SGW-63998
Revision 0

Borehole Summary Report for the Installation of Six Wells and Two Boreholes in the 100-FR-3 Operable Unit, FY2019

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

Approved for Public Release;
Further Dissemination Unlimited

SGW-63998
Revision 0

Borehole Summary Report for the Installation of Six Wells and Two Boreholes in the 100-FR-3 Operable Unit, FY2019

D. J. Charbonneaux
GRAM Northwest, LLC

Date Published
October 2019

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

APPROVED
By Lynn M. Ayers at 10:51 am, Oct 28, 2019

Release Approval Date

Approved for Public Release;
Further Dissemination Unlimited

TRADEMARK DISCLAIMER

Reference herein to any specific commercial product, process, or service by tradename, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

This report has been reproduced from the best available copy.

Printed in the United States of America

Contents

1 Introduction 1

1.1 Drilling, Sampling, and Well Construction Activities 1

1.2 General Information 1

1.2.1 Drilling, Sampling, and Borehole Logging 1

1.2.2 Health and Safety Screening 4

1.2.3 Well Construction and Development 6

1.3 Well-Specific Information 7

1.3.1 Well 699-60-27 (C9874) 7

1.3.2 Borehole 699-68-29 (C9873) 10

1.3.3 Well 699-70-29 (C9985) 11

1.3.4 Well 699-71-24 (C9872) 12

1.3.5 Borehole 699-71-30B (C9876) 14

1.3.6 Well 699-71-30C (D0130) 15

1.3.7 Well 699-73-30 (C9875) 16

1.3.8 Well 699-77-34B (C9877) 18

2 Geologic Observations 19

2.1 Geology of the 100-FR-3 Operable Unit 19

2.2 Borehole Geology 20

2.2.1 Well 699-60-27 (C9874) 20

2.2.2 Borehole 699-68-29 (C9873) 21

2.2.3 Well 699-70-29 (C9985) 22

2.2.4 Well 699-71-24 (C9872) 22

2.2.5 Borehole 699-71-30B (C9876) 23

2.2.6 Well 699-71-30C (D0130) 23

2.2.7 Well 699-73-30 (C9875) 24

2.2.8 Well 699-77-34B (C9877) 24

3 Waste Management 25

3.1 Drill Cuttings 25

3.2 Purgewater 25

4 Civil Survey 25

5 Well Acceptance 26

6 References 26

Appendices

A Well Documentation for 699-60-27 (C9874) ..... A-i

B Borehole Documentation for 699-68-29 (C9873) ..... B-i

C Well Documentation for 699-70-29 (C9985) ..... C-i

D Well Documentation for 699-71-24 (C9872) ..... D-i

E Borehole Documentation for 699-71-30B (C9876) ..... E-i

F Well Documentation for 699-71-30C (D0130) ..... F-i

G Well Documentation for 699-73-30 (C9875) ..... G-i

H Well Documentation for 699-77-34B (C9877) ..... H-i

Figures

Figure 1. Hanford Site Map Showing the 100-FR-3 OU 2

Figure 2. Locations of the Six New Wells and Two Decommissioned Boreholes in the 100-FR-3 OU 3

Tables

Table 1. Project Well Identification and Drilling Date Summary 4

Table 2. Project Sample Summary 5

Table 3. Well Development Data Summary 8

Table 4. Construction Summary for Well 699-60-27 (C9874) 10

Table 5. Decommissioning Summary for Borehole 699-68-29 (C9873) 11

Table 6. Construction Summary for Well 699-70-29 (C9985) 12

Table 7. Construction Summary for Well 699-71-24 (C9872) 13

Table 8. Decommissioning Summary for Borehole 699-71-30B (C9876) 15

Table 9. Construction Summary for Well 699-71-30C (D0130) 16

Table 10. Construction Summary for Well 699-73-30 (C9875) 17

Table 11. Construction Summary for Well 699-77-34B (C9877) 19

Table 12. Civil Survey Summary 26

Terms

bgs	below ground surface
BTR	buyer's technical representative
Cascade	Cascade Environmental Drilling LP
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
hp	horsepower
NMLS	neutron moisture logging system
NTU	nephelometric turbidity unit
OD	outer diameter
OU	operable unit
RUM	Ringold Formation upper mud
SGLS	spectral gamma logging system
TD	total depth
VOC	volatile organic compound

This page intentionally left blank.

1 Introduction

This borehole summary report describes the well drilling and construction activities performed during installation of six monitoring wells and the drilling and decommissioning of two new boreholes in the 100-FR-3 Operable Unit (OU) in the River Corridor of the Hanford Site. Figure 1 shows the location of the 100-FR-3 OU. SGW-63389, *Description of Work for the Installation of Six Monitoring Wells and One Optional Monitoring Well in the 100-FR-3 Groundwater Operable Unit, FY 2019* (hereinafter referred to as the description of work [DOW]), is the controlling document for installation of the six new wells. Figure 2 shows the locations of the six new wells and the two decommissioned boreholes in the 100-FR-3 OU.

The six wells and two boreholes were drilled, constructed, and developed between July 17 and August 14, 2019, by Cascade Drilling, LP (Cascade) for CH2M HILL Plateau Remediation Company (CHPRC). GRAM Northwest, LLC, provided well site geology, well drilling documentation, and construction documentation services. Geophysical logging services were provided by Bay West, LLC.

The new wells are being installed to support monitored natural attenuation of hexavalent chromium, nitrate, strontium-90, and trichloroethene in groundwater, which is the remedy selected in the 100-F/IU Record of Decision (EPA and DOE, 2014, *Record of Decision Hanford 100 Area Superfund Site 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*). The wells were installed as part of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) preferred remedy (SGW-63389).

Table 1 lists the well names, well identification numbers, well type, Washington State Department of Ecology (Ecology) unique well tag numbers, and installation (start and finish) dates for the six new wells and two decommissioned boreholes. Appendices A through H provide well summary sheets, borehole logs, geophysical log data reports, final civil survey reports, and photo logs for the six new wells and two decommissioned boreholes.

1.1 Drilling, Sampling, and Well Construction Activities

This section summarizes the field activities associated with installing unconfined monitoring wells 699-60-27 (C9874), 699-70-29 (C9985), 699-71-24 (C9872), 699-71-30C (D0130), 699-73-30 (C9875), and 699-77-34B (C9877). Summaries of the field activities for drilling of two additional decommissioned boreholes (C9873 and C9876) are also included.

1.2 General Information

All six new wells were constructed in compliance with the substantive standards of WAC 173-160, “Minimum Standards for Construction and Maintenance of Wells,” and the construction specifications listed in the DOW (SGW-63389). All of the well drilling and construction activities were documented in daily field activity reports, and borehole geology was logged. The sampling activities conformed to requirements established in the sampling and analysis plan in Appendix A of DOE/RL-2014-44-ADD2, *Remedial Design Report/Remedial Action Work Plan Addendum for the 100-F/IU Groundwater*.

1.2.1 Drilling, Sampling, and Borehole Logging

This section describes the drilling, sampling, and borehole logging activities for installing the six new wells, as well as the drilling and decommissioning two new boreholes.

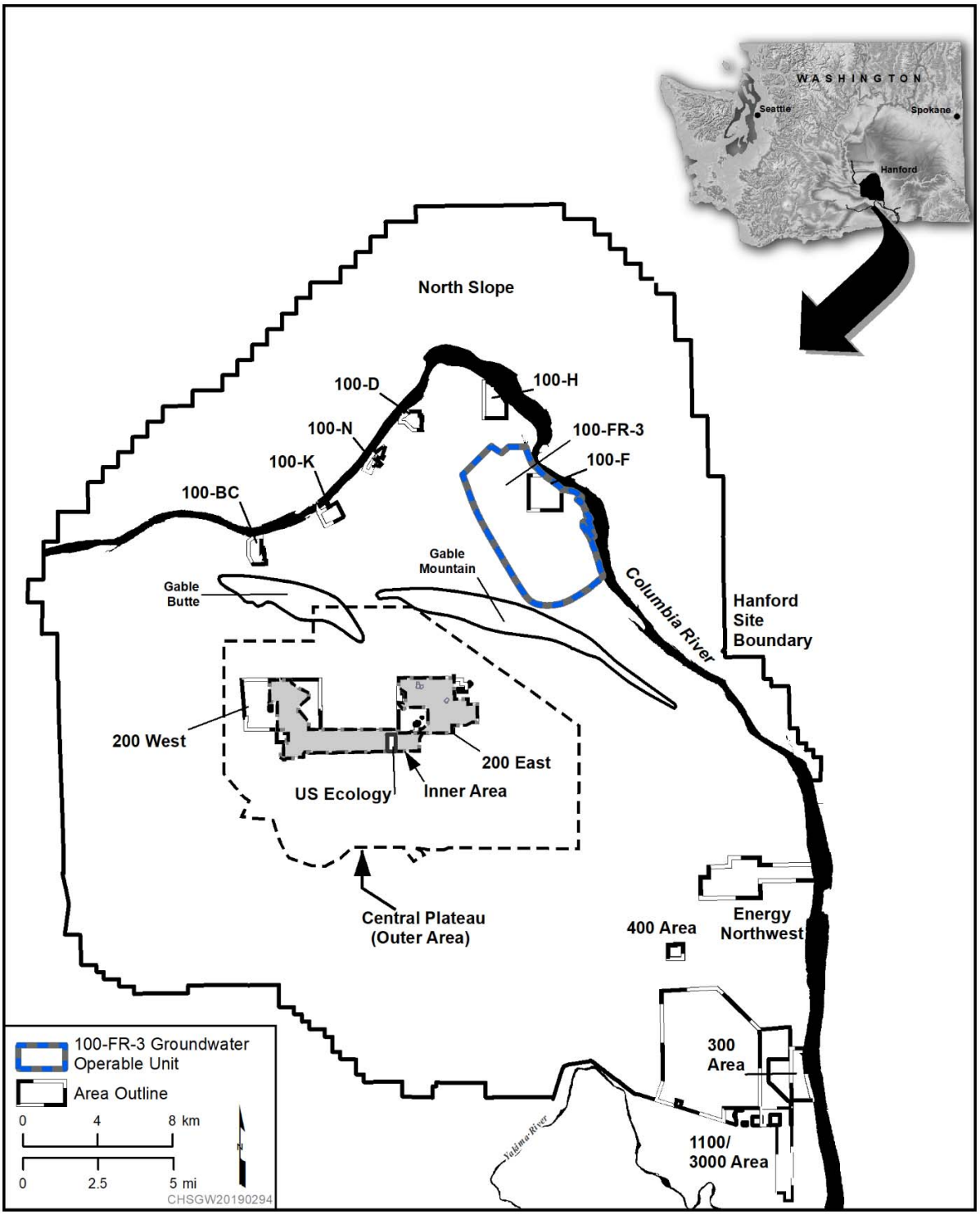


Figure 1. Hanford Site Map Showing the 100-FR-3 OU

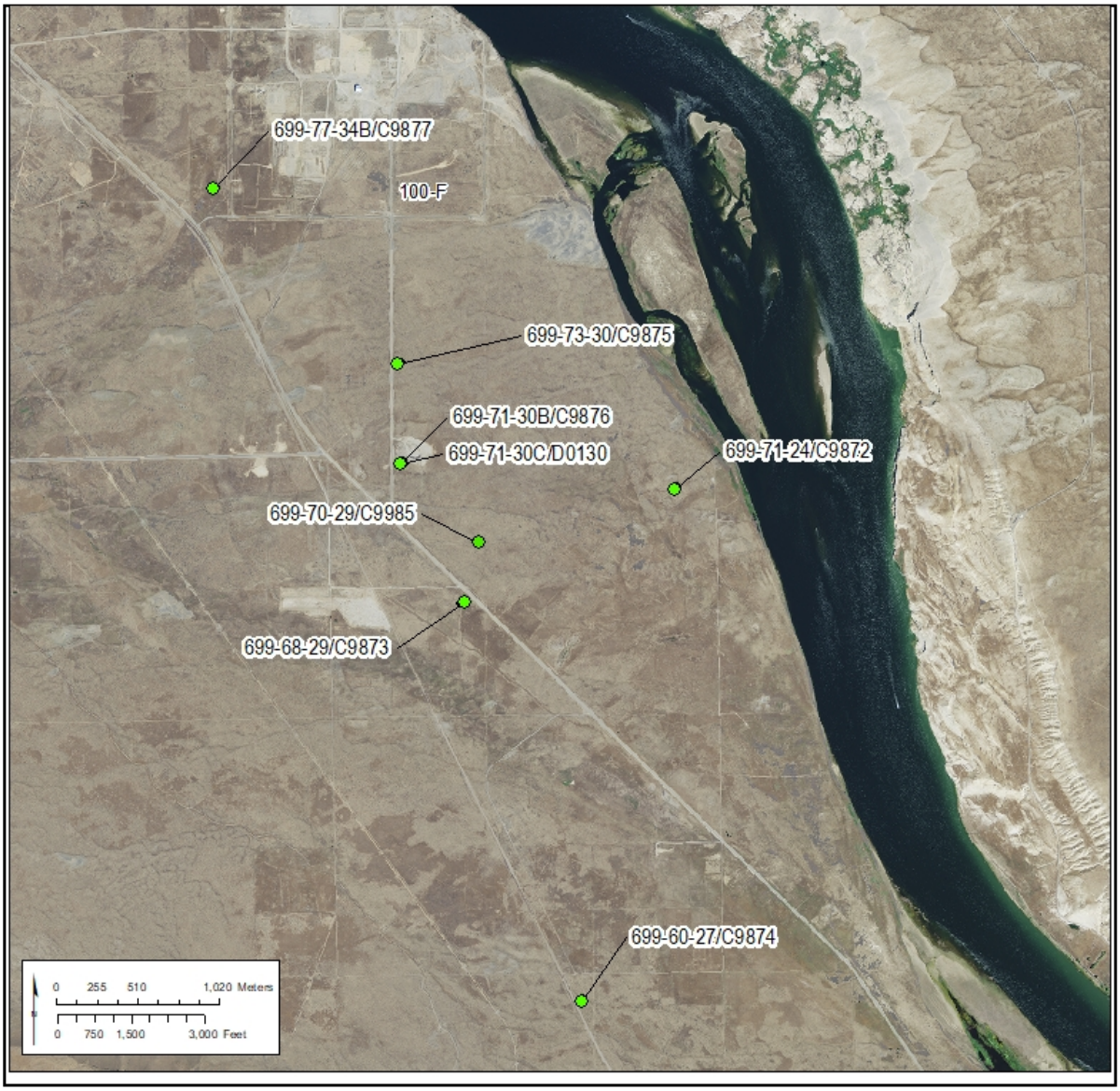


Figure 2. Locations of the Six New Wells and Two Decommissioned Boreholes in the 100-FR-3 OU

1.2.1.1 Drilling

Boreholes C9874, C9985, C9872, D0130, C9875, C9877, C9873, and C9876 were drilled using a Prosonic™ T600 truck-mounted sonic drilling rig operated by Cascade. Each borehole was cased with 8-1/4 in. outer-diameter (OD), 7-1/4 in. inner-diameter carbon steel temporary casing. Each borehole was drilled to at least 3.0 m (10 ft) past the Hanford formation/Ringold Formation upper mud (RUM) contact except for C9874, which was drilled to 1.4 m (4.5 ft) past the Hanford formation/RUM contact.

