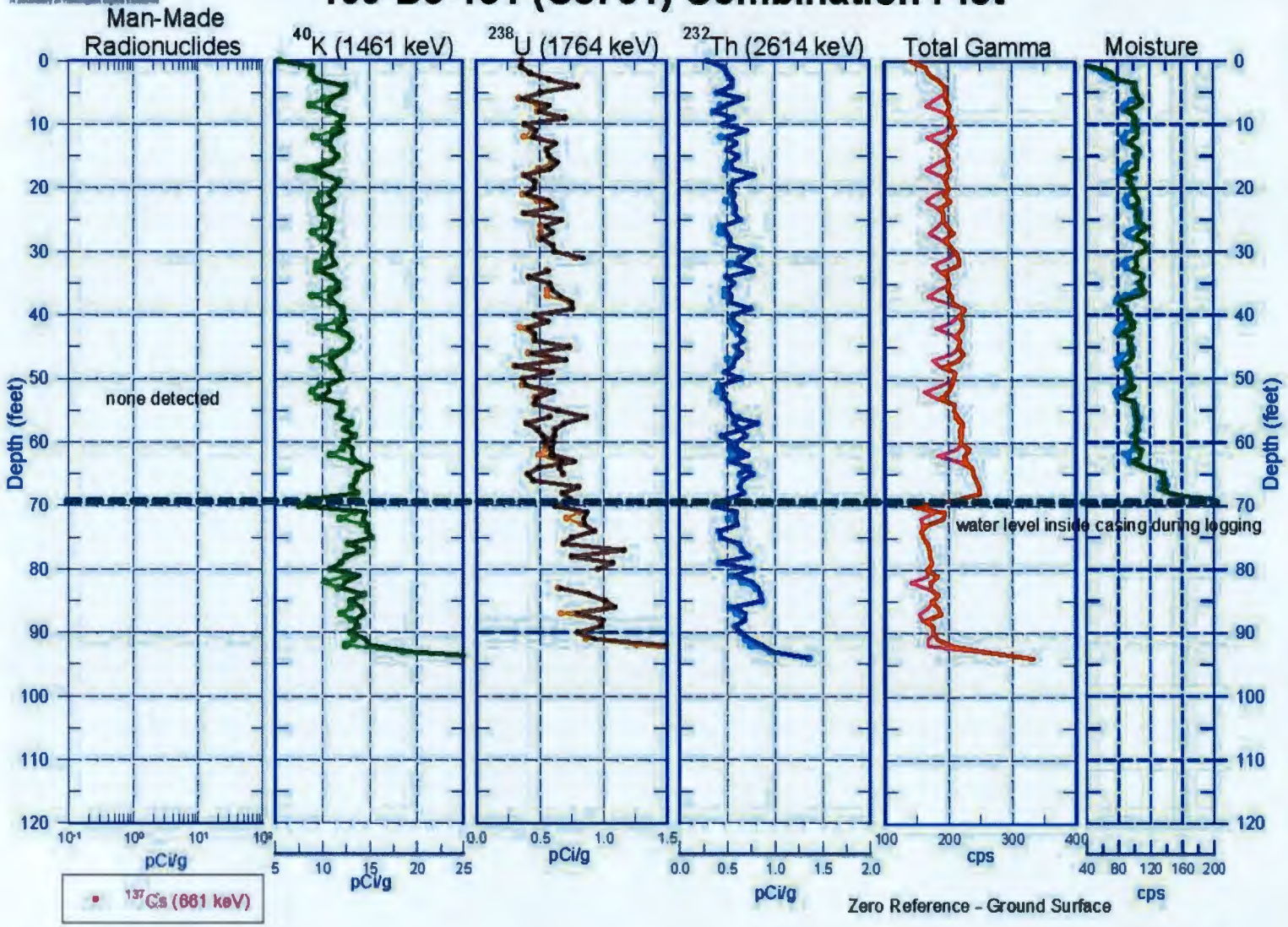
199-D5-151 (C8731) Combination Plot



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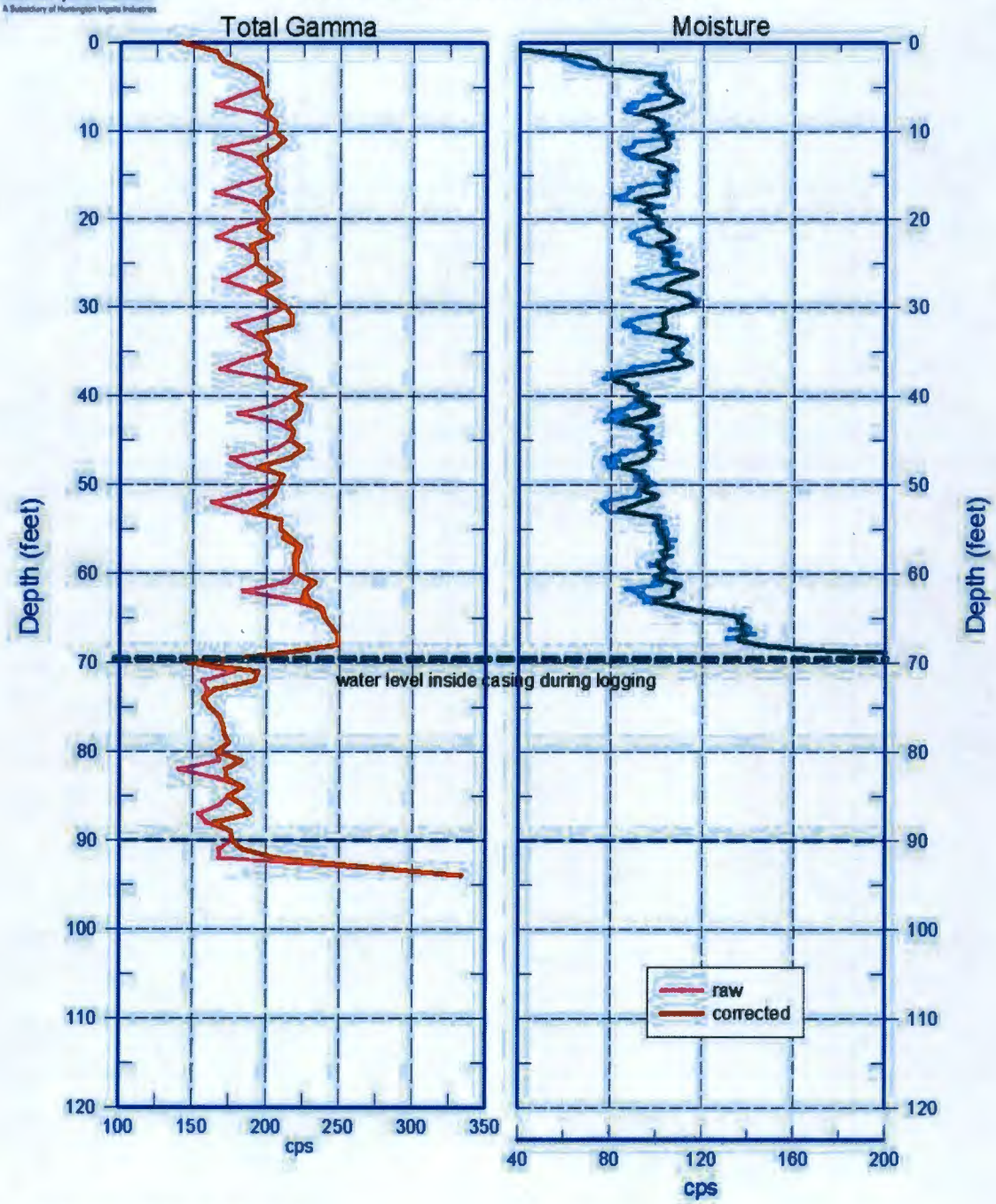
199-D5-151 (C8731)
Total Gamma & Moisture



Zero Reference - Ground Surface

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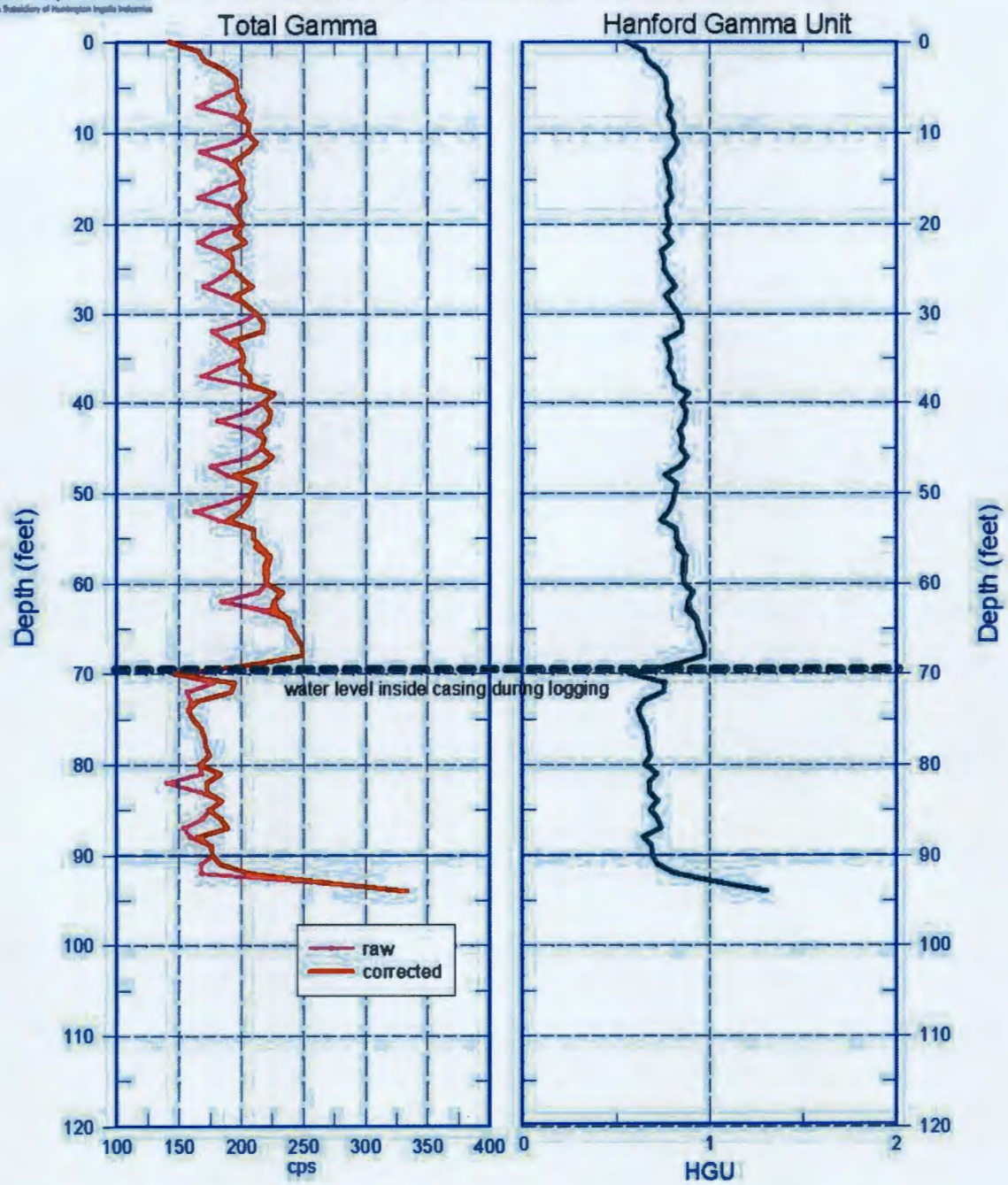
199-D5-151 (C8731)
Total Gamma & Hanford Gamma Unit



Zero Reference - Ground Surface

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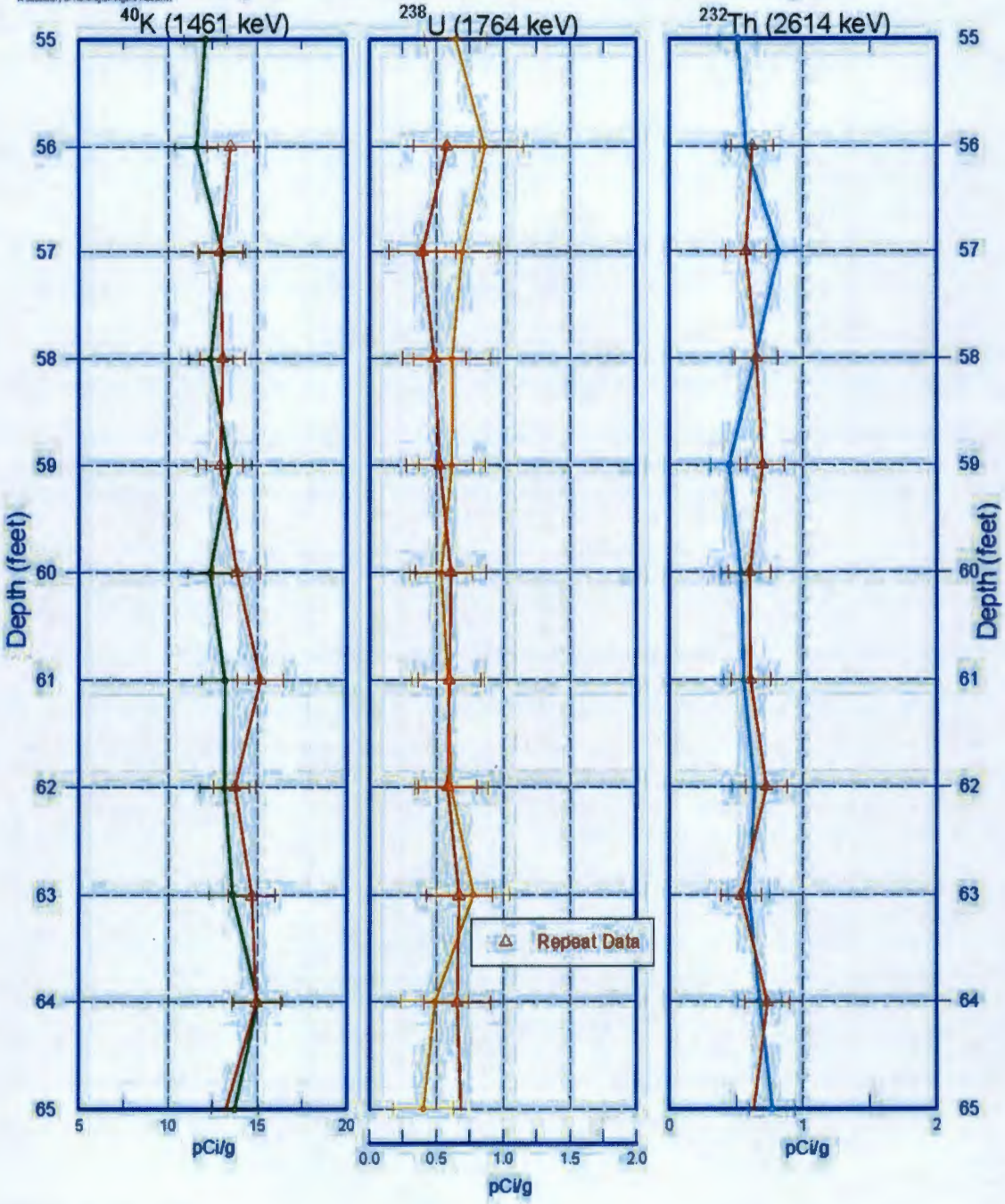
199-D5-151 (C8731)

Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

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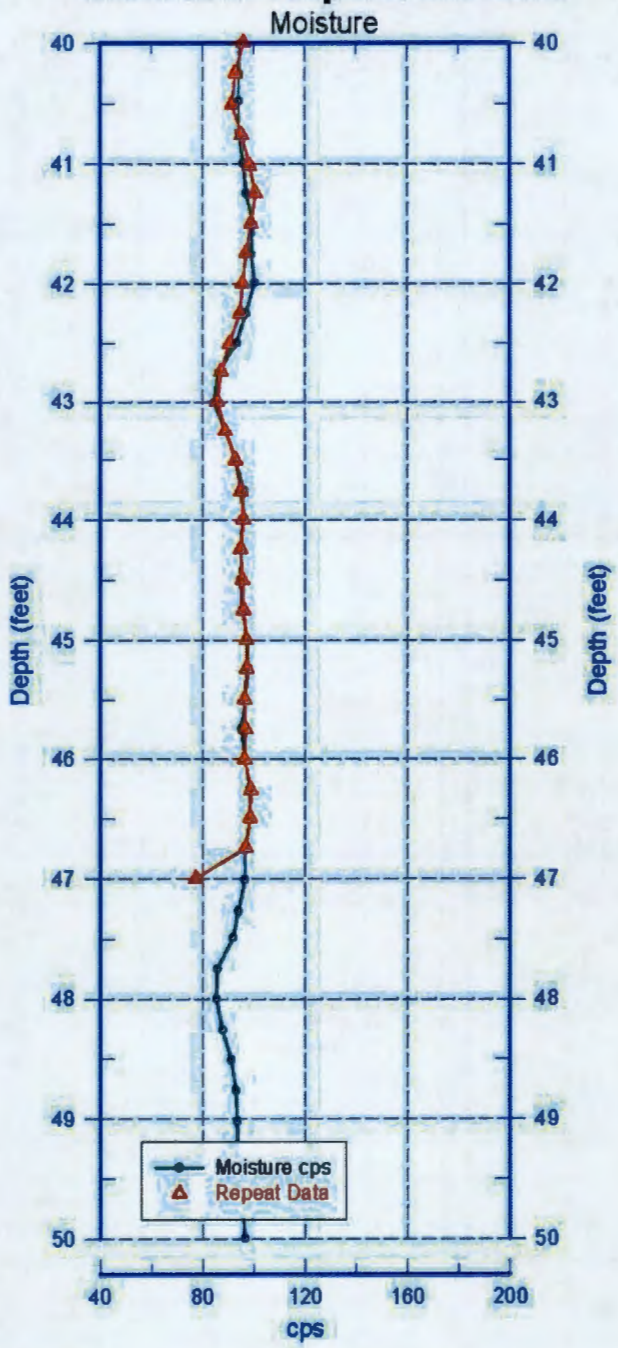
199-D5-151 (C8731)
Moisture Repeat Section



Zero Reference - Ground Surface

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WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 03/10/16	Requestor: Ed Rafuse (CHPRC)
Date of Survey: 03/17/16	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of 100D Replacement Well C8731 (199-D5-151).	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 100D

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
D-6 (CHPRC) and D-9 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C8731	199-D5-151	573312.03	151391.88		Center of Casing
				139.970	"X" on Rim
				139.210	Brass Survey Marker

Notes:

139.643 Top Inner Casing, North Edge

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.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

3-17-16

A-6003-659 (04/03)

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Split Spoon Sample Photos C8731

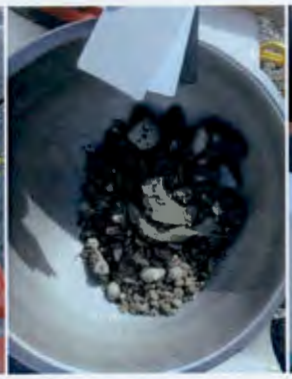
Soil sample at 60 ft bgs

60 ft Bottom of Liner A

60 ft Bottom of Liner B

60 ft Bottom of Liner C

60 ft Bottom of Liner D



Soil sample at 65 ft bgs

65 ft Bottom of Liner

65 ft Bottom of Liner B

65 ft Bottom of Liner C

65 ft Bottom of Liner D

Soil sample at 70 ft bgs

70 ft Bottom of Liner A

70 ft Bottom of Liner B 70 ft Bottom of Liner C 70 ft Bottom of Liner D

Appendix D

Borehole Documentation for C8732

- Well Summary Sheet for C8732
- Borehole Log for C8732
- Log Data Report for C8732
- Final Survey Report for C8732
- Photo Log for C8732

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WELL SUMMARY SHEET

Start Date: 2/10/16
Finish Date: 3/8/16
Page 1 of 1

Well ID: C8732	Well Name: 199-D5-152
Location: 100D ~100 yrds SE of power station	Project: HR-3 Replacement Wells
Prepared by: Julie Johanson — Date: 4/4/16	Reviewed by: J.D. MEHRER, Environmental Scientist — Date: 4-13-16
Signature: Julie Johanson	Signature:

CONSTRUCTION DATA

Surface Completion:

4'x4'x6" Concrete Pad with brass survey marker and 6 9/16" protective monument (3.00' ags)

Well Completion material:

High Strength Concrete
0.0' bgs - 1.96' bgs

Type I/II Portland Cement
1.96' bgs - 10.08' bgs

Granular Bentonite 3/8"
10.08' bgs - 54.04' bgs

3/8" Bentonite Pellets
54.04 bgs - 57.17' bgs

8-16 Colorado Silica Sand
57.17' bgs - 95.73' bgs

Natural Fill
95.73' bgs - 98.25' bgs

Permanent Well:

6" ID Stainless Steel Blank
2.00' ags - 61.02' bgs

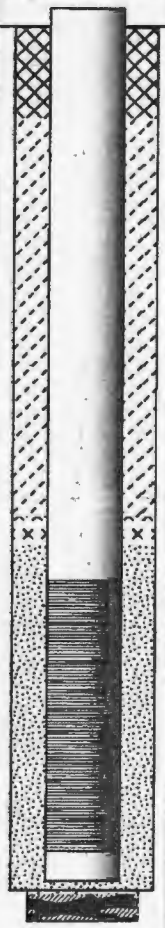
6" ID Stainless Steel 0.050 Slot Screen
61.02' bgs - 91.07' bgs

6" ID Stainless Steel Sump
91.07' bgs - 94.07' bgs

All temporary casing completely removed from ground on 3/3/2016

ags = above ground surface
bgs = below ground surface

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 20, 40, 60, 80, 100

Graphic Log

Lithologic Description

- 0-10: Sandy Gravel (sG)
- 10-30: Silty Gravely Sand (mgS)
- 30-45: Gravelly Sand (gS)
- 45-60: Sandy Gravel (sG)
- 60-70: Silty Sandy Gravel (msG)
- 70-80: Sandy Gravel (sG)
- 80-91.5: Silty Sandy Gravel (msG)
- 91.5-98.25: Silt (M) [RUM]

A-6003-643 (03/03)

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BOREHOLE LOG

Page 1 of 3
Date: 2-22-16

Well ID: C8732 | Well Name: 199-D5-152 | Location: 100D ~100 yards SE of Power Station

