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Revision 0

Borehole Summary Report for the Installation of One M-24 Well in the 300-FF-5 Operable Unit, FY 2018

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

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

CH2MHILL
Plateau Remediation Company

P.O. Box 1600
Richland, Washington 99352

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B. J. Thurnau
GRAM Northwest, LLC

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

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Terms

bgs	below ground surface
Holt	Holt Service Inc.
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CHPRC	CH2M HILL Plateau Remediation Company
DOW	description of work
Ecology	Washington State Department of Ecology
HCl	hydrochloric acid
HII	Huntington Ingalls Industries
IHT	industrial hygiene technician
NTU	nephelometric turbidity unit
OD	outer diameter
OU	operable unit
ppm	parts per million
RCT	radiological control technician
TD	total depth
VOC	volatile organic compound

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1 Introduction

This borehole summary report provides a general overview of the well drilling, construction, and development activities performed during the installation of one new groundwater monitoring well at the Hanford Site. The well is located in the 300-FF-5 Groundwater Operable Unit (OU) in the southern portion of the Hanford Site (shown within the area outlined in red on Figure 1). SGW-61963, *Description of Work for the Installation of One M-24 Monitoring Wells in the 300-FF-5 Groundwater Operable Unit, FY 2018* (hereinafter referred to as the description of work [DOW]), is the controlling document for installation of the new well. Well 699-S6-E3 (C9870) was installed downgradient (southeast) of the 316-4 Crib in accordance with DOE/RL-2017-49, *Cleanup Verification Package for the 316-4 Liquid Waste Disposal Crib.* Figure 2 provides a map of the well location.

The well was drilled, constructed, and developed between May 15 and May 24, 2018, by Holt Services Inc. (Holt) for CH2M HILL Plateau Remediation Company (CHPRC). Well site geology, well drilling documentation, and well construction documentation services were provided by GRAM Northwest, LLC. Geophysical logging services were provided by Huntington Ingalls Industries (HII).

The well was installed in response to Ecology et al., 1989, *Hanford Federal Facility Agreement and Consent Order*, Milestone M-024, which requires the installation of sufficient groundwater wells for monitoring, protection, and remediation of groundwater. The well was installed to support the remedies selected in EPA et al., 2013, *Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*. Monitoring well installation complied with the requirements of the *Resource Conservation and Recovery Act of 1976* and the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA).

Table 1 provides summary information for well identification and the installation date for new monitoring well 699-S6-E3 (C9870). Appendix A includes the well summary sheet, borehole log, geophysical log data reports, final civil survey report, and the well development and testing data sheet for the new well.

2 Drilling, Sampling, and Well Construction Activities

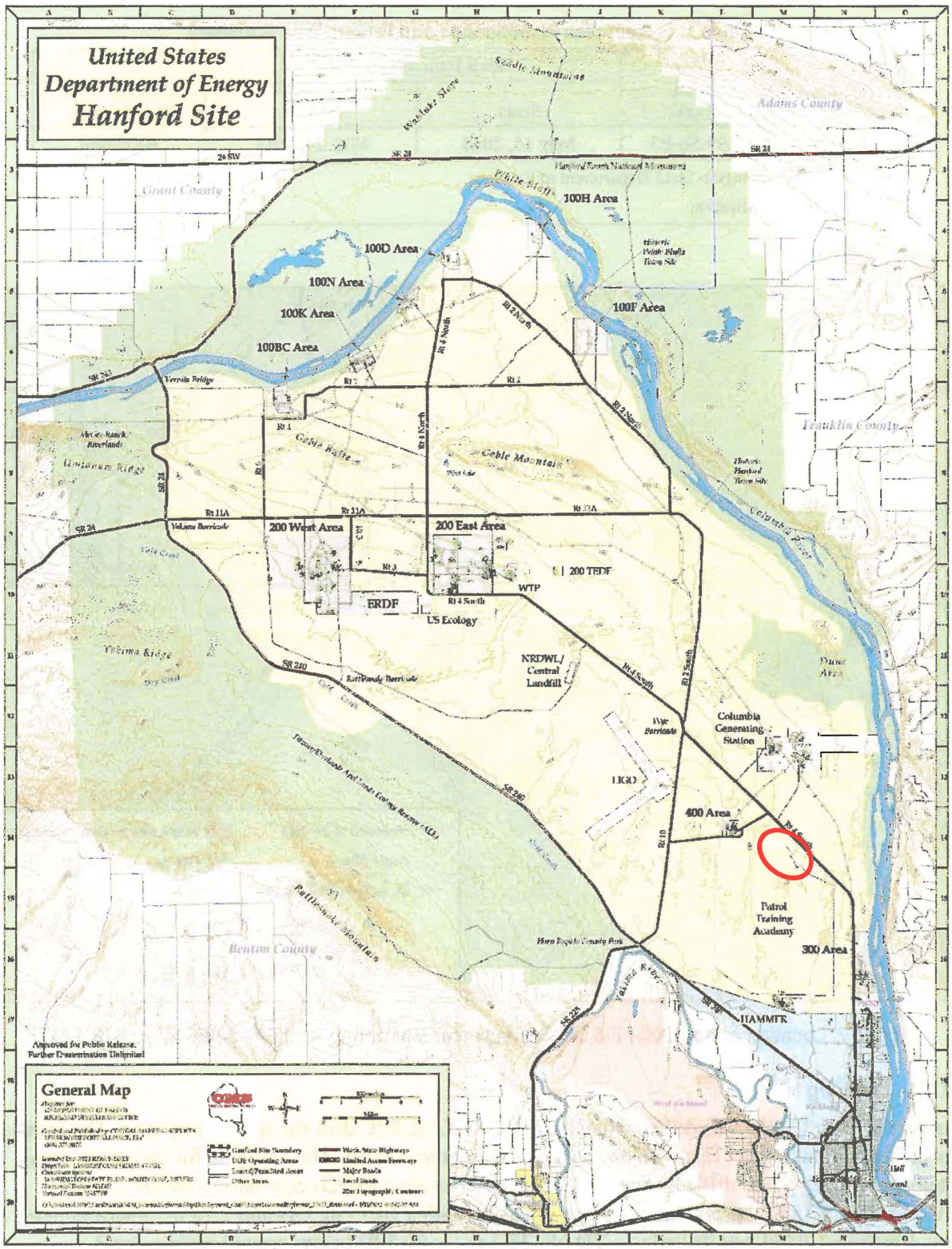
This chapter summarizes the field activities associated with new monitoring well 699-S6-E3 (C9870).

2.1 General Information

New monitoring well 699-S6-E3 (C9870) was constructed in compliance with WAC 173-160-420, "Minimum Standards for Construction and Maintenance of Wells," "What are the general construction requirements for resource protection wells?"; and CHPRC construction specifications identified in the DOW (SGW-61963), with the exception of the lack of performance of a straightness test prior to installing the permanent screen and casing (described further in Section 2.1.3.2 of this report). All well drilling and construction activities were documented in daily field activity reports, and the borehole geology was logged.

2.1.1 Drilling, Sampling, and Borehole Logging

The drilling, sampling, and borehole logging activities for installing the new monitoring well are summarized in the following sections.



Note: Well 699-S6-E3 is located within the area outlined in red on the map.

Figure 1. Hanford Site Map

Table 1. Project Well Identification and Drilling Date Summary

Well ID	Well Name	Well Installation Date		Ecology Well Tag Number
		Start	Finish	
C9870	699-S6-E3	May 15, 2018	May 24, 2018	BKG 089

Ecology = Washington State Department of Ecology
ID = identification

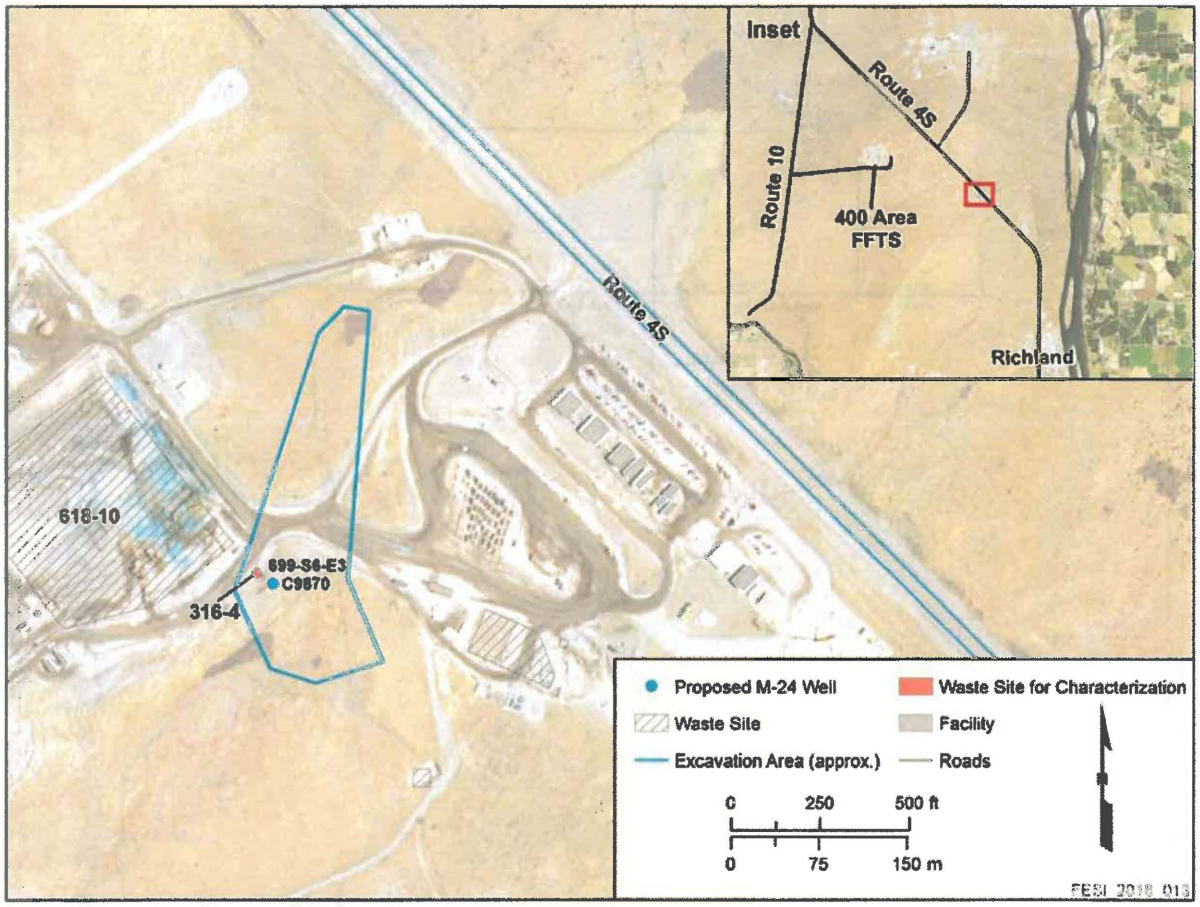


Figure 2. Location of New 300-FF-5 OU Groundwater Monitoring Well 699-S6-E3 at the 316-4 Crib

2.1.1.1 Drilling

The borehole for C9870 was drilled using a TSi® 150CC SONIC drill rig operated by Holt. The borehole was drilled to total depth (TD) with one string of temporary casing. The borehole for the single string of temporary casing was drilled using an 8.25 in. outer-diameter (OD) core barrel, advanced with a 10.5 in. OD, 9.75 in. inner-diameter piece of casing with a 10.75 in. OD and 9.75 in. inner-diameter shoe. Borehole C9870 was drilled to a TD of ~33.3 m (~109.3 ft) below ground surface (bgs).