Prosonic™ is a trademark of Boart Longyear, South Jordan, Utah.

Table 1. Project Well Identification and Drilling Date Summary

Well Name	Well ID Number	Well Type	Well Installation Date		Ecology Well Tag Number
			Start	Finish	
699-60-27	C9874	Unconfined monitoring well	7/24/2019	8/14/2019	BLD029
N/A	C9873	Borehole, decommissioned	7/23/2019	7/29/2019	N/A
699-70-29	C9985	Optional unconfined monitoring well	8/6/2019	8/12/2019	BLD026
699-71-24	C9872	Unconfined monitoring well	7/24/2019	8/8/2019	BLD025
N/A	C9876	Borehole, decommissioned	7/18/2019	8/6/2019	N/A
699-71-30C	D0130	Replacement unconfined monitoring well	8/6/2019	8/7/2019	BLD023
699-73-30	C9875	Unconfined monitoring well	7/17/2019	7/31/2019	BLD024
699-77-34B	C9877	Unconfined monitoring well	7/22/2019	8/5/2019	BLD022

Ecology = Washington State Department of Ecology
ID = identification
N/A = not applicable

1.2.1.2 Sampling

Sampling was conducted in accordance with the DOW (SGW-63389) and the sampling and analysis plan (Appendix A of DOE/RL-2014-44-ADD2). Geologic grab samples were collected and archived at 1.5 m (5 ft) intervals and at major lithologic changes during the drilling of each borehole. Archive grab samples were placed in pint-size glass mason jars and plastic chip tray compartments and then labeled for storage at the Hanford Geotechnical Sample Library. Additional grab samples were obtained over the predicted screened interval every 1.5 m (5 ft) and composited into 2.4 to 6.1 m (8 to 20 ft) particle-size distribution analysis (sieve analysis) samples. Sieve analyses were run on these samples to determine grain-size distributions to determine filter pack mesh size and well screen slot size for well construction.

A post-development water sample was collected from each well after construction and well development were completed. All samples for chemical analysis were collected by CHPRC nuclear chemical operators (samplers). A waste verification grab sample was collected at well 699-77-34B (C9877). Section 1.3 provides well-specific sampling information, and Table 2 provides a summary of sample information for all of the boreholes drilled for this project.

1.2.1.3 Geophysical Logging

The eight boreholes were logged using a spectral gamma logging system (SGLS) to detect natural and manmade gamma-emitting radionuclides and a neutron moisture logging system (NMLS) to detect soil moisture in the vadose zone. Each borehole was drilled to total depth (TD) and cased with 8-1/4 in. OD carbon steel temporary casing prior to geophysical logging and construction, Bay West performed the geophysical logging at all eight boreholes. Manmade radionuclides were not detected in any of the eight boreholes. Section 1.3 provides well-specific geophysical logging information.

1.2.2 Health and Safety Screening

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

Table 2. Project Sample Summary

Well Name	Well ID	Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS Number
699-60-27	C9874	8/14/2019	Post-development	61.50	Water	Pumped	B3R446, B3R447
N/A	C9873	7/23/2019	Contingency	25.30	Water	Bailed	B3R443, B3R444, B3R445
699-70-29	C9985	8/12/2019	Post-development	35.00	Water	Pumped	B3R475, B3R476
699-71-24	C9872	8/8/2019	Post-development	36.70	Water	Pumped	B3R430, B3R431 (B3R433, B3R434 [duplicates])
N/A	C9876	7/312019	Post-development*	33.05	Water	Pumped	B3R458, B3R459, B3R460
699-71-30C	D0130	8/7/2019	Post-development	32.00	Water	Pumped	B3RFC4, B3RFC5, B3RFC6
699-73-30	C9875	7/31/2019	Post-development	28.00	Water	Pumped	B3R452, B3R453
699-77-34B	C9877	8/5/2019	Post-development	21.50	Water	Pumped	B3R467, B3R468, B3R469
699-77-34B	C9877	7/22/2019	Waste verification	5.00	Soil	Grab	B3R481

*Post-development sample was collected before the well was decommissioned.

bgs = below ground surface
HEIS = Hanford Environmental Information System
ID = identification
N/A = not applicable

1.2.2.1 Radiological Field Screening

For all eight boreholes, a radiological control technician provided twice daily (once in the morning and once in the afternoon) surveys during drilling, development, and construction. Radiological contamination was not detected above background levels at any point during field activities.

1.2.2.2 Air Monitoring for Volatile Chemicals

An industrial hygiene technician performed atmospheric monitoring twice daily (once in the morning and once in the afternoon) during drilling. The industrial hygiene technician used a photoionization detector and a multi-gas meter to monitor VOCs during drilling. Constituents monitored using the multi-gas meter included carbon monoxide, hydrogen sulfide, lower explosive limits, ammonia, and oxygen. Areas monitored for VOCs included the driller's breathing zone near the wellhead, the wellhead or source, any fresh drill cuttings and/or geologic samples, and any other areas of potential concern. All readings collected by industrial hygiene technicians at all eight boreholes were below action levels.

1.2.3 Well Construction and Development

This section provides additional details on well construction and development activities.

1.2.3.1 Screen and Casing Materials

Each well was constructed with permanent casing consisting of 4-1/2 in. OD, 4-1/4 in. inner diameter, Type 304 stainless-steel blank casing, screens, and caps or sumps with end caps. Screens used at the wells were continuous vee-wire wrap with a 20-slot (0.020 in) aperture, and each well used either an end cap or a 0.9 m (3 ft) sump with a welded end cap located below the screened interval. Section 1.3 provides further information on the construction materials used for each well.

1.2.3.2 Well Completion

In accordance with the substantive standards of WAC 173-160, a straightness test was conducted in each borehole prior to setting the permanent well casing with a tool that was 6.1 m (20 ft) in length with a 6 in. OD.

During construction, the boreholes were backfilled up to approximately 0.3 m (1 ft) below the bottom of the sump or endcap with ¼ in. bentonite pellets. The screen size and filter pack size used for construction were determined based on sieve analysis results, geologic borehole logs, geophysical logs, and intended well use. The wells were constructed with filter packs consisting of 12-20 mesh Colorado silica sand from ~0.3 m (1 ft) below the sump or endcap to ~0.9 m (3 ft) above the top of the screen. The filter packs were settled using a dual-flange surging method. Section 1.3 provides further information on the construction materials used for each well.

The annular seals for the six new wells used 1/4 in. bentonite pellets from ~0.9 m (3 ft) above the top of the screened interval to ~1.8 m (6 ft) above the top of the screened interval, and then 3/8 in. bentonite chips were used to ~3 m (10 ft) below ground surface (bgs). Above ~3 m (10 ft) bgs, Type I/II Portland cement was used for the surface seal, generally up to ~0.3 m (1 ft) bgs, with the remaining annular space filled with high-strength concrete during well pad construction. Boreholes C9873 and C9876 were decommissioned using bentonite crumbles from TD up to ~0.6 m (2 ft) bgs and Type I/II Portland cement or high-strength concrete to ground surface, with a brass surveyor's marker (stamped with borehole identification number and the date of decommissioning) embedded facing northward in the cement/concrete.

The surface completion consists of permanent casing surrounded by a gray-painted, stainless-steel protective monument with a unique Ecology well tag number riveted to the north-facing side of the

monument. Each surface completion has a 1.2 m by 1.2 m by 0.15 m (4 ft by 4 ft by 0.5 ft) concrete pad constructed around the wellhead protective monument. The wells are centered within the concrete pad with a brass surveyor's marker (stamped with the well name, well identification number, and final construction date) embedded on the northern side of the pad. The monuments have a lockable cap, and the lock hasps were positioned to face northward. The surface completion also includes four steel bollards (6 ft long and 3 in. diameter, one of which is removable) placed at the four corners of each concrete pad, with ~0.9 m (3 ft) stickup for wellhead protection. The bollards were painted yellow in accordance with ANSI Z535.1-2017, *American National Standard for Safety Colors*, for increased visibility of physical hazards. Section 1.3 provides further information on well construction.

1.2.3.3 Final Well Development

Final well development for the six new wells took place after filter pack placement and surging, but typically before the bentonite pellet seal, granular bentonite, and cement grout were placed (except for well 699-73-30 [C9875], which was developed after placement of bentonite and cement up to ground surface). Each well was developed with a submersible electric pump, with the pump intake generally placed near the bottom of the screened well interval (except for well 699-71-24 [C9872], which was developed with the pump intake close to the middle of the screened well interval). The groundwater was pumped while water quality parameters (turbidity, conductivity, dissolved oxygen, pH, and temperature) were monitored. Development was considered complete when the turbidity was measured at <5 nephelometric turbidity units (NTUs) and the remaining water quality parameters stabilized. Once final development had been fulfilled, post-development samples were collected. For all wells, an In Situ LevelTROLL® 700 data logger was used to record the drawdown and recovery data during development activities. Table 3 lists the final water quality data for each well. Appendices A through H provide well development and testing data sheets for each well, respectively.

1.2.3.4 Washington State Department of Ecology Well Identification

Each well received a unique Ecology well identification number that was embossed onto a stainless-steel tag and riveted to the protective monument. When the monuments were set, all identification tags were set to face toward the north. Table 1 lists the Ecology tag numbers and the associated wells.

1.3 Well-Specific Information

This section summarizes the drilling, air monitoring, sampling, geophysical logging, construction, and development activities specific to each well.

1.3.1 Well 699-60-27 (C9874)

Drilling activities were performed at well 699-60-27 (C9874) from July 24 to July 29, 2019, and the well was constructed on August 13 and August 14. The borehole was drilled to a TD of 46.5 m (152.5 ft) bgs. This hole was originally planned to be drilled 3.0 m (10 ft) into the RUM but by the time the RUM was encountered, the drillers had run out of temporary casing and the BTR made the decision to stop drilling there. The 8-1/4 in. OD, 7-1/4 in. inner-diameter threaded carbon steel temporary casing was advanced to a depth of 46.4 m (152.2 ft) bgs. Approximately 379 L (100 gal) of potable water were added downhole during drilling activities.

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

Table 3. Well Development Data Summary

Well Name	Well ID Number	Date Developed	Initial Water Level (ft bgs)	Pump Intake Depth (ft bgs)	Duration Pumped (minutes)	Average Flow Rate (gal/min)	Maximum Drawdown (ft)	Final Turbidity (NTU)	Specific Conductance (µS/cm)	Dissolved Oxygen (mg/L)	pH	Temperature (°C)	Total Gallons Pumped
699-60-27	C9874	8/14/2019	45.27	61.50	124	4.80	0.14	2.76	314[a]	6.15	8.00	16.30	595.2
699-70-29	C9985	8/12/2019	28.90	35.00	66	6.00	2.45	1.15	511[a]	7.58	7.41	16.30	396.0
699-71-24	C9872	8/08/2019	33.40	36.70	57	6.00	3.08	3.12	460[a]	8.45	7.52	17.53	342.0
699-71-30B[b]	C9876[b]	7/31/2019	29.72	33.05	66	5.00	2.44	4.81	455	7.51	7.80	16.76	330.0
699-71-30C	D0130	8/7/2019	29.50	32.00	76	4.00	2.28	4.70	615	7.58	7.47	18.75	304.0
699-73-30	C9875	7/31/2019	25.60	28.00	69	5.20	2.46	2.43	635	7.37	7.81	16.70	353.8
699-77-34B	C9877	8/5/2019	13.85	21.50	76	5.45	2.83	0.94	632	5.32	7.55	15.71	414.2

a. Field calibration for specific conductance probe failed.

b. Well was developed before being removed from borehole and the borehole was decommissioned.

bgs = below ground surface
ID = identification
N/A = not applicable
NTU = nephelometric turbidity unit

Sampling at C9874 included collecting soil grab samples for geologic archival purposes, composited soil grab samples for sieve analysis, and one post-development water sample for chemical analysis. Geologic archive soil samples were collected by the field geologist at 1.5 m (5 ft) intervals from 1.5 m (5 ft) bgs to TD and at major lithology changes throughout the borehole. Samples for sieve analysis were collected as 6.1 m (20 ft) composites of each 1.5 m (5 ft) soil grab sample from 11.5 to 17.7 m (38 to 58 ft) bgs and from 17.7 to 23.8 m (58 to 78 ft) bgs. A post-development water sample was collected at 18.7 m (61.5 ft) bgs on August 14. Static water was initially tagged at 14.9 m (48.8 ft) bgs on April 25. A final static water level was tagged at 14.1 m (46.1 ft) bgs on August 14. Table 2 provides summary information for the sample collected for chemical analysis.