Project: HR-3 Replacement Wells. | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0 - 5 : Sandy Gravel (sG)	Sonic Rig
				10% silt, 60% v.fn.-v.crs sand (v.crs.), 30% v.fn.peb.-sm. cob.; max 114mm, moist, poorly sorted, sub ang.-rnd.; s: 75% mafic/25% felsic, g: 65%m/35%f; weak HCl rxn; 2.5Y 2.5/1 black	Fill from ground surface to ~ 29' bgs.
5	G.S.				Archive @ 5' bgs
10	G.S.			10-30 : Silty Sandy Gravel (msG)	Archive @ 10' bgs
				15% silt, 35% v.fn.-v.crs. sand, 50% v.fn.peb.-sm.cob; max 117mm, moist, poorly sorted, ang.-sub rnd.; s: 80%m, 20%f, g: 75%m/25%f, weak-mod. HCl rxn, 2.5Y 3/1 very dark gray.	
15	G.S.			@ 15' bgs: 20% silt, 30% v.fn.-v.crs. sand; 50% v.fn.peb.-sm.cob., max 113mm, slightly moist, s: 50%m/50%f, g: 70%m/30%f; strg. HCl rxn; 10YR 4/1 dark gray	Archive @ 15' bgs
20	G.S.			@ 20' bgs: 15% silt, 40% v.fn.-v.crs. sand (v.crs.), 45% v.fn.peb.-sm.cob.; max 98mm; moist, sub ang.-sub rnd.; s: 50%m/50%f; g: 70%m/30%f; v.weak-no HCl rxn; 2.5Y 2.5/1 black	Archive @ 20' bgs
25	G.S.			@ 25' bgs: 15% silt, 35% v.fn.-v.crs. sand (v.crs.); 50% v.fn.peb.-sm. cob.; max 123mm, moist, s: 55%m/45%f; g: 75%m/25%f; mod.-strg. HCl rxn; 2.5Y 3/1 very dark gray. Boulders encountered during clean out.	Archive @ 25' bgs
30	G.S.			~~Gravel~~ 30-45: Gravelly Sand (gS)	Hanford @ ~ 29' bgs
				10% silt, 55% v.fn.-v.crs. sand (crs.), 35% v.fn.peb.-sm.cob.; max 90mm; moist, poorly sorted, ang.-sub rnd; s: 55%f/45%m, g: 70%m/30%f; mod. HCl rxn; 2.5Y 3/2 very dark grayish brown.	Archive @ 30' bgs
35	G.S.			@ 35' bgs: max 68mm, sub ang.-sub rnd.; s: 60%f/40%m; g: 80%m/20%f; strg. HCl rxn; 2.5Y 3/2 very dark grayish brown	Archive @ 35' bgs

Reported By: Julie Johanson		Reviewed By: Sarah Springer	
Title: Geologist		Title: Geologist	
Signature: Julie Johanson	Date: 2-22-16	Signature: Sara Flynn	Date: 05-03-16

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 3
Date: 2-22-16

Well ID: C8732 | Well Name: 199-D5-152 | Location: 100D ~100yrds. SE of Power station

Project: HR-3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	G.S.			30 - 45 : Gravelly Sand (gS) 10% silt, 55% v.fn.-v.crs sand(crs.-v.crs.), 25% v.fn. peb.-sm.cob.; max 70mm; moist, poorly sorted, subang.-subrnd; s: 70%m/30%f, g: 65%m/35%f; strg. HCl rxn; 2.5Y 3/1 very dark gray	Sonic Rig Archive @ 40' bgs
45	G.S.			45 - 60 : Sandy Gravel (sG) 10% silt, 40% v.fn.-v.crs. sand (v.crs.), 50% v.fn.peb.-sm. cob.; max 105mm; moist; poorly sorted, ang.-sub rnd; s: 60%m/40%f, g: 60%m/40%f; strg. HCl rxn; 10YR 3/1 very dark gray; possible staining	Archive @ 45' bgs.
50	G.S.			@50' bgs: 10% silt, 60% v.fn.-v.crs. sand, 30% v.fn. peb.-sm.cob; max 71mm; slightly moist-dry; s: 60%m/40%f, g: 55%m/45%f; v. strg. HCl rxn, 2.5Y 5/1 gray	Archive @ 50' bgs
55	G.S.			@55' bgs: 10% silt, 50% v.fn.-v.crs sand(v.crs.), 40% v.fn. peb.-sm. cob.; max 80mm; moist, ang.-sub rnd s: 50%m/50%f, g: 55%m/45%f, v.strg. HCl rxn; 10YR 2/2 very dark brown; staining present.	Archive @ 55' bgs
60	G.S. S.S. I-001 I-002 DUP 2-22-16			~~One-time~~ 60 - 70: Silty Sandy Gravel (msG) 15% silt, 40% v.fn.-v.crs. sand, 50% v.fn.peb.-sm.cob.; max 112mm; slightly moist, dry, poorly sorted; ang.-sub ang. s: 50% m/50% f, g: 55%f/45%m; strg. HCl rxn; ~~10YR~~ 2.5YR 3/2 very dark grayish brown	Archive @ 60' bgs Split Spoon Sample I-001, Hels# B34JT4, I-001 DUP Hels# B34JT5, 2-22-16 @ 1457 60.33'-62.83' bgs
65	G.S. S.S. I-002 2-22-16			@65' bgs: 20% silt, 40% v.fn.-v.crs. sand, 40% v.fn.-v.crs. peb.; max 55mm; dry; ang.-sub.rnd.; s: 70%f/30%m; g: 60%f/40%m, mod.-strg. HCl rxn, 2.5Y 6/1 gray	Archive @ 65' bgs Split Spoon Sample I-002 Hels# B34JT6 2-22-16 @ 0909 65.24-67.74' bgs.
70	G.S. S.S. I-003 2-22-16			70 - 80 : Sandy Gravel (sG) 10% silt, 40% v.fn.-v.crs. sand (crs.-v.crs.), 50% v.fn.peb.-sm.cob; max 109mm, wet, poorly sorted, subang.-subrnd s: 85%f/15%m, g: 80%f/20%m; mod-strg. HCl rxn; 2.5Y 4/2 dark grayish brown	DTW: 69.23' bgs (2-22-16) Archive @ 70' bgs Split Spoon Sample I-003 Hels# B34JT7 2-22-16 @ 0953 70.14'-72.64' bgs
75	G.S. H_2O I-004 2-22-16	2-22-16 Save sample 70'-80'		@75' bgs: 10% silt, 45% v.fn.-v.crs. sand(crs.-v.crs.), 45% v.fn.peb.-lg.cob.; max 132mm; s: 80%f/20%m, g: 80%f/20%m; mod.-strg. HCl rxn, 2.5Y 5/2 grayish brown	Archive @ 75' bgs H_2O Sample I-004 Hels# B34JV2 Cr(VI) 0.007 ~~34~~, 2-22-16 @ 1041; 75.00' bgs.

Reported By: Julie Johanson | Reviewed By: Sarah Springer

Title: Geologist | Title: geologist

Signature: Julie Johanson | Date: 2-22-16 | Signature: Sarah Fyn | Date: 05-03-16

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 3
Date: 2-23-16

Well ID: C8732 | Well Name: 199-D5-152 | Location: 100D ~ 100yards SE of power station

Project: HR-3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
80	G.S.	Solve Sample 80-90'		80-91.5: Silty Sandy Gravel (msG) 20% silt 20% v.fa.-v.crs. sand, 60% v.fa.peb.-sm.cob.; max 75mm, wet, poorly sorted, ang.-rnd.; s: 75%f/25%m; g: 75%f/25%m, mod.-strg. HCl rxn; 2.5Y 5/2 grayish brown	Sonic Rig Archive @ 80' bgs
85	G.S. H2O I-005 2-23-16			@85' bgs: 15% silt, 40% v.fa.-v.crs. sand(crs.-v.crs.), 45% v.fa.peb.-lg cob; max 144 mm, sub.ang.-sub.rnd.; s: 75%f/25%m; g: 75%f/25%m; v.weak-no HCl rxn; 10YR 3/2 very dark grayish brown.	Archive @ 85' bgs H2O Sample I-005 HRS# B34JV4 Cr(VI) 0.010 mg/L 2-23-16 @ 1242; 85.00' bgs
90	G.S. H2O I-006 2-23-16 G.S.			@90' bgs: 15% silt, 40% v.fa.-v.crs. sand(crs.-v.crs.), 45% v.fa.peb.-sm.cob.; max 97mm, ang.-sub.rnd.; s: 70%f/30%m; g: 70%f/30%m; v.weak-no HCl rxn, 2.5Y 4/2 dark grayish brown.	Archive @ 90' bgs
95				91.5-98.25: Silt (M) [RUM] 100% silt, well sorted, v.weak-no HCl rxn; 10YR 4/2 dark grayish brown; low plasticity	Archive @ 91.5' bgs H2O Sample I-006 HRS# B34JW4 Cr(VI) 0.009 mg/L 2-23-16 @ 1511; 90.11' bgs TD: 98.25' bgs
100					
105					
110					
115					

Reported By: Julie Johanson | Reviewed By: Sarah Springer
Title: Geologist | Title: geologist
Signature: Julie Johanson | Date: 2-23-16 | Signature: Sarah Springer | Date: 05-03-16

A-6003-642 (03/03)

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199-D5-152 (C8732)
Log Data Report

Borehole Information

Log Date	2016-02-25	Filename	C8732_HG-NM_2016-02-25	Site	100-D
Coordinates (WA St Plane)		DTW[1] (ft)	70.0	DTW Date	02/24/16

North (m)	East (m)	Drill Date	TOC[2] Elevation	Total Depth (ft)
N/A	N/A	2/24/16	N/A	98.25

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	Sonic	0.35	10 1/2	9 5/8	0.25 – 0.42	0.35	95.1

Borehole Notes

The logging engineer measured depth to water with an e-tape. Drill depth and casing depth were provided by the wellsite geologist. Zero reference is ground surface.

This borehole was drilled by a sonic method, using internal-upset casing in 5-ft lengths. This results in a significant reduction in count rate for both the gamma log and neutron moisture log at each casing joint. The sonic drill casing, through which log data were collected, was manufactured by Terra Sonic International. A telephone conversation with the manufacturer's representative indicated that the 10.5-in. casing has a nominal wall thickness of 0.25 in. At the end of each 5-ft length, an insert with either a box (female) or pin (male) thread is welded inside the pipe. When the box and pin are screwed together, the total length of the insert is 13.5 in. This consists of 5 in. on the pin side of the joint, and 8.5 in. on the box side. Over this distance, wall thickness is 0.42 in. Both inserts are tapered for an additional 4.5 in. to avoid a sharp edge on the inside of the casing.

Logging Equipment Information

Logging System	Gamma 5 Tb	Type	HPGe SGLS[3]
Effective Calibration Date	2/23/16	Serial No.	54-TP13441B
Calibration Reference	HGLP-CC-136, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 4M	Type	NMLS[4]
Effective Calibration Date	10/20/2015	Serial No.	H34055445
Calibration Reference	HGLP-CC-129, Rev. 0	Logging Procedure	SGRP-PRO-OP-53016, Rev. 0

SGLS Log Run Information

Log Run	3	4 Repeat			
HEIS Number	1017439	1017440			
Date	2/25/16	2/25/16			
Logging Engineer	Spatz/McClellan	Spatz/McClellan			
Start Depth (ft)	0.0	60.0			
Finish Depth (ft)	96.0	71.0			

[1] depth to water inside casing
[2] top of casing
[3] Spectral Gamma Logging System
[4] Neutron Moisture Logging System

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Log Run	3	4 Repeat			
Count Time (sec)	100	100			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C8732FTB20160 225AV00CAB1	C8732FTB20160 225AV00CAB1			
Start File	AD000000	BD006000			
Finish File	AD009600	BD007100			
Post-Verification	BV00CAA1	BV00CAA1			
Depth Return Error (in.)	N/A	4.0 high			
Comments	No fine gain adjustments made	No fine gain adjustments made			

NMLS Log Run Information

Log Run	1	2 Repeat			
HEIS Number	1017441	1017442			
Date	2/24/16	2/24/16			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0.0	5.0			
Finish Depth (ft)	69.75	15.0			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	NA	NA			
MSA Interval (ft)	0.25	0.25			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	DMAB2CAB	DMAB2CAB			
Start File	DMAB2000	DMAB2280			
Finish File	DMAB2279	DMAB2320			
Post-Verification	DMAB2CAA	DMAB2CAA			
Depth Return Error (in.)	N/A	0.0			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on both sondes.

Pre- and post-survey verification measurements met the acceptance criteria for the established systems.

Analysis Notes

Analyst	P. D. Henwood	Date	04/20/16
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as

FTB20160223_CC-136_corr01 for the SGLS, using an efficiency function and corrections for casing and dead time as determined during annual response checks.

NMLS data are reported in counts per second.

The internal upsets in casing thickness at 5-ft intervals significantly affect both gamma and moisture log response, with the result being a distinctive "saw tooth" pattern in the log results after conventional casing correction has been applied. This was corrected by calculating an "effective casing thickness" for each measurement point and calculating a casing correction based on this value. Log detectors respond to material both above and below the actual measurement point, so the first step is to determine a sensitivity function describing the variation in detector sensitivity as a function of depth above and below the measurement point. For the gamma log, the sensitivity range was assumed to be within +/- 1 ft of the measurement point. For the moisture log, the sensitivity range was estimated to be within +/- 0.5 ft of the measurement point. The sensitivity function was then used to create an estimated "effective thickness" based on distance from the nearest casing joint above the measurement point.

For both the gamma and moisture log, a depth offset was estimated to align the measurement points and the casing joints. This allows the effective thickness to be estimated for all measurement points. For measurement points that fall between casing joints, the effective thickness is equal to the nominal casing wall thickness (0.25 in.), but for measurement points at or near a casing joint the effective thickness may be greater, up to a maximum or 0.42 in. for a point at the casing joint and thus well inside the internal upset region.

For the gamma log, a corrected activity was calculated by using a casing correction calculated from the effective casing thickness at each measurement point.

For the moisture log, an empirical correction factor was determined by examining the log over an interval of relatively stable moisture content. For measurement points well within the interval between casing joints (nominal casing thickness = 0.25 in.), the correction factor is assumed to be 1.0. For measurement points within a casing joint (casing thickness = 0.42 in.), the correction factor is estimated to be 1.2. Correction factors for intermediate effective thickness values are interpolated, using a simple linear function.

Most of the sonic drill casing was in 5-ft lengths. From the character of the total gamma and moisture logs, it is apparent that casing joints occur at 5-ft intervals at approximately 4.5, 9.5, 14.5... ft. In this borehole, however, three 10-ft sections were apparently used. When the correction is applied for casing joints, anomalous spikes in the log data are observed at 59.5, 69.5, and 79.5 ft. These were determined to be the result of the *absence* of a casing joint at those depths. Ed Rafuse of CHPRC confirmed that the drillers do have a few 10-ft casing lengths. Therefore the casing joint corrections at 59.5, 69.5, and 79.5 ft were "removed" by manually setting the casing wall thickness to 0.25 in. at these depths.

Most log plots show both "raw" and "corrected" values. Raw values are those computed for a constant casing thickness. Corrected values are those computed from the effective casing thickness.

The HGU[5] is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Model Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

Results and Interpretations

No manmade radionuclides were detected. An apparent increase in the 609-keV Bi-214 line relative to the 1764 keV Bi-214 line below 70 ft indicates the presence of radon inside casing, most likely dissolved in groundwater.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content.

The KUT and moisture repeat plots indicate that the respective systems were working properly.

[5] Hanford Gamma Unit

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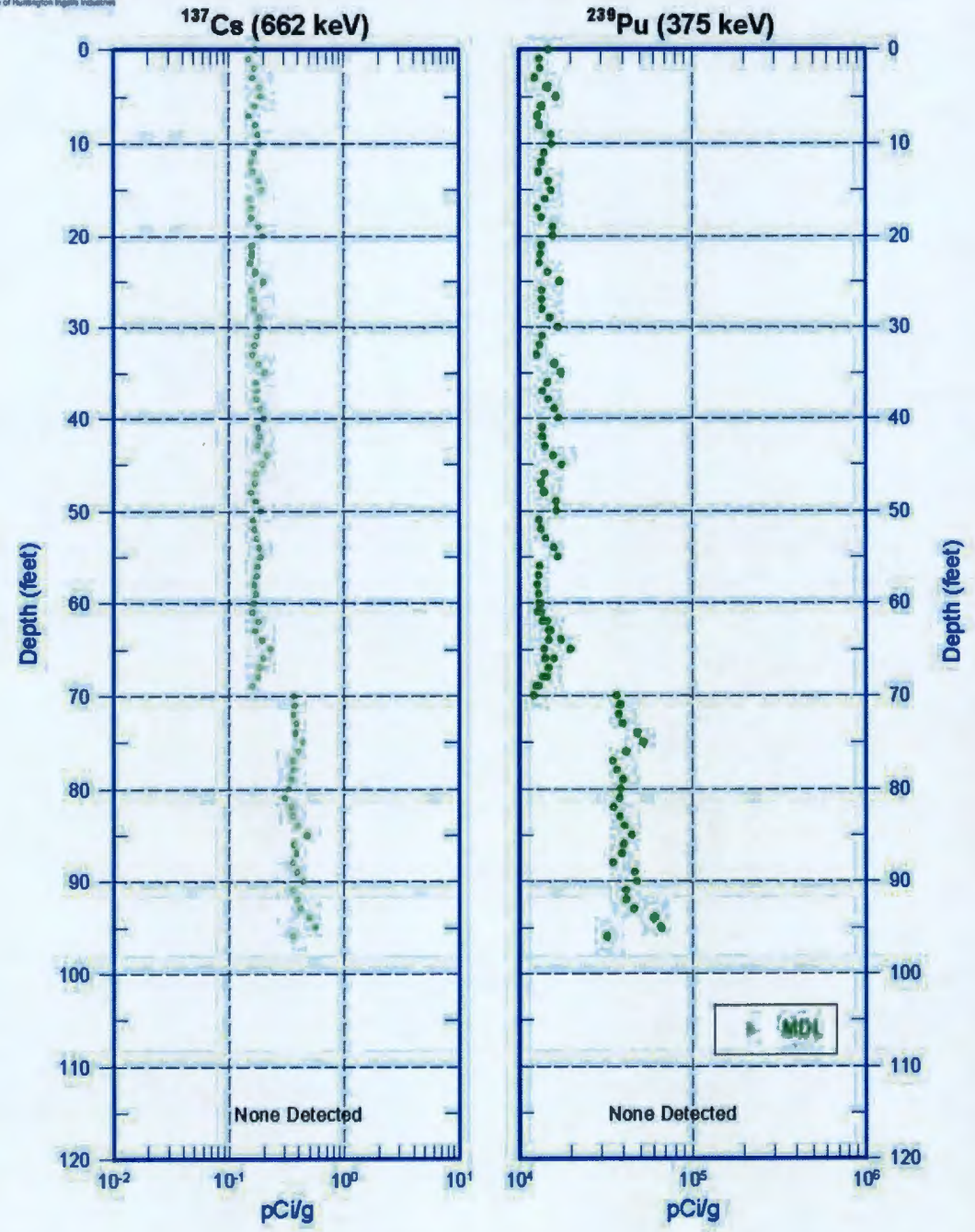
List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-120 ft)
Natural Gamma Logs (0-120 ft)
Combination Plot (0-120 ft)
Total Gamma & Moisture (0-120 ft)
Total Gamma & Hanford Gamma Unit (0-120 ft)
Repeat Section of Natural Gamma Logs (60-71 ft)
Moisture Repeat Section (5-15 ft)

199-D5-152 (C8732)
Manmade Radionuclides



Zero Reference - Ground Surface

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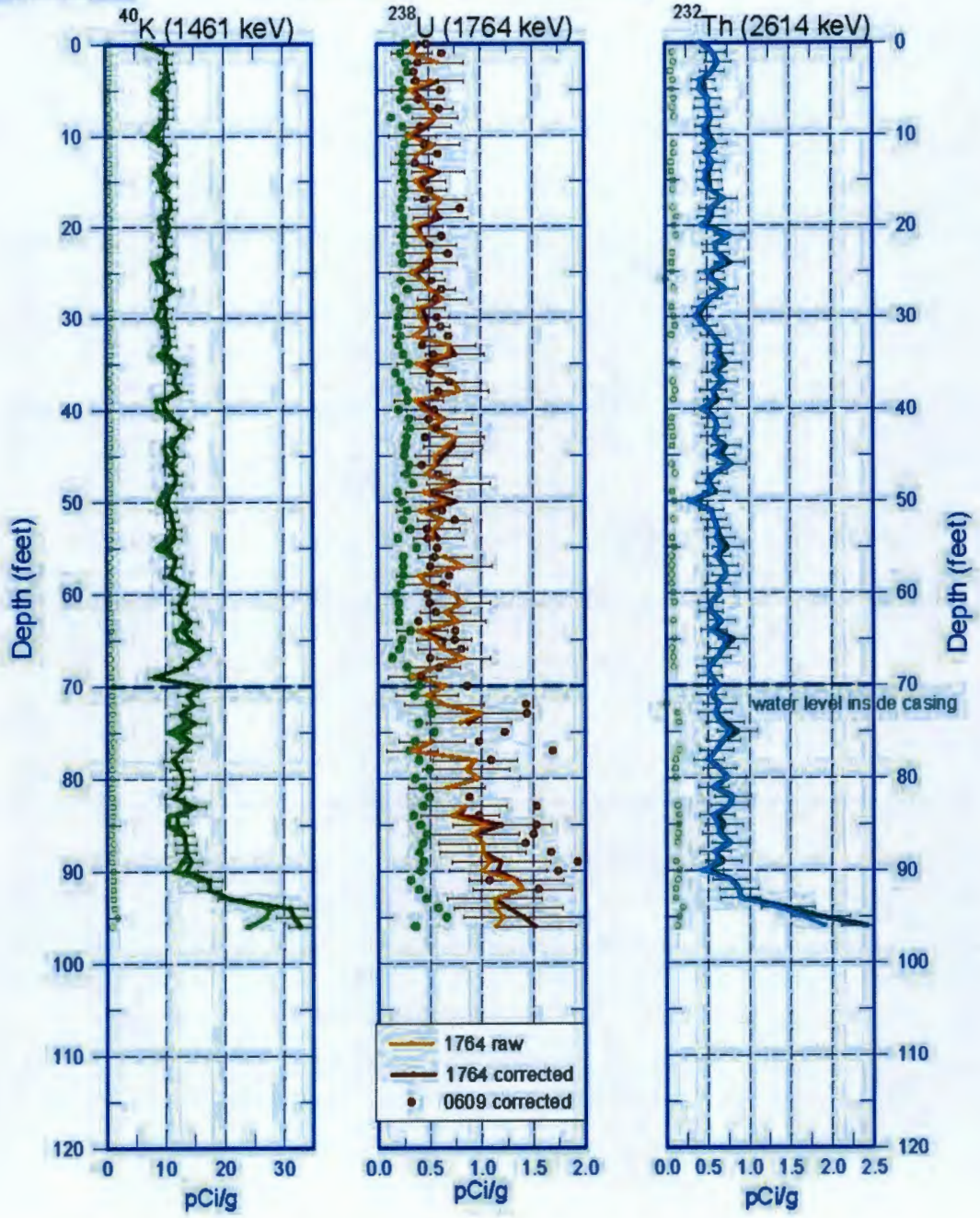
199-D5-152 (C8732)
Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
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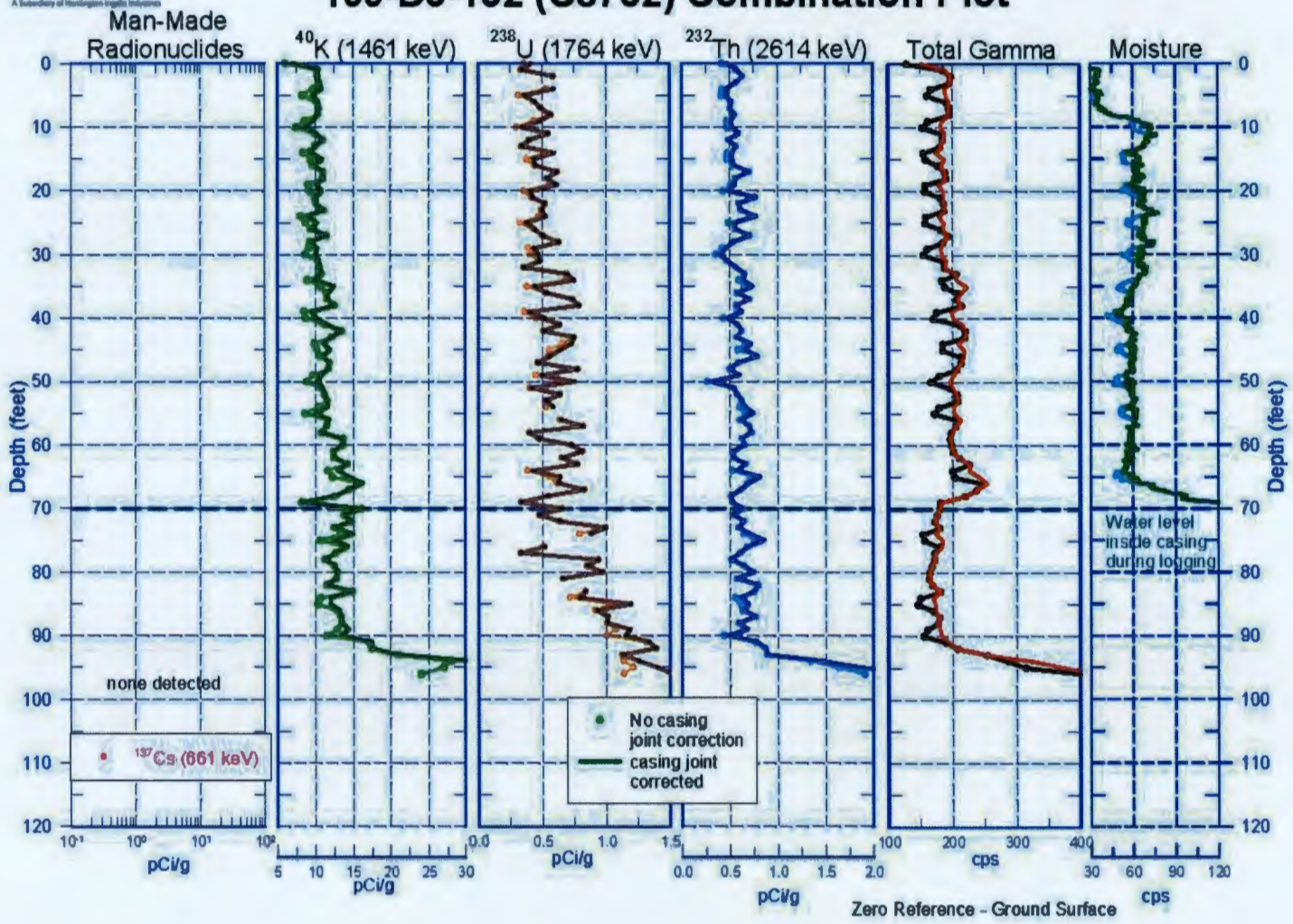
199-D5-152 (C8732) Combination Plot