TSi® is a registered trademark of Terra Sonic International, Marietta, Ohio.

2.1.1.2 Sampling

Sampling was conducted in accordance with the DOW (SGW-61963). Geologic grab samples were collected and archived at 1.5 m (5 ft) intervals and at major lithologic changes during drilling of the borehole. Sampling started at 18.3 m (60 ft) bgs due to the known presence of gravel backfill from 17.7 m (58 ft) bgs to the ground surface from past remediation operations. Geologic grab samples were not collected between the depths of 21.3 and 27.4 m (70 and 90 ft) bgs due to onsite readings by an industrial hygiene technician (IHT) indicating high volatile organic compound (VOC) concentrations (Section 2.1.2.2). Archive grab samples were photographed and then placed into labeled pint-size glass jars and labeled chip tray compartments for archiving. Additional soil grab samples were collected every 1.5 m (5 ft) once water was encountered at 20.4 m (66.80 ft), except between 21.3 and 27.4 m (70 and 90 ft) bgs (for the aforementioned reason), until TD was reached. All of the additional grab samples from the unconfined aquifer were composited into one sample. Sieve analysis of the composited sample was performed to determine particle-size distribution for selection of the filter pack and well screen slot size. Appendix A provides the photo log for the geologic grab samples collected, and Section 2.2 provides additional well-specific sampling information.

2.1.1.3 Geophysical Logging

The borehole for C9870 was logged by HII using a spectral gamma logging system to detect natural and manmade gamma-emitting radionuclides, and a neutron moisture logging system to detect soil moisture in the vadose zone (Section 2.2). Appendix A provides the HII report for borehole C9870 (HGLP-LDR-1050).

2.1.2 Health and Safety Screening

The health and safety screening included radiological field screening and air monitoring for VOCs, as discussed in the following sections.

2.1.2.1 Radiological Field Screening

A radiological control technician (RCT) performed radiological surveys, with full-time coverage during drilling, construction, and development activities. An RCT conducted the surveys using standard radiological field screening instruments to detect any contaminants with beta and gamma radiation on drill cuttings, geologic samples, temporary casing, and any other equipment that was used downhole. Radiological contamination was not detected above background readings during drilling activities.

2.1.2.2 Air Monitoring for Volatile Chemicals

Air quality monitoring was performed by an IHT throughout drilling activities, with full-time coverage until the temporary casing was back pulled above the depth of the backfill material. The IHT checked for VOC contamination using a photoionization detector to ensure that air quality met the lower explosive limit. The IHT used a multi-gas meter in areas of concern, including at the wellhead and in the breathing zone near the wellhead. Typically, except between the depths of 21.3 and 27.4 m (70 and 90 ft) bgs, very low to no levels of VOCs were detected downhole, and no readings were detected in the breathing zone during drilling activities. During the drilling process, ~150 parts per million (ppm) VOCs were detected at the source, which exceeded the 5 ppm action level at the source. Due to the readings of high VOCs between 21.3 and 27.4 m (70 and 90 ft) bgs, the IHT collected an air sample for analysis using a Tedlar® gas sampling bag to better characterize the VOCs present. The analysis indicated the highest VOC result was 386 ppm of kerosene.

Tedlar® is a registered trademark of E.I. du Pont de Nemours and Company, Wilmington, Delaware.

2.1.3 Well Construction and Development

The following sections provide details on well construction and development activities.

2.1.3.1 Screen and Casing Materials

The well was constructed using 4-1/2 in. OD, 4 in. inner-diameter, Schedule 10S Type 304 stainless-steel blanks, screen, and sump. The screen is 9.1 m (30 ft) long and is continuous round-wire wrap, with 20-slot (0.020 in.) apertures. The well has a 0.9 m (3 ft) long sump (0.9 m [3 ft] of blank stainless-steel casing with a welded endcap) located below the screened interval. The well has a protective monument consisting of a 6-3/4 in. OD and 6-3/8 in. inner-diameter blank piece of Schedule 10S stainless-steel casing with a 1.2 m by 1.2 m by 0.2 m (4 ft by 4 ft by 0.5 ft) concrete pad and protective posts placed around the well monument. Section 2.2 provides detailed information on the well construction, including screened interval, filter pack placement, and annular seal.

2.1.3.2 Well Completion

By mistake, a straightness test was not performed on the well prior to adding construction materials to the borehole.

The screen size and filter pack size used for construction were predetermined by CHPRC and confirmed by the geologic borehole logs and the intended well use. The filter pack was settled using the sonic oscillator on the drill rig and confirmed settled with a dual-flange surge block using the surging method after well development activities were completed. The borehole was decommissioned from the actual TD, which was 2.7 m (8.8 ft) deeper than the planned TD (Section 2.2), to ~1.2 m (~4 ft) below the bottom of the sump depth with bentonite pellets and crumbles.

The annular seal for the well consists of layers of a 3/8 in. bentonite and 3/8 in. bentonite crumbles above and below the filter pack (Section 2.2).

Type I/II Portland cement was placed from ~3.1 m (~10 ft) bgs to ground surface for the surface seal. Any remaining unfilled annular space in the upper 3.1 m (10 ft) during the settlement of the cement was filled in with high-strength concrete during well pad construction.

2.1.3.3 Final Well Development

Final well development for well 699-S6-E3 was conducted during construction activities, after the sand filter pack was added and before the final bentonite seal was in place. The well was developed in one interval using an electric submersible pump with the intake placed approximately at the bottom of the screen. The water was pumped while water quality parameters (turbidity, conductivity, pH, and temperature) were collected. The development interval was completed when the turbidity was ≤5 nephelometric turbidity units (NTUs) and the remaining water quality parameters had stabilized. A LevelTROLL® 700 data logger was used to record the drawdown during development and recovery when the pump was turned off. Table 2 provides the final water quality data for the one development interval. Appendix A provides the well development and testing data sheets for the well.

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

Table 2. 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 (gal/min)	Maximum Drawdown (ft)	Specific Capacity (gpm/ft)	Final Turbidity (NTU)	Specific Conductance (µS/cm)	pH	Temperature (°C)	Total Gallons Pumped
C9870	699-S6-E3	5/22/2018 – 5/23/2018	67.82	93.10	145	5.5	18.03	0.305	4.37	538	7.51	23.1	646

bgs = below ground surface
ID = identification
NTU = nephelometric turbidity unit

2.1.3.4 Washington State Department of Ecology Well Identification

The well received a unique Washington State Department of Ecology (Ecology) well identification (tag) number that was embossed onto a stainless-steel tag and riveted to the protective monument. When the monument was set, the identification tag was set to face approximately toward the north. Table 1 lists the Ecology tag number for the well, and Section 2.2 provides a detailed construction summary for the well.

2.2 Well-Specific Information

This section summarizes the drilling, sampling, geophysical logging, construction, and development activities specific to well 699-S6-E3 (C9870). Table 2 presents well development information for the new monitoring well.

Well 699-S6-E3 (C9870) was drilled, installed, and developed between May 15 and May 24, 2018. The borehole was drilled to a TD of 33.3 m (109.30 ft) bgs on May 21.

Drilling began on May 15, with a single string of 10-1/2 in. OD carbon steel temporary casing with threaded joints. Water was encountered on May 15 and tagged on May 16 at 20.4 m (66.80 ft) bgs. The temporary casing was advanced to a depth of 30.6 m (100.47) ft bgs (anticipated to be TD) on May 16. However, drilling continued on May 21, after the borehole was geophysically logged, because heaving sands had filled in the lower ~1.7 m (5.5 ft) of the borehole. On May 21, the 10-1/2 in. temporary casing was advanced (to alleviate the heaving sands) to a final TD of 33.3 m (109.30 ft) bgs, and the section of the borehole that could not be logged on May 16 was geophysically logged.

Sampling at borehole C9870 consisted of collecting soil samples for geologic archival purposes and a composited soil sieve sample to determine particle-size distribution (sieve analysis). Geologic archive soil samples were collected by the field geologist at 1.5 m (5 ft) intervals and at lithology changes throughout the borehole, except for depths from 21.3 and 27.4 m (70 to 90 ft) bgs to due high VOC readings. One sieve sample, composited from four 1.5 m (5 ft) grab samples, was collected from 27.4 m (90 ft) bgs to TD for sieve analysis as requested by the CHPRC hydrogeologist. No sieve samples were collected between 21.3 and 27.4 m (70 and 90 ft) bgs due to elevated VOC readings encountered during drilling (as described in Section 2.1.2.2).

On May 16 and 17, a geophysical survey was performed through the 10-1/2 in. OD temporary casing using a spectral gamma logging system from the ground surface to 28 m (92.0 ft) bgs and using a neutron moisture logging system from ground surface to 21.9 m (71.76 ft) bgs. A second geophysical survey was performed on May 21 using only the spectral gamma logging system from 27.7 to 30.8 m (91.0 to 101.01 ft) bgs. Appendix A provides the HII report for C9870 (HGLP-LDR-1050).

Well installation began on May 21 using a 0.9 m (3 ft) long sump, 9.1 m (30 ft) of 20-slot continuous round-wire wrap, and 19.8 m (64.98 ft) of 4 in. inner-diameter stainless-steel blank casing. Stainless-steel centralizers were placed at the bottom and top of the screen and at 12.2 m (40 ft) intervals above the screen. Table 3 provides information on the well construction materials and associated depths for borehole C9870. Additional well completion detail, including the annular construction material placement of the filter pack and the bentonite seal, as well as the surging and development process, is discussed in Section 2.1.3.2.