Geophysical logging was performed through the 8-1/4 in. OD temporary casing using NMLS on July 29 from ground surface to 7.013 m (23.01 ft) bgs and using SGLS on July 31 from ground surface to 45.72 m (150.0 ft) bgs. Manmade radionuclides were not detected in the borehole. Appendix A provides the geophysical logging report for C9874 (HGLP-LDR-1098).

Well construction activities were performed from August 13 to August 14. Cascade performed a straightness test with a 20 ft long, 6 in. OD core barrel, which passed through the 8 in. temporary casing without binding. Well installation materials included 4-1/2 in. OD, 4-1/4 in. inner-diameter, Schedule 10S Type 304 stainless-steel blanks, screen, and sump with welded end cap. A total of 3.05 m (10.01 ft) of continuous vee-wire wrap, 4-7/8 in. OD, 4-1/4 in. inner-diameter stainless-steel screen with 20-slot (0.020 in.) apertures was used. Another 3.05 m (10.00 ft) section of 17-slot (0.017 in. aperture) screen had been labeled as 20-slot (0.020 in. aperture) screen. With approval of the client buyer's technical representative (BTR) and well design authority, the 17-slot screen (0.017 in. aperture) was used to construct this well instead of 20-slot (0.020 in. aperture) screen per the well design. Stainless-steel centralizers were placed at the bottom and top of the screened interval. Table 4 provides information on the well construction materials and associated depths for C9874, and Appendix A provides the well summary sheet depicting the final construction for this well.

Well development at C9874 was performed after placing and surging the filter pack and before placing the bentonite pellet seal. Development activities were performed on August 14. The 4-7/8 in. OD screen was developed with a 1-horsepower (hp) Grundfos[1] submersible electric pump. The average pumping rate during development was 18.2 L/min (4.8 gal/min). Completion of development required pumping until turbidity was <5 NTUs and all other key parameters (specific conductance, dissolved oxygen, pH, and temperature) were stabilized. A total of 2,253.1 L (595.2 gal) was pumped to develop C9874. Table 3 provides development data for this well.

[1] Grundfos is a tradename of Grundfos, Bjerringbro, Denmark.

Table 4. Construction Summary for Well 699-60-27 (C9874)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	Stainless-Steel Permanent Casing, Screen, and Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Slot Size (in.)	Material	Interval (ft bgs)	Mesh Size
152.5	46.10 (8/14/2019)	6-5/8 in. OD stainless-steel monument	+3.00 – 2.00	N/A	High-strength concrete	0.0 – 2.5	N/A
		4-1/2 in. OD stainless-steel blank casing	+1.75 – 45.34	N/A	Portland cement	2.5 – 10.1	Type I/II
					Bentonite crumbles	10.1 – 36.5	3/8 in.
		4-1/2 in. OD stainless-steel screen	45.34 – 55.35	0.020			
					Bentonite pellets	36.5 – 41.4	1/4 in.
		4-1/2 in. OD stainless-steel screen	55.35 – 65.35	0.017			
					Filter pack sand	41.4 – 69.0	12-20
		4-1/2 in. OD stainless-steel sump with cap	65.35 – 68.67	N/A	Bentonite crumbles	69.0 – 99.9	3/8 in.
					Bentonite pellets	99.9 – 151.3	1/4 in.
					Natural fill	151.3 – 152.5	N/A

bgs = below ground surface
N/A = not applicable

1.3.2 Borehole 699-68-29 (C9873)

Drilling activities were performed at borehole 699-68-29 (C9873) on July 23, 2019, and the borehole was decommissioned on July 29. The borehole was drilled to a TD of 11.5 m (37.7 ft). The 8-1/4 in. OD, 7-1/4 in. inner-diameter threaded carbon steel temporary casing was advanced to a depth of 10.8 m (35.5 ft) bgs. During drilling, water was not encountered within the Hanford formation. With the bottom of the casing set above the Hanford formation/RUM contact, drilling was paused for 2 hours (per client BTR direction) to determine if water would appear. Water seeped into the hole at a rate of approximately 3.8 L/hr (1 gal/hr) and was tagged at 7.7 m (25.3 ft) bgs. The hole was decommissioned on July 29. Approximately 11 L (3 gal) of potable water were added downhole during decommissioning activities.

Sampling at C9873 included collecting soil grab samples for geologic archival purposes, composited soil grab samples for sieve analysis, and one bailed water sample for chemical analysis. Geologic archive soil samples were collected by the field geologist at 1.5 m (5 ft) intervals from 1.5 m (5 ft) bgs to TD and at major lithology changes throughout the borehole. A sample for sieve analysis was collected from the 1.2 m (4 ft) composite soil grab sample from 6.1 to 7.3 m (20 to 24 ft) bgs but was not analyzed due to the decision to decommission the borehole. Water was tagged at 7.7 m (25.3 ft) bgs on July 23 below the Hanford formation/RUM contact. A bailed water sample was collected from the water present in the hole

at 7.7 m (25.3 ft) bgs on July 23, and Table 2 provides sample summary information for the bailed water sample collected for chemical analysis.

Geophysical logging was performed through the 8-1/4 in. OD temporary casing on July 23 using SGLS and NMLS from ground surface to 11.0 m (36.0 ft) bgs. Manmade radionuclides were not detected in the borehole. Appendix B provides the geophysical logging report for C9873 (HGLP-LDR-1099). Well decommissioning activities were performed on July 29. After decommissioning, a brass surveyor's marker (including borehole identification number and the date of decommissioning) was embedded facing northward on the surface of the cement poured from 0.61 m (2.0 ft) bgs to ground surface. Prior to decommissioning, Cascade performed a straightness test with a 20 ft long, 6 in. OD core barrel, which passed through the 8 in. temporary casing without binding. Table 5 provides information on the well decommissioning materials and associated depth for C9873, and Appendix B provides the well summary sheet depicting the final decommissioning for this well.

Table 5. Decommissioning Summary for Borehole 699-68-29 (C9873)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	Decommissioning Materials		
		Material	Interval (ft bgs)	Mesh Size
37.7	25.3 (7/23/2019)	Cement grout	0.0 – 2.0	Type I/II
		Bentonite crumbles	2.0 – 37.7	3/8 in.

bgs = below ground surface

1.3.3 Well 699-70-29 (C9985)

Well 699-70-29 (C9985) was planned as an optional well to be installed if C9873 had insufficient water to be constructed as a usable well. Very little water was present and it was not constructed as a well (see Section 1.3.5). Drilling activities were performed at well 699-70-29 (C9985) from August 6 to August 7, 2019, and the well was constructed on August 12. The borehole was drilled to a TD of 14.9 m (49.0 ft) bgs. The 8-1/4 in. OD, 7-1/4 in. inner-diameter threaded carbon steel temporary casing was advanced to a depth of 14.7 m (48.3 ft) bgs. Approximately 38 L (10 gal) of potable water were added downhole during drilling activities.

Sampling at C9985 included collecting soil grab samples for geologic archival purposes, composited soil grab samples for sieve analysis, and one post-development water sample for chemical analysis. Geologic archive soil samples were collected by the field geologist at 1.5 m (5 ft) intervals from 1.5 m (5 ft) bgs to TD and at major lithology changes throughout the borehole. A sample for sieve analysis was collected as a 4.6 m (15 ft) composite of each 1.5 m (5 ft) soil grab sample from 6.4 to 11.0 m (21 to 36 ft) bgs. A post-development water sample was collected at 10.7 m (35.0 ft) bgs on August 12. Static water was initially tagged at 8.8 m (29.0 ft) bgs on August 7. A final static water level was tagged at 8.9 m (29.1 ft) bgs on August 14. Table 2 provides summary information for the post-development water sample collected for chemical analysis.

Geophysical logging was performed on August 8 through the 8-1/4 in. OD temporary casing using SGLS from ground surface to 14.6 m (48.0 ft) bgs and using NMLS from ground surface to 12.2 m (40.0 ft) bgs. Manmade radionuclides were not detected in the borehole. Appendix C provides the geophysical logging report for C9985 (HGLP-LDR-1105). Well construction activities were performed on August 12. Cascade performed a straightness test with a 20 ft long, 6 in. OD core barrel, which passed through the 8 in.

temporary casing without binding. Well installation materials included 4-1/2 in. OD, 4-1/4 in. inner-diameter, Schedule 10S Type 304 stainless-steel blanks, screen, and sump with welded end cap. A total of 3.05 m (10.01 ft) of continuous vee-wire wrap, 4-7/8 in. OD, 4-1/4 in. inner-diameter stainless-steel screen with 20-slot (0.020 in.) screen apertures was used. A stainless-steel centralizer was placed at the bottom of the screened interval. Table 6 provides information on the well construction materials and associated depths for C9985, and Appendix C provides the well summary sheet depicting the final construction for this well.

Table 6. Construction Summary for Well 699-70-29 (C9985)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	Stainless-Steel Permanent Casing, Screen, and Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Slot Size (in.)	Material	Interval (ft bgs)	Mesh Size
49.0	28.9 (8/12/2019)	6-5/8 in. OD stainless-steel monument	+3.05 – 1.95	N/A	High-strength concrete	0.0 – 0.1	N/A
		4-1/2 in. OD stainless-steel blank casing	+2.00 – 26.25	N/A	Portland cement	0.1 – 10.9	Type I/II
					Bentonite crumbles	10.9 – 20.0	3/8 in.
		4-1/2 in. OD stainless-steel screen	26.25 – 36.26	0.020	Bentonite pellets	20.0 – 23.0	1/4 in.
		4-1/2 in. OD stainless-steel sump with cap	36.26 – 39.48	N/A	Filter pack sand	23.0 – 40.0	12-20
					Bentonite pellets	40.0 – 48.8	1/4 in.
					Natural fill	48.8 – 49.0	N/A

bgs = below ground surface
N/A = not applicable

Well development at C9985 was performed after placing and surging the filter pack and before placement of the bentonite pellet seal. Development activities were performed on August 12. The 4-7/8 in. OD screen was developed with a 1 hp Grundfos submersible electric pump. The average pumping rate during development was 22.7 L/min (6.0 gal/min). Completion of development required pumping until turbidity was <5 NTUs and all other key parameters (specific conductance, dissolved oxygen, pH, and temperature) were stabilized. A total of 1,499.0 L (396.0 gal) was pumped to develop C9985. Table 3 provides development data for this well.

1.3.4 Well 699-71-24 (C9872)

Drilling activities were performed at well 699-71-24 (C9872) on July 24, 2019, and the well was constructed on August 8. The borehole was drilled to a TD of 17.9 m (58.7 ft) bgs. The 8-1/4 in. OD, 7-1/4 in. inner-diameter threaded carbon steel temporary casing was advanced to a depth of 17.9 m (58.7 ft) bgs.

Sampling at C9872 included collecting soil grab samples for geologic archival purposes, composited soil grab samples for sieve analysis, and one post-development water sample for chemical analysis. Geologic archive soil samples were collected by the field geologist at 1.5 m (5 ft) intervals from 1.5 m (5 ft) bgs to TD and at major lithology changes throughout the borehole. A sample for sieve analysis was collected as a 6.1 m (20 ft) composite of each 1.5 m (5 ft) soil grab sample from 8.2 to 14.3 m (27 to 47 ft) bgs. A post-development water sample was collected at 11.2 m (36.7 ft) bgs on August 8. Static water was initially tagged at 10.3 m (33.8 ft) bgs on July 24. A final static water level was tagged at 10.1 m (33.2 ft) bgs on August 8. Table 2 provides summary information for the post-development water sample collected for chemical analysis.

Geophysical logging was performed on July 25 through the 8-1/4 in. OD temporary casing using SGLS from ground surface to 17.68 m (58.02 ft) bgs and using NMLS from ground surface to 10.82 m (35.51 ft) bgs. Manmade radionuclides were not detected in the borehole. Appendix D provides the geophysical logging report for C9872 (HGLP-LDR-1104). Well construction activities were performed on August 8. Cascade performed a straightness test with a 20 ft long, 6 in. OD core barrel, which passed through the 8 in. temporary casing without binding. Well installation materials included 4-1/2 in. OD, 4-1/4 in. inner-diameter, Schedule 10S Type 304 stainless-steel blanks, screen, and threaded end cap. A total of 6.07 m (19.91 ft) of continuous vee-wire wrap, 4-7/8 in. OD, 4-1/4 in. inner-diameter stainless-steel screen with 20-slot (0.020 in.) screen apertures was used. Stainless-steel centralizers were placed at the bottom and top of the screened interval. Table 7 provides information on the well construction materials and associated depths for C9872, and Appendix D provides the well summary sheet depicting the final construction for this well.