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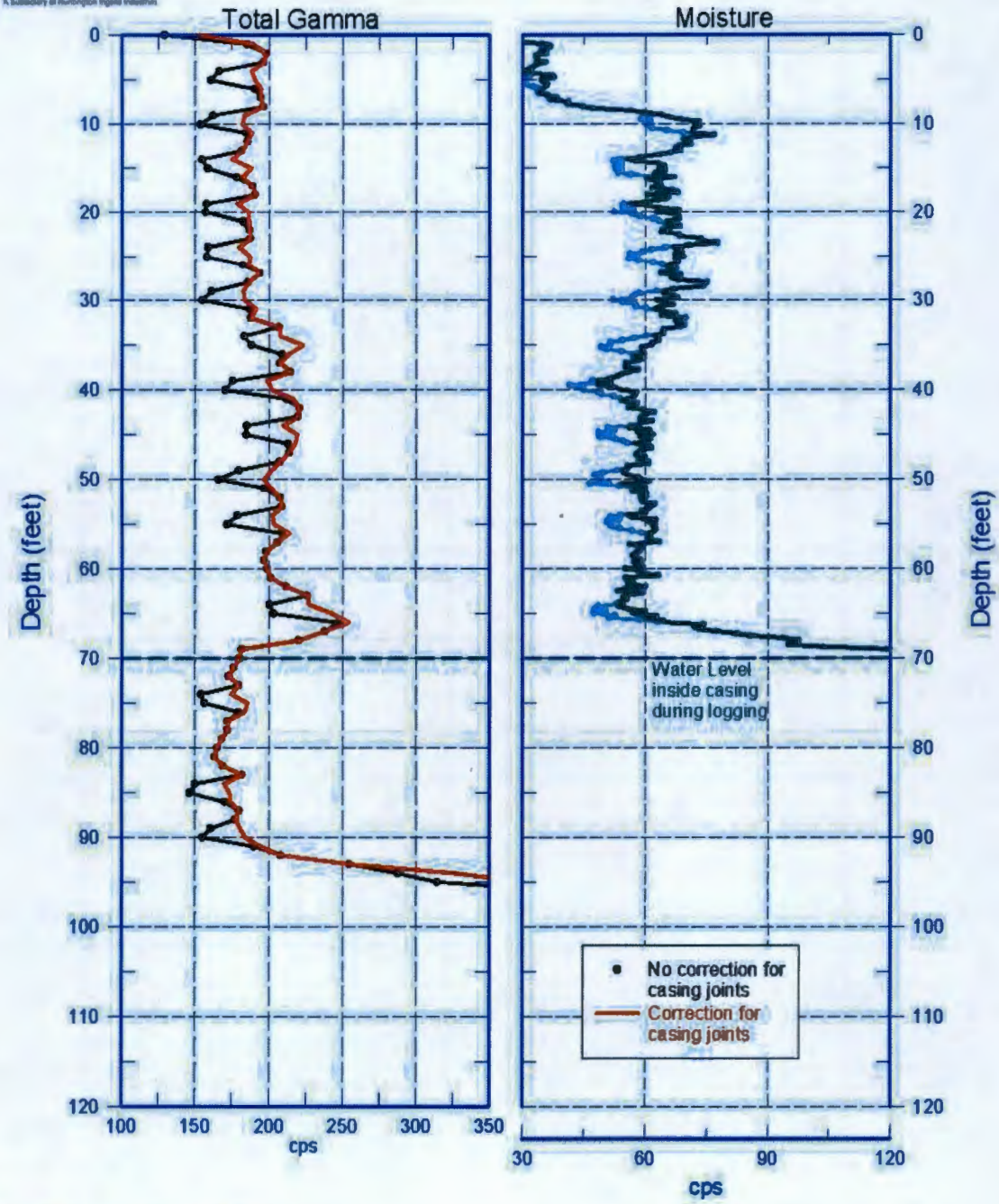
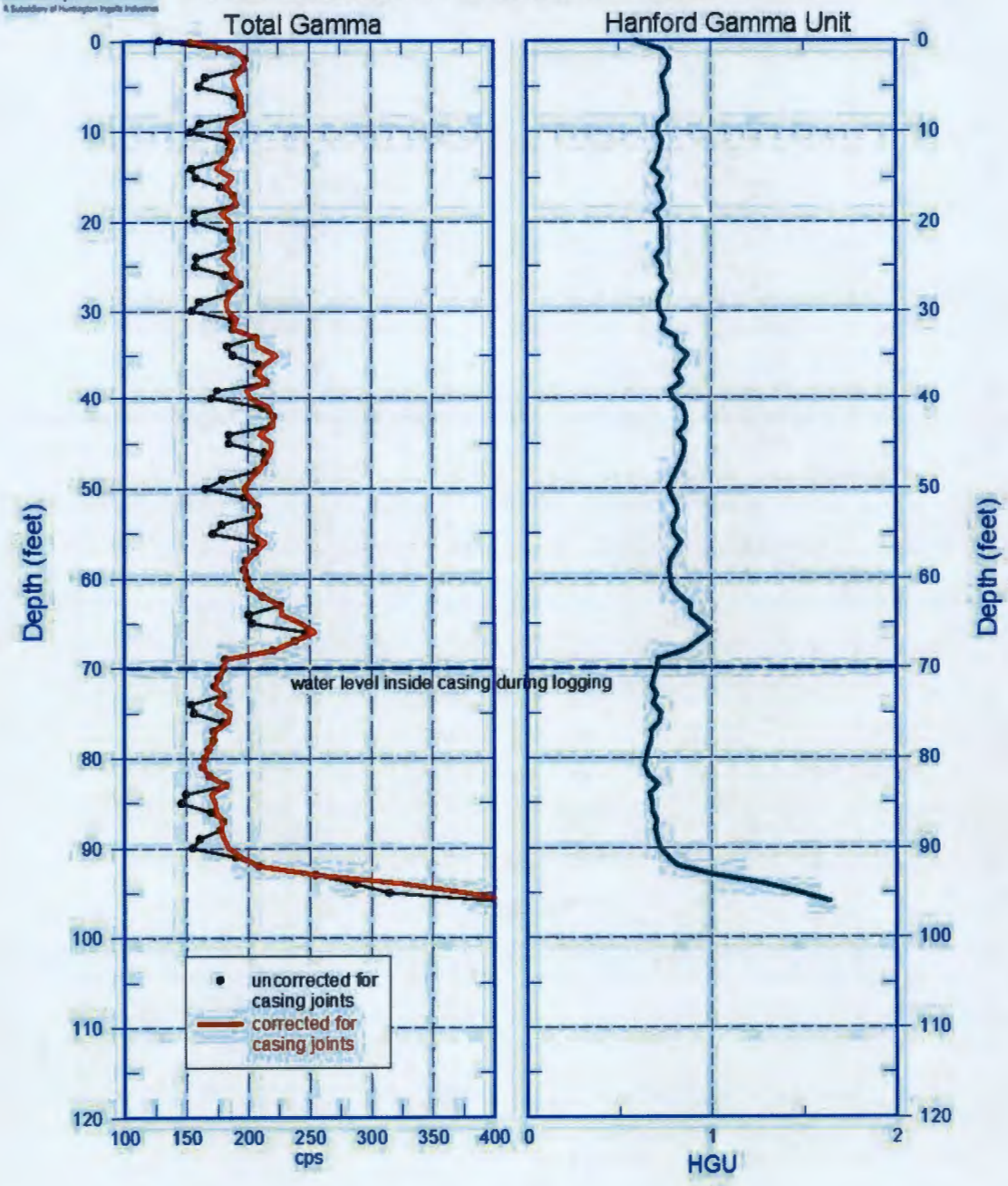
199-D5-152 (C8732)
Total Gamma & Moisture



Zero Reference - Ground Surface

199-D5-152 (C8732)
Total Gamma & Hanford Gamma Unit



Zero Reference - Ground Surface

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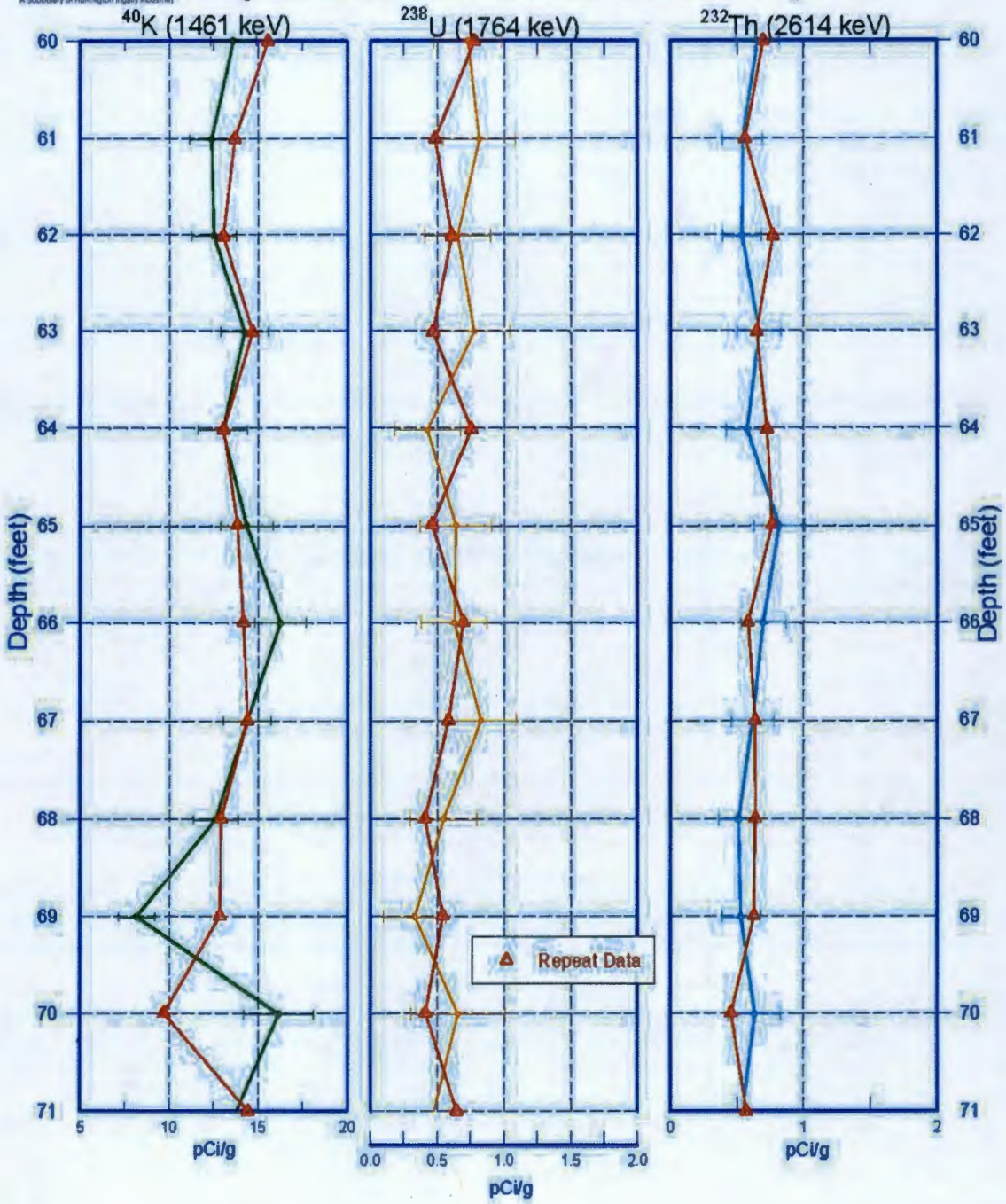
199-D5-152 (C8732)

Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

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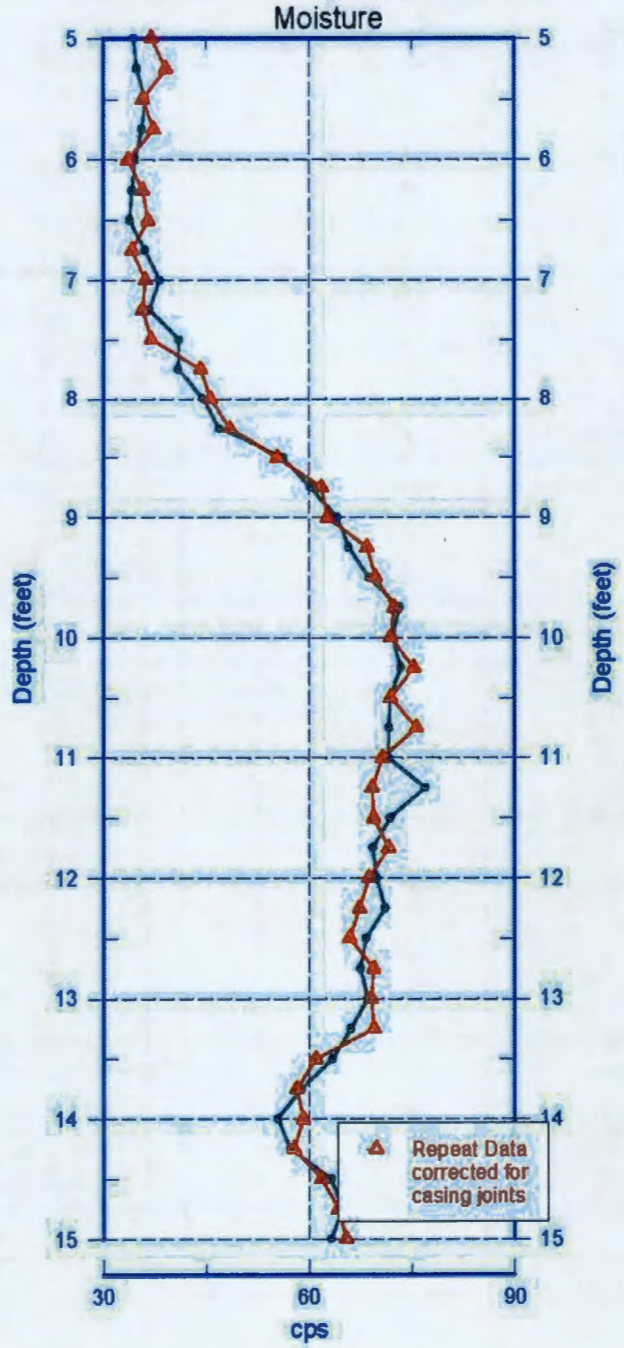
199-D5-152 (C8732)
Moisture Repeat Section



Zero Reference - Ground Surface

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WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 03/10/16	Requestor: Ed Rafuse (CHPRC)
Date of Survey: 03/17/16	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of 100D Replacement Well C8732 (199-D5-152).	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 100D

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
D-6 (CHPRC) and D-9 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C8732	199-D5-152 ·	573300.18 ·	151349.10 ·		Center of Casing
				139.791 ·	"X" on Rim
				139.013 ·	Brass Survey Marker

Notes:

139.455· Top Inner Casing, North Edge

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.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

3-17-16

A-6003-659 (04/03)

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Split Spoon Sample Photos C8732

Soil sample at 60ft bgs

60 ft Bottom of Liner A

60 ft Bottom of Liner B

60 ft Bottom of Liner C

60 ft Bottom of Liner D

Soil sample at 65 ft bgs

65 ft Bottom of Liner A

65 ft Bottom of Liner B

65 ft Bottom of Lienr C

65 ft Bottom of Liner D

Soil sample at 70 ft bgs

70 ft Bottom of Liner A

70 ft Bottom of Liner B

70 ft Bottom of Liner C

Full Split Spoon at 70 ft

Appendix E

Borehole Documentation for C8733

- Well Summary Sheet for C8733
- Borehole Log for C8733
- Log Data Report for C8733
- Final Survey Report for C8733
- Photo Log for C8733

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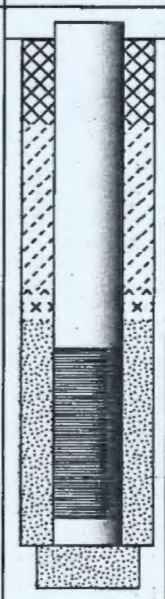
WELL SUMMARY SHEET		Start Date: 3/22/16 Finish Date: 3/28/16	Page 1 of 1
Well ID: C8733		Well Name: 199-H4-87	
Location: 550 ft NNW of H reactor		Project: HR-3 Replacement Wells	
Prepared by: Julie Johanson	Date: 4/6/16	Reviewed by: J.D. MEHRER Environmental Scientist	Date: 4-13-16
Signature: Julie Johanson		Signature:	

CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram		Graphic Log	Lithologic Description
Surface Completion: 4'x4'x6" Concrete Pad with brass survey marker and 6 9/16" protective monument (3.00' ags)		0		0-16: Silty Sandy Gravel (msG)
Well Completion material: Type I/II Portland Cement 0.00' bgs - 9.80' bgs		20		16-22: Sandy Gravel (sG)
Granular Bentonite 3/8" 9.80' bgs - 29.80' bgs				22-23: Silty Sandy Gravel (msG) 23-40: Sandy Gravel (sG)
3/8" Bentonite Pellets 29.80 bgs - 33.60' bgs				
6-9 Colorado Silica Sand 33.60' bgs - 64.91' bgs		40		40-50: Silty Sandy Gravel (msG)
				50-55: Sandy Gravel (sG)
				55-57: Silty Sandy Gravel (msG)
		60		57-64.91: Silt (M) [RUM]
Permanent Well: 6" ID Stainless Steel Blank 2.00' ags - 37.05' bgs				
6" ID Stainless Steel 0.075 Slot Screen 37.05' bgs - 57.08' bgs		80		
6" ID Stainless Steel Sump 57.08' bgs - 60.08' bgs				
		100		
All temporary casing completely removed from ground on 3/28/2016 ags = above ground surface bgs = below ground surface				

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BOREHOLE LOG

Page 1 of 2
Date: 3-22-16

Well ID: C8733 | Well Name: 199-H4-87 | Location: 550' NNW of H-Reactor

Project: HR-3 Replacement Wells. | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0					Sonic Rig
				0'-16' SILTY SANDY GRAVEL	
				50% pebbles to cobbles, 30% v.f.n - v.c.a sand,	
				20% silt; max size 85mm, sub ang to sub	
				rnd; v. poorly sorted; slightly moist, strong to	
5	G.S.	8'/min		v. strong HCl; Sand/silt: 75% f-c2 - 25% m-f2,	Archive @ 5'
				gravel: 60% m-f2, 10% int, 30% f-c2; Dark Yellow	
				Brown ~~(10YR 4/4)~~ 3/2 (10 YR 3/4) to Dark Brown	TIGHT CASING 7'-10'
				(10YR 3/3)	
10	G.S.			@ 10' INCREASE IN MOISTURE	Archive grab @ 10'
				@ 10' INCREASE IN SAND TO 40%, & SILT TO 10%	
				@ 14' INCREASE IN SILT to 15%, decrease in SAND to	
15	G.S.	5'/min		30%; GRAVEL STILL AT 50%	Archive grab @ 15
					TIGHT @ 16
				16'-22' SANDY GRAVEL	
				45% GRAVEL (PEBS + CBLS), 55% SAND (fn + v.c.a),	
				max size: 180mm, Dark Gray Brown (10YR 4/2)	@ 18 - TIGHT CASING
20	G.S.			moist, poorly sorted, sub rnd gravel, sub ang SAND,	Archive grab @ 20'
				40% int, 30% f-c2, 30% m-f2, strong RXN HCl	
				@ 22'-23' SILTY SANDY GRAVEL	
				45% Gravel, 35% sand, 20% silt	
25	G.S.			23'-30' SANDY GRAVEL	Archive grab @ 25
				45% Gravel (pebble to cobble) - 55% Fine to coarse Sand	
				Dark Y. Brn (10YR 3/4), moist, poorly sorted, sub ang - rnd,	
				(@ 27-28 INCREASE IN GRAVEL TO 65%)	@ 27 - Drill rate slows
				5: 30% m, 20% sil, 50% f; (sub ang); 6: 70% m/30% f	
30	G.S.			Strong RXN to HCl, max size: 120mm	
		SS. I-001			Archive @ 30' bgs
		I-001 DUP			S.S. Sample I-001 HCT#B34HL8, I-001
					DUP HCT#B34HL9; 3-22-16 @ 1127;
					#30.17'-32.17' bgs
35	G.S.			@ 35' bgs:	
		SS. I-002		~~35-40: Silty Sand Gravel (SG)~~	Archive @ 35' bgs
				10% silt, 55% v.fn-v.crs. sand (crs.), 45% v.fn. peb.-sub.rnd cobs;	S.S. Sample I-002 HCT#B34HM0
				max 105mm, moist; sub ang.-sub.rnd; poorly sorted; 5: 70% f/ @ 1216; 35.25'-37.75' bgs	
				30% m, g: 65% m/35% f; mod. HCl rxn; 2.5Y 3/2 very dark grayish brown	

Reported By: Julie Johansen | Reviewed By: Sarah Springer

Title: Geologist | Title: geologist

Signature: [signature] | Date: 3-22-16 | Signature: [signature] | Date: 05-03-16

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2
Date: 3-22-16

Well ID: C8733 | Well Name: 199-H4-87 | Location: 550' NNW of H-Reactor

Project: HR-3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
					Sonic Rig
40	G.S.	S.S. I-003		40-50 : Silty Sandy Gravel (msG)	Archive @ 40' bgs
				15% silt, 50% v.fn.-v.crs. sand (med.-crs.); 35% v.fn. peb.-sm. cob.; max 114 mm, slightly moist-dry; poorly sorted; ang.-sub.round.; s: 70%f/30%m, g: 65%m/35%f; weak-mod. HCl rxn; 10YR 4/1 dark gray (re-drilled)	S.S. sample I-003 HCT# B34HM1, 3-22-16 @ 1546; 39.99'-42.24' bgs.
	G.S.				
45		S.S. I-004		@ 44' 44' bgs: 20% silt, 45% v.fn.-v.crs. sand (fn.-med.); 35% v.fn. peb.-sm. cob.; max 92 mm; mod. HCl rxn, 10YR 4/1 dark gray to 54 6/1 gray	Archive @ 44' bgs.
					S.S. sample I-004 HCT# B34HM3, 3-22-16 @ 1429, 44.75'-47.25' bgs
					DTW: 47.15' bgs
50	G.S.	Sieve Sample		50-55 : Gravelly Sand (gS)	Archive @ 50' bgs.
				10% silt, 65% v.fn.-v.crs. sand (crs), 25% v.fn. peb.-sm. cob.; max 25 mm; wet, poorly sorted, sub-ang.-sub rnd; s: 65%f/35%m, g: 65%m/35%f; mod. HCl rxn, 10YR 3/2 very dark grayish brown.	
55	G.S.	Sieve Sample		55-57 : Sandy Gravel (sG)	Archive @ 55' bgs.
	G.S.			10% silt, 45% v.fn.-v.crs. Sand, 45% v.fn. peb.-lg. cob.; max 180 mm; wet, poorly sorted; sub ang.-sub rnd.; s: 65%f/35%m, g: 70%m/30%f; weak-No HCl rxn wet, mod-strg. HCl rxn dry; 10YR 4/1 dark gray	Archive @ 57' bgs.
60				57- : Mud/Silt (m) [RUM]	
				100% silt; wet; well sorted, strg.-v.strg. HCl rxn; 10YR 4/4 dark yellowish brown	
					TD: 64.91' bgs

Reported By: Julie Johanson | Reviewed By: Sarah Springer

Title: Geologist | Title: geologist

Signature: Julie Johanson | Date: 3-22-16 | Signature: [illegible] | Date: 05-03-16

A-6003-642 (03/03)

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Stoller Newport News Nuclear

199-H4-87 (C8733)
Log Data Report

Borehole Information

Log Date	2016-03-23	Filename	C8733_HG-NM_2016-03-23	Site	100-H
Coordinates (WA St Plane)		DTW[1] (ft)	47.5	DTW Date	03/23/16

North (m)	East (m)	Drill Date	TOC[2] Elevation	Total Depth (ft)
N/A	N/A	3/23/16	N/A	64.9

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	Sonic	0.5	10 1/2	9 5/8	0.25 – 0.42	0.5	55.95

Borehole Notes

The logging engineer measured depth to water with an e-tape. Drill depth and casing depth were provided by the wellsite geologist. Zero reference is ground surface.