Table 3. Construction Summary for Well 699-S6-E3 (C9870)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	4 in. Diameter, Stainless-Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
109.30	67.78 (5/23/2018)	Stainless-steel blank	+1.97 (above ground surface) – 63.01	N/A	Concrete	+0.5 – 0.0	N/A
		Stainless-steel screen	63.01 – 93.01	0.020	Portland cement	0.0 – 9.67	Type I/II
		Stainless-steel sump	93.01 – 96.01	N/A	Bentonite crumbles	9.67 – 56.87	3/8 in.
					Bentonite pellet seal	56.87 – 59.92	3/8 in.
					Primary filter pack silica sand	59.92 – 63.20	12-20
					Primary filter pack silica sand	63.20 – 99.50	10-20
					Bentonite crumbles	99.50 – 104.40	3/8 in.
					Bentonite pellet seal	104.40 – 109.30	3/8 in.

bgs = below ground surface
N/A = not applicable

Well development at well 699-S6-E3 (C9870) was performed during construction, prior to surging and adding the final bentonite seal. Development operations were conducted on May 22 and 23. Development was first attempted on May 22 using a one-phase, 2-horsepower submersible pump, but it was determined that the pump was too powerful. Readings from the transducer and the e-tape indicated that the drawdown was below the depth of the transducer, which was set ~0.3 m (~1 ft) above the intake. Development was completed on May 23 using a smaller, one-phase, 1.5-horsepower submersible pump. The average flow rate for the interval was ~20.8 L/min (~5.5 gal/min). For development to be considered complete, the turbidity had to decrease to ≤5 NTUs and other key parameters (specific conductance, pH, and temperature) had to stabilize to within 10% of each subsequent reading. The lowest NTU reading was 4.37 with the intake set at 28.4 m (93.10 ft) bgs. A total of ~2,460.5 L (~650 gal) of water was purged during development. Table 2 presents the results for the one development interval for this well, and Appendix A provides the well development and testing data sheet.

3 Geologic Observations

This chapter summarizes the local geology of the 300-FF-5 OU and the overlying vadose zone and the borehole geology encountered at the well site during drilling.

3.1 Geology of the 300-FF-5 Operable Unit

The 300-FF-5 OU underlies the 618-10 Burial Ground and the 316-4 Crib in the southern portion of the Hanford Site. The general geology of the OU and the overlying vadose zone is discussed in this section (SGW-61963). The stratigraphy includes sedimentary deposits that lie above the Columbia River Basalt Group. The major units are the following (from youngest to oldest):

- Gravel backfill from grading, backfilling and excavation operations that occurred during remediation of the 618-10 Burial Ground and 316-4 Crib
- Pleistocene sand and gravel sediments of the Hanford formation (not present at the borehole location due to excavation and backfilling of the 316-4 Crib)
- Miocene-Pliocene Ringold Formation sediments:
  - Sand and gravel sediments of the Ringold Formation, member of Wooded Island, unit E (hereinafter referred to as Rwie)
  - Fine-grained sediments of the Ringold Formation, member of Wooded Island, lower mud unit (the Ringold lower mud unit was not encountered at the borehole location due to drilling to TD before reaching the unit)

Additional information regarding the local geology is provided in the following:

- BHI-00184, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*
- DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for the Post-Ringold-Formation Sediments Within the Central Pasco Basin*
- PNNL-14320, *Soil-Gas Survey and Well Installations at the 618-10 Burial Ground, 300-FF-5 Operable Unit, Hanford Site, Washington*

3.2 Borehole Geology

This section describes the geologic characteristics and stratigraphic units that were observed from grab sampling during drilling of borehole C9870 for new monitoring well 699-S6-E3. Appendix A provides the borehole log for the well.

The stratigraphic interpretations included in this report are based on field observations from drill cuttings collected every 1.5 m (5 ft) after drilling through the remediation backfill or where major lithologic changes occurred; therefore, the depths of contacts included should be viewed as approximations. Final stratigraphic unit contacts will be determined by project geologists and will incorporate field observations, borehole geophysical logging data, and regional stratigraphic interpretations.

Samples that were collected from below the water table may appear to have a weaker reaction to 10% diluted hydrochloric acid (HCl) due to the presence of water. The following sections discuss the determination of estimated stratigraphic unit contacts for the borehole.

The major stratigraphic unit encountered during drilling is the Rwie after drilling through the gravel backfill placed during cleanup operations. The Hanford formation was not present during the drilling phase due to the past excavation and backfill activities from cleanup operations.

Sandy gravel backfill extended from ground surface to 17.8 m (58.5 ft) bgs. The gravels are dominantly mafic (70%). The gravels are poorly to moderately sorted, subrounded to subangular, and ranged from very fine pebble to large cobble (2 to 250 mm). The sands are also dominantly mafic (65%) and are poorly sorted, ranging from very fine to very coarse and are subrounded to well-rounded. There is very little silt present (~5%), which is dark gray in color. No reaction was observed with the gravel, sand, or silt when tested with HCl.

The contact between the gravel backfill and the Rwie is at 17.8 m (58.5 ft) bgs, indicated by a color change from dark gray to gray or light brownish-gray, the observation of a very strong reaction to HCl, and the transition from mafic-dominated gravels and sands into more felsic composition. The soil classifications for Rwie are sandy gravel, silty-sandy gravel, and slightly silty-gravelly sand. Sandy gravel is present from 17.8 to 27.4 m (58.5 to 90 ft) bgs and is dominantly felsic (60%). The maximum gravel size is large cobble (130 mm), ranging from medium to very coarse pebble (10 to 35 mm). Angularity of the gravel ranged mostly from subrounded to well rounded. A strong reaction with HCl was observed when the sample was dry, and either no or a slight reaction with HCl reaction was observed with the presence of water. The moderately sorted sand composition is dominantly felsic, ranging from 70% to 75%, with grain size ranging from very fine to very coarse (0.125 to 2 mm), subrounded to subangular. The small amount of silt present (~5%), is light brownish-gray to grayish-brown in color. From 29 to 30.5 m (95 to 100 ft) bgs, silty-sandy gravel was observed by an increase in presence of silt (~15%) that is olive-brown in color and has medium plasticity. Between 30.5 to 32 m (100 to 105 ft) bgs, slightly silty-gravelly sand was observed by an increase in composition of sand (~25% to ~70%) and silt (~15% to 20%), and a decrease in gravel composition (~60% to 10%). From 29 to 32 m (95 to 105 ft), drillers encountered heaving sands and had to drill an additional ~3 m (~10 ft) to reach TD. From 32 m (105 ft) bgs to TD at 33.3 m (109.3 ft) bgs, silty-sandy gravel comparable to the composition found from 29 to 30.5 m (95 to 100 ft) bgs was observed, except the silt is very dark grayish-brown in color.

The final static water level was observed at 20.7 m (67.78 ft) bgs on May 23, 2018.

4 Waste Management

Waste generated during installation of the new monitoring well included drill cuttings, purgewater, and miscellaneous solid waste. Waste was managed in accordance with CERCLA and DOE/RL-2000-56, *Waste Management Plan for the 300-FF-5 Operable Unit.*

4.1 Drill Cuttings

Drill cuttings from the vadose and saturated zone were placed in clear plastic bags and stored in a tip dumpster to be managed as investigation-derived waste that was surveyed by the IHT and RCT. The drill cuttings were then placed into designated Environmental Restoration Disposal Facility roll-off boxes after being surveyed and removing water as necessary. Miscellaneous solid waste associated with sampling activities was contained in clear plastic bags and also disposed in the roll-off boxes. The roll-off boxes were then transported to the Environmental Restoration Disposal Facility for disposal at the completion of the drilling project.

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 using regulated purge trucks in accordance with DOE/RL-2009-80, *Investigation Derived Waste Purgewater Management Work Plan*; and DOE/RL-2011-41, *Hanford Site Strategy for Management of Investigation Derived Waste.*

5 Civil Survey

The location for well 699-S6-E3 (C9870) was surveyed using a Trimble® R8 RTK global positioning system and a Trimble DiNi 12 level to collect coordinates. Washington State Plane (south zone) *North American Datum of 1983* (NAD83) (1991 adjustment) was used to record the horizontal coordinates; *North American Vertical Datum of 1988* (NAVD88) was used to record the vertical survey elevation data. Well 699-S6-E3 (C9870) was surveyed on June 4, 2018. Table 4 lists the locations of the surveyed well, and Appendix A provides the survey report for the well.

Table 4. Civil Survey Summary

Well ID	Well Name	Northing[a] (m)	Easting[a] (m)	Brass Survey Marker Elevation[b] (m)	Top of Casing[b,c] Elevation (m)
C9870	699-S6-E3	121661.62	590987.56	134.185	134.904

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

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

c. Protective casing.

ID = identification

6 Well Acceptance

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

After the well was completed, representatives from CHPRC and Holt completed well inspections for the new well. Well C9870 was walked down and accepted on June 7, 2018.

Trimble® is a registered trademark of Trimble Inc., Sunnyvale, California.

7 References

BHI-00184, 1995, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington,* U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0083482H.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: https://www.csu.edu/cerc/researchreports/documents/CERCLASummary1980.pdf.

DOE/RL-2000-56, 2015, *Waste Management Plan for the 300-FF-5 Operable Unit*, Rev. 2, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0079823H.

DOE/RL-2002-39, 2002, *Standardized Stratigraphic Nomenclature for the Post-Ringold-Formation Sediments Within the Central Pasco Basin*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0081471H.

DOE/RL-2009-80, 2009, *Investigation Derived Waste Purgewater Management Work Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0094946.

DOE/RL-2011-41, 2011, *Hanford Site Strategy for Management of Investigation Derived Waste*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: http://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0093937.

DOE/RL-2017-49, 2018, *Cleanup Verification Package for the 316-4 Liquid Waste Disposal Crib*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/arpir/index.cfm/viewDoc?accession=0066399H.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: http://www.hanford.gov/?page=81.

EPA, Ecology, and DOE, 2013, *Hanford Site 300 Area Record of Decision for 300-FF-2 and 300-FF-5, and Record of Decision Amendment for 300-FF-1*, U.S. Environmental Protection Agency, Washington State Department of Ecology, and U.S. Department of Energy, Olympia, Washington. Available at: https://pdw.hanford.gov/arpir/pdf.cfm?accession=0087180.

NAD83, 1991, *North American Datum of 1983*, as revised, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland.

NAVD88, 1988, *North American Vertical Datum of 1988*, as revised, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland.

PNNL-14320, 2003, *Soil-Gas Survey and Well Installations at the 618-10 Burial Ground, 300-FF-5 Operable Unit, Hanford Site, Washington*, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-14320.pdf.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Pub. L. 94-580, 90 Stat. 2795. Available at: https://elr.info/sites/default/files/docs/statutes/full/rcra.pdf.

SGW-61963, 2018, *Description of Work for the Installation of One M-24 Monitoring Wells in the 300-FF-5 Groundwater Operable Unit, FY 2018*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

WAC 173-160-420, "Minimum Standards for Construction and Maintenance of Wells," "What are the general construction requirements for resource protection wells?," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-160-420.