Table 7. Construction Summary for Well 699-71-24 (C9872)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	Stainless-Steel Permanent Casing, Screen, and Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Slot Size (in.)	Material	Interval (ft bgs)	Mesh Size
58.7	33.2 (8/8/2019)	6-5/8 in. OD stainless-steel monument	+3.00 – 2.00	N/A	High-strength concrete	0.0 – 0.4	N/A
					Portland cement	0.4 – 10.9	Type I/II
		4-1/2 in. OD stainless-steel blank casing	+2.10 – 27.02	N/A	Bentonite crumbles	10.9 – 21.4	3/8 in.
		4-1/2 in. OD stainless-steel screen	27.02 – 46.93	0.020	Bentonite pellets	21.4 – 24.1	1/4 in.
		4-1/2 in. OD stainless-steel cap	46.93 – 47.25	N/A	Filter pack sand	24.1 – 48.0	12-20
					Bentonite pellets	48.0 – 58.7	1/4 in.

bgs = below ground surface
N/A = not applicable

Well development at C9872 was performed after placing and surging the filter pack and before placement of the bentonite pellet seal. Development activities were performed on August 8. The 4-7/8 in. OD screen was developed with a 1 hp Grundfos submersible electric pump. The average pumping rate during development was 22.7 L/min (6.0 gal/min). Completion of development required pumping until turbidity was <5 NTUs and all other key parameters (specific conductance, dissolved oxygen, pH, and temperature) were stabilized. A total of 1,294.6 L (342.0 gal) was pumped to develop C9872. Table 3 provides development data for this well.

1.3.5 Borehole 699-71-30B (C9876)

Drilling activities were performed at borehole 699-71-30B (C9876) on July 18, 2019, and construction was attempted unsuccessfully from July 30 to August 6. The borehole was drilled to a TD of 15.7 m (51.4 ft) bgs. The 8-1/4 in. OD, 7-1/4 in. inner-diameter threaded carbon steel temporary casing was advanced to a depth of 13.2 m (43.2 ft) bgs. Approximately 379 L (100 gal) of potable water were added downhole during drilling activities.

Sampling at C9876 included collecting soil grab samples for geologic archival purposes, composited soil grab samples for sieve analysis, and one post-development water sample for chemical analysis. Geologic archive soil samples were collected by the field geologist at 1.5 m (5 ft) intervals from 1.5 to 13.4 m (5 to 44 ft) bgs and at major lithology changes throughout the borehole. A sample for sieve analysis was collected as a 3.0 m (10 ft) composite of each 1.5 m (5 ft) soil grab sample from 7.3 to 10.4 m (24 to 34 ft) bgs. The results for the sieve sample were used to determine screen and filter pack size for the replacement well 699-71-30C (D0130). Static water was tagged at 9.1 m (29.72 ft) bgs on July 31. Table 2 provides summary information for the post-development water sample collected for chemical analysis.

Geophysical logging was performed on July 22 through the 8-1/4 in. OD temporary casing using SGLS and NMLS from ground surface to 13.7 m (45.0 ft) bgs. Manmade radionuclides were not detected in the borehole. Appendix E provides the geophysical logging report for C9876 (HGLP-LDR-1102). Well construction activities, including development, began on July 31. The initial well was successfully developed on July 31. Table 3 provides development data for this now decommissioned well. During the pouring of the cement grout surface seal for the initial well construction attempt, the 8-1/4 in. OD temporary casing became bound with the 4-1/2 in. OD permanent well casing. During attempts to unbind the temporary and permanent casing, the 4-1/2 in. stainless-steel screen became separated from the 4-1/2 in. stainless-steel blanks. All permanent well materials were removed from the hole, and the hole was flushed with approximately 379 L (100 gal) of potable water to prevent the cement grout from setting up. A second attempted well construction in the same borehole with new materials began on August 5. During construction, the second attempted well was found to be dry. After several unsuccessful attempts to produce water, the BTR and drilling contractor made the decision to remove the permanent well materials from the borehole, decommission the borehole, and install a replacement well (699-71-30C [D0130]) approximately 3.0 m (10 ft) to the southwest.

After decommissioning, a brass surveyor's marker (including borehole identification number and date of decommissioning) was embedded facing northward on the surface of the cement poured from 0.49 m (1.6 ft) bgs to ground surface. Table 8 provides information on the well decommissioning materials and associated depths for C9876, and Appendix E provides the well summary sheet depicting the final decommissioning of this well.

Table 8. Decommissioning Summary for Borehole 699-71-30B (C9876)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	Decommissioning Materials		
		Material	Interval (ft bgs)	Mesh Size
51.4	29.72 (7/31/2019)	High strength concrete	0.0 – 1.6	N/A
		Bentonite crumbles	1.6 – 28.5	3/8 in.
		Colorado silica sand	28.5 – 37.2	12-20
		Bentonite pellets	37.2 – 51.0	1/4 in.
		Natural fill	51.0 – 51.4	N/A

bgs = below ground surface
N/A = not applicable

1.3.6 Well 699-71-30C (D0130)

Well 699-71-30C (D0130) was installed to replace the decommissioned well at C9876; D0130 is located approximately 3.0 m (10.0 ft) southwest of C9876 (Section 1.3.5). Drilling activities were performed at well 699-71-30C (D0130) on August 6, 2019, and the well was constructed on August 7. The borehole was drilled to a TD of 13.2 m (43.4 ft) bgs. The 8-1/4 in. OD, 7-1/4 in. inner-diameter threaded carbon steel temporary casing was advanced to a depth of 12.1 m (39.7 ft) bgs.

Sampling at C9872 included collecting soil grab samples for geologic archival purposes, composited soil grab samples for sieve analysis, and one post-development water sample for chemical analysis. Geologic archive soil samples were collected by the field geologist at 1.5 m (5 ft) intervals from 1.5 m (5 ft) bgs to TD and at major lithology changes throughout the borehole. A sample for sieve analysis was not collected at D0130 because the sieve analysis results from C9876 were used to design the well for D0130 (as its lithology was nearly identical). A post-development water sample was collected at 9.8 m (32.0 ft) bgs on August 7. Static water was initially tagged at 9.0 m (29.4 ft) bgs on August 6. A final static water level was tagged at 8.9 m (29.3 ft) bgs on August 8. Table 2 provides summary information for the post-development water sample collected for chemical analysis.

Geophysical logging was performed on August 7 through the 8-1/4 in. OD temporary casing using SGLS from ground surface to 12.2 m (40.0 ft) bgs and NMLS from ground surface to 11.6 m (38.0 ft) bgs. Manmade radionuclides were not detected in the borehole. Appendix F provides the geophysical logging report for D0130 (HGLP-LDR-1106). Well construction activities were performed on August 7. Cascade performed a straightness test with a 20 ft long, 6 in. OD core barrel, which passed through the 8 in. temporary casing without binding. Well installation materials included 4-1/2 in. OD, 4-1/4 in. inner-diameter, Schedule 10S Type 304 stainless-steel blanks, screen, and sump with welded end cap. A total of 1.53 m (5.01 ft) of continuous vee-wire wrap, 4-7/8 in. OD, 4-1/4 in. inner-diameter stainless-steel screen with 20-slot (0.020 in.) screen apertures was used. Stainless-steel centralizers were placed at the bottom and top of the screened interval. Table 9 provides information on the well construction materials and associated depths for D0130, and Appendix F provides the well summary sheet depicting the final construction for this well.

Table 9. Construction Summary for Well 699-71-30C (D0130)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	Stainless-Steel Permanent Casing, Screen, and Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Slot Size (in.)	Material	Interval (ft bgs)	Mesh Size
43.4	29.3 (8/8/2019)	6-5/8 in. OD stainless-steel monument	+3.00 – 2.00	N/A	High-strength concrete	0.0 – 0.6	N/A
					Portland cement	0.6 – 9.9	Type I/II
		4-1/2 in. OD stainless-steel blank casing	+1.90 – 28.10	N/A	Bentonite crumbles	9.9 – 22.5	3/8 in.
		4-1/2 in. OD stainless-steel screen	28.10 – 33.11	0.020	Bentonite pellets	22.5 – 25.0	1/4 in.
					Filter pack sand	25.0 – 38.0	12-20
		4-1/2 in. OD stainless-steel sump with cap	33.11 – 36.34	N/A	Bentonite pellets	38.0 – 43.1	1/4 in.
					Natural fill	43.1 – 43.4	N/A

bgs = below ground surface
N/A = not applicable

Well development at D0130 was performed after placing and surging the filter pack and before placement of the bentonite pellet seal. Development activities were performed on August 7. The 4-7/8 in. OD screen was developed with a 1 hp Grundfos submersible electric pump. The average pumping rate during development was 15.1 L/min (4.0 gal/min). Completion of development required pumping until turbidity was <5 NTUs and all other key parameters (specific conductance, dissolved oxygen, pH, and temperature) were stabilized. A total of 1,151 L (304.0 gal) was pumped to develop D0130. Table 3 provides development data for this well.

1.3.7 Well 699-73-30 (C9875)

Drilling activities were performed at well 699-73-30 (C9875) on July 17, 2019, and the well was constructed on July 29 and July 30. The borehole was drilled to a TD of 12.3 m (40.5 ft). The 8-1/4 in. OD, 7-1/4 in. inner-diameter threaded carbon steel temporary casing was advanced to a depth of 11.8 m (38.7 ft) bgs.

Sampling at C9875 included collecting soil grab samples for geologic archival purposes, composited soil grab samples for sieve analysis, and one post-development water sample for chemical analysis. Geologic archive soil samples were collected by the field geologist at 1.5 m (5 ft) intervals from 1.5 m (5 ft) bgs to TD and at major lithology changes throughout the borehole. A sample for sieve analysis was collected as a 2.4 m (8 ft) composite of each 1.5 m (5 ft) soil grab sample from 6.1 to 8.5 m (20 to 28 ft) bgs. A post-development water sample was collected at 8.5 m (28.0 ft) bgs on July 31. Static water was initially tagged at 7.8 m (25.5 ft) bgs on July 17. A final static water level was tagged at 7.8 m (25.6 ft) bgs on August 5. Table 2 provides summary information for the post-development water sample collected for chemical analysis.

Geophysical logging was performed on July 22 through the 8-1/4 in. OD temporary casing using SGLS from ground surface to 11.9 m (39.0 ft) bgs and using NMLS from ground surface to 8.915 m (29.25 ft) bgs. Manmade radionuclides were not detected in the borehole. Appendix G provides the geophysical logging report for C9875 (HGLP-LDR-1100). Well construction activities were performed on July 29 and July 30. Cascade performed a straightness test with a 20 ft long, 6 in. OD core barrel, which passed through the 8 in. temporary casing without binding. Well installation materials included 4-1/2 in. OD, 4-1/4 in. inner-diameter, Schedule 10S Type 304 stainless-steel blanks, screen, and sump with welded end cap. A total of 1.52 m (5.00 ft) of continuous vee-wire wrap, 4-7/8 in. OD, 4-1/4 in. inner-diameter stainless-steel screen with 20-slot (0.020 in.) screen apertures was used. Stainless-steel centralizers were placed at the bottom and top of the screened interval. Table 10 provides information on the well construction materials and associated depths for C9875, and Appendix G provides the well summary sheet depicting the final construction for this well.

Table 10. Construction Summary for Well 699-73-30 (C9875)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	Stainless-Steel Permanent Casing, Screen, and Construction Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Slot Size (in.)	Material	Interval (ft bgs)	Mesh Size
40.5	25.6 (8/5/2019)	6-5/8 in. OD stainless-steel monument	+3.00 – 2.00	N/A	Portland cement	0.0 – 8.0	Type I/II
					Bentonite crumbles	8.0 – 14.5	3/8 in.
		4-1/2 in. OD stainless-steel blank casing	+1.85 – 23.14	N/A	Bentonite pellets	14.5 – 20.1	1/4 in.
		4-1/2 in. OD stainless-steel screen	23.14 – 28.14	0.020	Filter pack sand	20.1 – 31.7	12-20
		4-1/2 in. OD stainless-steel sump with cap	28.14 – 31.36	N/A	Bentonite pellets	31.7 – 40.5	N/A

bgs = below ground surface
N/A = not applicable

Well development at C9875 was performed after subsurface construction was completed, including placement of the bentonite pellet seal and cement grout seal but before surface construction. Development activities were performed on July 31. The 4-7/8 in. OD screen was developed with a 1 hp Grundfos submersible electric pump. The average pumping rate during development was 19.7 L/min (5.2 gal/min). Completion of development required pumping until turbidity was <5 NTUs and all other key parameters (specific conductance, dissolved oxygen, pH, and temperature) were stabilized. A total of 1,339.3 L (353.8 gal) was pumped to develop C9875. Table 3 provides development data for this well.

1.3.8 Well 699-77-34B (C9877)

Drilling activities were performed at well 699-77-34B (C9877) on July 22, 2019, and the well was constructed on August 1 and August 5. The borehole was drilled to a TD of 12.2 m (40.0 ft). The 8-1/4 in. OD, 7-1/4 in. inner-diameter threaded carbon steel temporary casing was advanced to a depth of 11.7 m (38.5 ft) bgs.