This borehole was drilled by a sonic method, using internal-upset casing in 5-ft lengths. This results in a significant reduction in count rate for both the gamma log and neutron moisture log at each casing joint. The sonic drill casing, through which log data were collected, was manufactured by Terra Sonic International. A telephone conversation with the manufacturer's representative indicated that the 10.5-in. casing has a nominal wall thickness of 0.25 in. At the end of each 5-ft length, an insert with either a box (female) or pin (male) thread is welded inside the pipe. When the box and pin are screwed together, the total length of the insert is 13.5 in. This consists of 5 in. on the pin side of the joint, and 8.5 in. on the box side. Over this distance, wall thickness is 0.42 in. Both inserts are tapered for an additional 4.5 in. to avoid a sharp edge on the inside of the casing.

Logging Equipment Information

Logging System	Gamma 5 Tb	Type	HPGe SGLS[3]
Effective Calibration Date	2/23/16	Serial No.	54-TP13441B
Calibration Reference	HGLP-CC-136, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 5P	Type	NMLS[4]
Effective Calibration Date	04/15/2015	Serial No.	H34055445
Calibration Reference	HGLP-CC-116, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0

SGLS Log Run Information

Log Run	1	2 Repeat			
HEIS Number	1017443	1017444			
Date	03/23/16	03/23/16			
Logging Engineer	Spatz/McClellan	Spatz/McClellan			
Start Depth (ft)	0.0	46.0			
Finish Depth (ft)	57.0	52.0			

[1] depth to water inside casing
[2] top of casing
[3] Spectral Gamma Logging System
[4] Neutron Moisture Logging System

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Log Run	1	2 Repeat			
Count Time (sec)	100	100			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C8733FTB20160323AV00CAB1	C8733FTB20160323AV00CAB1			
Start File	AD000000	BD004600			
Finish File	AD005700	BD005200			
Post-Verification	C8733FTB20160323BV00CAA1	C8733FTB20160323BV00CAA1			
Depth Return Error (in.)	N/A	1.5 high			
Comments	No fine gain adjustments made	No fine gain adjustments made			

NMLS Log Run Information

Log Run	3	4 Repeat			
HEIS Number	1017445	1017446			
Date	03/23/16	03/23/16			
Logging Engineer	Spatz/McClellan	Spatz/McClellan			
Start Depth (ft)	0.0	30.0			
Finish Depth (ft)	47. 5	35.0			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	NA	NA			
MSA Interval (ft)	0.25	0.25			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C8733FPB20160323AV00CAB1	C8733FPB20160323AV00CAB1			
Start File	AD000000	CD003000			
Finish File	AD004750	CD003500			
Post-Verification	A8733FPB20160323CV00CAA1	A8733FPB20160323CV00CAA1			
Depth Return Error (in.)	N/A	0.5 high			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on both sondes.

Pre- and post-survey verification measurements met the acceptance criteria for the established systems.

Analysis Notes

Analyst	P. D. Henwood	Date	04/25/16
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as FTB20160223_CC-136_corr01 for the SGLS, using an efficiency function and corrections for casing and dead time as determined during annual response checks.

NMLS data are reported in counts per second.

The internal upsets in casing thickness at 5-ft intervals significantly affect both gamma and moisture log response, with the result being a distinctive "saw tooth" pattern in the log results after conventional casing correction has been applied. This was corrected by calculating an "effective casing thickness" for each measurement point and calculating a casing correction based on this value. Log detectors respond to material both above and below the actual measurement point, so the first step is to determine a sensitivity function describing the variation in detector sensitivity as a function of depth above and below the measurement point. For the gamma log, the sensitivity range was assumed to be within +/- 1 ft of the measurement point. For the moisture log, the sensitivity range was estimated to be within +/- 0.5 ft of the measurement point. The sensitivity function was then used to create an estimated "effective thickness" based on distance from the nearest casing joint above the measurement point.

For both the gamma and moisture log, a depth offset was estimated to align the measurement points and the casing joints. This allows the effective thickness to be estimated for all measurement points. For measurement points that fall between casing joints, the effective thickness is equal to the nominal casing wall thickness (0.25 in.), but for measurement points at or near a casing joint the effective thickness may be greater, up to a maximum or 0.42 in. for a point at the casing joint and thus well inside the internal upset region.

For the gamma log, a corrected activity was calculated by using a casing correction calculated from the effective casing thickness at each measurement point.

For the moisture log, an empirical correction factor was determined by examining the log over an interval of relatively stable moisture content. For measurement points well within the interval between casing joints (nominal casing thickness = 0.25 in.), the correction factor is assumed to be 1.0. For measurement points within a casing joint (casing thickness = 0.42 in.), the correction factor is estimated to be 1.2. Correction factors for intermediate effective thickness values are interpolated, using a simple linear function.

Most of the sonic drill casing was in 5-ft lengths. From the character of the total gamma and moisture logs, it is apparent that casing joints occur at 5-ft intervals at approximately 5, 10, 15,.. ft.

Most log plots show both "raw" and "corrected" values. Raw values are those computed for a constant casing thickness. Corrected values are those computed from the effective casing thickness.

The HGU[5] is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Model Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

Results and Interpretations

No manmade radionuclides were detected. An apparent increase in the 609-keV Bi-214 line relative to the 1764-keV Bi-214 line below 47.5 ft indicates the presence of radon inside casing, most likely dissolved in groundwater.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content.

The KUT and moisture repeat plots indicate that the respective systems were working properly.

[5] Hanford Gamma Unit

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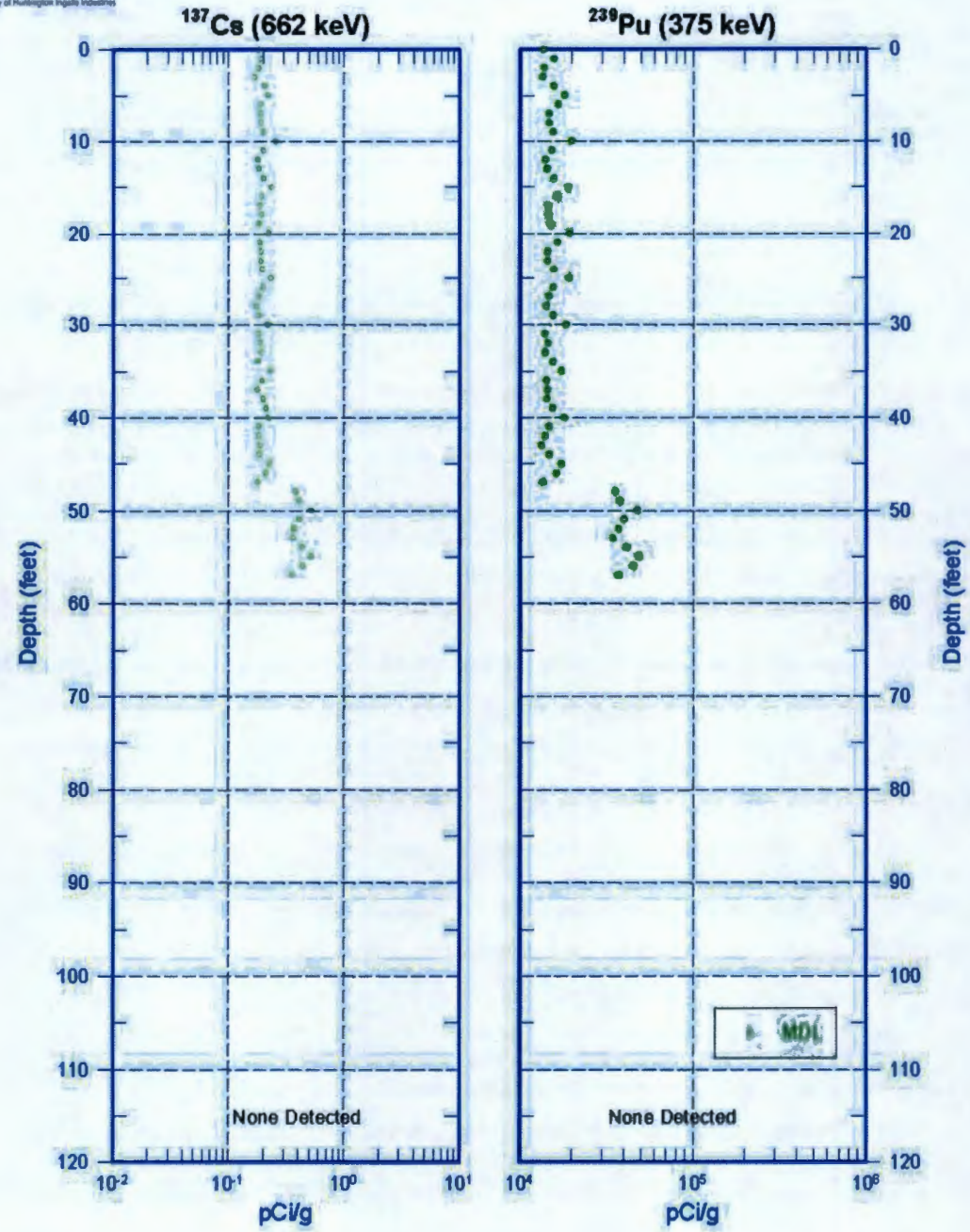
List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-120 ft)
Natural Gamma Logs (0-120 ft)
Combination Plot (0-120 ft)
Total Gamma & Moisture (0-120 ft)
Total Gamma & Hanford Gamma Unit (0-120 ft)
Repeat Section of Natural Gamma Logs (46-52 ft)
Moisture Repeat Section (30-35 ft)

199-H4-87 (C8733)
Manmade Radionuclides



Zero Reference - Ground Surface

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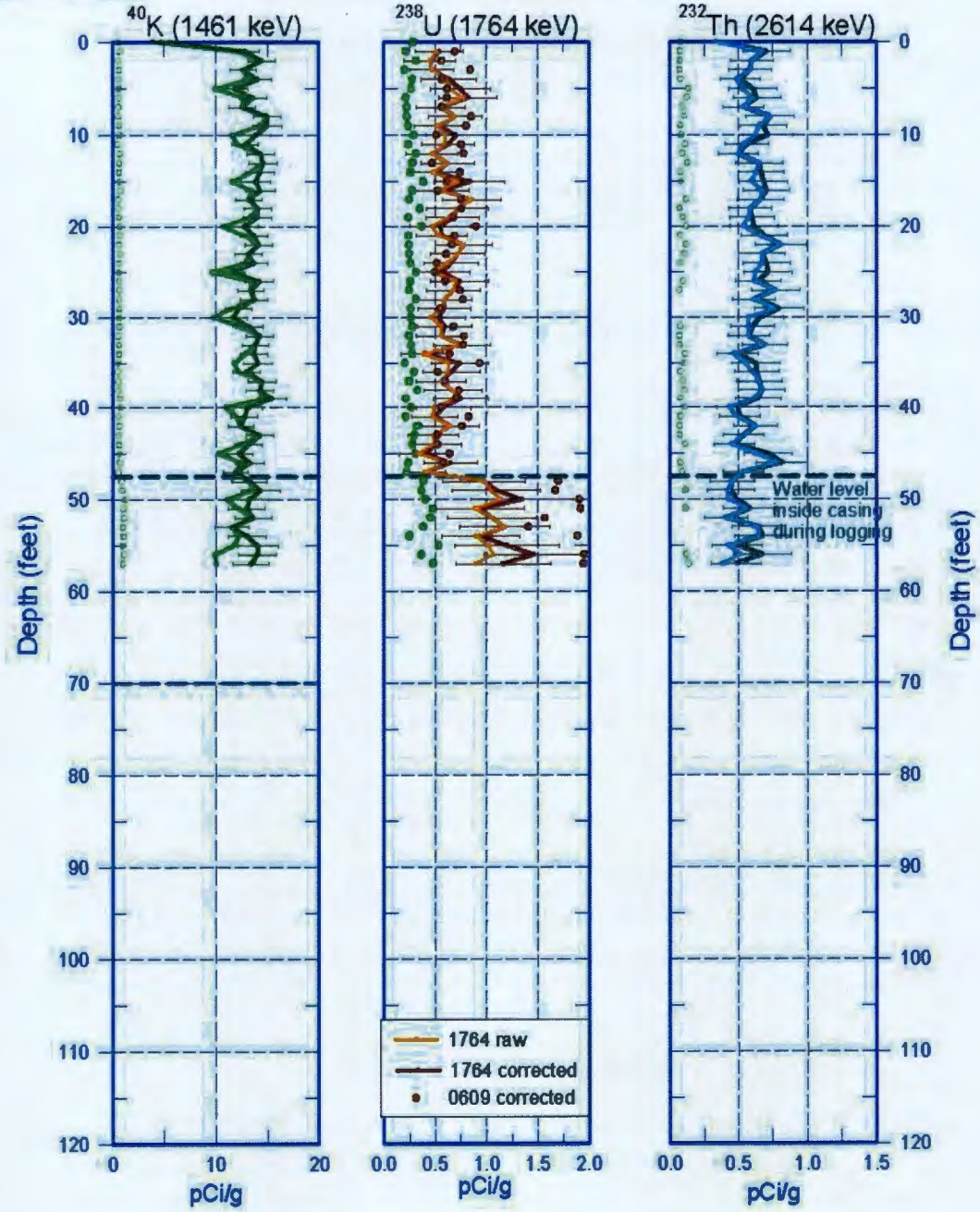
199-H4-87 (C8733)
Natural Gamma Logs



Zero Reference - Ground Surface

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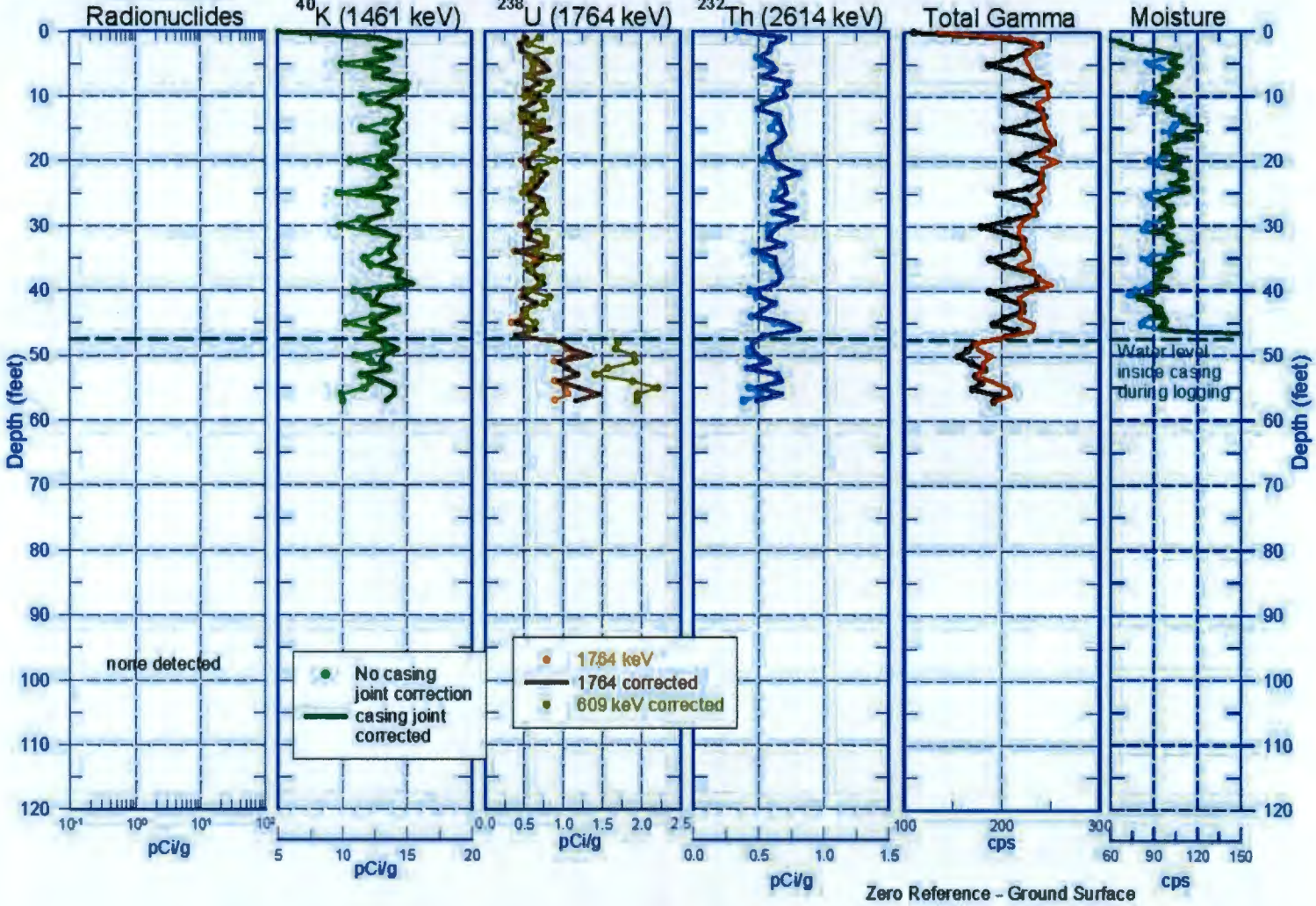
199-H4-87 (C8733) Combination Plot



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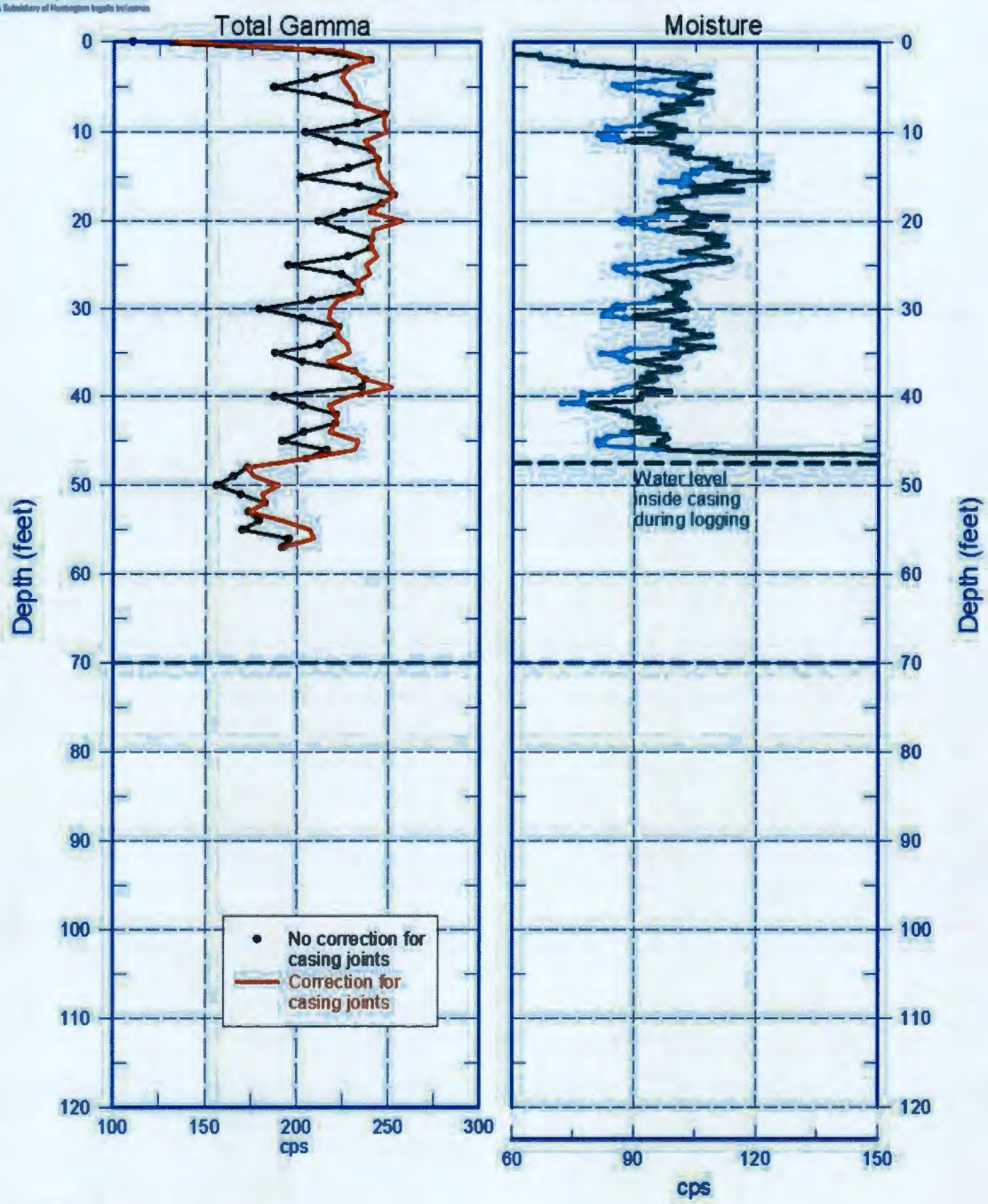
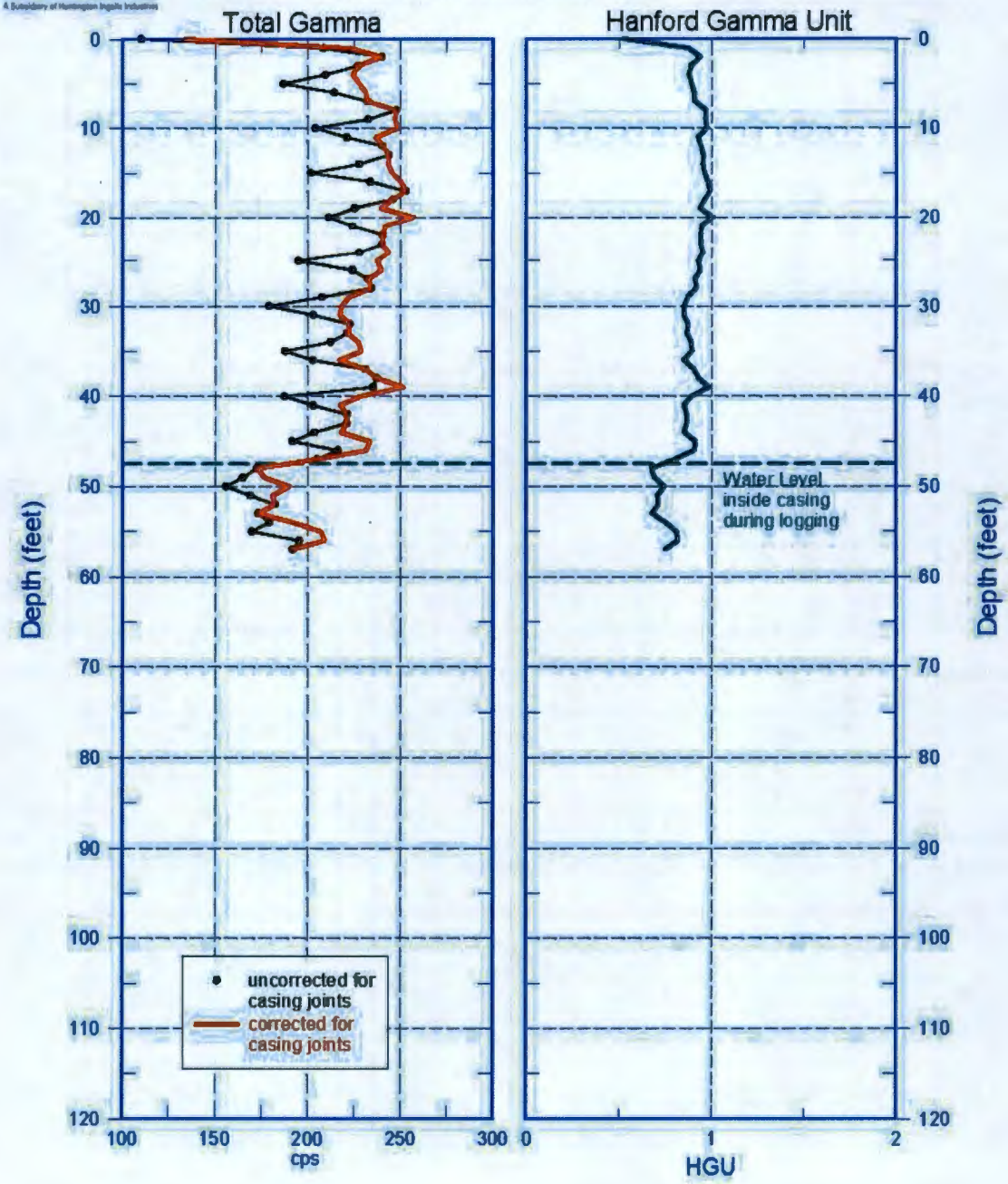
A Subsidiary of Huntington Ingalls Industries