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Appendix A

Well Documentation for 699-S6-E3 (C9870)

- Well Summary Sheet for C9870
- Borehole Log for C9870
- Geophysical Log Data Report for C9870
- Final Survey Report for C9870
- Well Development and Testing Data Sheet C9870
- Photo Log for C9870

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WELL SUMMARY SHEET

Page 1 of 1

Well ID: C9870	Well Name: 699-S6-E3	Start Date: 5/15/18
Project: M-24 Monitoring Well	Location: ~3 mi S of Energy NW	End Date: 5/24/18

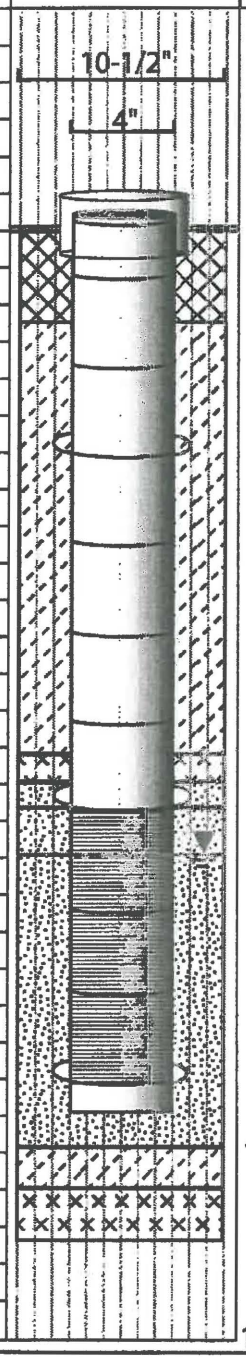
CONSTRUCTION DATA

Surface Completion:
4' x4' x 6" Concrete Pad with brass survey marker and protective monument (3.00' ags - 2.01' bgs)
Ecology Well # BKG089

Well Completion Material:
Type I/II Portland Cement
0.00' bgs - 9.67' bgs
3/8" Bentonite Crumbles
9.67' bgs - 56.87' bgs
3/8" Bentonite Pellet Seal
56.87' bgs - 59.92' bgs
12-20 mesh Primary Filterpack
59.92' bgs - 63.20' bgs
10-20 mesh Primary Filterpack
63.20' bgs - 99.50' bgs
3/8" Bentonite Crumbles
99.50' bgs - 104.40' bgs
3/8" Bentonite Pellet Seal
104.40' bgs - 109.30' bgs

Permanent Well:
4" ID Stainless Steel Blank
1.97' ags - 63.01' bgs
4" ID Stainless Steel 0.020-in Screen
63.01' bgs - 93.01' bgs
4" ID Stainless Steel Sump
93.01' bgs - 96.01' bgs

Hole Dimensions:
10" Temporary Casing : 110.27' bgs
(all temporary casing removed)
Total Depth : 109.30' bgs
ags = above ground surface
bgs = below ground surface



GEOLOGIC/HYDROLOGIC DATA

Graphic Log

Lithologic Description (ft bgs)

0 - 95 : Sandy Gravel (sG)

Depth to Water: 67.78' bgs (5/23/18)

95 - 100 : Silty Sandy Gravel (msG)
100 - 105: Slightly Silty Gravelly Sand ((m)gS)
105 - 109.3: Silty Sandy Gravel (msG)

Reported By: Brandon Thurnau (Print Name)	Geologist (Title)	Brandon Thurnau (Signature)	5/29/18 (Date)
Reviewed By: Jennifer Richart (Print Name)	Well Coordinator (Title)	J. Richart (Signature)	5/31/18 (Date)

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

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BOREHOLE LOG

Page 1 of 3

Date: 5/15/18

Well ID: C9870 | Well Name: 699-56-E3 | Location: ~3 mi S of Energy DW

Project: Installation of one M-24 Monitoring Well in the 300-FF-5 OU/OU | Reference Measure Point: Ground Surface

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
0			0-58.5': Backfill - Sandy Gravel (SG) 60% Sand: 65% M/35% F, medium-u. crs., poorly-mod. sorted, subrounded-subangular; d. amp, no rxn w/ HCl; 35% Gravel: 2mm-250mm, 70% M/30% F, poorly sorted, subrounded-well rounded; 5% Silt: 5Y 4/1 Dark Gray	Drilling conducted w/ a Terrasonic
5				No grab samples collected from 0-60' bgs as per DOW
10				
15				
20				
25				
30				

Reported By:			
Brandon Thurman	Geologist	Brandon Thurman	5/15/18
Print Name	Title	Signature	Date

Reviewed By:			
Sarah Springer	Sr. Geologist	Sarah Springer	05-23-18
Print Name	Title	Signature	Date

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Page 2 of 3

Date: 5/15/18

Well ID: C9870 | Well Name: 699-S6-E3 | Location: ~3mi S of Energy NW

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
35			58.5'- 90 : Sandy Gravel (SG) up to 60% Gravel: (60% F/40% M, poorly sorted, dry, well rounded - subrounded; 35% Sand: 70% F/30% M, v. fn - crs, mod. sorted, subrounded - subangular, dry, v. strg rxn w/ HCl; 5% Silt; overall silt and sand color change to 2.5Y 6/2 light brownish gray @60' (2.5Y 5/1 Gray from 58.5'-60')	Drilling conducted w/ a Terra Sonic. G.S. = Grab Sample
40				
45				
50				
55				
60	G.S.		@60' color change from 2.5Y 5/1 Gray to 2.5Y 6/2 light brownish gray	Grab samples start being collected @ 60'
65	G.S.			DTW = 68.19' bgs on 5/16/18 @ 0635 DTW = 68.80' bgs on 5/16/18 @ 1127 DTW = 68.65' bgs on 5/21/18 @ 0745
70	G.S.		@70' lithology appears to be darker in color possibly due to the presence of hydrocarbons or below the water table	Grab samples not collected from 70'-90' due to concern of hydrocarbons present

Reported By:

Print Name	Title	Signature	Date
Brandon Thurnau	Geologist	Brandon Thurnau	5/15/18

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Page 3 of 3

Date: 5/15/18

Well ID: C9870 | Well Name: 699-S6-E3 | Location: ~3mi S of Energy NW

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
75			85.5-90': Sandy Gravel (sG)	Drilling conducted w/ a terrasonic
			60% Gravel: 60% F/40% M, poorly sorted, dry, max size ~80mm, well rounded-subrounded; 35% Sand: 70% F/30% M, V. fn.-crs., mod. sorted, subrounded-sub angular, dry, v. strong rxn w/ HCl; 5% Silt:	Grab samples collected every 5' or @ lithologic changes starting @ 60'
80			BT 5/11/18 2.5Y 6/2 light brownish gray	
				Grab samples not collected from 70'-90' due to concern of hydrocarbons being present in the soil
85				
				Unable to open bags due to possible concern of hydrocarbons present; also unable to see material in bag due to presence of water that looks 2.5Y 5/1 Gray
90	G.S.		90-95: Sandy Gravel (sG)	
			70% Gravel: 60% F/40% M, poorly sorted, wet, max size ~80mm, well rounded-subrounded; 27% Sand: 75% F/25% M, v. fn.-v. crs., mod. sorted, wet, slight-mod. rxn w/ HCl when moist; 3% Silt: 2.5Y 5/2 light olive brown BT 5/16/18	
95	G.S.		95-100: Silty Sandy Gravel (msG)	
			60% Gravel: 65% F/35% M, poorly sorted, wet, max size 134mm, well rounded-subangular; 25% Sand: 70% F/30% M, v. fn.-v. crs., mod. sorted, wet, strong rxn w/ HCl when dry; 15% Silt: medium plasticity; 2.5Y 4/3 olive brown BT 5/21/18	Borehole came up during the geophysical process between 5/16/18-5/21/18 from 95.1' to ~92' bags due to the possibility of heaving sands; drillers continue to drill until out of the uncase
100	G.S.		105	
			100-104.5' bags: Slightly Silty Sandy Gravelly Sand (mSG) BT 5/21/18	
			60% Gravel: 60% F/40% M, poorly sorted, wet, max size 35mm, subangular-well rounded; 70% Sand: V. fn.-crs. sand, mod. sorted, wet, no rxn w/ HCl (wet), subangular-well rounded; 20% Silt: 2.5Y 4/3 olive brown	Borehole came up again during the geophysical logging process from 104.5' bgs to 101.8' bgs on 5/21/18; drillers continue to drill until out of uncase
105	G.S.		105-109.3' bgs: Silty Sandy Gravel msG	
			60% Gravel: 60% F/40% M, poorly sorted, wet; max size: 78mm, subangular-well rounded; 25% Sand: 65% F/35% M, v. fn.-v. crs., poorly sorted, wet, strong rxn w/ HCl (after drying), subangular-well rounded; 15% Silt: low plasticity, 2.5Y 3/2 very dark grayish brown	10" casing reaches a depth of ~~109.75' bgs~~ 110.27' bgs BT 5/21/18
110	G.S.	TD = 109.3' bgs		TD = ~~104.5'~~ bgs 109.3' bgs BT 5/21/18

Reported By:

Print Name	Title	Signature	Date
Brandon Thurnau	Geologist	Brandon Thurnau	5/21/18 BT 5/21/18

A-6006-993 (REV 0)

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699-S6-E3 (C9870)
Log Data Report

Borehole Information

Log Date	2018-05-21	Filename	C9870_HG-NM_2018-05-21	Site	316-4 Crib

DTW[1] (ft)	DTW Date	DTW Source	Drill Date	Total Depth (ft)	Depth Datum
69.3	05/17/18	SN3	05/16/18	109.3	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.)		Thickness (in.)	Top (ft)	Bottom (ft)
			Outer	Inside			
Threaded Steel	Terra Sonic	0	10.5	9.650	0.25-0.42	0	110.27

Borehole Notes

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing stick-up and casing diameters. The maximum logging depth achieved was 101 ft. 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.