Sampling at C9877 included collecting soil grab samples for geologic archival purposes, composited soil grab samples for sieve analysis, one post-development water sample for chemical analysis, and one waste verification soil grab sample. Geologic archive soil samples were collected by the field geologist at 1.5 m (5 ft) intervals from 1.5 m (5 ft) bgs to TD and at major lithology changes throughout the borehole. A sample for sieve analysis was collected as a 4.3 m (14 ft) composite of each 1.5 m (5 ft) soil grab sample from 3.0 to 7.3 m (10 to 24 ft) bgs. A post-development water sample was collected at 6.6 m (21.5 ft) bgs on August 5. A waste verification soil grab sample was collected at 1.5 m (5.0 ft) bgs on July 22. Static water was initially tagged at 4.4 m (14.5 ft) bgs on July 22. A final static water level was tagged at 4.2 m (13.8 ft) bgs on August 12. Table 2 provides summary information for the post-development water sample collected for chemical analysis.

Geophysical logging was performed on July 23 through the 8-1/4 in. OD temporary casing using SGLS and NMLS from ground surface to 11.9 m (39.0 ft) bgs. Manmade radionuclides were not detected in the borehole. Appendix H provides the geophysical logging report for C9877 (HGLP-LDR-1101). Well construction activities were performed on August 1 and August 5. Cascade performed a straightness test with a 20 ft long, 6 in. OD core barrel, which passed through the 8 in. temporary casing without binding. Well installation materials included 4-1/2 in. OD, 4-1/4 in. inner-diameter, Schedule 10S Type 304 stainless-steel blanks, screen, and threaded end cap. A total of 3.05 m (10.01 ft) of continuous vee-wire wrap, 4-7/8 in. OD, 4-1/4 in. inner-diameter stainless-steel screen with 20-slot (0.020 in.) screen apertures was used. Stainless-steel centralizers were placed at the bottom and top of the screened interval. Table 11 provides information on the well construction materials and associated depths for C9877, and Appendix H provides the well summary sheet depicting the final construction for this well.

Well development at C9877 was performed after placing and surging the filter pack and before placement of the bentonite pellet seal. Development activities were performed on August 1 and August 5. The 4-7/8 in. OD screen was developed with a 1 hp Grundfos submersible electric pump. The average pumping rate during development was 20.6 L/min (5.45 gal/min). Completion of development required pumping until turbidity was <5 NTUs and all other key parameters (specific conductance, dissolved oxygen, pH, and temperature) were stabilized. A total of 1,567.9 L (414.2 gal) was pumped to develop C9877. Table 3 provides development data for this well.

Table 11. Construction Summary for Well 699-77-34B (C9877)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	Stainless-Steel Permanent Casing, Screen, and Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Slot Size (in.)	Material	Interval (ft bgs)	Mesh Size
40.0	13.8 (8/12/2019)	6-5/8 in. OD stainless-steel monument	+3.00 – 2.00	N/A	High-strength concrete	0.0 – 0.4	N/A
					Portland cement	0.4 – 9.2	Type I/II
		4-1/2 in. OD stainless-steel blank casing	+1.85 – 14.20	N/A	Bentonite pellets	9.2 – 11.8	1/4 in.
		4-1/2 in. OD stainless-steel screen	14.20 – 24.21	0.020	Filter pack sand	11.8 – 25.9	12-20
		4-1/2 in. OD stainless-steel cap	24.21 – 24.53	N/A	Bentonite pellets	25.9 – 39.7	1/4 in.
					Natural fill	39.7 – 40.0	N/A

bgs = below ground surface
N/A = not applicable

2 Geologic Observations

The generalized geology of the 100-FR-3 OU and the geology encountered at each of the well sites during drilling are summarized in this chapter.

2.1 Geology of the 100-FR-3 Operable Unit

The 100-FR-3 OU is located in the northeast portion of the Hanford Site along the southwestern shoreline of the Columbia River, ~40 km (25 mi) north-northwest of Richland, Washington. The stratigraphy of this area is composed of various sedimentary deposits that lie above the Columbia River Basalt Group bedrock. The major units in the 100-F Area include the following (from youngest to oldest):

- Holocene eolian deposits, disturbed sediments, and recent sand and gravel backfill
- Pleistocene sand and gravel sediments of the Hanford formation
- Miocene silt-clay and sand of the RUM
- Deeper Miocene units of the Ringold Formation overlying the Columbia River Basalt Group (not encountered during this project)

Depending on the proximity to former facilities and/or remediation sites, the ground surface of the 100-F Area has been extensively disturbed by grading, construction, and demolition work. Disturbed sediments can extend more deeply but generally range from 0.30 to 4.6 m (1 to 15 ft) bgs in the 100-FR-3 OU (SGW-63389) The Pleistocene Hanford formation (as encountered for this project)

was a gravel-dominated facies consisting of uncemented, highly mafic gravel with sand and silt beds deposited by high-energy waters of the cataclysmic Lake Missoula floods (WHC-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*). The RUM in the 100-FR-3 OU is typical and (as encountered in this project) consists of silt and clay. Remnants of sand and gravel of the Ringold Formation member of Wooded Island – unit E may be present locally but are difficult to distinguish from Hanford formation sediments, which were not identified during this project (SGW-63389).

Additional information regarding geological units found in the 100-F Area is presented in the following:

- BHI-00184, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*
- BHI-01648, *Late Pleistocene and Holocene-Age Columbia River Sediments and Bedforms: Hanford Reach Area, Washington, Part 1*
- Lindsey, 1996, *The Miocene to Pliocene Ringold Formation and Associated Deposits of the Ancestral Columbia River System, South-central Washington and North-central Oregon*
- WHC-SA-0740-FP, *Sedimentology and Stratigraphy of the Miocene-Pliocene Ringold Formation, Hanford Site, South-Central Washington*
- WHC-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*

Summaries of the geologic units encountered throughout each borehole are presented in the following discussion.

2.2 Borehole Geology

This section describes the geological characteristics of grab samples collected during the drilling of six monitoring wells and two new boreholes, as well as interpreted stratigraphic units based on collected grab samples. Appendices A through H provide the respective borehole logs.

The stratigraphic interpretations of each drill site included in this report are based on field observations of drill cuttings collected every 1.5 m (5 ft) or where major lithologic changes occurred. Sample collection involved emptying the drill cuttings from the core barrel into plastic sleeves for observation and analysis by the field geologist. The depths of contacts included in this report should be viewed as approximations. Final stratigraphic unit contacts will be determined using field observations, borehole geophysical logging data, and regional stratigraphic interpretations.

Some samples (dry samples in particular) may appear to be more homogeneous due to the sampling method used, and wet samples may have had a weaker reaction to 10% concentration hydrochloric acid (HCl). The following sections discuss the estimated stratigraphic unit contacts for each borehole.

2.2.1 Well 699-60-27 (C9874)

Well 699-60-27 (C9874) is located ~5 km (~3.1 mi) south of F Reactor in the 100-F Area. The major stratigraphic units encountered were the Hanford formation and the RUM.

The Hanford formation was present from ground surface to 45.1 m (148 ft) bgs and consisted of the following:

- From 0 to 9.8 m (0 to 32 ft) bgs: sandy gravel
- From 9.8 to 11.6 m (32 to 38 ft) bgs: sand
- From 11.6 to 24.7 m (38 to 81 ft) bgs: sandy gravel
- From 24.7 to 26.5 m (81 to 87 ft) bgs: gravel
- From 26.5 to 30.5 m (87 to 100 ft) bgs: sand
- From 30.5 to 32.6 m (100 to 107 ft) bgs: gravelly sand
- From 32.6 to 37.5 m (107 to 123 ft) bgs: sandy gravel
- From 37.5 to 45.1 m (123 to 148 ft) bgs: gravel

Percentages were variable within the Hanford formation, with silt ranging from 0% to 10%, sand ranging from 0% to 95%, and gravel ranging from 5% to 100%. The silt was nonplastic to somewhat plastic. Sand ranged from very fine to very coarse (62.5 µm to 2 mm), subround to subangular, 60% to 90% mafic and 10% to 40% felsic, and poorly to moderately sorted with no reaction to mild reaction to HCl. Gravels ranged from pebbles to cobbles (2 to 150 mm), subround to angular, 60% to 90% mafic and 10% to 40% felsic, and very poorly to very well sorted. Soil colors were dark gray, very dark gray, grayish-brown, dark grayish-brown, very dark grayish-brown, and black. The soil was dry to nearly dry from ground surface to the water table (14.1 m [46.1 ft] bgs) and was saturated below that.

The RUM was present from 45.1 m (148 ft) bgs to TD at 46.5 m (152.5 ft) bgs and consisted of silt and clay. Percentages were 2% gravel, 3% sand, and 95% silt/clay. The plasticity was very high, there was no reaction to HCl, and the soil color was dark grayish-brown. The soil was damp.

A final static water level was tagged at 14.1 m (46.1 ft) bgs on August 14, 2019. Appendix A provides the borehole log for C9874.

2.2.2 Borehole 699-68-29 (C9873)

Borehole C9873 is located ~3 km (1.9 mi) south of F Reactor. The major stratigraphic units encountered after drilling through gravelly sand backfill were the Hanford formation and the RUM.

Gravelly sand backfill extended from ground surface to 0.9 m (3 ft) bgs. The backfill consisted of 15% silt, 75% sand, and 15% gravel. The silt was nonplastic. Sand ranged from very fine to very coarse (62.5 µm to 2 mm), subround to subangular, was moderately sorted, and had no reaction to HCl. Gravels ranged from pebbles to cobbles (2 to 75 mm), 40% mafic and 60% felsic, and rounded to subangular with moderate sorting. The soil color was light olive-brown and was dry.

The Hanford formation was present from 0.9 to 7.3 m (3 to 24 ft) bgs and consisted of sandy gravel. Percentages were variable within this interval, with silt ranging from 0% to 5%, sand ranging from 25% to 60%, and gravel ranging from 40% to 70%. The silt was nonplastic. Sand ranged from very fine to very coarse (62.5 µm to 2 mm), angular to subangular, and 40% mafic and 60% felsic with poor sorting and no reaction to HCl. Gravels ranged from pebbles to cobbles (2 to 90 mm), rounded to subangular, poorly to moderately sorted, and 60% mafic and 40% felsic. Soil colors were grayish-brown and dark grayish-brown. The soil was dry to damp from ground surface to near the water table (7.7 m [25.3 ft] bgs) and was saturated below that.

The RUM was present from 7.3 m (24 ft) bgs to TD at 11.5 m (37.7 ft) bgs and consisted of 100% silt and clay. The clay/silt was highly plastic, and the soil colors were dark grayish-brown and very dark gray. The soil was damp.

Static water was tagged at 7.7 m (25.3 ft) bgs on July 23, 2019. Appendix B provides the borehole log for C9873.

2.2.3 Well 699-70-29 (C9985)

Well 699-70-29 (C9985) is located ~3 km (~1.9 mi) southeast of F Reactor. The major stratigraphic units encountered after drilling through sand backfill were the Hanford formation and the RUM.

Sand backfill extended from ground surface to 1.8 m (6 ft) bgs. The backfill consisted of 95% sand and 5% gravel. Sand ranged from fine to medium (125 µm to 0.5 mm), subround to subangular, 60% mafic and 40% felsic, and was moderately sorted with no reaction to HCl. Gravel was rounded to subround with moderate sorting and was 50% mafic and 50% felsic. The soil color was brown and it was damp.

The Hanford formation was present from 1.8 to 11.0 m (6 to 36 ft) bgs and consisted of sandy gravel. Percentages were variable within this interval, with silt ranging from 0% to 5%, sand ranging from 25% to 60%, and gravel ranging from 40% to 75%. The silt was loose and nonplastic. Sand ranged from very fine to coarse (62.5 µm to 1 mm), subround to angular, and 60% mafic and 40% felsic. The sand was well sorted and had a mild reaction to HCL. Gravels ranged from pebbles to cobbles (2 to 140 mm), rounded to angular, 65% mafic and 35% felsic, and moderately sorted. Some gravel surfaces were covered in calcium carbonate with a strong HCl reaction. The soil color was dark grayish-brown, and the soil was dry to moist from ground surface to the water table (8.9 m [29.1 ft] bgs) and was saturated below that.

The RUM is present from 11.0 m (36 ft) bgs to TD at 14.9 m (49 ft) bgs and consisted of 100% silt and clay. The silt was semiplastic to plastic, massive, moist, and had no reaction to vigorous reaction to HCl. Large pieces of caliche were present at 11.9 m (39 ft bgs). The soil colors were olive and greenish-gray.

A final static water level was tagged at 8.9 m (29.1 ft) bgs on August 14, 2019. Appendix C provides the borehole log for C9985.

2.2.4 Well 699-71-24 (C9872)

Well 699-71-24 (C9872) is located ~3 km (~1.9 mi) southeast of F Reactor. The major stratigraphic units encountered after drilling through gravelly sand backfill were the Hanford formation and the RUM.

Gravelly sand backfill extended from ground surface to 0.9 m (3 ft) bgs. The backfill consisted of 10% silt, 80% sand, and 10% gravel. The silt was somewhat plastic and had no reaction to HCl. The sand was fine to medium (125 µm to 0.5 mm), 15% mafic and 85% felsic, well sorted, and mostly subangular. Gravel ranged from pebbles to cobbles (5 to 70 mm), rounded to subangular, 60% mafic and 40% felsic, and was moderately sorted. The soil color was brown and it was damp.