199-H4-87 (C8733)
Total Gamma & Moisture



Zero Reference - Ground Surface

199-H4-87 (C8733)
Total Gamma & Hanford Gamma Unit

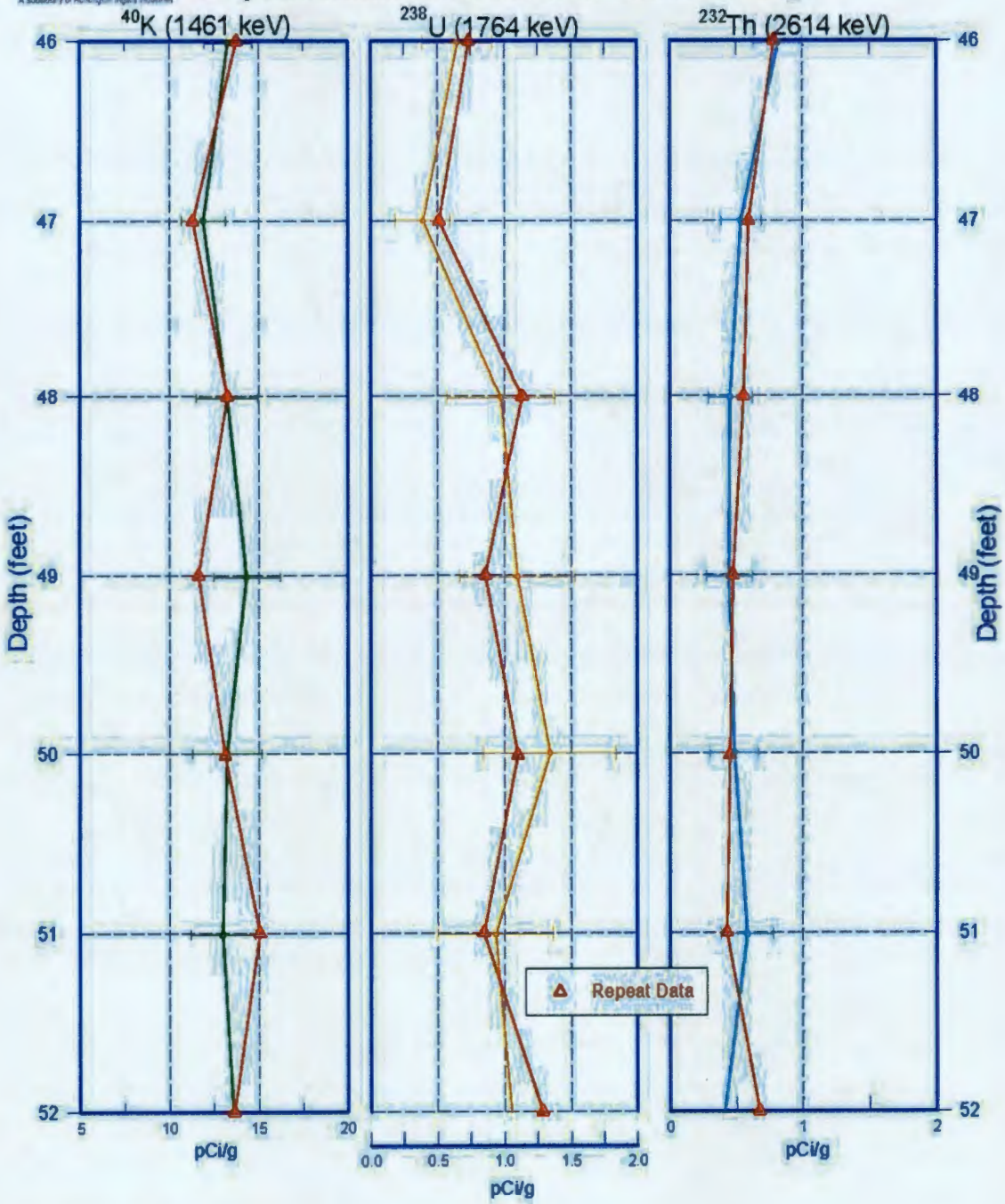


Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

199-H4-87 (C8733)

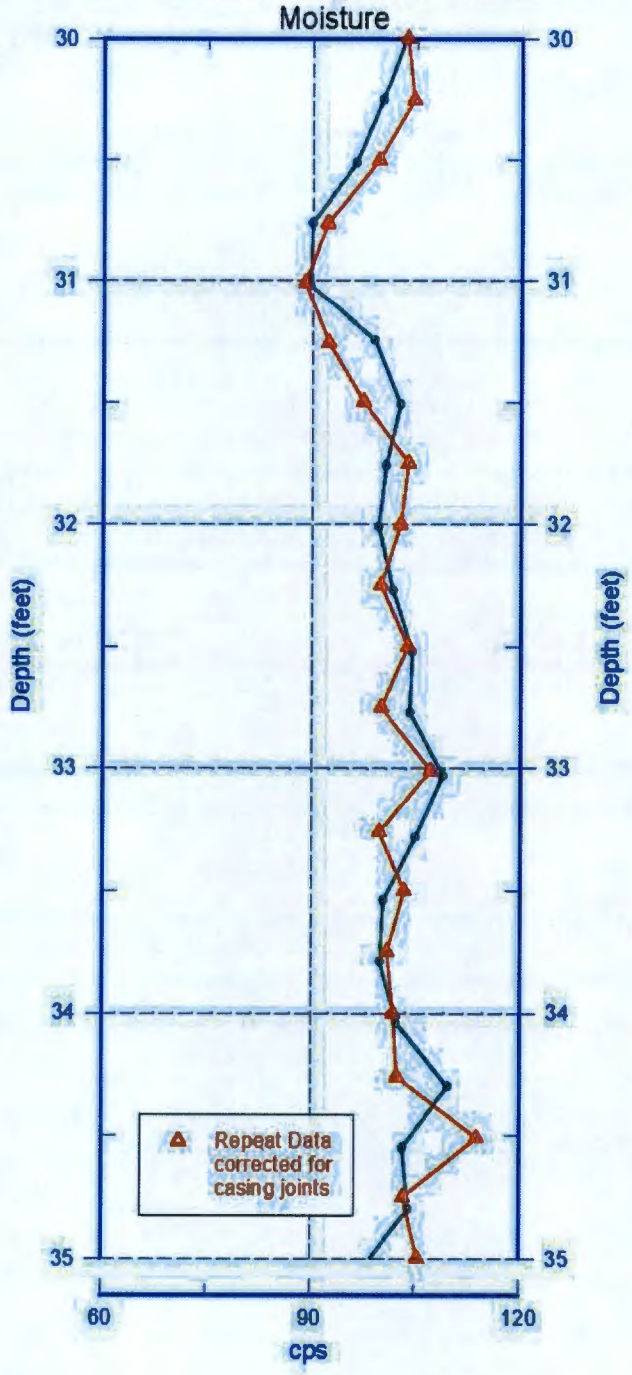
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

Steller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

199-H4-87 (C8733)
Moisture Repeat Section



Zero Reference - Ground Surface

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WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 03/31/16	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 04/07/16	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C8733 (199-H4-87) at 100H Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 100H

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
100H-2 (CHPRC) and 100H-3 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C8733	199-H4-87	577736.16	152667.79		Center of Casing
				130.017	"X" on Rim
				129.250	Brass Survey Marker

Notes:

129.713 Top Inner Casing, North Edge

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 that this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

4-7-16

A-6003-659 (04/03)

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Split Spoon Sample Photos C8733

Soil sample at 30 ft bgs

30 ft Bottom of Liner A

30 ft Bottom of Liner B

Soil sample at 35 ft bgs

35 ft Bottom of Liner A

35 ft Bottom of Liner B

35 ft Bottom of Liner C

35 ft Bottom of Liner D

Soil sample at 40 ft bgs

40 ft Bottom of Liner A

40 ft Bottom of Liner B

40 ft Bottom of Liner C

40 ft Bottom of Liner D

Shoe at 40 ft Split Spoon

Soil sample at 44 ft bgs

44 ft Bottom of Liner A

44 ft Bottom of Liner B

44 ft Bottom of Liner C

44 ft Bottom of Liner D

Appendix F

Borehole Documentation for C8734

- Well Summary Sheet for C8734
- Borehole Log for C8734
- Log Data Report for C8734
- Final Survey Report for C8734
- Photo Log for C8734

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WELL SUMMARY SHEET

Start Date: 3/14/16
Finish Date: 3/23/16
Page 1 of 1

Well ID: C8734
Well Name: 199-H4-88
Location: 0.2 miles NNE of H reactor
Project: HR-3 Replacement Wells
Prepared by: Julie Johanson Date: 4/6/16
Reviewed by: J.D. MEHRER Environmental Scientist Date: 4-13-16
Signature:
Signature:

CONSTRUCTION DATA

Surface Completion:

4'x4'x6" Concrete Pad with brass survey marker and 6 9/16" protective monument (3.00' ags)

Well Completion material:

High Strength Concrete
0.0' bgs - 0.65' bgs

Type I/II Portland Cement
0.65' bgs - 10.08' bgs

Granular Bentonite 3/8"
10.08' bgs - 30.08' bgs

3/8" Bentonite Pellets
30.08 bgs - 34.29' bgs

10-20 Colorado Silica Sand
34.29' bgs - 52.91' bgs

20-40 Colorado Silica Sand
52.91' bgs - 59.17' bgs

Natural Fill
59.17' bgs - 59.90' bgs

Permanent Well:

6" ID Stainless Steel Blank
2.01' ags - 38.00' bgs

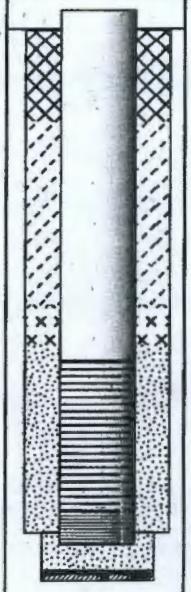
6" ID Stainless Steel 0.040 Slot Screen
38.00' bgs - 53.00' bgs

6" ID Stainless Steel 0.006 Slot Screen w/Cap
53.00' bgs - 58.09' bgs

All temporary casing completely removed from ground on 3/21/2016

ags = above ground surface
bgs = below ground surface

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 20, 40, 60, 80, 100

Graphic Log

Lithologic Description

0-16: Sandy Gravel (sG)

53-59.90: Silt (M) [RUM]

A-6003-643 (03/03)

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BOREHOLE LOG

Page 1 of 2
Date: 3-14-16

Well ID: C8734 | Well Name: 199-H4-88 | Location: 0.2 miles NNE of H Reactor

Project: HR3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0					Sonic Drill Rig
				0-22' SANDY GRAVEL (FILL DIRT)	Fill down to 22'
				Gravel (70%) with SAND (20%) and SILT (10%)	
				VERY DRY, occasional BOULDER, very rounded,	
				Mostly Discoidal, Poorly Sorted, Even Mix of	
5	G.S.	HARD DRILLING		Felsic/Mafic; Max Size: >20cm; WR RAN	Archive @ 5
				Dark brown (10YR 3/3) to Brown ~~(10YR 3/4)~~ (10YR 4/3)	
10	G.S.				Archive @ 10
				@ 11' INCREASE IN FINES	
				Gravel 60%, v.f.w to v.coarse sand 20%, Silt (20%)	DRY FM HINDERINGER 7-15-16 REMOVAL
				max size 150mm; Dry; v. poorly sorted, sub rounded	TIGHT SECTION
				to rounded; sand: 80% mafic / 20% felsic, gravel: 80%	
15	G.S.			v strong raw HCL; Dark brown (10YR 3/2)	Archive @ 15
		RARE SLOWS			
				@ 18' LARGE GRANITIC BOULDER	
20	G.S.			VERY DRY due to sonic drilling	Archive @ 20
				22'-53' ~~Slightly~~ SANDY GRAVEL	
				Mostly Gravel (85%) with both natural	
25	G.S.			Sand as well as drilling sand/silt (5-15 fraction);	Archive @ 25
				Mostly dry to v. dry;	
				Mostly rounded to occasional sub-ang; poorly	
		RARE SLOWS		sorted; Dominantly (70%) mafic/intermediate	
				with some intermediate and occasional felsic (10%)	
30	G.S.			Mostly spherical; Avg range 4-40mm w/max 10cm	Archive @ 30; Also Sample H.D
		S.S. 100%		Dark gray (10YR 4/1), mod raw HCL.	SPLITSPOON 30.20-32.12
				@ 28' BASALT BOULDER	
				@ 29' SLOW RATE PULVERIZING GRAVEL, RETURNS: FINES	
		VERY DRY		very dry, most likely due to hard sonic	VERY TIGHT DRILLING
35	G.S.			drilling	Archive @ 35
					SPLITSPOON 35.1-37.6
		S.S. 100%			

Reported By: James Patterson | Reviewed By: Sarah Springer

Title: Geologist | Title: geologist

Signature: [signature] Date: 7-15-16 | Signature: [signature] Date: 05-03-16

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2
Date: 3-14-16

Well ID: C8734 | Well Name: 199-H4-88 | Location: 0.2 miles NNE of H Reactor

Project: HR3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	G.S.	S.S. 100%		22-53: SANDY GRAVEL	ARCHIVE @ 40
				@ 40' 60% gravel, 35% v.fine to v.coarse sand, 5% silt; well rounded; max: 80mm	SPLITSPOON 40.0-42.10
				Slightly moist, 60% Mafic, 40% Felsic, mod rxn, very dark grayish brown (2.5Y 3/2)	3-15-16
45	G.S.	S.S. 100%		@ 45' SLIGHT DECREASE IN SAND CONTENT	ARCHIVE @ 45 DRILLING RATE ROWS
				@ 47' INCREASE IN SAND TO 50%	
50	G.S.	▽		@ 50' Gravel content ~ 85% (15% Fine sand)	ARCHIVE @ 50
				@ 51' Gravel size INCREASES (Avg 40mm-60mm)	
				% SAND decreases to 10-15%	~8" SATURATED ZONE @ 52'
	G.S.			53 - TD RUN 3-17-16	ARCHIVE @ 54
55				79.5% SILT/CLAY; <5% (~3% clay), 5% f.fn sand; very moist, very well sorted, max size 1/10 mm; v. strong rxn; 10YR 5/4 yellowish brown; Occasional gravel (<1%, 2-8mm)	* Very little water
60				TD @ 59.90'	TD: 59.90' bgs

Reported By: James Patterson | Reviewed By: Sarah Springer

Title: Geologist | Title: geologist

Signature: | Date: 3-15-16 | Signature: | Date: 05-03-16

A-6003-642 (03/03)

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199-H4-88 (C8734)
Log Data Report

Borehole Information

Log Date	2016-03-15	Filename	C8734_HG-NM_2016-03-15	Site	100-H
Coordinates (WA St Plane)		DTW[1] (ft)	56.0	DTW Date	03/15/16

North (m)	East (m)	Drill Date	TOC[2] Elevation	Total Depth (ft)
N/A	N/A	3/15/16	N/A	59.9

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	Sonic	0.7	10 1/2	9 5/8	0.25 – 0.42	0.7	55.0

Borehole Notes

The logging engineer measured depth to water with an e-tape. Drill depth and casing depth were provided by the wellsite geologist. Zero reference is ground surface.

This borehole was drilled by a sonic method, using internal-upset casing in 5-ft lengths. This results in a significant reduction in count rate for both the gamma log and neutron moisture log at each casing joint. The sonic drill casing, through which log data were collected, was manufactured by Terra Sonic International. A telephone conversation with the manufacturer's representative indicated that the 10.5-in. casing has a nominal wall thickness of 0.25 in. At the end of each 5-ft length, an insert with either a box (female) or pin (male) thread is welded inside the pipe. When the box and pin are screwed together, the total length of the insert is 13.5 in. This consists of 5 in. on the pin side of the joint, and 8.5 in. on the box side. Over this distance, wall thickness is 0.42 in. Both inserts are tapered for an additional 4.5 in. to avoid a sharp edge on the inside of the casing.

Logging Equipment Information

Logging System	Gamma 5 Tb	Type	HPGe SGLS[3]
Effective Calibration Date	2/23/16	Serial No.	54-TP13441B
Calibration Reference	HGLP-CC-136, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 5P	Type	NMLS[4]
Effective Calibration Date	04/15/2015	Serial No.	H34055445
Calibration Reference	HGLP-CC-116, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0

SGLS Log Run Information

Log Run	1	2 Repeat			
HEIS Number	1017447	1017448			
Date	03/15/16	03/15/16			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0.0	47.0			
Finish Depth (ft)	56.0	53.0			

[1] depth to water inside casing
[2] top of casing
[3] Spectral Gamma Logging System
[4] Neutron Moisture Logging System

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Log Run	1	2 Repeat			
Count Time (sec)	100	100			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C8734FTB20160 315AV00CAB1	C8734FTB20160 315AV00CAB1			
Start File	AD000000	BD004700			
Finish File	AD005600	BD005300			
Post-Verification	C8734FTB2016 0315BV00CAA 1	C8734FTB2016 0315BV00CAA 1			
Depth Return Error (in.)	N/A	1.0 high			
Comments	No fine gain adjustments made	No fine gain adjustments made			

NMLS Log Run Information

Log Run	3	4 Repeat			
HEIS Number	1017449	1017450			
Date	03/15/16	03/15/16			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0.0	47.0			
Finish Depth (ft)	55.26	53.01			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	NA	NA			
MSA Interval (ft)	0.25	0.25			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C8734FPB20160 315AV00CAB1	C8734FPB20160 315AV00CAB1			
Start File	AD000000	BD000000			
Finish File	AD005526	BD005301			
Post-Verification	C8734FPB20160 315BV00CAA1	C8734FPB20160 315BV00CAA1			
Depth Return Error (in.)	N/A	0.5 high			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on both sondes.

Pre- and post-survey verification measurements met the acceptance criteria for the established systems.

Analysis Notes

Analyst	P. D. Henwood	Date	04/27/16
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as FTB20160223_CC-136_corr01 for the SGLS, using an efficiency function and corrections for casing and dead time as determined during annual response checks.

NMLS data are reported in counts per second.

The internal upsets in casing thickness at 5-ft intervals significantly affect both gamma and moisture log response, with the result being a distinctive "saw tooth" pattern in the log results after conventional casing correction has been applied. This was corrected by calculating an "effective casing thickness" for each measurement point and calculating a casing correction based on this value. Log detectors respond to material both above and below the actual measurement point, so the first step is to determine a sensitivity function describing the variation in detector sensitivity as a function of depth above and below the measurement point. For the gamma log, the sensitivity range was assumed to be within +/- 1 ft of the measurement point. For the moisture log, the sensitivity range was estimated to be within +/- 0.5 ft of the measurement point. The sensitivity function was then used to create an estimated "effective thickness" based on distance from the nearest casing joint above the measurement point.

For both the gamma and moisture log, a depth offset was estimated to align the measurement points and the casing joints. This allows the effective thickness to be estimated for all measurement points. For measurement points that fall between casing joints, the effective thickness is equal to the nominal casing wall thickness (0.25 in.), but for measurement points at or near a casing joint the effective thickness may be greater, up to a maximum or 0.42 in. for a point at the casing joint and thus well inside the internal upset region.

For the gamma log, a corrected activity was calculated by using a casing correction calculated from the effective casing thickness at each measurement point.

For the moisture log, an empirical correction factor was determined by examining the log over an interval of relatively stable moisture content. For measurement points well within the interval between casing joints (nominal casing thickness = 0.25 in.), the correction factor is assumed to be 1.0. For measurement points within a casing joint (casing thickness = 0.42 in.), the correction factor is estimated to be 1.2. Correction factors for intermediate effective thickness values are interpolated, using a simple linear function.

All of the sonic drill casing was in 5-ft lengths. From the character of the total gamma and moisture logs, it is apparent that casing joints occur at 5-ft intervals at approximately 4, 9, 14... ft.

Most log plots show both "raw" and "corrected" values. Raw values are those computed for a constant casing thickness. Corrected values are those computed from the effective casing thickness.