Logging Equipment Information

Logging System	Gamma 1LD	Type	60% Coaxial HPGe (SGLS)
Effective Calibration Date	10/19/2017	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-166, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0, Change 2

Logging System	Gamma 1HD	Type	He-3 (CPN 503DR) NMLS
Effective Calibration Date	10/16/2017	Serial No.	H310700352
Calibration Reference	HGLP-CC-161, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0, Change 2

SGLS Log Run Information

Log Run	3	4 Repeat	5	6 Repeat	
HEIS Number	1020178	1020179	1020180	1020181	
Date	05/17/18	05/17/18	05/21/18	05/21/18	
Logging Engineer	Spatz	Spatz/Felt	Spatz/Felt	Spatz/Felt	
Start Depth (ft)	0.0	50.0	91.0	95.0	
Finish Depth (ft)	92.0	60.0	101.01	100.01	
Count Time (sec)	100	100	100	100	
Live/Real	R	R	R	R	

[1] depth to water inside casing

Log Run	3	4 Repeat	5	6 Repeat	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
Log Speed (ft/min)	NA	NA	NA	NA	
Pre-Verification	C9870ALD2018 0517AV00CAB1	C9870ALD2018 0517AV00CAB1	C9870ALD2018 0521AV00CAB1	C9870ALD2018 0521AV00CAB1	
Start File	AD000000	BD005000	AD009100	BD009500	
Finish File	AD009200	BD006000	AD010101	BD010001	
Post-Verification	C9870ALD2018 0517BV00CAA1	C9870ALD2018 0517BV00CAA1	C9870ALD2018 0521BV00CAA1	C9870ALD2018 0521BV00CAA1	
Depth Return Error (in.)	N/A	0	N/A	0.5 high	
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	1	2 Repeat			
HEIS Number	1020182	1020183			
Date	05/16/18	05/16/18			
Logging Engineer	Spatz/McClellan	Spatz/McClellan			
Start Depth (ft)	0.01	64.0			
Finish Depth (ft)	71.76	71.0			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	0.25	0.25			
Log Speed (ft/min)	NA	NA			
Pre-Verification	C9607AHD2018 0516AV00CAB1	C9607AHD2018 0516AV00CAB1			
Start File	AD000001	BD006400			
Finish File	AD007176	BD007100			
Post-Verification	C9607AHD2018 0516BV00CAA1	C9607AHD2018 0516BV00CAA1			
Depth Return Error (in.)	N/A	0.5 high			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on the sondes.

Analysis Notes

Analyst	P.D. Henwood	Date	05/25/18
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

A casing correction for a 0.25-in. thick casing was applied to the SGLS log data.

A water correction was applied below 69.3 ft.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations for the SGLS were calculated in an EXCEL template identified as ALD20171019 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

An interpreted data set was created for this borehole. Depth overlaps from consecutive log runs were removed from 91 and 92 ft. This results in a data set where only one data point is presented for each depth.

Neutron moisture data are converted from count rate to volume percent moisture, using algorithms developed from recently completed MCNP modeling (HGLP-OTH-028, in progress); spectral gamma data are not updated. The new algorithms allow extrapolation of the instrument calibrations to a wide variety of borehole environments encountered at Hanford including borehole outside diameters from 4 to 12 in., steel casing thicknesses from 0.1 to 0.8 in., a sediment composition ratio of 50%-50% basalt fragment to quartzofeldspathic sand, and soil moisture contents up to 35% moisture by volume. With accurate knowledge of casing dimensions, corrections are made for thickened casing joints through application of the vertical depth resolution function, which was also determined during the modeling effort.

HGU[2] 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 Calibration 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 this borehole.

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

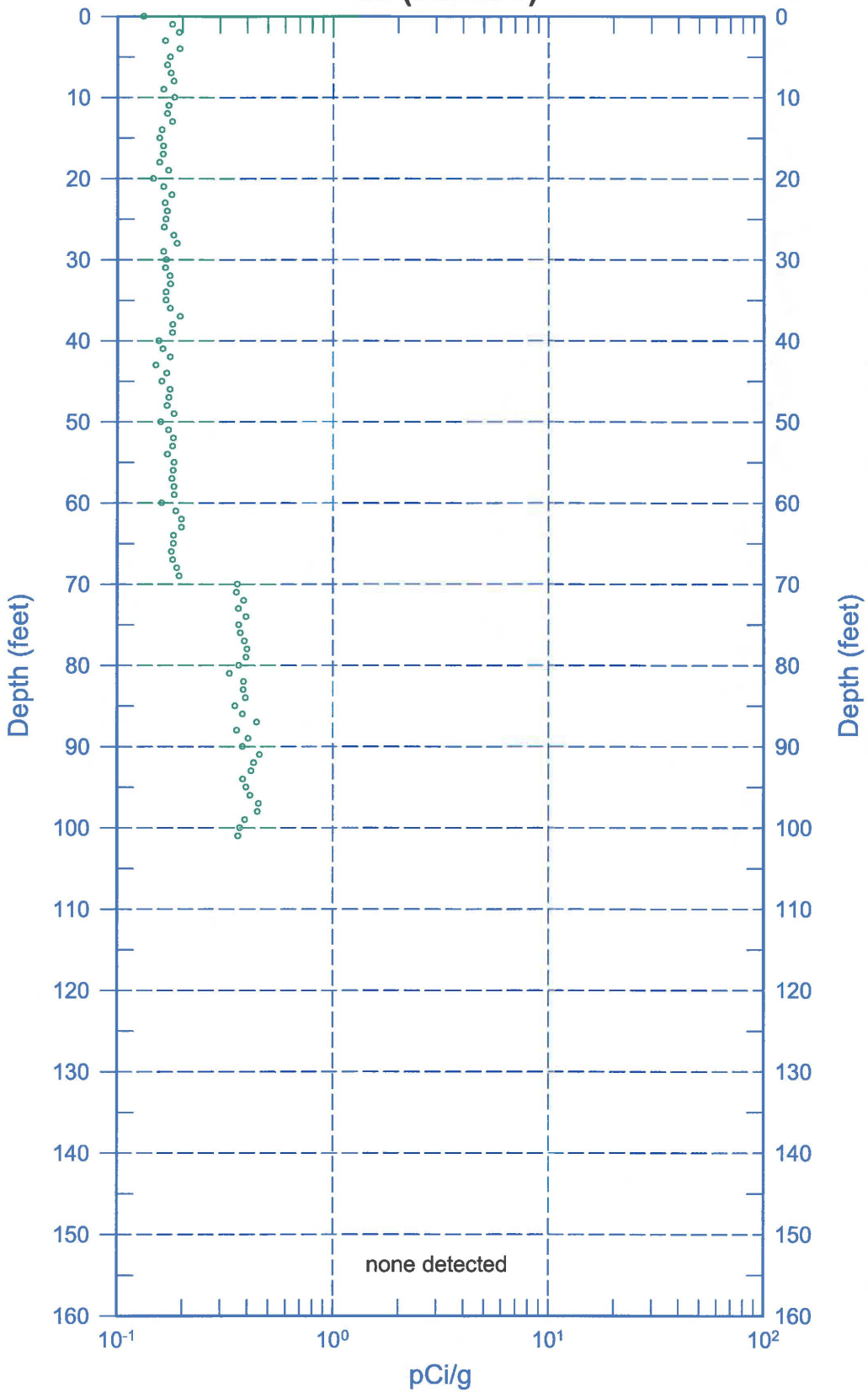
Depth Reference is ground surface.

Manmade Radionuclides (0-160 ft)
Natural Gamma Logs (0-160 ft)
Combination Plot (0-120 ft)
Total Gamma & Moisture (0-160 ft)
Moisture (0-160 ft)
Total Gamma & Hanford Gamma Unit (0-160 ft)
Repeat Section of Natural Gamma Logs (50-60 ft)
Repeat Section of Natural Gamma Logs (95-100 ft)
Moisture Repeat Section (64-71 ft)

[2] Hanford Gamma Unit

Huntington Ingalls Industries

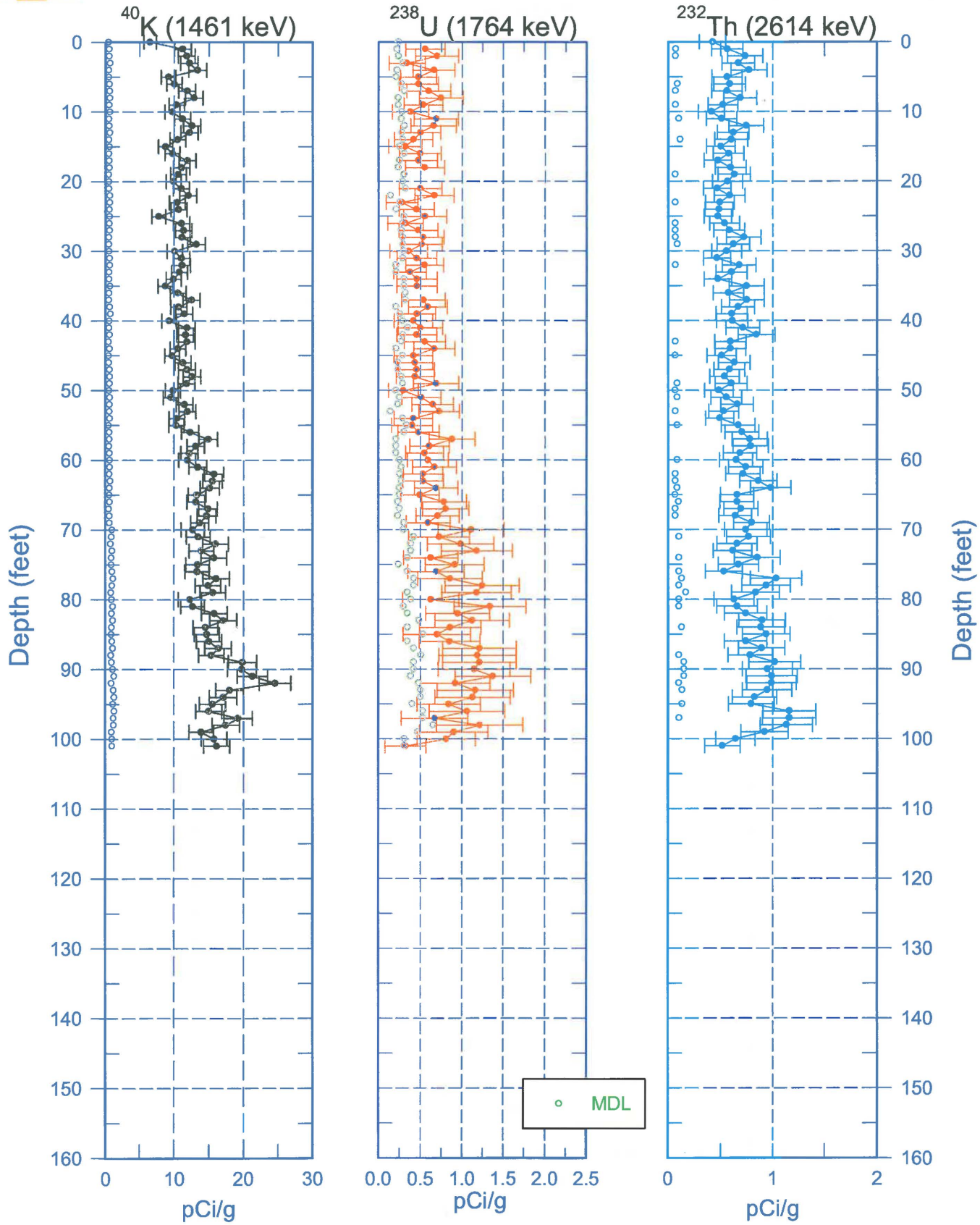
699-S6-E3 (C9870)
Manmade Radionuclides
^{137}Cs (662 keV)