The Hanford formation was present from 0.9 to 14.3 m (3 to 47 ft) bgs and consisted of sandy gravel (0.9 to 11.3 m [3 to 37 ft] bgs) and gravel (11.3 to 14.3 m [37 to 47 ft] bgs). Percentages were variable within this interval, with silt ranging from 0% to 5%, sand ranging from 15% to 50%, and gravel ranging from 50% to 85%. The silt was nonplastic with a strong HCl reaction. The sand was fine to very coarse (125 µm to 2 mm), moderately sorted, mostly subangular, and 30% mafic and 70% felsic, with no reaction to strong HCl reaction. Gravels ranged from pebbles to cobbles (2 to 110 mm), moderately to well sorted, rounded to subangular, and 50% mafic and 50% felsic. The soil colors were light

olive-brown, olive-brown, and dark grayish-brown. The soil was dry to slightly damp from ground surface to the water table (10.1 m [33.2 ft] bgs) and was damp to saturated below that.

The RUM was present from 14.3 m (47 ft) bgs to TD at 17.8 m (58.5 ft) bgs and consisted of silt and clay. Percentages were 90% silt/clay, 5% sand, and 5% gravel. Silt/clay was highly plastic with no reaction to vigorous reaction to HCl, had caliche was present from 14.3 to 16.1 m (47 to 53 ft). The sand was mostly medium to coarse (0.5 to 1 mm) and subangular. The gravel was pebble size (2 to 15 mm) and subround, similar to the gravels of the overlying Hanford formation. The soil colors were grayish-brown and dark yellowish-brown, and the caliche was white. The soil was wet.

A final static water level was tagged at 10.1 m (33.2 ft) bgs on August 8, 2019. Appendix D provides the borehole log for C9872.

2.2.5 Borehole 699-71-30B (C9876)

Borehole C9876 is located ~2.5 km (~1.6 mi) south of F Reactor. The major stratigraphic units encountered after drilling through silty-sandy gravel backfill were the Hanford formation and the RUM.

Silty-sandy gravel backfill extended from ground surface to 3.4 m (11 ft) bgs. The silty-sandy gravel consisted of 15% silt, 15% sand, and 70% gravel. The silt was dry. The sand ranged from very fine to very coarse (62.5 µm to 2 mm), was mostly subangular, moderately sorted, and had a strong reaction to HCl. Gravels ranged from pebbles to cobbles (2 to 90 mm), rounded to subangular, moderately sorted, and 40% mafic and 60% felsic. The soil color was light brownish-gray, and the soil was dry.

The Hanford formation was present from 3.4 to 10.4 m (11 to 34 ft) bgs and consisted of sandy gravel. Percentages were variable within this interval, with silt ranging from 0% to 10%, sand ranging from 30% to 40%, and gravel ranging from 60% to 65%. The silt was dry. The sand ranged from very fine to very coarse (62.5 µm to 2 mm) and from no reaction to a strong reaction to HCl. Gravels ranged from pebbles to cobbles (2 to 130 mm), rounded to subround, poorly to moderately sorted, and 40% mafic and 60% felsic. The soil colors were grayish-brown and light brownish-gray. The soil was dry to slightly damp above the water table.

The RUM was present from 10.4 to 14.2 m (34 to 46.6 ft) bgs and consisted of 100% silt/clay. The silt/clay was highly plastic with no reaction to HCl. From 12.5 to 13.1 m (41 to 43 ft) bgs, caliche was present and had a vigorous reaction to HCl. The soil color was grayish-brown.

Static water was tagged at 9.1 m (29.72 ft) bgs on July 31, 2019. Appendix E provides the borehole log for C9876.

2.2.6 Well 699-71-30C (D0130)

Well 699-71-30C (D0130) is located ~2.5 km (~1.6 mi) south of F Reactor. The major stratigraphic units encountered after drilling through sandy gravel backfill were the Hanford formation and RUM.

Sandy gravel backfill extended from ground surface to 1.8 m (6 ft) bgs. The backfill consisted of 40% sand and 60% gravel. Sand ranged from fine to medium (125 µm to 0.5 mm), subround to angular, 60% mafic and 40% felsic, and was moderately sorted with a strong reaction to HCl. Gravels ranged from pebbles to cobbles (2 to 90 mm), rounded to subangular (mostly rounded), and 55% mafic and 45% felsic with moderate sorting. The soil color was olive-gray and it was dry.

The Hanford formation was present from 1.8 to 10.1 m (6 to 33 ft) bgs and consisted of sandy gravel. Percentages were variable within this interval, with silt ranging from 0% to 10%, sand ranging from 25% to 40%, and gravel ranging from 55% to 70%. The silt was loose and nonplastic. The sand ranged from very fine to medium (62.5 µm to 0.5 mm), subround to subangular, moderately sorted, 60% mafic and 40% felsic, and had a weak to strong reaction to HCl. Gravels ranged from pebbles to cobbles (2 to 90 mm), rounded to subangular (mostly rounded), and 55% mafic and 45% felsic with moderate sorting. The soil colors were olive, olive-gray, and dark gray. The soil was dry to saturated, with moisture content generally increasing with depth.

The RUM was present from 10.1 m (33 ft) bgs to TD at 13.2 m (43.4 ft) bgs and consisted of 100% silt and clay. The silt/clay was massive, plastic, and had no reaction to HCl. The soil color was dark grayish-brown, and it was slightly damp.

A final static water level was tagged at 8.9 m (29.3 ft) bgs on August 8, 2019. Appendix F provides the borehole log for D0130.

2.2.7 Well 699-73-30 (C9875)

Well 699-73-30 (C9875) is located ~2 km (1.2 mi) south of F Reactor. The major stratigraphic units encountered after drilling through sandy gravel backfill were the Hanford formation and the RUM.

Sandy gravel backfill extended from ground surface to 1.5 m (5 ft) bgs. The backfill consisted of 70% sand and 30% gravel. The sand ranged from very fine to very coarse (62.5 µm to 2 mm), subround to subangular, well sorted, 40% mafic and 60% felsic, and had a strong reaction to HCl. Gravel ranged from pebbles to cobbles (2 to 95 mm), rounded to subangular, poorly sorted, and 70% mafic and 30% felsic. The soil color was light olive-brown, and it was slightly damp.

The Hanford formation was present from 1.5 to 12.3 m (5 to 28 ft) bgs and consisted of sandy gravel. Percentages were variable within this interval, with sand ranging from 40% to 50% and gravel ranging from 50% to 60%. The sand ranged from very fine to very coarse (62.5 µm to 2 mm), subround to subangular, well sorted, 40% to 50% mafic and 50% to 60% felsic, and had a weak to strong reaction to HCl. Gravel ranged from pebbles to cobbles (2 to 130 mm), rounded to subangular, poorly to moderately well sorted, and 70% mafic and 30% felsic. The soil colors were dark grayish-brown and very dark grayish-brown. The soil was dry to saturated near the water table (7.8 m [25.6 ft] bgs).

The RUM was present from 8.5 m (28 ft) bgs to TD at 12.3 m (40.5 ft) bgs and consisted of silt and clay. Percentages were 97% silt/clay and 3% sand. The silt/clay was highly plastic with no reaction to mild reaction to HCl. The soil colors were grayish-brown and dark grayish-brown, and it was damp.

A final static water level was tagged at 7.8 m (25.6 ft) bgs on August 5, 2019. Appendix G provides the borehole log for C9875.

2.2.8 Well 699-77-34B (C9877)

Well 699-77-34B (C9877) is located ~1 km (0.6 mi) southwest of F Reactor. The major stratigraphic units encountered after drilling through sand backfill were the Hanford formation and RUM.

Sand backfill extended from ground surface to 1.8 m (6 ft) bgs. The backfill consisted of 100% sand. The sand was very fine to medium (62.5 µm to 0.5 mm), 60% mafic and 40% felsic, subangular to subround, well sorted, and had no reaction to HCl. The soil color was olive-brown and it was damp.

The Hanford formation was present from 1.8 to 7.3 m (6 to 24 ft) bgs and consisted of sandy gravel. Percentages were variable within this interval, with silt ranging from 0% to 5%, sand ranging from 40% to 65%, and gravel ranging from 30% to 60%. The silt was saturated and clumpy. The sand ranged from fine to very coarse (125 µm to 2 mm), 45% mafic and 55% felsic, mostly subround, moderately well sorted, and had no reaction to mild reaction to HCl. Gravels ranged from pebbles to cobbles (2 to 75 mm), rounded to subangular, 80% mafic and 20% felsic, and moderately sorted. The soil colors were olive-brown and very dark gray. The soil was damp to saturated.

The RUM was present from 7.3 m (24 ft) bgs to TD at 12.2 m (40 ft) bgs and consisted of silt and clay. The silt and clay consisted of 90% silt/clay and 10% sand. The silt/clay was massive, had high plasticity, and had a moderate to vigorous reaction to HCl. Caliche was present at 9.1 m (30 ft) bgs. The soil color was dark green, and it was mostly dry to damp.

A final static water level was tagged at 4.2 m (13.8 ft) bgs on August 12, 2019. Appendix H provides the borehole log for C9877.

3 Waste Management

Waste generated during installation of the six new wells and two new boreholes included drill cuttings, purgewater, and miscellaneous solid waste. Waste was managed in accordance with CERCLA and the waste management plan for the 100-FR-3 OU (Appendix C of DOE/RL-2014-44-ADD2).

3.1 Drill Cuttings

All drill cuttings from the six new wells and two new boreholes were collected in tip dumpsters, and water was absorbed using WaterWorks Crystals® when necessary. The drill cuttings were then placed into designated Environmental Restoration Disposal Facility roll-off boxes. Any miscellaneous solid waste associated with sampling activities was sealed in clear plastic bags and also disposed in the roll-off boxes. The roll-off boxes were transported to the Environmental Restoration and Disposal Facility for disposal after project completion.

3.2 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 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*.

4 Civil Survey

The locations for the six new wells and two new boreholes were surveyed using a Trimble® R8 RTK global positioning system and a Trimble DiNi 12 level to measure coordinates. 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 six new wells and two new boreholes were surveyed on October 3, 2019.

WaterWorks Crystals® is a registered trademark of WaterWorks America, LLC, Independence, Ohio.

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

Table 12 provides the civil survey summary for the six new wells and two new boreholes. Appendices A through H provide the survey reports for each respective well.

Table 12. Civil Survey Summary

Well Name	Well ID Number	Northing[a] (m)	Easting[a] (m)	Brass Survey Marker Elevation[b] (m)	Top of Casing[b, c] Elevation (m)
699-60-27	C9874	141878.48	581838.35	125.058	125.824
N/A	C9873	144382.90	581102.94	120.77	N/A
699-70-29	C9985	144752.85	581195.52	122.221	122.962
699-71-24	C9872	145086.96	582414.97	122.207	122.930
N/A	C9876	145242.64	580710.85	122.84	N/A
699-71-30C	D0130	145238.78	580709.69	123.036	123.740
699-73-30	C9875	145873.73	580687.11	121.688	122.447
699-77-34B	C9877	146970.73	579538.04	119.265	119.957

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

N/A = not applicable

5 Well Acceptance

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

After the wells were completed, representatives from CHPRC and Cascade performed inspections for the new wells. Well site assessments were completed for the six new wells (C9874, C9985, C9872, D0130, C9875, and C9877) and for the two decommissioned boreholes (C9873 and C9876) on August 20, 2019.

6 References

ANSI Z535.1-2017, 2017, *American National Standard for Safety Colors*, National Electrical Manufacturers Association (approved by the American National Standards Institute, Inc.), Rosslyn, Virginia. Available at: https://www.nema.org/Standards/ComplimentaryDocuments/ANSI%20Z535_1-2017%20CONTENTS%20AND%20SCOPE.pdf.

BHI-00184, 1995, *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington*, Rev. 00, Bechtel Hanford, Inc., Richland, Washington. Available at: https://pdw.hanford.gov/document/0083482H.

BHI-01648, 2004, *Late Pleistocene and Holocene-Age Columbia River Sediments and Bedforms: Hanford Reach Area, Washington, Part 1*, Rev. 0, Bechtel Hanford, Inc., Richland, Washington.

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

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: https://pdw.hanford.gov/document/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: https://pdw.hanford.gov/document/0093937.

DOE/RL-2014-44-ADD2, 2015, *Remedial Design Report/Remedial Action Work Plan Addendum for the 100-F/IU Groundwater*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington. Available at: https://pdw.hanford.gov/document/0079673H.

EPA and DOE, 2014, *Record of Decision Hanford 100 Area Superfund Site 100-FR-1, 100-FR-2, 100-FR-3, 100-IU-2, and 100-IU-6 Operable Units*, U.S. Environmental Protection Agency and U.S. Department of Energy, Olympia, Washington. Available at: https://pdw.hanford.gov/document/0082927H.

Lindsey, Kevin A., 1996, *The Miocene to Pliocene Ringold Formation and Associated Deposits of the Ancestral Columbia River System, South-central Washington and North-central Oregon*, Open File Report 96-8, Washington Division of Geology and Earth Resources, Washington State Department of Natural Resources, Olympia, Washington. Available at: http://www.dnr.wa.gov/Publications/ger_ofr96-8_ringold_formation.pdf.