The HGU[5] is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Model Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

Results and Interpretations

No manmade radionuclides were detected. An apparent increase in the 609-keV Bi-214 line relative to the 1764-keV Bi-214 line indicates the presence of radon inside the casing.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content.

The KUT and moisture repeat plots indicate that the respective systems were working properly.

List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-120 ft)

[5] Hanford Gamma Unit

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Natural Gamma Logs (0-120 ft)
Combination Plot (0-120 ft)
Total Gamma & Moisture (0-120 ft)
Total Gamma & Hanford Gamma Unit (0-120 ft)
Repeat Section of Natural Gamma Logs (47-53 ft)
Moisture Repeat Section (47-53 ft)

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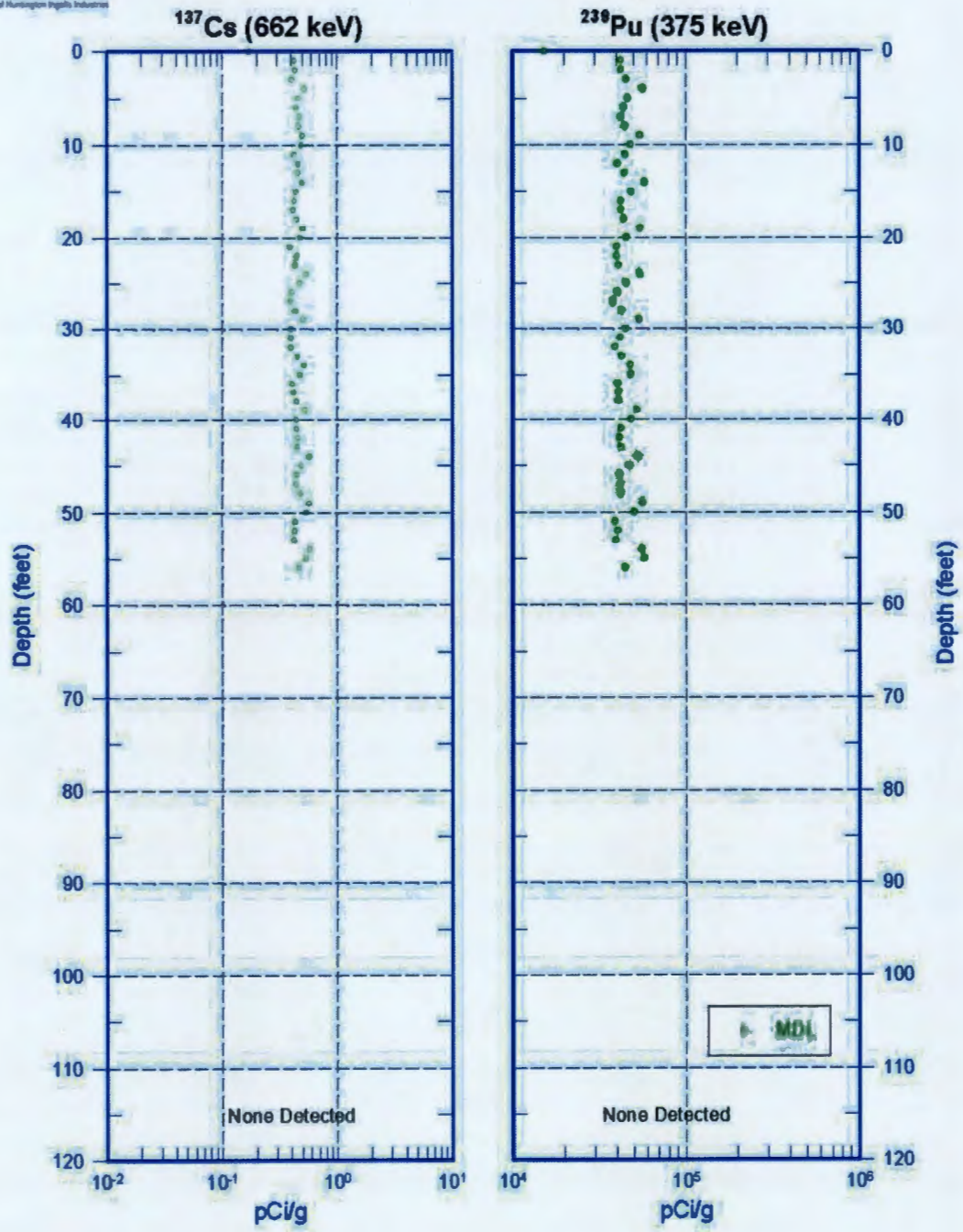
199-H4-88 (C8734)
Manmade Radionuclides



Zero Reference - Ground Surface

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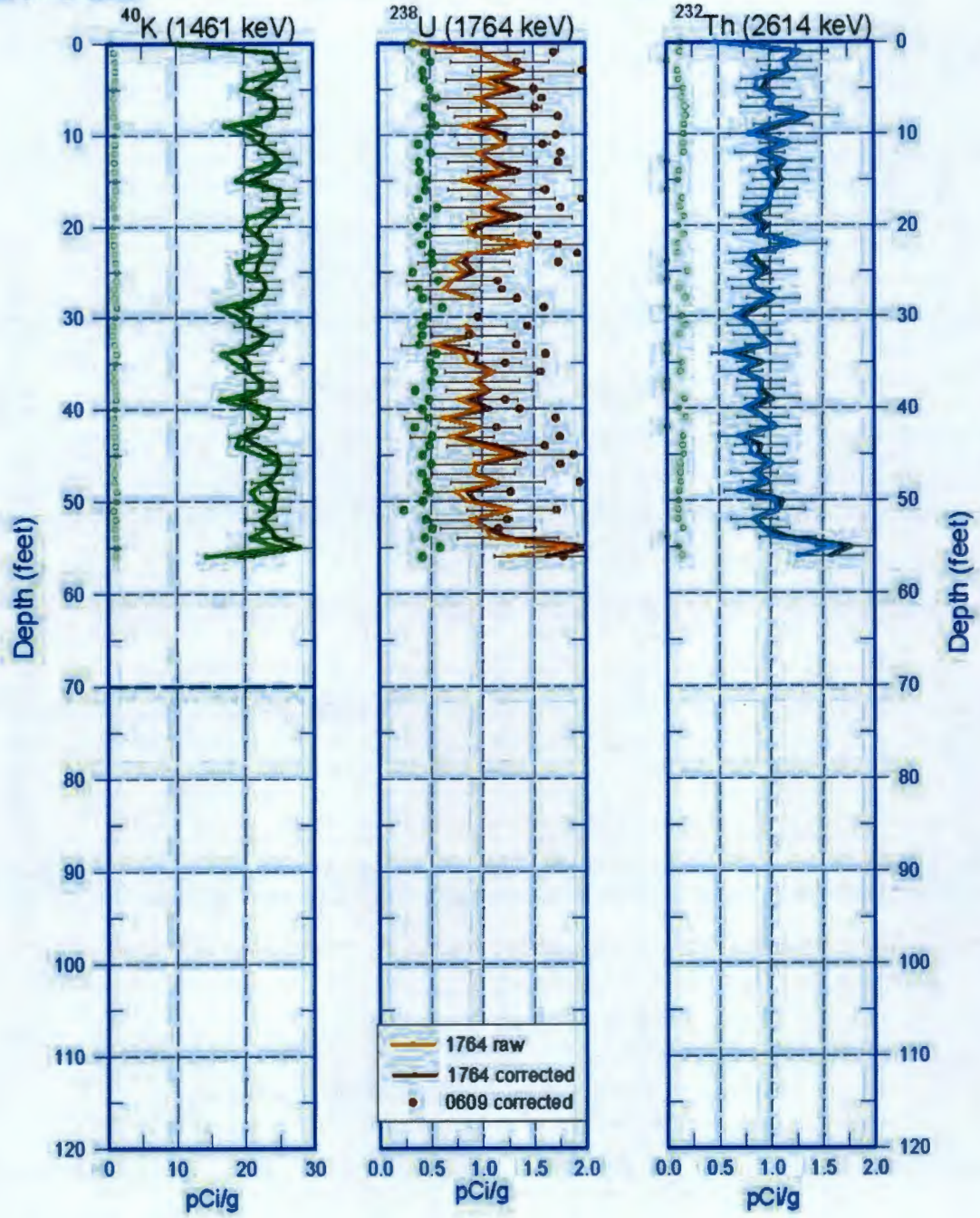
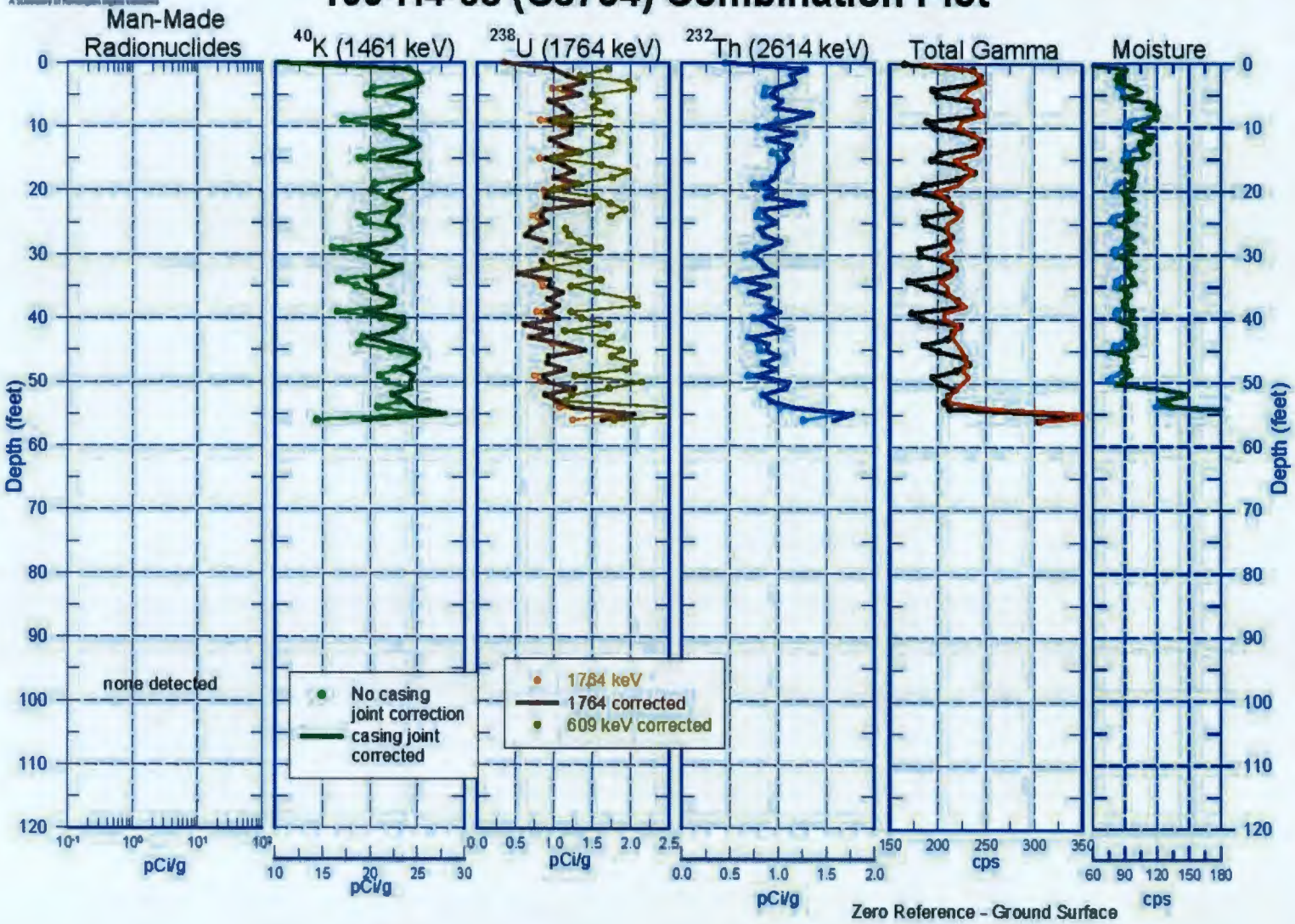
199-H4-88 (C8734)
Natural Gamma Logs



Zero Reference - Ground Surface

199-H4-88 (C8734) Combination Plot



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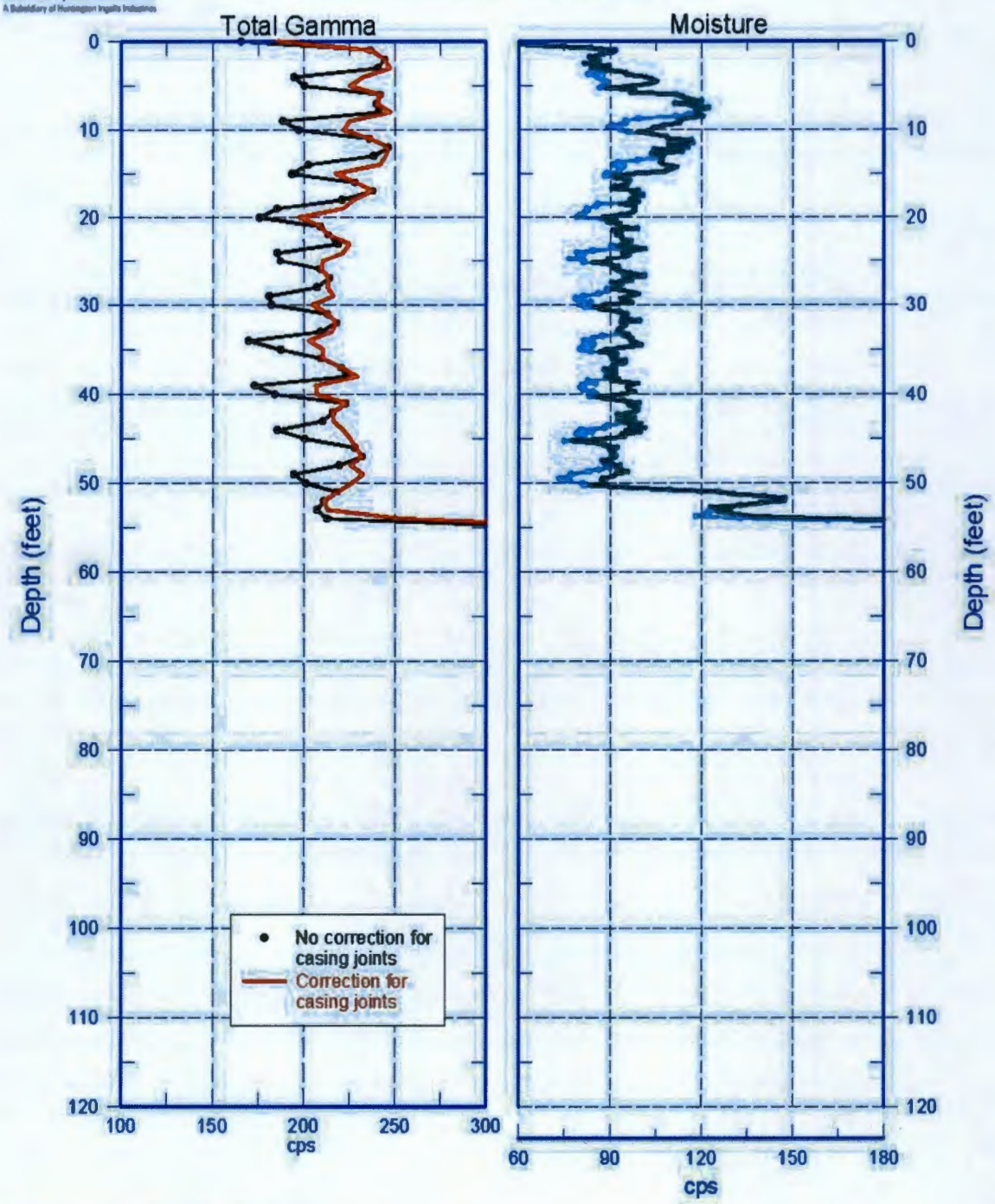
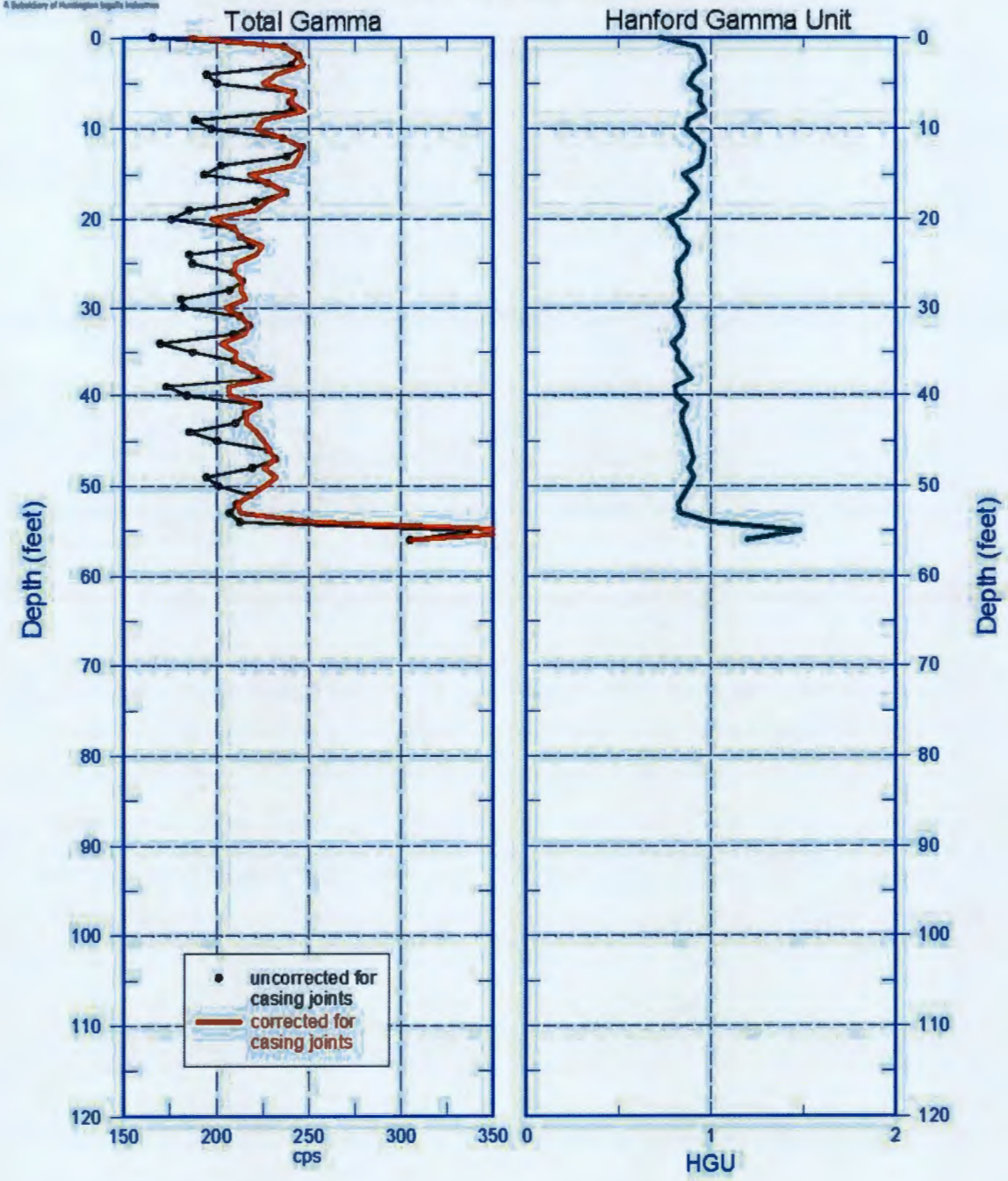
199-H4-88 (C8734)
Total Gamma & Moisture



Zero Reference - Ground Surface

199-H4-88 (C8734)
Total Gamma & Hanford Gamma Unit



Zero Reference - Ground Surface

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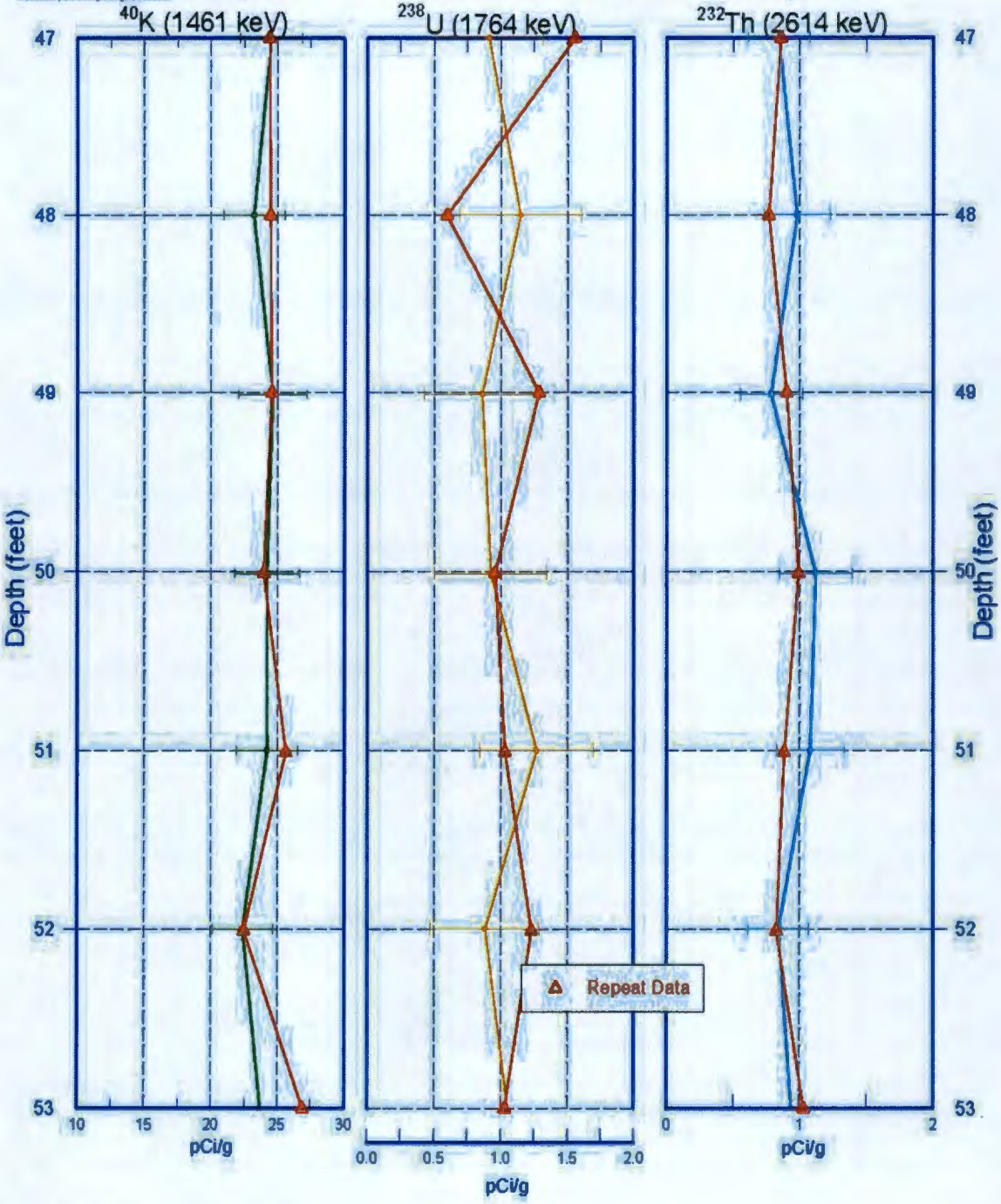
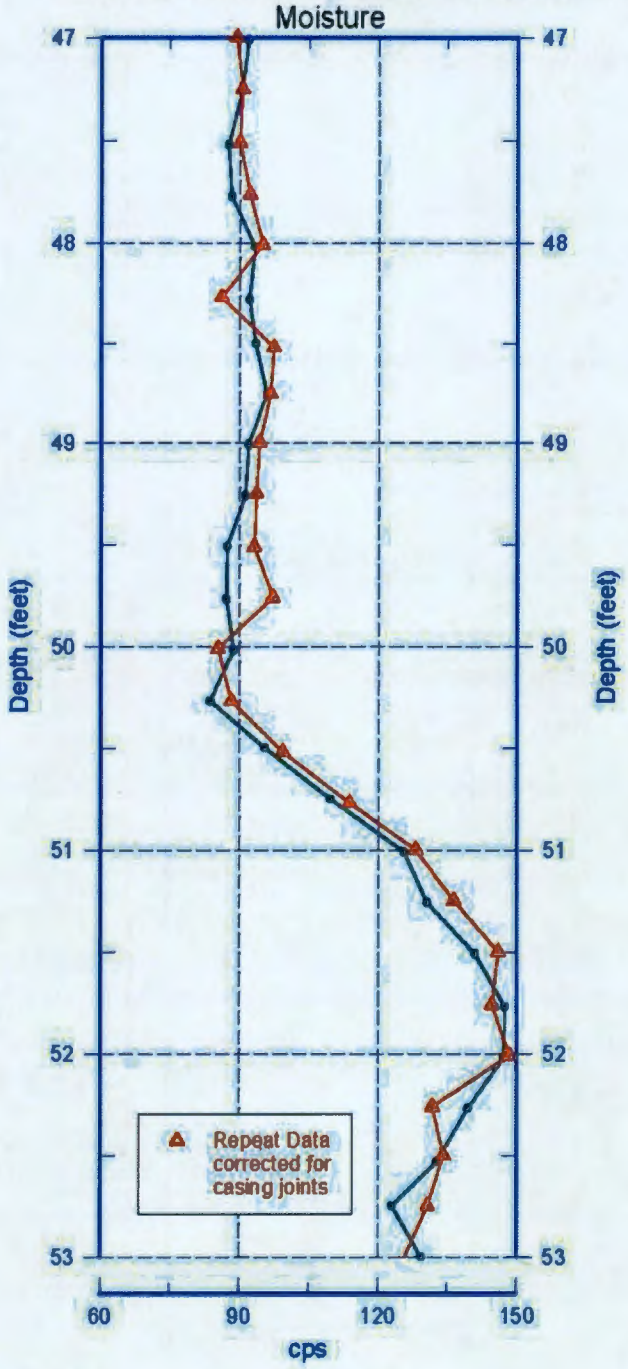
199-H4-88 (C8734)

Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

199-H4-88 (C8734)
Moisture Repeat Section



Zero Reference - Ground Surface

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WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 03/31/16	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 04/07/16	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C8734 (199-H4-88) at 100H Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 100H

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
100H-2 (CHPRC) and 100H-3 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C8734	199-H4-88	577850.51	152833.59		Center of Casing
				131.698	"X" on Rim
				130.917	Brass Survey Marker

Notes:

131.399 Top Inner Casing, North Edge

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 that this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

4-7-16

A-6003-659 (04/03)

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Split Spoon Sample Photos C8734

Soil sample at 30 ft bgs

30 ft Bottom of Liner A

30 ft Bottom of Liner A

30 ft Bottom of Liner A Close up

30 ft Split Spoon Liners

Soil sample at 35 ft bgs Liner

35 ft End of a Liner

35 ft End of a Liner

Soil sample at 40 ft bgs

40 ft End of a Liner

40 ft End of a Liner

40 ft End of two Liners

Soil sample at 44 ft bgs

44 ft Liner B

44 ft Bottom of Liner B

Appendix G

Borehole Documentation for C8735

- Well Summary Sheet for C8735
- Borehole Log for C8735
- Log Data Report for C8735
- Final Survey Report for C8735

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WELL SUMMARY SHEET

Start Date: 1/27/16
Finish Date: 3/30/16
Page 1 of 1

Well ID: C8735	Well Name: ~~199-H4-87~~ 199-H4-89
Location: S. of 100 H Pump & Treat	Project: HR-3 Replacement Wells
Prepared by: Julie Johanson Date: 4/6/16	Reviewed by: J.D. MEHRER ~~Environmental Scientist~~ Date: 4-13-16
Signature: Julie Johanson	Signature:

CONSTRUCTION DATA

Surface Completion:

4'x4'x6" Concrete Pad with brass survey marker and 6 9/16" protective monument (3.00' ags)

Well Completion material:

Type I/II Portland Cement
0.00' bgs - 10.10' bgs

Granular Bentonite 3/8"
10.10' bgs - 24.02' bgs

3/8" Bentonite Pellets
24.02 bgs - 27.10' bgs

10-20 Colorado Silica Sand
27.10' bgs - 50.25' bgs

3/8" Bentonite Pellets
50.25' bgs - 53.40' bgs

Natural Fill
53.40' bgs - 56.60' bgs

Permanent Well:

6" ID Stainless Steel Blank
2.00' ags - 31.42' bgs

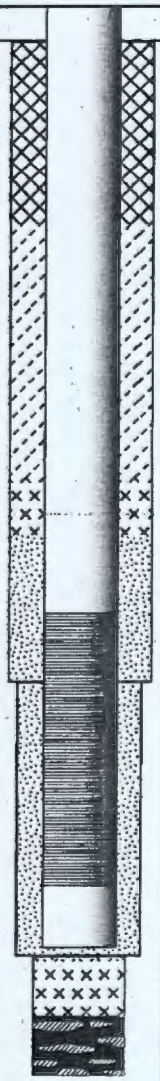
6" ID Stainless Steel 0.040 Slot Screen
31.42' bgs - 46.37' bgs

6" ID Stainless Steel Sump
46.37' bgs - 49.35' bgs

All temporary casing completely removed from ground on 3/17/2016

ags = above ground surface
bgs = below ground surface

Diagram



GEOLOGIC/HYDROLOGIC DATA

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

Graphic Log

Lithologic Description

0-15: Silty Sandy Gravel (msG)

15-29: Sandy Gravel (sG)

29-35: Silty Gravel (mG)

35-45: Sandy Gravel (sG)

45-46: Silty Sand (mS)

46-56.60: Silt (M) [RUM]

A-6003-643 (03/03)

BOREHOLE LOG

Page 1 of 2
Date: 1-27-16

Well ID: C8735 | Well Name: 199-H4-89 | Location: S of 100H Pump + Treat

Project: HR-3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0				0-15: Silty Sandy Gravel (msG) @ 5' bgs: 15% silt, 40% v.fn.-v.crs. sand (crs); 45% v.fn. peb.-sm. cob; max 100mm, moist; poorly sorted; sub ang.-sub rnd.; s: 85%f/15%m; g: 65%m/35%f; strg-v.strg HCl rxn; 10YR 3/3 dark brown.	Sonic
					Fill material to ~29'
5	G.S.				Archive @ 5' bgs
10	G.S.			@ 10' bgs: 15% silt, 40% v.fn.-v.crs. sand (crs), 45% v.fn. peb.-sm. cob; max 112mm; sub ang.-sub rnd.; s: 85%f/15%m; g: 50%m/50%f; strg. HCl rxn	Archive @ 10' bgs
15	G.S.			SGW 1-27-16 ~~@ 15' bgs~~ 15-29: Sandy Gravel (sG) 10% silt, 45% v.fn.-v.crs. sand (crs), 45% v.fn. peb.-lg. cob (med.-crs); max 140mm; moist, poorly sorted; ang.-sub. rnd.; s: 70%f/30%m, g: 65%m/35%f; strg. HCl rxn; 10YR 3/3 dark brown	Archive @ 15' bgs
20	G.S.			@ 20' bgs: 10% silt, 40% v.fn.-v.crs. sand (med.-crs), 50% v.fn.-v.crs. peb.; max 65mm; moist-slightly moist; s: 70%f/30%m, g: 55%m/45%f; strg.-v.strg HCl rxn; 10YR 4/3 brown	Archive @ 20' bgs.
25	G.S.			@ 25' bgs: 10% silt, 45% v.fn.-v.crs sand (med.-crs), 45% v.fn. peb.-lg. cob. f max 135mm, moist, s: 75%f/25%m; g: 60%m/40%f; strg. HCl rxn; 10YR 3/3 dark brown	Archive @ 25' bgs
30	G.S.			JAF 1-28-16 30-29'-35: Silty Gravel (mG) 45% silt/clay, 10% v.fn.-v.crs. sand, 45% v.fn. peb.-sm. cob; max 107mm; moist; poorly sorted, sub ang.-sub rnd.; s: 75%f/25%m; g: 70%m/30%f, No HCl rxn; 10YR 4/1 dark gray; med.-good plasticity	Archive @ 30' bgs.
35	G.S.			35-45: Sandy Gravel (sG) 10% silt, 40% v.fn.-v.crs sand (med.-crs); 50% v.fn. peb.-sm. cob; max 96mm, slightly moist-moist, poorly sorted, sub ang.-sub rnd., s: 70%m/30%f; g: 70%m/30%f; med.-strg. HCl rxn; 2.5Y 3/1 very dark gray	

Reported By: Julie Johanson | Reviewed By: Sarah Springer

Title: Geologist | Title: geologist

Signature: Julie Johanson | Date: 1-28-16 | Signature: Sarah Springer | Date: 05-03-16

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 2
Date: 1-28-16

Well ID: C8735 | Well Name: 199-H4-89 | Location: S of 100H Pump + Treat

Project: HR-3 Replacement Wells | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
40	G.S.			35-45: Sandy Gravel (sG)	Sonic Rig
				@ 40' bgs: 10% silt, 50% v.fn.-v.crs. sand (med.-crs.),	Archive @ 40' bgs
				40% v.fn. peb. - sm. cob.; max 114 mm; slightly moist - moist;	
				poorly sorted, sub ang. - sub rnd.; s: 60% m/40% f, g: 70% m/	DTW: 42.27' bgs (3-10-16)
				30% f; mod. - strg. HCl rxn; 2.5Y 3/2 very dark	
45	G.S.	Sieve Sample 45'-46'		grayish brown; Colorado Silica Sand from ~~same~~ the 1-28-16	
	~~G.S.~~	~~HC~~		previous well in sample	Archive @ 45' bgs
	G.S.	Sieve Sample 45'-46'		@ 45' bgs: 10% silt, 50% v.fn.-v.crs. sand (med.-crs.);	Archive @ 45'-46' bgs
				40% v.fn. peb. - sm. cob.; max 125 mm; moist - wet; poorly	Archive @ 46' bgs.
				sorted; s: 70% f / 30% m, g: 55% m / 45% f; mod. - strg. HCl	
				rxn; 2.5Y 3/2 very dark grayish brown	
50				45-46: Silty Sand (MS)	
				35% silt, 60% v.fn.-crs. sand, <5% v.fn.-crs. peb.; max	
				25 mm, wet; sub ang.-sub rnd.; moderatly sorted; s: 85% f / 15%	
				m; g: 80% m / 20% f; strg. - v. strg. HCl rxn; 10YR 4/4	
				dark yellowish brown	
55				46-56.60: Silt (M) [BUM]	
				98% silt, 1% v.fn.-crs. sand, 1% v.fn.-med. peb.; max 10	TD: 56.60' bgs
				mm; wet, well sorted; v. strg. HCl rxn, 10YR 5/4	
				yellowish brown	
60					
65					
70					
75					

Reported By: Julie Johanson | Reviewed By: Sarah Springer

Title: Geologist | Title: geologist

Signature: Julie Johanson | Date: 3-10-16 | Signature: Sarah Springer | Date: 05-03-16

A-6003-642 (03/03)

199-H4-89 (C8735)
Log Data Report

Borehole Information

Log Date	2016-03-14	Filename	C8735_HG-NM_2016-03-14	Site	100-H
Coordinates (WA St Plane)		DTW[1] (ft)	42.5	DTW Date	03/14/16

North (m)	East (m)	Drill Date	TOC[2] Elevation	Total Depth (ft)
N/A	N/A	3/10/16	N/A	50

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	Sonic	0.5	12	10.88	0.25 – 0.56	-0.5	35.11
Threaded Steel	Sonic	0.4	10 1/2	9 5/8	0.25 – 0.42	-0.4	50.15

Borehole Notes

The logging engineer measured depth to water with an e-tape prior to logging. Drill depth and casing depth were provided by the wellsite geologist.

The borehole was drilled to 34.92 ft on January 26, 2016, using 12-in. casing. On March 10, 2016, the hole was extended to 50 ft, using 10.5-in. casing. This borehole was drilled by a sonic method, using internal-upset casing in 5-ft lengths. This results in a significant reduction in count rate for both the gamma log and neutron moisture log at each casing joint. The sonic drill casing, through which log data were collected, was manufactured by Terra Sonic International. **A telephone conversation with the manufacturer**'s representative indicated that the 12-in. casing has a nominal wall thickness of 0.25 in. At the end of each 5-ft length, an insert with either a box (female) or pin (male) thread is welded inside the pipe. When the box and pin are screwed together, the total length of the insert is 13.5 in. This consists of 5 in. on the pin side of the joint, and 8.5 in. on the box side. Over this distance, wall thickness is 0.56 in. Both inserts are tapered for an additional 4.5 in. to avoid a sharp edge on the inside of the casing. The 10.5-in. casing is similar in construction to the 12-in. casing, with the exception that the wall thickness inside the joints is 0.42 in.

Logging Equipment Information

Logging System	Gamma 5 Tb	Type	HPGe SGLS[3]
Effective Calibration Date	2/23/16	Serial No.	54-TP13441B
Calibration Reference	HGLP-CC-136, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 1L	Type	HPGe SGLS
Effective Calibration Date	10/29/2015	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-130, Rev. 0	Logging Procedure	SGRP-PRO-OP-53010, Rev. 0

Logging System	Gamma 1H	Type	NMLS[4]
Effective Calibration Date	10/21/15	Serial No.	H310700352
Calibration Reference	HGLP-CC-131, Rev. 1	Logging Procedure	SGRP-PRO-OP-53016, Rev. 0

[1] depth to water inside casing
[2] top of casing
[3] Spectral Gamma Logging System
[4] Neutron Moisture Logging System

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Logging System	Gamma 5 Pb	**Type**	NMLS
Effective Calibration Date	04/15/2015	**Serial No.**	H34055445
Calibration Reference	HGLP-CC-116, Rev. 0	**Logging Procedure**	SGRP-PRO-OP-53024, Rev. 0

SGLS Log Run Information

Log Run	**1**	**2 Repeat**	**5**	**6 Repeat**	
HEIS Number	1018153	1018154	1018157	1018158	
Date	2/01/16	2/01/16	3/14/16	3/14/16	
Logging Engineer	Felt	Felt	Felt/Spatz	Felt/Spatz	
Start Depth (ft)	0.0	26.0	33.0	35.0	
Finish Depth (ft)	34.0	30.0	51.0	38.0	
Count Time (sec)	100	100	100	100	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
Log Speed (ft/min)	N/A	N/A	N/A	N/A	
Pre-Verification	AL293CAB	AL293CAB	C8735FTB20160 314AV00CAB1	C8735FTB20160 314AV00CAB1	
Start File	AL293000	AL293035	-AD003300	-BD003500	
Finish File	AL293034	AL293039	-AD005100	-AD005100	
Post-Verification	AL293CAA	AL293CAA	-BVV00CAA	-BVV00CAA	
Depth Return Error (in.)	N/A	0.0	N/A	high 1	
Comments	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made	

NMLS Log Run Information

Log Run	**3**	**4 Repeat**	**7**	**8 Repeat**	
HEIS Number	1018155	1018156	1018159	1018160	
Date	2/01/16	2/01/16	3/14/16	3/14/16	
Logging Engineer	Felt	Felt	Felt/Spatz	Felt/Spatz	
Start Depth (ft)	0.0	30.0	33.0	38.0	
Finish Depth (ft)	34.75	34.0	42.5	40.0	
Count Time (sec)	15	15	15	15	
Live/Real	R	R	R	R	
Shield (Y/N)	NA	NA	NA	NA	
MSA Interval (ft)	0.25	0.25	0.25	0.25	
Log Speed (ft/min)	N/A	N/A	N/A	N/A	
Pre-Verification	AH238CAB	AH238CAB	C8735FPB20160 314AV00CAB1	C8735FPB20160 314AV00CAB1	
Start File	AH238000	AH238140	-AD003300	-BD003800	
Finish File	AH238139	AH238156	-AD004251	-BD004000	
Post-Verification	AH238CAA	AH238CAA	-BV00CAA1	-BV00CAA1	
Depth Return Error (in.)	N/A	high 1/2"	N/A	high 1/2"	
Comments	None	None	None	None	

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Logging Operation Notes

A centralizer was installed on both sondes.

The hole was logged after the first casing and again after the second casing.

Pre- and post-survey verification measurements met the acceptance criteria for the established systems.

Analysis Notes

Analyst	R G McCain	**Date**	04/07/16
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0, SGRP-PRO-OP-53052, Rev. 0		

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in EXCEL templates identified as C8735_AL20151029_CC-130_corr0 and C8735_FTb20160223_CC-136_assay_corr01, using an efficiency function and corrections for casing and dead time as determined during annual response checks.

NMLS data are reported in counts per second.

The internal upsets in casing thickness at 5-ft intervals significantly affect both gamma and moisture log response, **with the result being a distinctive** "saw tooth" **pattern in the** log results after conventional casing correction has been **applied. This was corrected by calculating an "effective casing thickness" for each measurement point and** calculating a casing correction based on this value. Log detectors respond to material both above and below the actual measurement point, so the first step is to determine a sensitivity function describing the variation in detector sensitivity as a function of depth above and below the measurement point. For the gamma log, the sensitivity range was assumed to be within +/- 1 ft of the measurement point. For the moisture log, the sensitivity range was estimated to be within +/- 0.5 ft of the measurement point. The sensitivity function was then used to create an **estimated "effective thickness"** based on distance from the nearest casing joint above the measurement point.

For both the gamma and moisture log, a depth offset was estimated to align the measurement points and the casing joints. This allows the effective thickness to be estimated for all measurement points. For measurement points that fall between casing joints, the effective thickness is equal to the nominal casing wall thickness (0.25 in.), but for measurement points at or near a casing joint the effective thickness may be greater.

For the gamma log, a corrected activity was calculated by using a casing correction calculated from the effective casing thickness at each measurement point.

For the moisture log, an empirical correction factor was determined by examining the log over an interval of relatively stable moisture content. For measurement points well within the interval between casing joints (nominal casing thickness = 0.25 in.), the correction factor is assumed to be 1.0. For measurement points within a casing joint the correction factor is estimated to be 1.2 for casing thickness equal to 0.42 in., and 1.3 for casing thickness equal to 0.56 in. Correction factors for intermediate effective thickness values are interpolated using a simple linear function.

Most log **plots show both "raw" and "corrected" values. Raw values are those computed for a constant casing** thickness. Corrected values are those computed from the effective casing thickness.

Repeat logs were run for both logging events. For brevity, repeat data for both runs are shown in the same log plots.

The HGU[5] is an empirical unit of gamma activity proposed as a means to standardize gamma log response across multiple logging systems with different response characteristics. The HGU is defined in terms of measurements in the Hanford Borehole Model Facility, and the magnitude is selected such that 1 HGU is approximately equivalent to typical Hanford background activity, based on data from background samples as reported in *Hanford Site Background Part 2, Soil Background for Radionuclides* (DOE/RL-96-12).

[5] Hanford Gamma Unit

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Results and Interpretations

No manmade radionuclides were detected. Cs-137 was detected at the MDL at a depth of 50 ft, but inspection of the gamma energy spectra shows no evidence of a photopeak at 662 keV, so this is judged to be a false positive.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content.

The KUT and moisture repeat plots indicate that the respective systems were working properly. There is a discrepancy in the K-40 data for the second repeat run (34.6 to 35.6 ft). It appears that the original data may not have been properly corrected.

List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-120 ft)
Natural Gamma Logs (0-120 ft)
Combination Plot (0-120 ft)
Total Gamma & Moisture (0-120 ft)
Total Gamma & Hanford Gamma Unit (0-120 ft)
Repeat Section of Natural Gamma Logs (20-40 ft)
Moisture Repeat Section (28-40 ft)