Zero Reference - Ground Surface

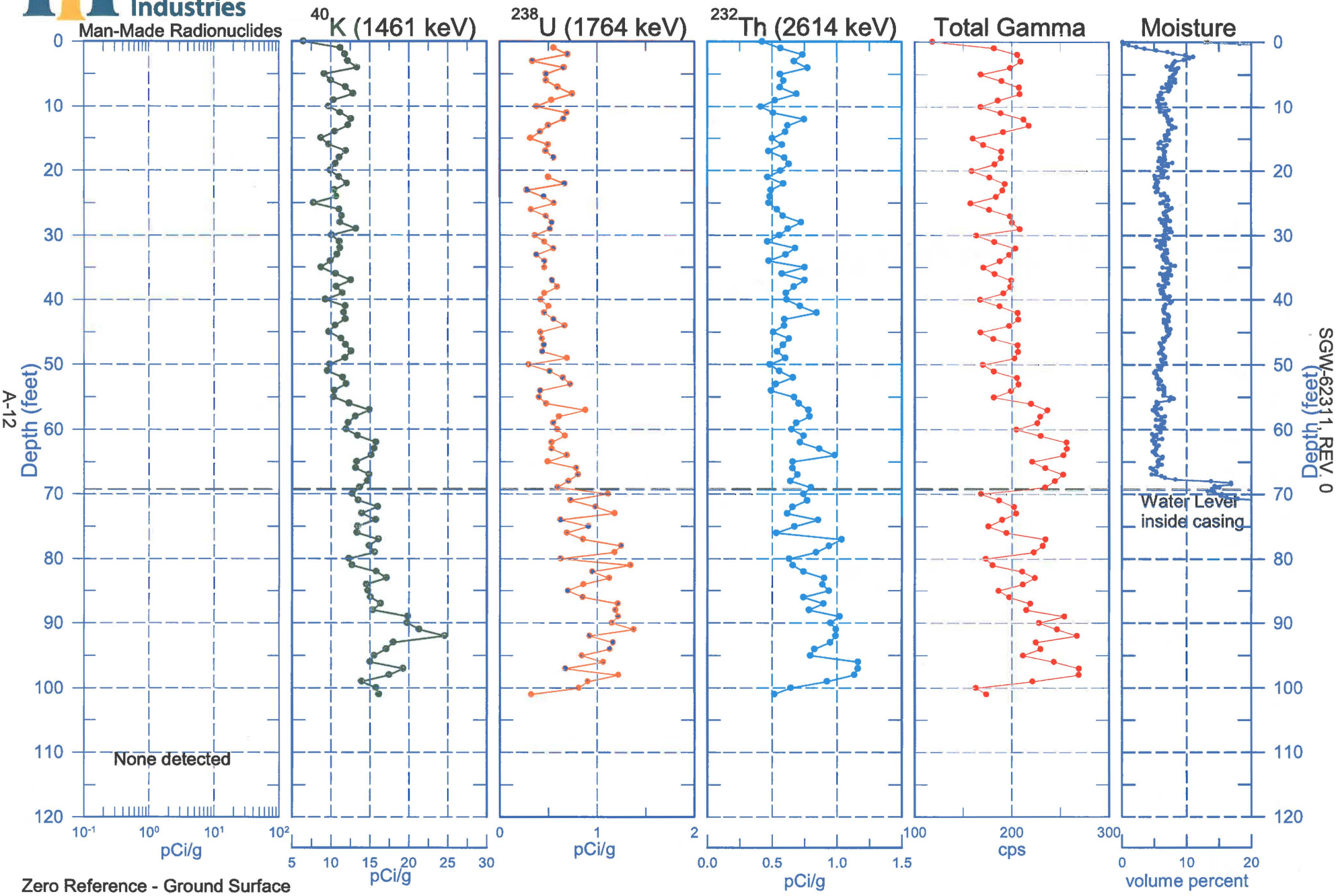
Huntington Ingalls Industries

699-S6-E3 (C9870)
Natural Gamma Logs



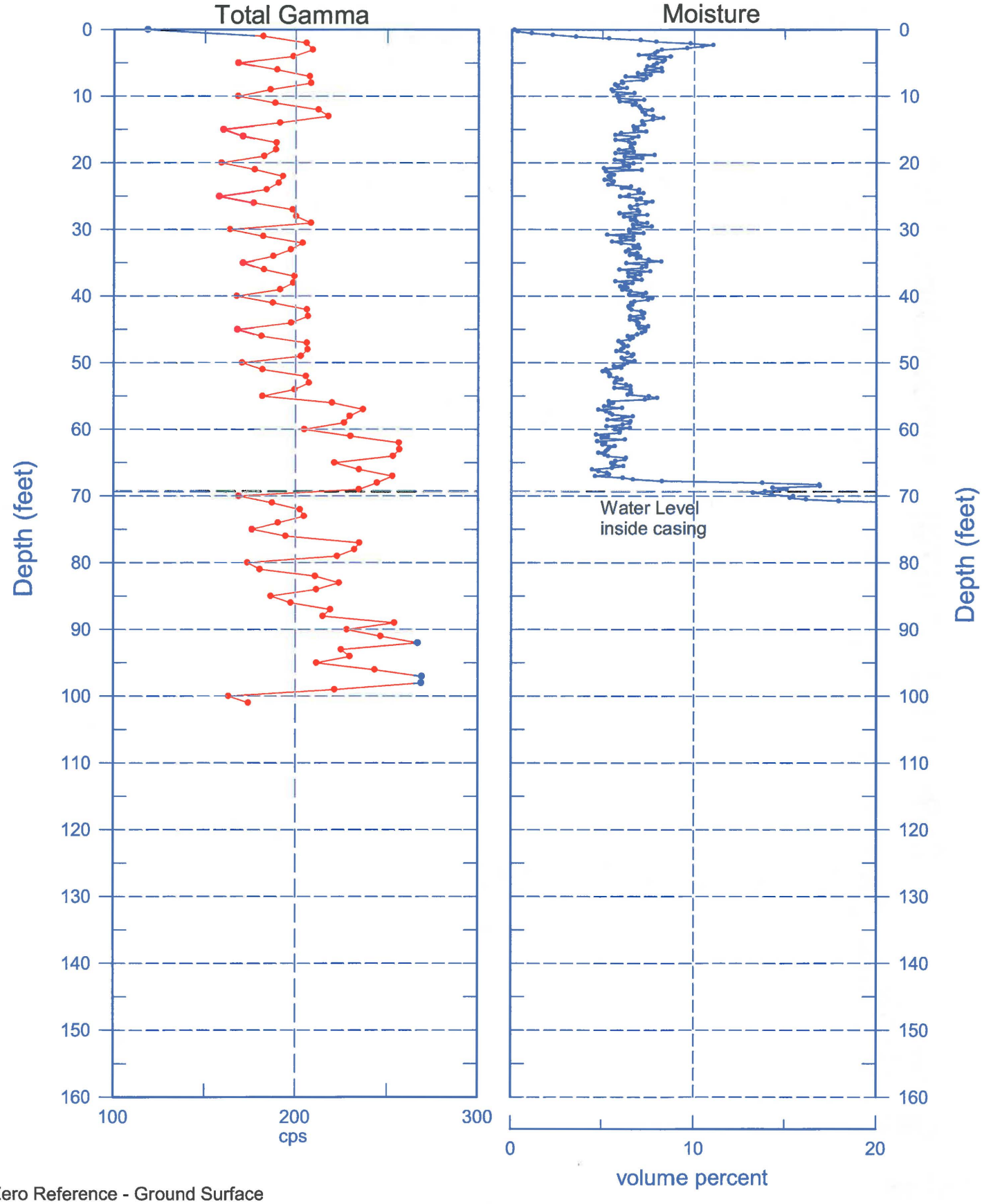
Zero Reference - Ground Surface

699-S6-E3 (C9870) Combination Plot



Huntington Ingalls Industries

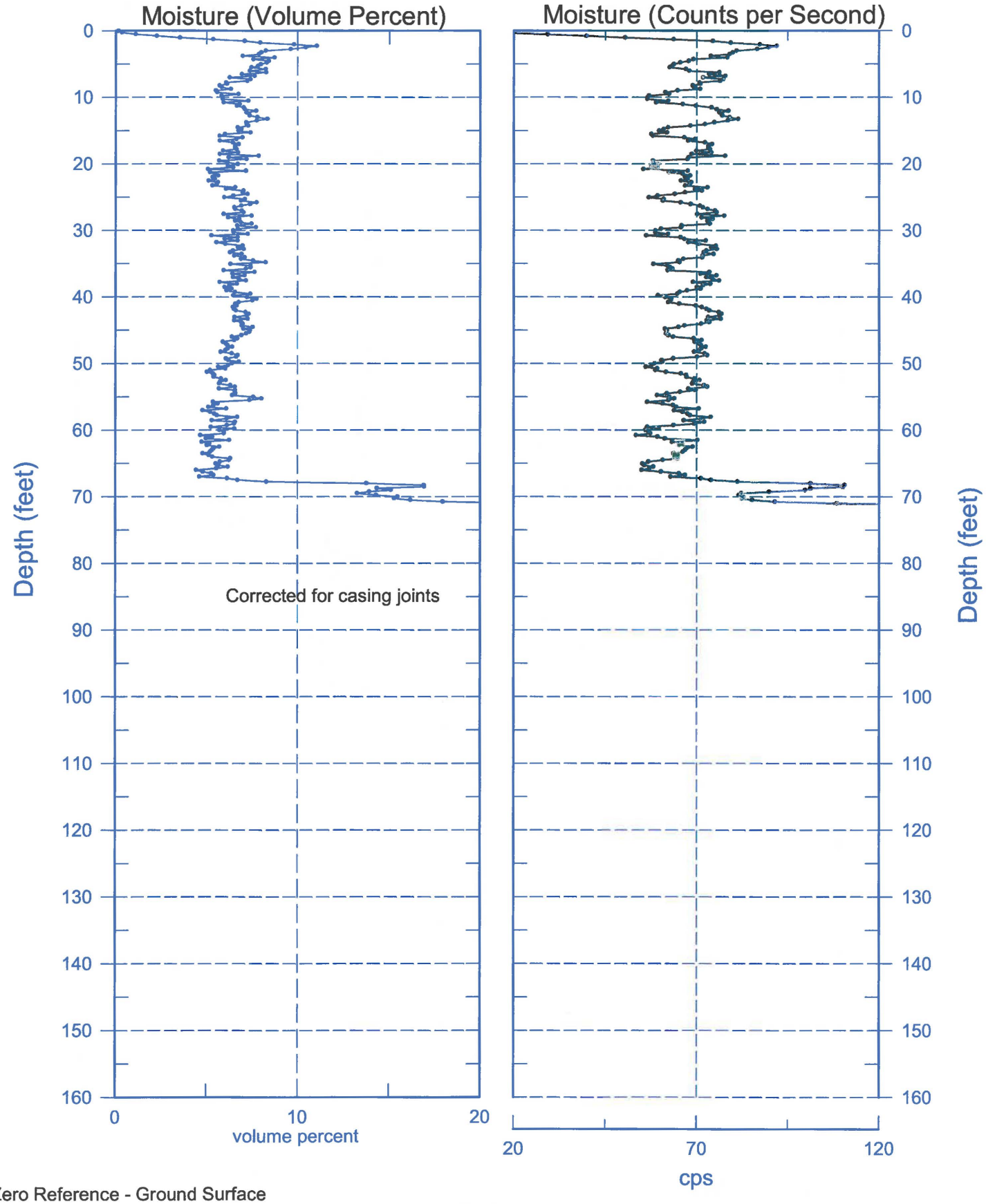
699-S6-E3 (C9870)
Total Gamma & Moisture