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. Available at: https://www.ngs.noaa.gov/PUBS_LIB/NAVD88/navd88report.htm.

SGW-63389, 2019, *Description of Work for the Installation of Six Monitoring Wells and One Optional Monitoring Well in the 100-FR-3 Groundwater Operable Unit, FY 2019*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, Olympia, Washington. Available at: http://apps.leg.wa.gov/WAC/default.aspx?cite=173-160.

WHC-SA-0740-FP, 1989, *Sedimentology and Stratigraphy of the Miocene-Pliocene Ringold Formation, Hanford Site, South-Central Washington*, Westinghouse Hanford Company, Richland, Washington. Available at: https://pdw.hanford.gov/document/E0020132.

WHC-SD-EN-TI-011, 1992, *Geology of the Northern Part of the Hanford Site: An Outline of Data Sources and the Geologic Setting of the 100 Areas*, Rev. 0, Westinghouse Hanford Company, Richland, Washington. Available at; https://pdw.hanford.gov/document/E0020132.

This page intentionally left blank.

Distribution

Onsite

CH2M HILL Plateau Remediation Company – Electronic Distribution

D.P. Capelle
R.T. Evans
J.B. Geiger
J.M. Griffith
M.J. Hartman
B.J. Howard
J.L. Kaas
S.A. Lynch
J.D. Mehrer
K.D. Meigs
J.M. Phipps
J.L. Richart
S.M. Sexton
J.L. Smoot
S.D. Springer
J.T. Stewart
K.K. Stiles
L.C. Sumner
K.M. Whitley
T.J. Woffinden

This page intentionally left blank.

Appendix A

Well Documentation for 699-60-27 (C9874)

- Well Summary Sheet for C9874
- Borehole Log for C9874
- Geophysical Log Data Report for C9874
- Well Survey Data Report for C9874
- Well Development and Testing Data Sheet C9874
- Archive Photo Log for C9874

This page intentionally left blank.

WELL SUMMARY SHEET

Well ID: C9874	Well Name: 699-60-27	Start Date: 7/24/2019
Project: Installation of 6+1 Wells in the 100-FR-3 OU	Location: ~5km S of F Reactor	End Date: 8/14/2019

CONSTRUCTION DATA

WA Ecology Well Tag: BLD029

Surface Construction:
4'x4'x6" Concrete pad with brass survey marker and protective monument

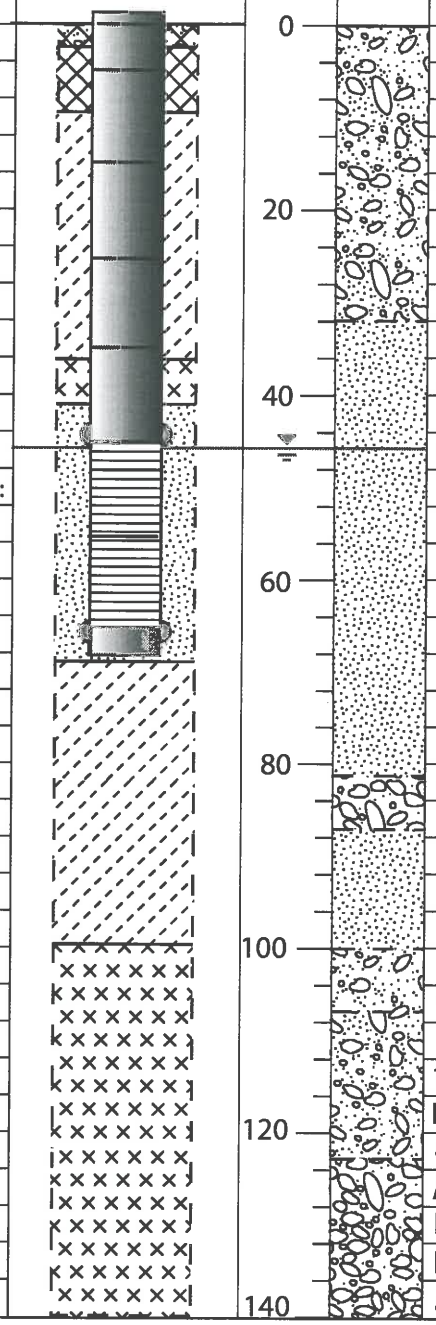
Temporary Casing Depth:
8" Carbon Steel Thd. joints =152.2 ft bgs

Permanent Well Materials:
4.5" OD TP-304 Sch 10s Riser:
1.75 ft ags - 45.34 ft bgs
4.875" OD TP-304 20-slot (0.020") Screen:
45.34 - 55.35 ft bgs
4.875" OD TP-304 17-slot (0.017") Screen*:
55.35 - 65.35 ft bgs
4.5" OD TP-304 Sch 10s Sump:
65.35 - 68.67 ft bgs

Well Construction Materials:
High Strength Concrete:
0.0 - 2.5 ft bgs
Type I/II Portland Cement:
2.5 - 10.1 ft bgs
Granular Bentonite:
10.1 - 36.5 ft bgs
Bentonite Pellet Seal:
36.5 - 41.4 ft bgs
Colorado Silica Sand 12/20# (Primary filter pack):
41.4 - 69.0 ft bgs
Granular Bentonite:
69.0 - 99.9 ft bgs
Bentonite Pellet Backfill:
99.9 - 151.3 ft bgs
Natural Fill:
151.3 - 152.5 ft bgs

Note:
All 8" temporary casing has been removed from the ground.

GEOLOGIC/HYDROLOGIC DATA



Lithologic Description (ft bgs):

0-32 ft: Sandy Gravel (sG)
32-38 ft: Sand (S)
38-81 ft: Sandy Gravel (sG)
DTW = 46.1 ft bgs (8/14/2019)
81-87 ft: Gravel (G)
87-100 ft: Sand (S)
100-107 ft: Gravelly Sand (gS)
107-123 ft: Sandy Gravel (sG)
123-148 ft: Gravel (G)

Note: *Screen was labeled as 20-slot, but was measured as 17-slot. BTR & well design authority gave OK to use it.

Acronyms:
DTW = depth to water
bgs = below ground surface
ags = above ground surface

Reported By:			
Dan Charbonneaux	Staff Geologist		8/26/2019
Print Name	*Title*	*Signature*	*Date*

Reviewed By:			
Jennifer Richart	Well Coordinator		9/5/19
Print Name	*Title*	*Signature*	*Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

WELL SUMMARY CONTINUATION SHEET

Well ID: C9874 | Well Name: 699-60-27 | Project: Installation of 6+1 Wells 100-FR-3 OU

CONSTRUCTION DATA			GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
Temporary Casing Depth:		140		123-148 ft: Gravel (G)
8" Carbon Steel Thd. joints =152.2 ft bgs				148-152.5 ft: Clay (M)
Well Construction Materials:				Total Depth = 152.5 ft bgs
High Strength Concrete:		160		
0.0 - 2.5 ft bgs				
Type I/II Portland Cement:				
2.5 - 10.1 ft bgs				
Granular Bentonite:				
10.1 - 36.5 ft bgs				
Bentonite Pellet Seal:		180		
36.5 - 41.4 ft bgs				
Colorado Silica Sand 12/20# (Primary Filter Pack):				
41.4 - 69.0 ft bgs				
Granular Bentonite:				
69.0 - 99.9 ft bgs		200		
Bentonite Pellet Backfill:				
99.9 - 151.3 ft bgs				
Natural Fill:				
151.3 - 152.5 ft bgs		220		
		240		
		260		
		280		
		300		

A-6006-992 (REV 0)

BOREHOLE LOG

Page 1 of 5
Date: 07/24/2019

Well ID: C9874 | Well Name: 699-60-27 | Location: ~5 km S of F reactor
Project: The Installation of 6+1 Wells in 100-FR-3 GU | 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' bgs - 32' bgs Sandy Gravel (SG)	Sonic rig, 8" casing 6" core barrel
0			Dry 30% Gravel, 70% Sand Gravel: 2mm - 140mm, very poorly sorted, subrounded to angular, No rxn to HCl 70% M, 30% F Sand: v fine to coarse sand, avg fine sand, subrounded to subangular, moderately sorted, No rxn to HCl, 2.5Y 5/2 grayish brown, 40% M, 60% F	
5	grab sample 7/24/19			Archive @ 5 ft bgs
			@ 10' bgs wet (due to water added in drilling). 2.5Y 3/2 very dark grayish brown. All else the same. 40% M, 60% F.	
10	grab sample 7/24/19			Archive @ 10 ft bgs (~4 gallons)
			@ 15' bgs damp. 70% Gravel, 30% Sand. Avg gravel size ~35, poorly sorted. Sand, medium to v coarse, avg coarse, moderately sorted, all else the same. 40% M, 60% F	
15	grab sample 7/24/19			Archive @ 15 ft bgs
			@ 20' bgs damp. Large gravel content decreases. Gravel 2mm-150mm, but avg 5mm. Well sorted (only 4 clasts over 20mm), subrounded to sub angular, all else stays the same. 40% ~~F~~ M 60% F edw 8/8/19	
20	grab sample 7/24/19			Archive @ 20 ft bgs
			@ 25' bgs dry. Lack of large gravel pieces continue. Gravel 2mm-100mm avg 5mm. (2 clasts over 20mm). 30% Gravel, 60% Sand, 10% Silt. Sand and Silt 2.5Y, 5/1 gray. Sand v fine to v coarse, very poorly sorted, No Rxn to HCl, silt slightly plastic. All else the same as 20' bgs. 40% M, 60% F.	
25	grab sample 7/24/19			Archive @ 25 ft bgs
30	grab sample 7/24/19 edw 7/24/19		@ 30' bgs almost dry. More large gravel pieces. Avg 20mm. Similar	Archive @ 30 ft bgs
				Archive @ 35 ft bgs

Reported By:

Print Name	Title	Signature	Date
Ellen Whitney	Geologist	[signature]	07/24/2019

Reviewed By:

Print Name	Title	Signature	Date
Sarah Spinger	Sr Geologist	[signature]	08-27-19

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Date: 07/24/2019

Well ID: C9874 | Well Name: 699-60-27 | Location: ~5 km S of F reactor

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	grab sample 7/24/19		size distribution to @ 15' bgs. No rxn to HCl. All else the same. as @ 30' bgs. 40% M, 60% F	Sonic rig 8" casing 6" core barrel.
				Archive @ 35' bgs
			32' bgs – 38' bgs Sand (S)	
			Nearly dry. 5% Gravel, 95% Sand.	
40	grab sample 7/24/19		Gravel: 2mm – 5mm avg 3mm. Very well sorted. Subrounded to subangular. Sand: v fine to v coarse sand. Poorly sorted, subrounded to subangular 2.5Y 4/2 dark grayish brown	Archive @ 40' bgs
45	grab sample 7/24/19		No rxn to HCl. 50% M, 50% F.	Archive @ 45' bgs
	H_2O tagged 7/24/19			H_2O tagged 46.9' bgs 07/24/19
			38' bgs – 81' bgs Sandy Gravel (SG)	* Material dropped by core barrel.
			Nearly dry. 70% Gravel, 25% Sand, 5% silt. Similar to @ 15 ft.	
50	* grab sample 7/24/19		Gravel: 2mm – 70mm, avg 20mm moderately sorted, 60% M/40% F rounded to sub angular. Sand: v fine to v coarse, avg med, poorly sorted, mostly subangular, No rxn	some fines may be washed out. 46' – 56' bgs. Archive @ 50' bgs Archive @ 55' bgs
55	* grab sample 7/24/19		with HCl, 2.5Y 4/1 dark gray, silt same color as sand, no obvious plasticity. ~~30%~~ edw 8/8/19 @ 45' bgs, * dry ~~35%~~ edw 07/24/19 Gravel, 60% ~~Med~~ Sand, 10% silt, mild	
60	grab sample 7/24/19		rxn to HCl, all else stays the same. as @ 38' bgs. @ 46' bgs * saturated. Same as 45' bgs aside from color change. 10YR 3/1 very dark gray.	Archive @ 60' bgs
65	grab sample 7/24/19		@ 55' bgs, saturated. Same as @ 46' bgs edw 7/25/19 ~~@ 60'~~ 1 bgs, saturated. 75% Gravel, ~~@ 65'~~ 25% Sand. Gravel avg 10mm. Sand med to very coarse. Almost all mafics 90% M/10% F. 10YR 2/1	Archive @ 65' bgs
70	grab sample 7/25/19		black. @ 70' bgs, 30% Gravel, 70% Sand. Gravel size and color the same, Sand coarseness the same,	Archive @ 70' bgs

Reported By:

Print Name	Title	Signature	Date
Ellen Whitney	Geologist		07/29/2019

BOREHOLE LOG (Cont.)