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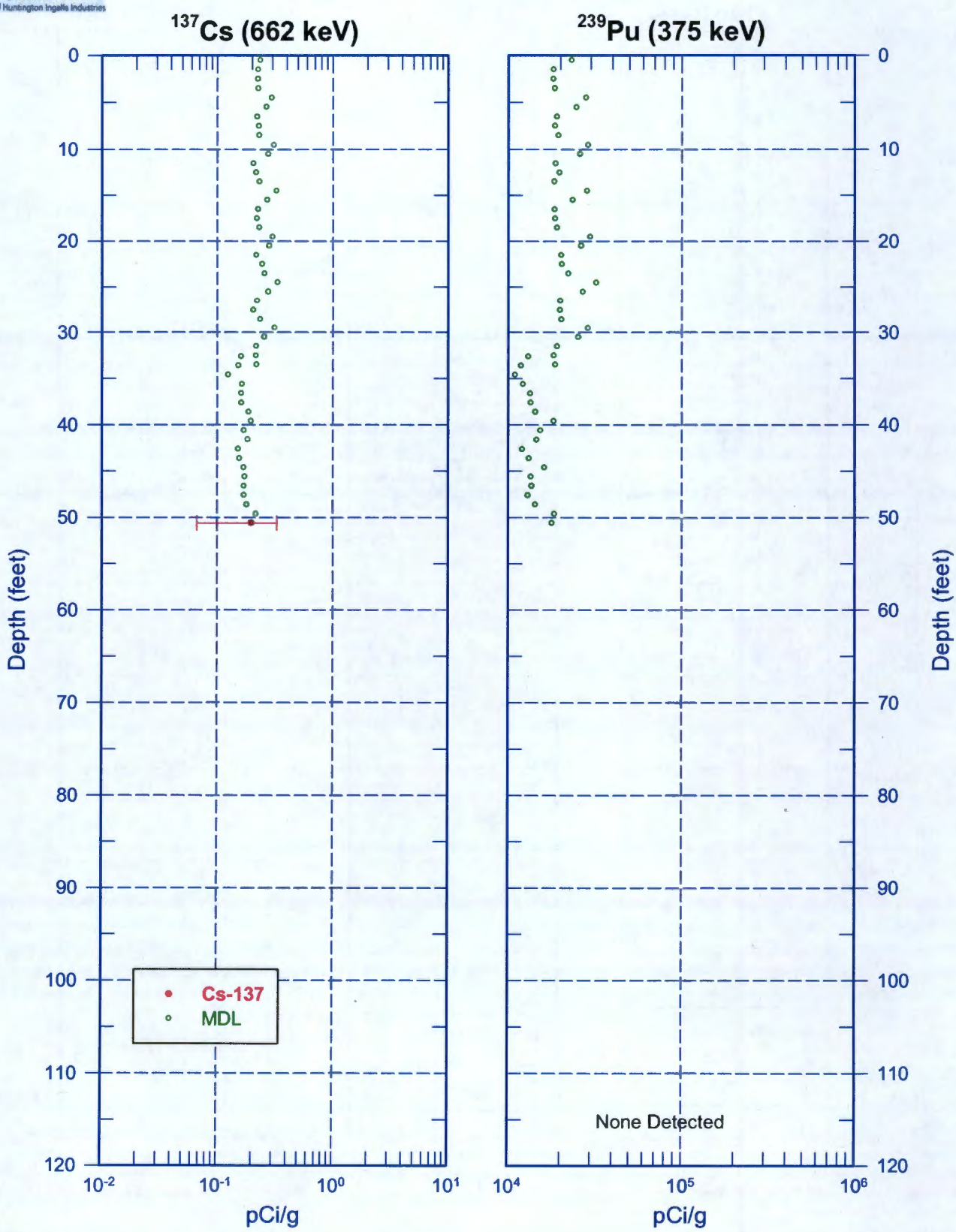
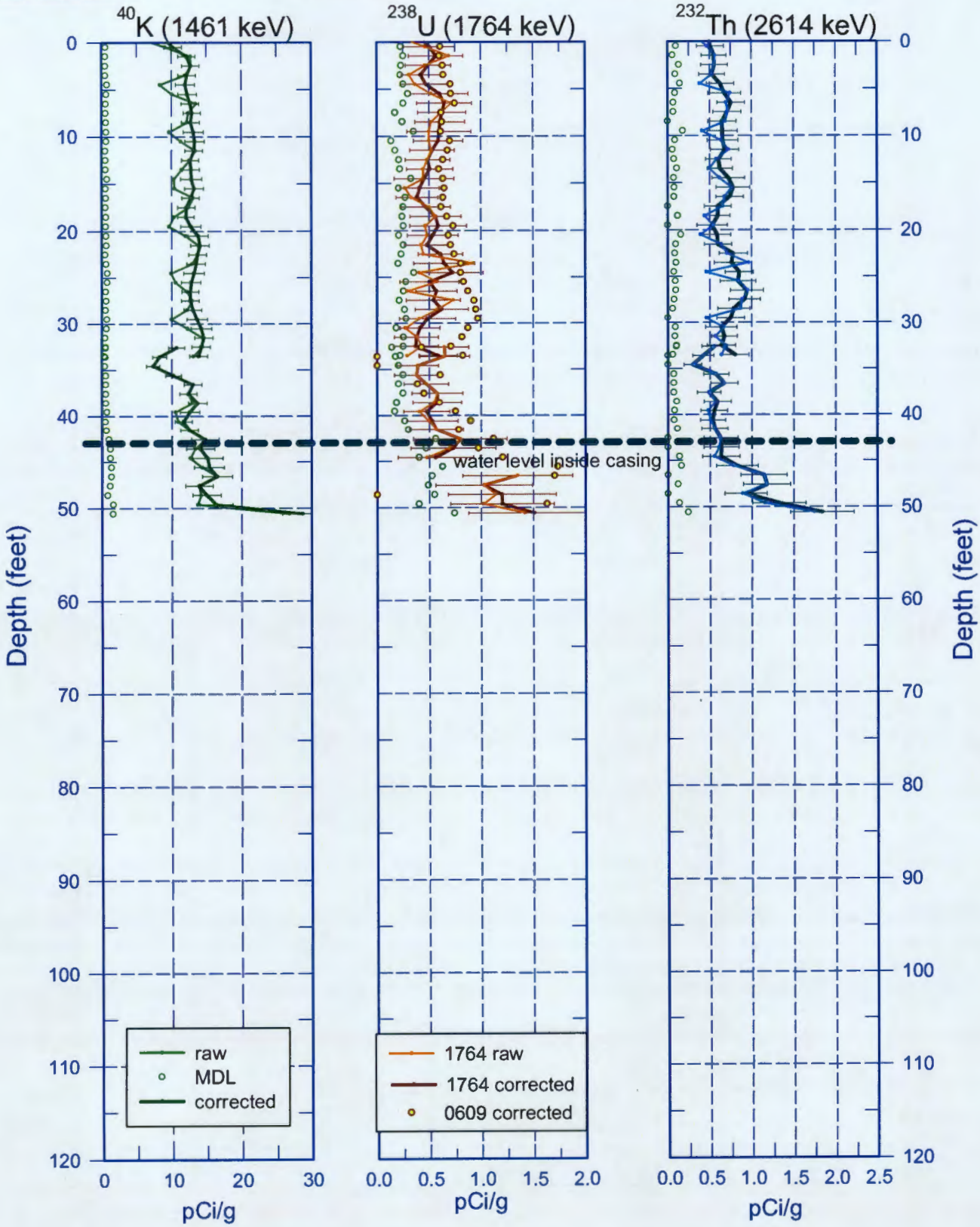
199-H4-89 (C8735)
Manmade Radionuclides



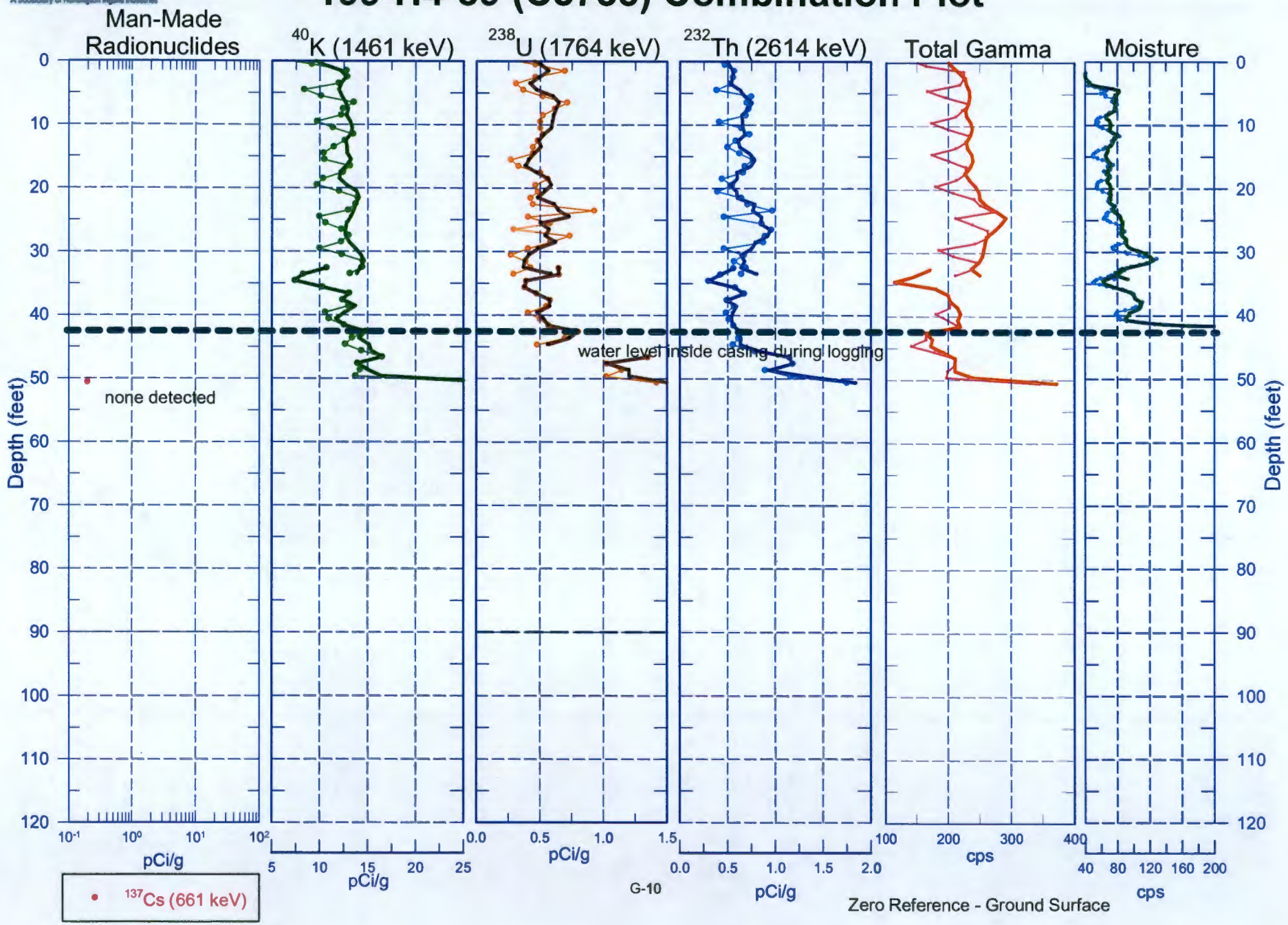
Zero Reference - Ground Surface

199-H4-89 (C8735)
Natural Gamma Logs

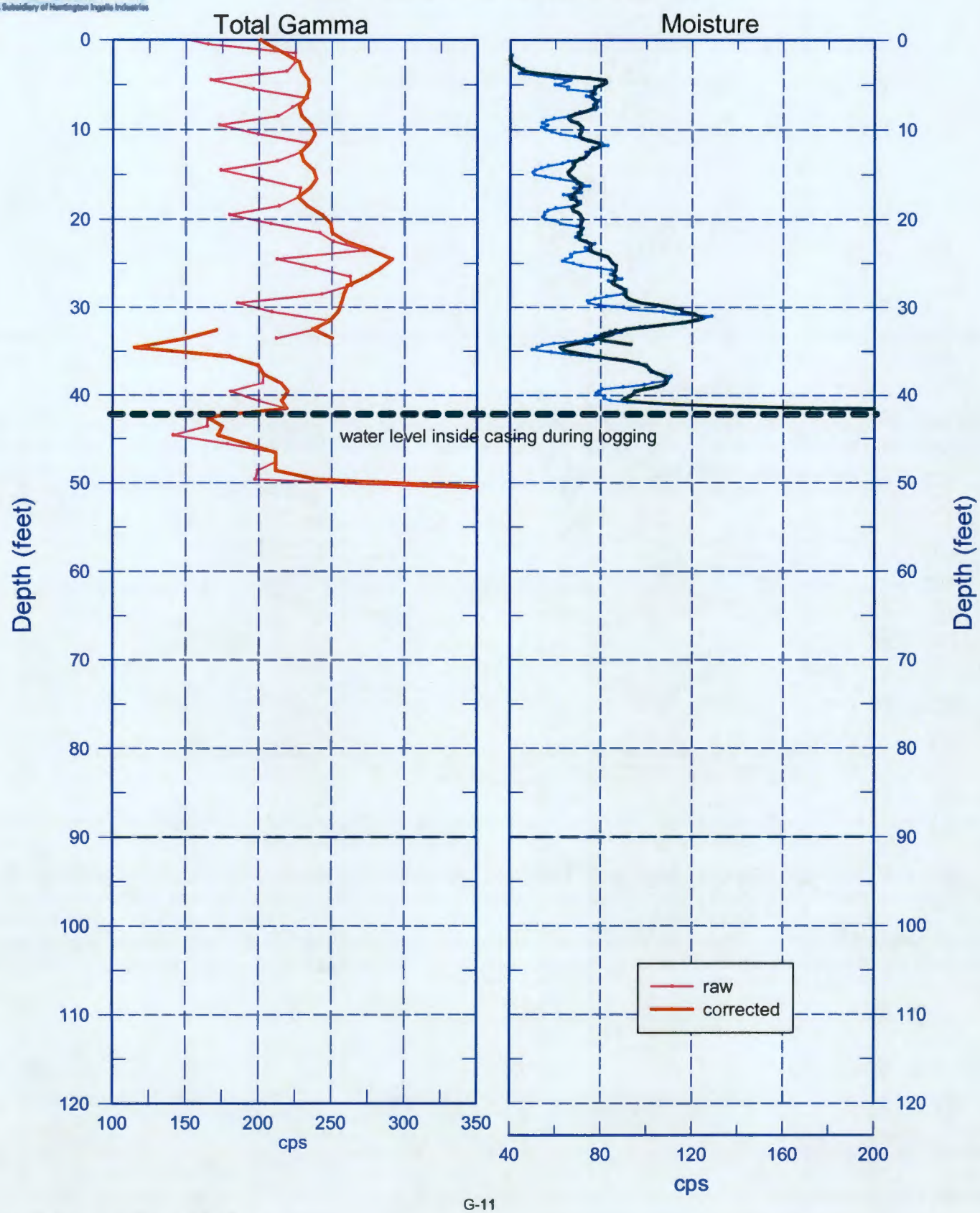


Zero Reference - Ground Surface

199-H4-89 (C8735) Combination Plot

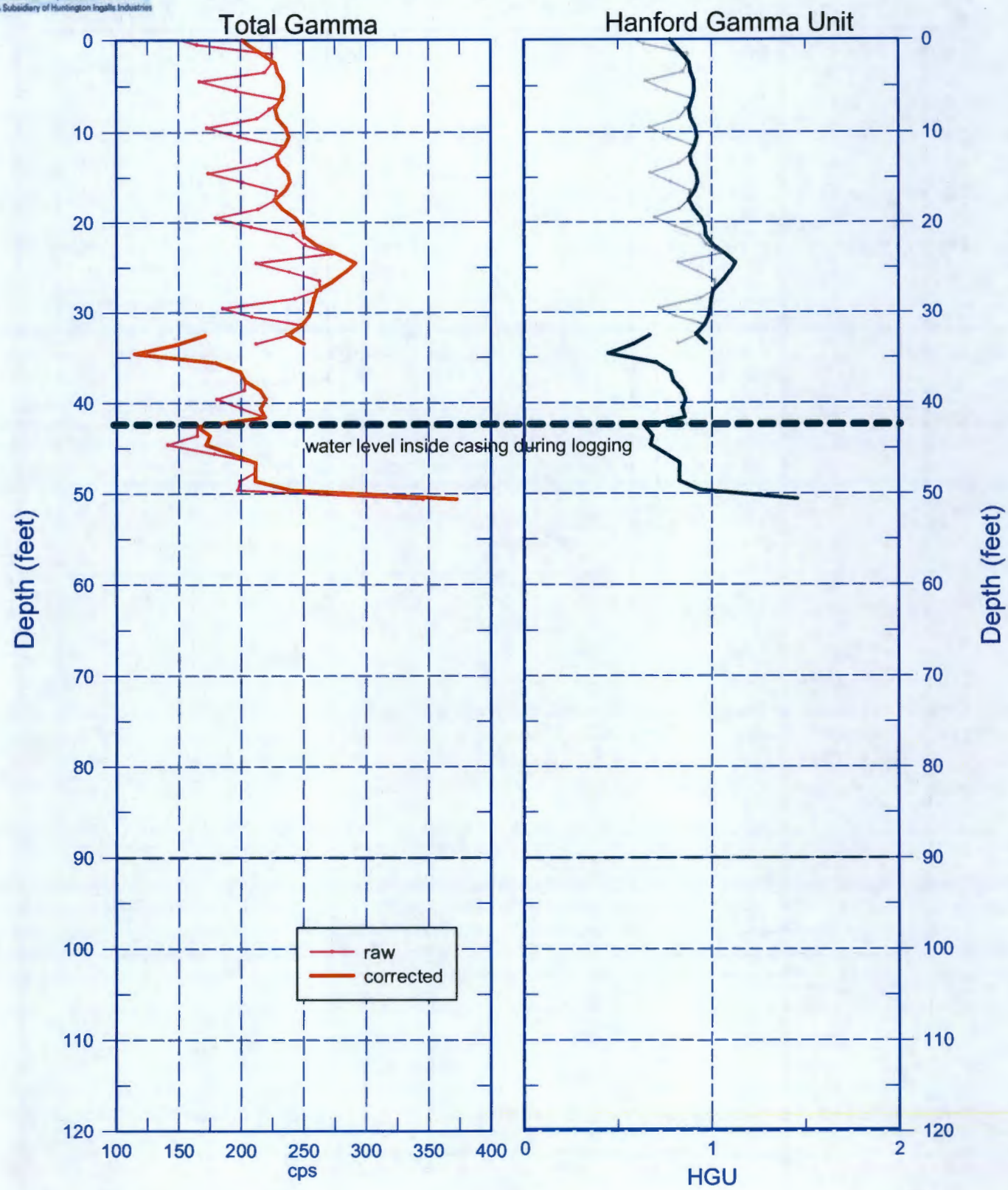


199-H4-89 (C8735)
Total Gamma & Moisture



Zero Reference - Ground Surface

199-H4-89 (C8735)
Total Gamma & Hanford Gamma Unit



Zero Reference - Ground Surface

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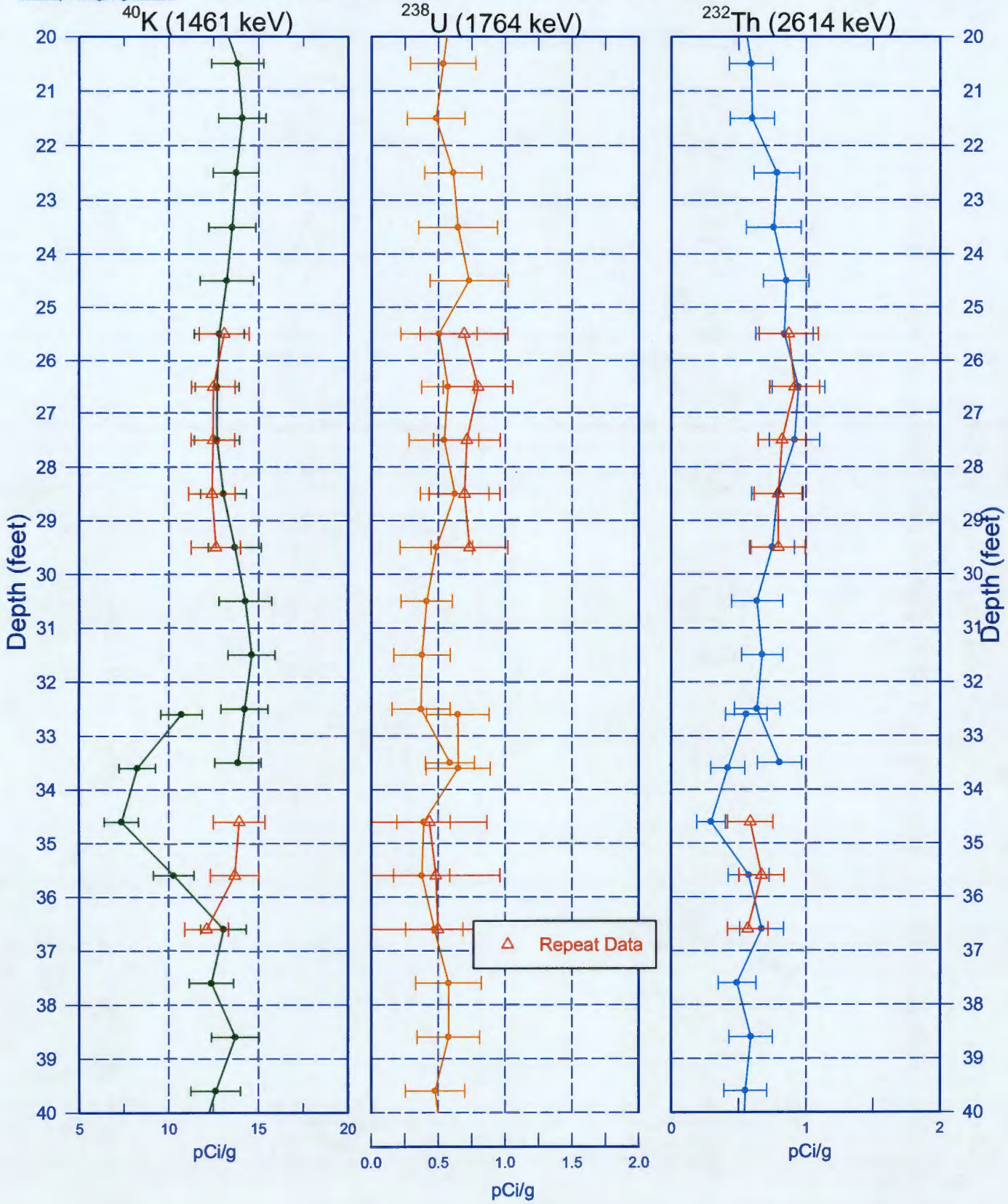
199-H4-89 (C8735)

Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

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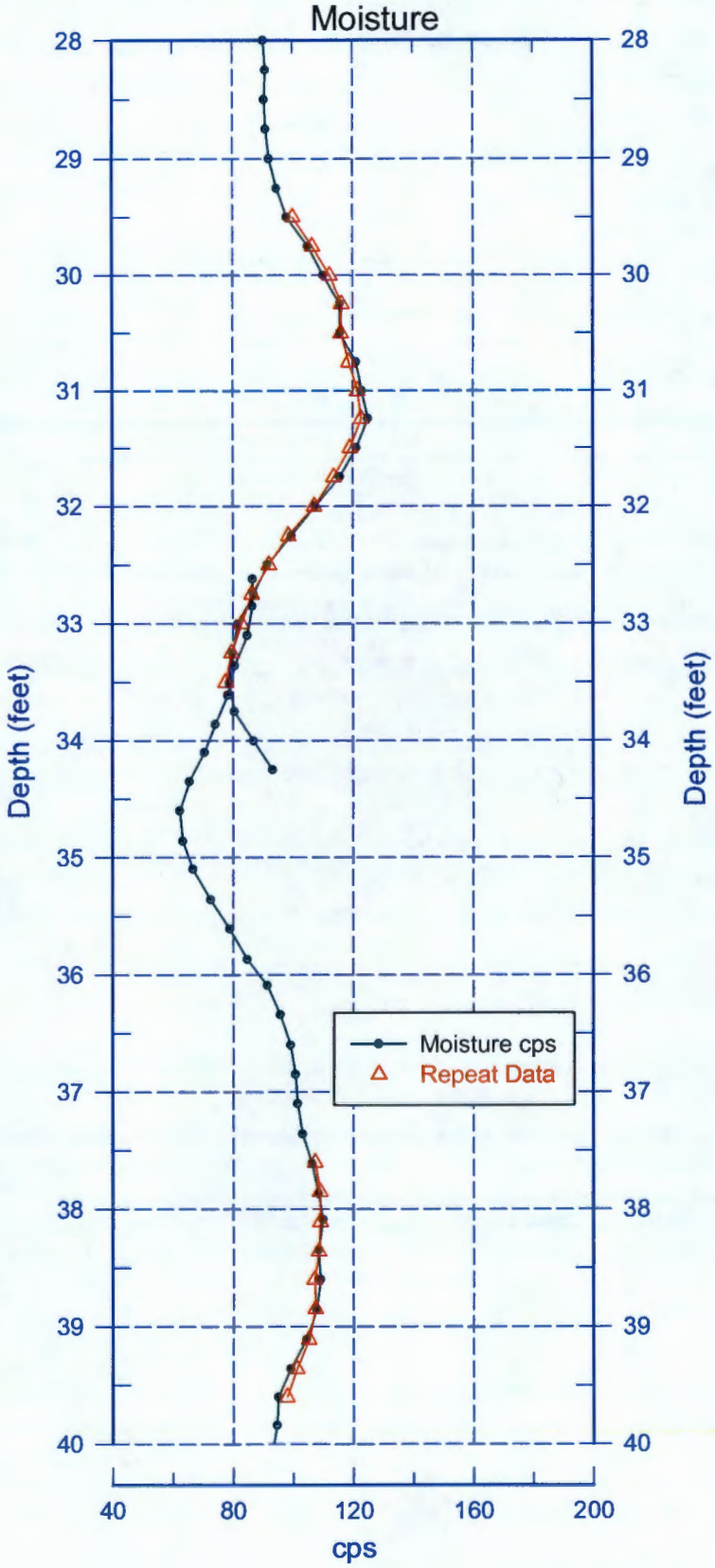
199-H4-89 (C8735)
Moisture Repeat Section



Zero Reference - Ground Surface

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 03/31/16	Requestor: Edward Rafuse (CHPRC)
Date of Survey: 04/07/16	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of Well C8735 (199-H4-89) at 100H Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 100H

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
100H-2 (CHPRC) and 100H-3 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C8735	199-H4-89	577923.32	152893.98		Center of Casing
				128.984	"X" on Rim
				128.198	Brass Survey Marker

Notes:

128.660 Top Inner Casing, North Edge

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 that this report is based on a field survey performed by me, or under my direct supervision.

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR

4-7-16

A-6003-659 (04/03)