Zero Reference - Ground Surface

Huntington Ingalls Industries

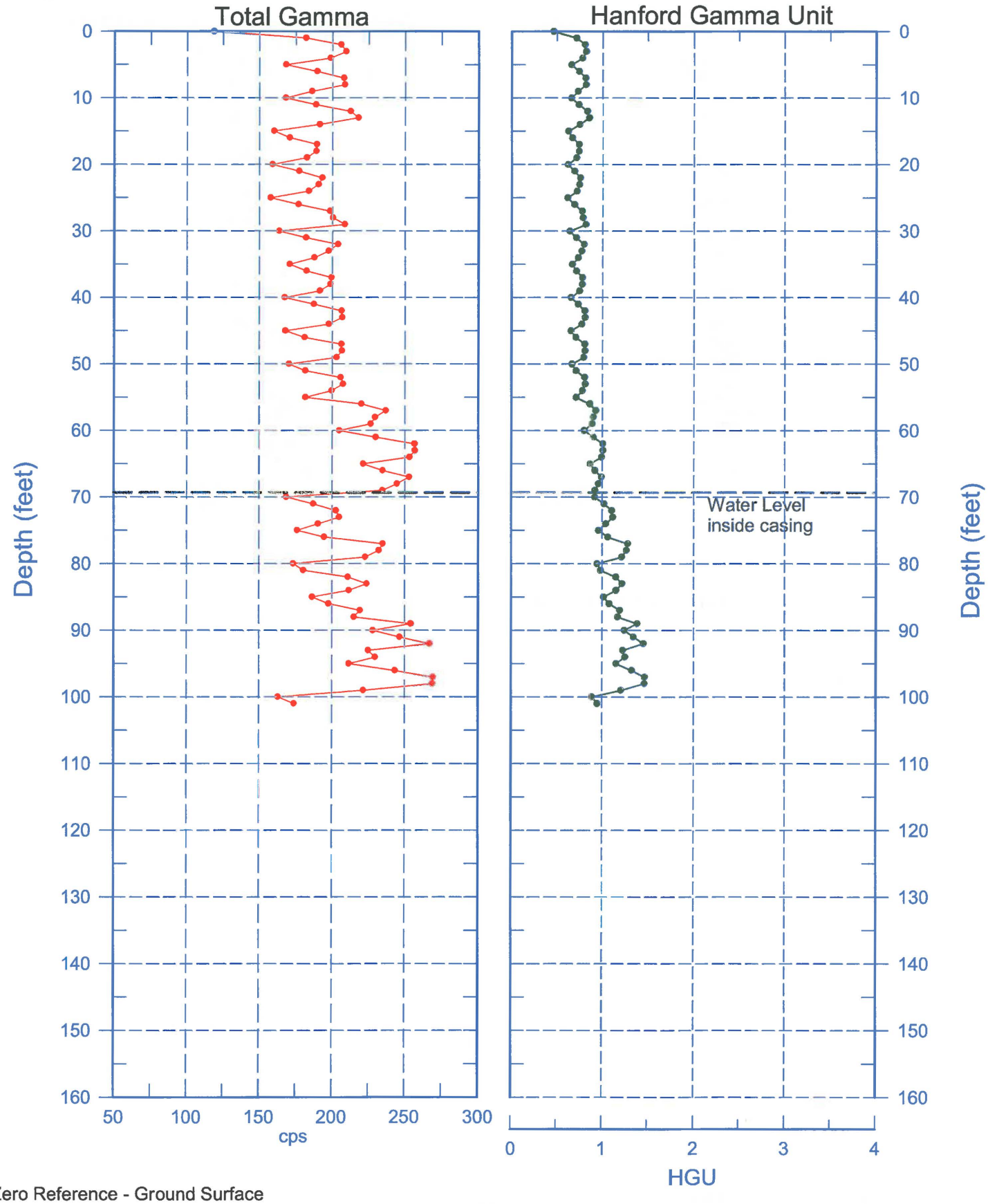
699-S6-E3 (C9870)
Moisture



Zero Reference - Ground Surface

Huntington Ingalls Industries

699-S6-E3 (C9870)
Total Gamma & Hanford Gamma Unit

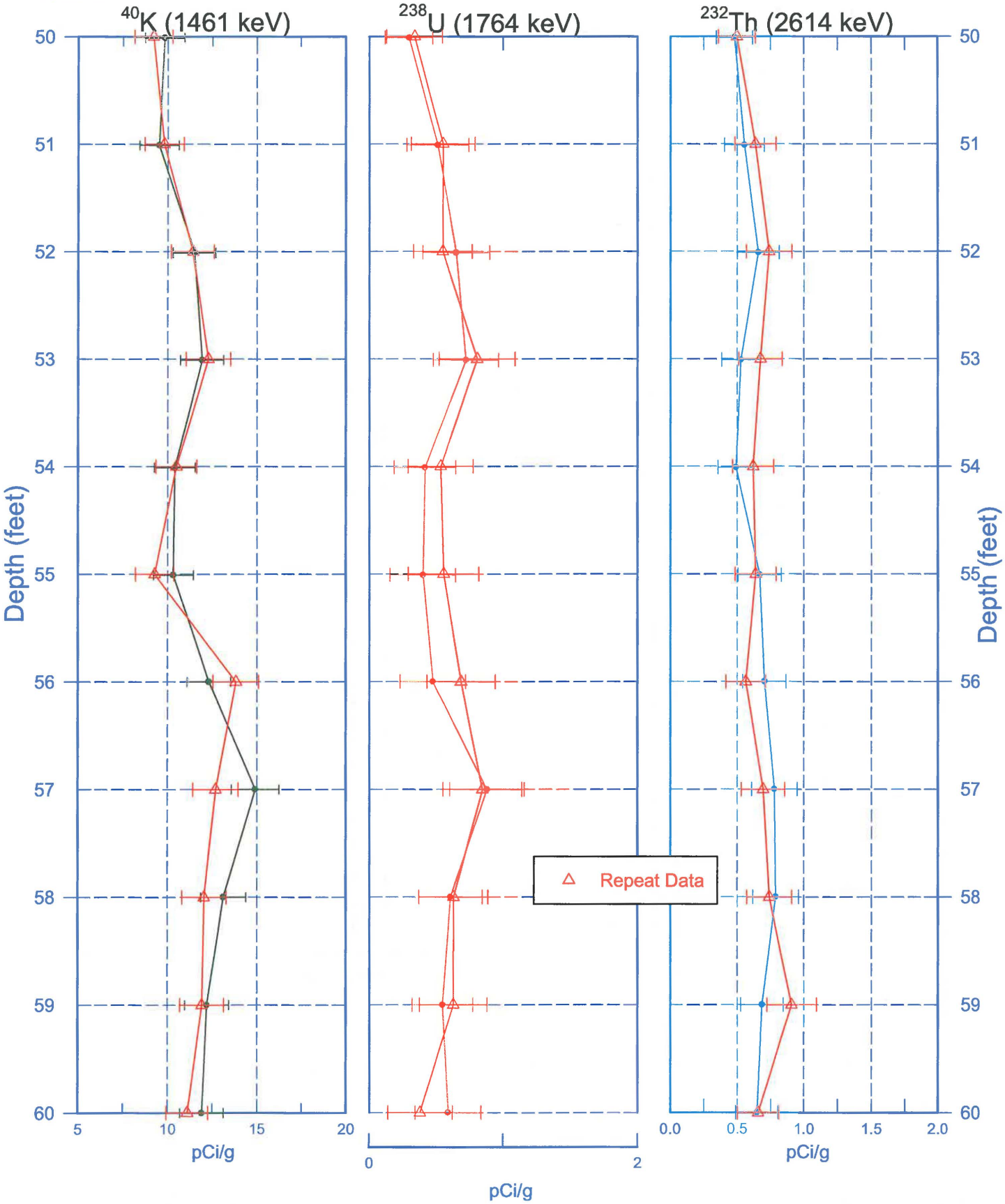


Zero Reference - Ground Surface

Huntington Ingalls Industries

699-S6-E3 (C9870)

Repeat Section of Natural Gamma Logs

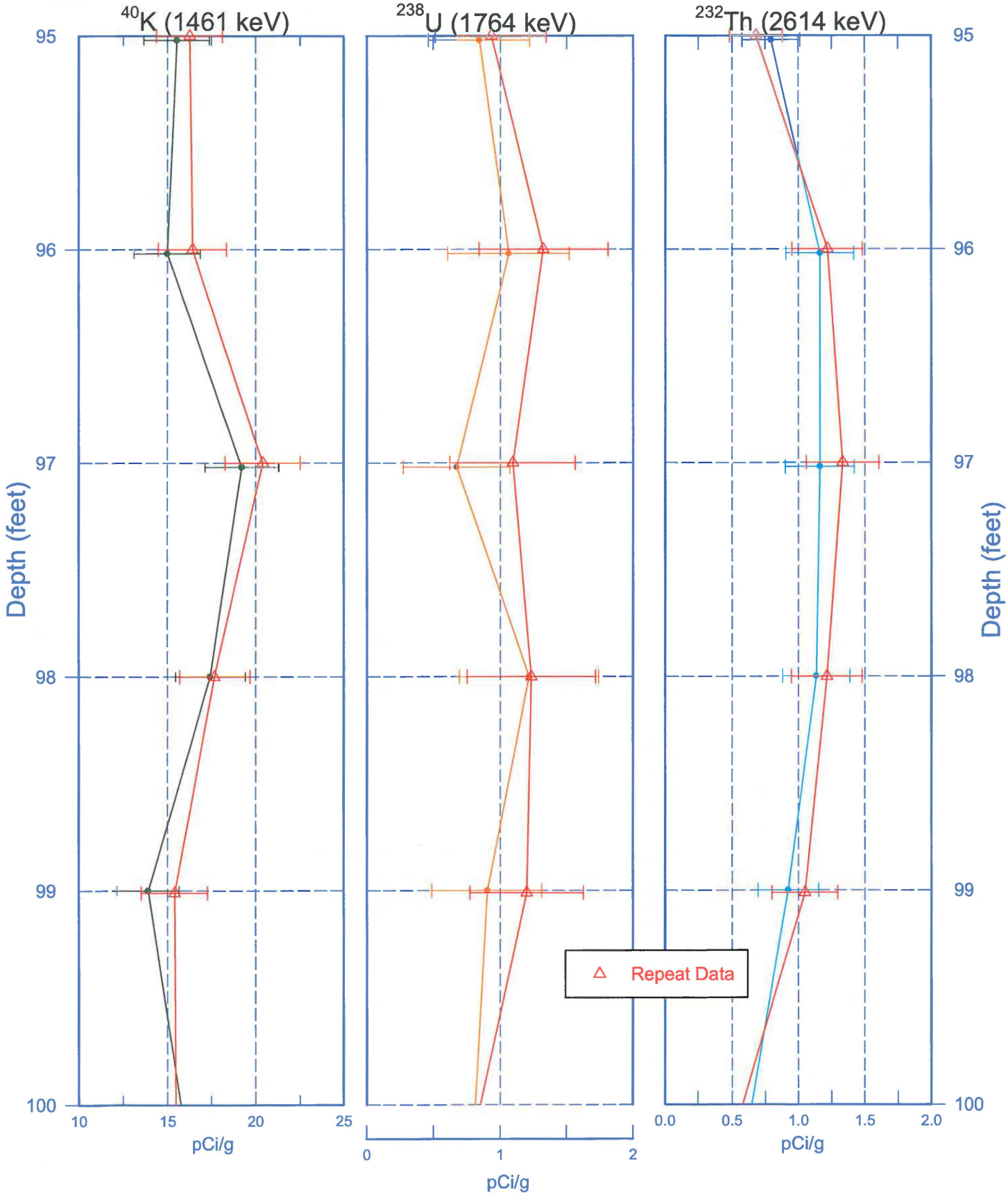


Zero Reference - Ground Surface

Huntington Ingalls Industries

699-S6-E3 (C9870)

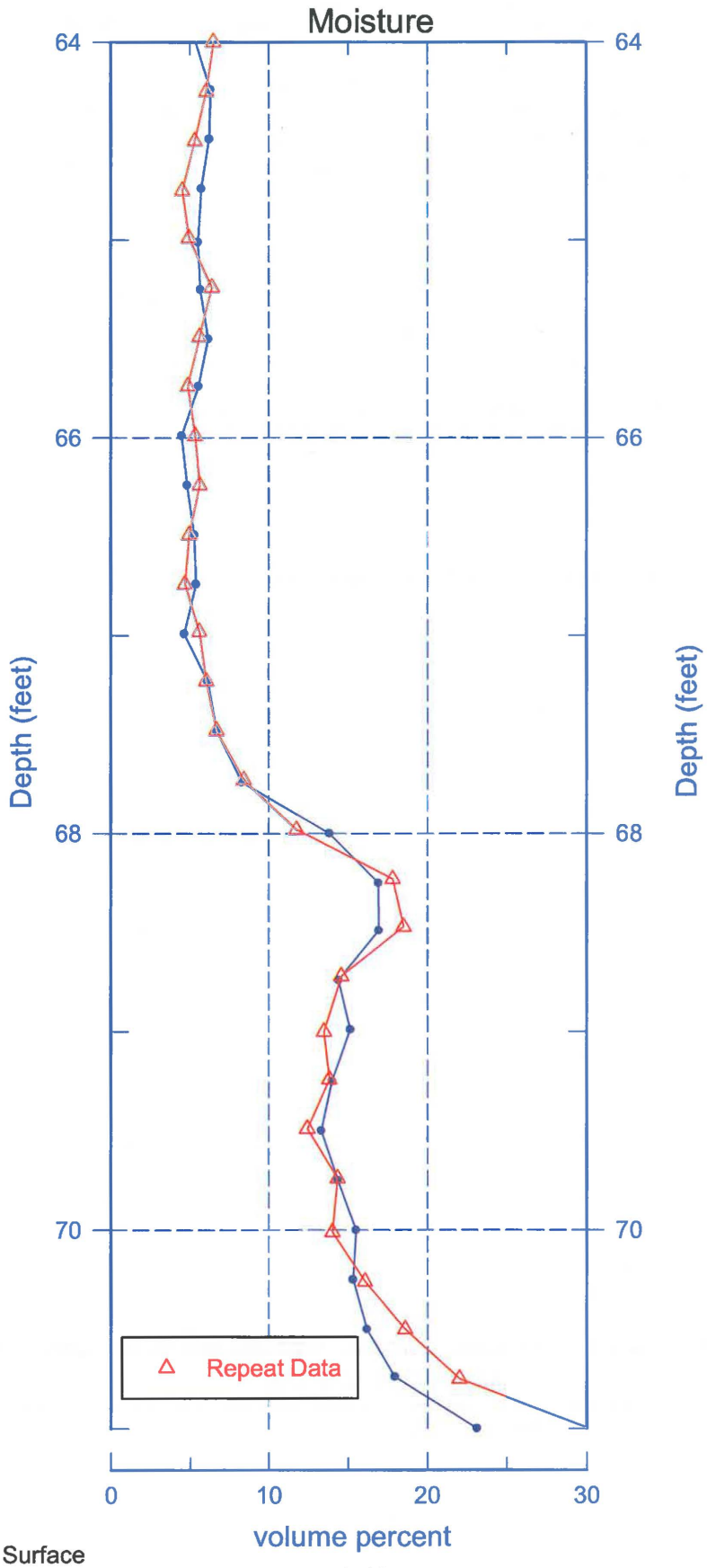
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

Huntington Ingalls Industries

699-S6-E3 (C9870)
Moisture Repeat Section



Zero Reference - Ground Surface

SURVEY DATA REPORT

Request No. 183-090

Project No.	Title	File No.
	M-24 Well C9870 (699-S6-E3) Final Survey	6AT11R28

Job. No.	Prepared By	Date	Reviewer
CACN: 304284-JPRC	N.P. Fastabend	6/4/18	LBM

DESCRIPTION OF WORK	DISTRIBUTION	SDR	PLOT	DWG
Obtained final coordinates (C/L Casing) and elevations of M-24 Well C9870 (699-S6-E3) located at the 618-10 Site southeast of 400 Area.	Survey File	OR		
	S.E. Imhoff	1		
	J.L. Hammons	1		
	J.L. Smoot	1		
	J.B. Geiger	1		
Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)	B.J. Howard	1		
	A.J. Green	1		

SURVEY RESULTS AND COMMENTS

See Attached Well Survey Data Report Sheet

FOR OFFICE USE ONLY

OR Doc Type:	WMU Code(S):

A-6006-495 (REV 1)

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 05/24/18	**Requestor:** Steven E. Imhoff (CHPRC)
Date of Survey: 06/04/18	**Surveyor / Company:** Lawrence B. Munnell (CHPRC)
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of M-24 Well C9870 (699-S6-E3) located at the 618-10 Site southeast of the 400 Area.	**Horizontal Datum:** NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 600A

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
Q323 (COE) and R323 (COE)

Well ID	Well Name	Easting	Northing	Elevation	[illegible]
C9870	699-S6-E3	590987.56	121661.62		Center of Casing
				134.904	Top Outer Casing,N.Edge Stamped "X"
				134.602	Top Inner 4"SS Casing, N.Edge
				134.185	Brass Survey Marker

Notes:

Brass Survey Marker elevation was taken on top domed brass cap in concrete.

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

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9870 | Well Name: 699-S6-E3 | Date: 5/23/18

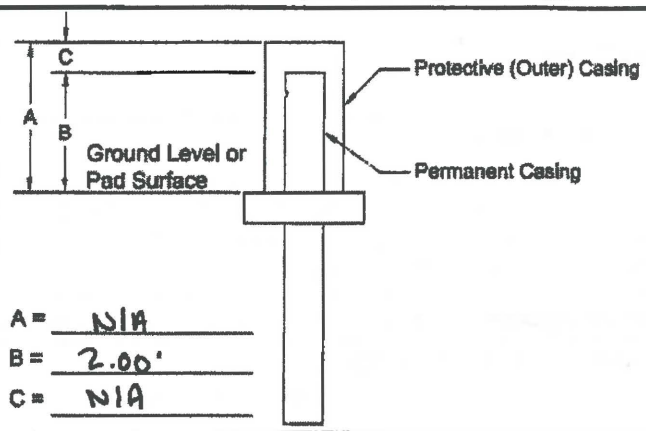
Location: ~3mi S of Energy NW

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

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

Initial Conditions

	Start of Job	End of Job
STATIC WATER LEVEL:		
Date: 5/23/18	67.82' bgs	67.78' bgs
Date: N/A	N/A	N/A
DEPTH TO BOTTOM:		
Date: 5/23/18	98.0' TOS	98.0' TOS
Date: N/A	N/A	N/A



A = N/A
B = 2.00'
C = N/A

Intake Depth (ft bgs)	Specific Capacity (gpm/ft)	Troll Depth (ft bwt)	Turbitidy (NTU) Initial	Turbitidy (NTU) Final	Pump Start	Pump Stop	Pumping Rate (gpm)	Maximum Drawdown (ft)
~~85.05~~ 93.10 BT 5/23/18	0.305	23.52	Overrange	4.37 BT 5/31/18	0803	1028	~5.5gpm avg.	18.03

JLR 5/31/18

Total Pumped: 6466gal

Pump Model: Grundfos X Type 16S15-14, Mod A 10K45 1V000X208, 60 Hz, 1.5 hp, 1-phase

Troll Serial Number and Pressure Range (PSI and depth): In-Situ Level Troll 700 SN 168724, range 21m/69ft/vented

Comments: Development was conducted prior to surging

Logfile name: C9870_develop_interval#1_5-22-18 ← test was not completed due to drawdown being too close to intake

C9870_develop_interval#2 BT 5/23/18_5-23-18 ← pump was turned on and off multiple times due to drawdown being to close to intake, were able to stabilize conditions w/ test that started @ 0803

TOS = Top of stainless

initial flow meter reading: 418,523 gal

final flow meter reading: 419,169 gal

Prepared By:

Brandon Thurnau — *Print Name* | Brandon Thurnau — *Signature* | 5/23/18 — *Date*

Reviewed By:

Jennifer Richart — *Print Name* | J. L. Richart — *Signature* | 5/31/18 — *Date*

For Office Use Only

OR Doc Type: | WMU Code(s):

A-6005-205 (REV 2)

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Photo Log

60-62.5 bgs

64-66 bgs

67.5-70 bgs

90-92.5 bgs

94-96 bgs

97.5-100 bgs

100-105 bgs

105-110 bgs