Date: 07/25/2019

Well ID: C9874 | Well Name: 699-60-27 | Location: ~5km S of F reactor

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
			all else the same.	Sonic rig. 8" casing 6" core barrel.
75	grab sample 7/25/19		@ 75' bgs Gravel content increases again. 70% Gravel, 30% Sand. All else the same as @ 65' bgs.	Archive @ 70' bgs Archive @ 75' bgs
80	grab sample 7/25/19		@ 80' bgs Gravel becomes more poorly sorted. Large clasts up to 90mm, but majority of gravel are ~5mm average. All else the same as @ 75' bgs. Still saturated.	Archive @ 80' bgs
			81' bgs – 87' bgs Gravel	
85	grab sample 7/25/19		100% Gravel. 5mm – 120mm. 70% M/30% F, saturated, avg size 30mm, moderately sorted. Overall color 10YR, 3/2 very dark grayish brown. Clasts vary in color. rounded to angular.	Archive @ 85' bgs
90	grab sample 7/25/19			Archive @ 90' bgs
			87' bgs – 100' bgs Sand (s)	
			Saturated. 5% Gravel, 90% Sand, 5% Silt. Gravel: 1 clast 50mm, the rest between 2–4mm. Sand ~~80% M~~ 20 edw 8/8/19 v fine to v coarse avg coarse. 80% M, 20% F, sub rounded to sub angular, moderately sorted. 10YR 3/1 very dark gray No rxn with HCl. Silt somewhat plastic.	
95	grab sample 7/25/19			Archive @ 95' bgs
100	grab sample 7/25/19		@ 95' bgs. Even more saturated. Color changes slightly to 10YR 2/1 black. Sand avg coarseness v coarse. Mafic composition increases from 50% M at 90' bgs to 70% M/30% F at 95' bgs. edw 7/25/19 ~~@ 100' bgs. Staturated Saturated, Gravel~~	Archive @ 100' bgs
105	grab sample 7/25/19			Archive @ 105' bgs
			100' bgs – 107' bgs Gravelly Sand (gS)	
110	grab sample 7/25/19		Saturated. 15% Gravel, 80% Sand, 5% Silt. Gravel 2mm – 100mm, avg 25mm, 50% M/50% F, poorly sorted, subrounded to subangular. Sand: med to v coarse sand. Avg coarse,	Archive @ 110' bgs

Reported By:

Print Name	Title	Signature	Date
Ellen Whitney	Geologist	[signature]	07/29/2019

BOREHOLE LOG (Cont.)

Page 4 of 5

Date: 07/25/2019

Well ID: C9974 | Well Name: 699-60-27 | Location: ~5KM S of F reactor

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
115	grab sample 07/25/19		mostly subangular. Silt has no obvious plasticity. Overall color: 10 YR 2/2 very dark brown. NO RXN to HCL. @ 105' bgs. All stays the same as 100' bgs.	Sonic rig. 8" casing. 6" core barrel. Archive @ 115' bgs.
120	grab sample 07/25/19		107' bgs – 123' bgs Sandy Gravel (SG) Saturated. 60% Gravel, 35% Sand, 5% silt. Gravel: 2mm – 110mm, avg 18mm, poorly sorted, sub rounded to sub angular, 80% M/20% F, Sand: v fine to v coarse sand, avg coarse sand, mostly subangular, poorly sorted 70% M/30% F, No rxn to HCl, Silt: no plasticity obvious. Overall color: 10 YR 2/2 very dark brown. @ 115' bgs. Saturated. All stays the same. @ 120' bgs Saturated. All stays the same.	Archive @ 120' bgs.
125	grab sample 07/25/19			Archive @ 125' bgs
130				* Material dropped by core barrel. edw 7/29/19 126' – 134' bgs. No sample was collected at a depth of 130' bgs.
135	grab sample 07/25/19		123' bgs – 148' bgs Gravel (G) Saturated. 95% Gravel, 5% Sand Gravel: 2mm – 80mm. Avg 15mm. Poorly sorted, subrounded to subangular, 90% M/10% F. Sand: fine to v coarse avg v coarse, moderately sorted, mostly subangular, No rxn to HCl, 90% M/10% F Overall color 10 YR, 3/1 very dark gray @ 135' bgs Saturated. All stays the same.	Archive @ 135' bgs
140	grab sample 07/25/19		@ 140' bgs saturated. Some silt and finer sands introduced. 80% Gravel, 10% Sand, 10% Silt. Gravel Same as above. Sand v fine to v coarse avg coarse, silt: no plasticity obvious. All else stays the same.	Archive @ 140' bgs
145	grab sample 07/25/19		@ 145' bgs saturated. All stays same.	Archive @ 145' bgs
150	grab sample 07/25/19			@ 152' bgs possible transition to gravel.
TD 7/29/19	edw 7/29/19			

Reported By:

Print Name	Title	Signature	Date
Ellen Whitney	Geologist		07/29/2019

BOREHOLE LOG (Cont.)

Page 5 of 5

Date: 07/25/2019

Well ID: C9874 | Well Name: 699-60-27 | Location: ~5 km S of F reactor

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
155			@ 148' bgs. Saturated. 85% Gravel, 5% Sand, 10% Silt. Gravel, same as above. Sand, same as above. Increased silt content. Non plastic. Overall color 2.5Y, 4/2 dark grayish brown, (maybe plastic just oversaturated)	Sonic rig, 8" casing 6" core barrel.
160			148' bgs – 152' bgs Clay (M) Damp, 2% Gravel 3% Sand, 95% silt/clay. Very ~~high~~ low plasticity, 2.5Y, 4/2 dark grayish brown. NO RXN to HCL	TD @ 152' bgs 07/29/19
165				
170				
175				
180				
185				
190				

NOT USED

08/08/2019

Reported By:

Ellen Whitney — Print Name | Geologist — Title | Signature | 07/29/2019 — Date

A-6006-993 (REV 0)

This page intentionally left blank.

699-60-27 (C9874)
Log Data Report

Borehole Information

Log Date	2019-07-31	Filename	C9874_HG-NM_2019-07-31	Site	100-FR-3
DTW[1] (ft)	**DTW Date**	**DTW Source**	**Drill Date**	**Total Depth (ft)**	**Depth Datum**
24.1	07/31/19	Bay West	07/25/19	152	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.)		Thickness (in.)	Top (ft)	Bottom (ft)
			Outer	Inside			
Threaded steel	Sonic	TC[2]	8.1	7.58	0.25	3.45 AGS[3]	152.2

Borehole Notes

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing using a dial gauge and circumference tape. The maximum logging depth achieved was 150 ft, approximately 2 ft above the casing. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma ALD	**Type**	60% Coaxial HPGe (SGLS)[4]
Effective Calibration Date	12/04/2018	**Serial No.**	47-TP-32211A
Calibration Reference	HGLP-CC-175, Rev. 0	**Logging Procedure**	SGRP-PRO-OP-53023, Rev. 0, Change 2

Logging System	Gamma 5PB	**Type**	He-3 (CPN 503DR) NMLS[5]
Effective Calibration Date	12/12/2018	**Serial No.**	H34055445
Calibration Reference	HGLP-CC-177, Rev. 0	**Logging Procedure**	SGRP-PRO-OP-53024, Rev. 0, Change 2

SGLS Log Run Information

Log Run	**3**	**4 Repeat**		
HEIS Number	1021196	1021197		
Date	07/31/19	07/31/19		
Logging Engineer	Spatz	Spatz		
Start Depth (ft)	0.0	20.0		
Finish Depth (ft)	150.0	35.0		
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)	NA	NA		

[1] depth to water inside casing
[2] Temporary casing
[3] Above ground surface
[4] Spectral Gamma Logging System
[5] Neutron Moisture Logging System

Log Run	3	4 Repeat		
Pre-Verification	C9874ALD20190731AV00CAB1	C9874ALD20190731AV00CAB1		
Start File	AD000000	BD002000		
Finish File	AD015000	BD003500		
Post-Verification	C9874ALD20190731BV00CAA1	C9874ALD20190731BV00CAA1		
Depth Return Error (in.)	N/A	0.0		
Comments	None	None		

NMLS Log Run Information

Log Run	1	2 Repeat			
HEIS Number	1021198	1021199			
Date	07/29/19	07/29/19			
Logging Engineer	Meisner/McClellan	Meisner/McClellan			
Start Depth (ft)	0.0	19.0			
Finish Depth (ft)	23.01	22.0			
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	C9874FPB20190729AV00CAB1	C9874FPB20190729AV00CAB1			
Start File	AD000000	BD001900			
Finish File	AD002301	BD002200			
Post-Verification	C9874FPB20190729BV00CAA1	C9874FPB20190729BV00CAA1			
Depth Return Error (in.)	N/A	0.5 low			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on the sondes. Verification measurements passed the acceptance criteria.

Analysis Notes

Analyst	P.D. Henwood	Date	09/09/19
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; no additional correction was made for the thick casing joints.

A water correction was applied below 24.1 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 ALD20181204 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

Casing diameter and thickness corrections for 0.25-in. thick, 8.1-in. OD casing were applied to the NMLS data acquired through the sonic casing. Integrated with the casing diameter and thickness corrections is an initial count rate correction for a sediment composition of a 50-50% ratio of basalt fragments to quartz sand (HGLP-OTH-028).

NMLS data are reported in counts per second for the entire length of the borehole. NMLS data are also reported in vol% moisture. Conversions from count rate to vol% moisture were performed using an EXCEL template identified as FPB_Cascade_Sonic_MCNP_assay. This template also provides corrections for the thick casing joints typical of sonic drill casings.

HGU[6] 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 generally increases as the sediment becomes more fine-grained. For example, moisture content would be expected to be greater near the top of a fining upward Hanford flood sequence.

The measured depth to water was at the time of logging. It appears the borehole had been pumped and the true water level may be deeper.

Thickened casing joints occur at 5 and 10 ft intervals beginning at approximately 2 ft in depth. No corrections have been made for the joints for the SGLS although corrections for moisture have been made.

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

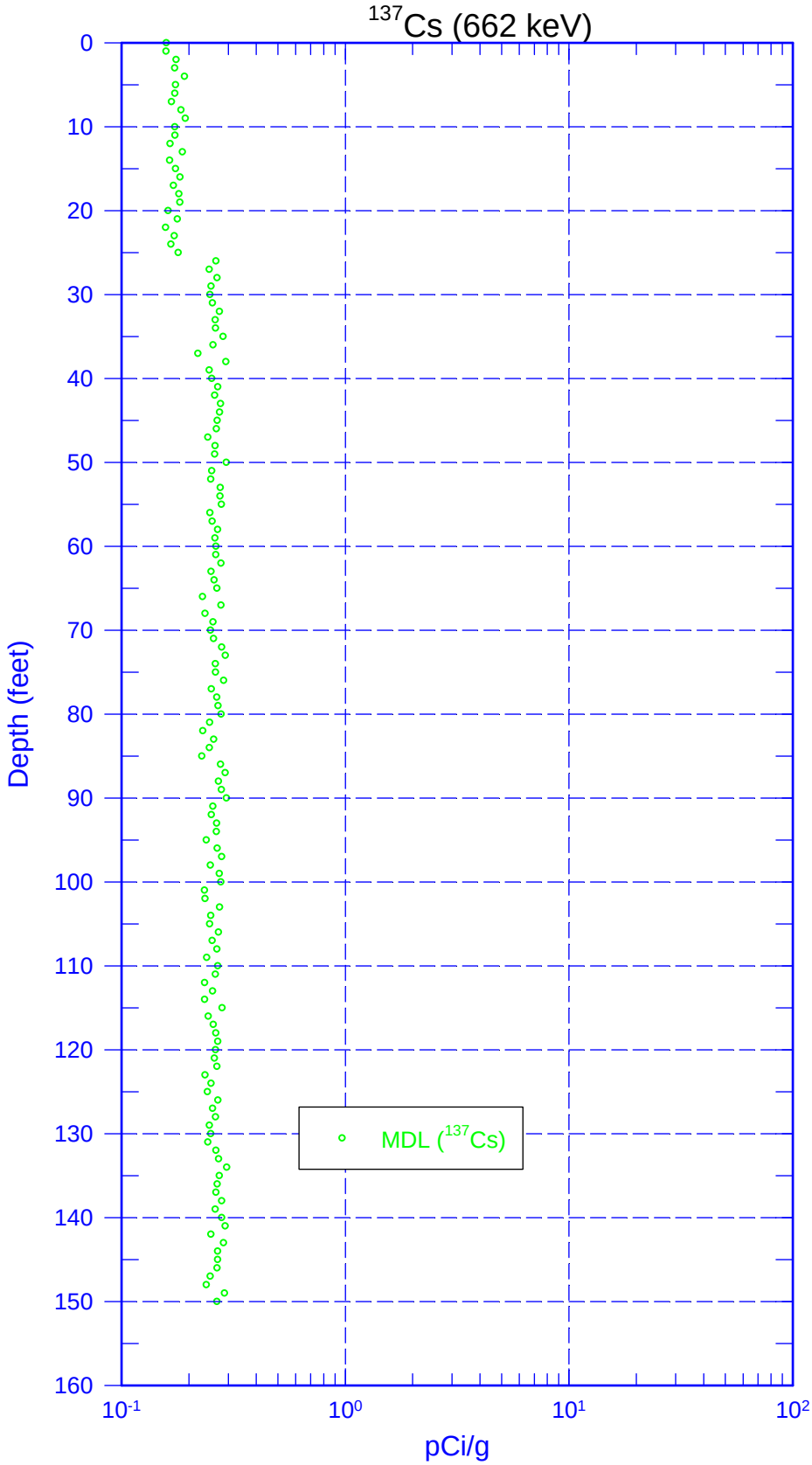
List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-160 ft)
Natural Gamma Logs (0-160 ft)
Combination Plot (0-120 ft)
Combination Plot (110-230 ft)
Combination Plot (0-160 ft)
Moisture (0-60 ft)
Total Gamma & Moisture (0-60 ft)
Total Gamma & Hanford Gamma Unit (0-160 ft)
Repeat Section of Natural Gamma Logs (20-35 ft)
Moisture Repeat Section (19-22 ft)

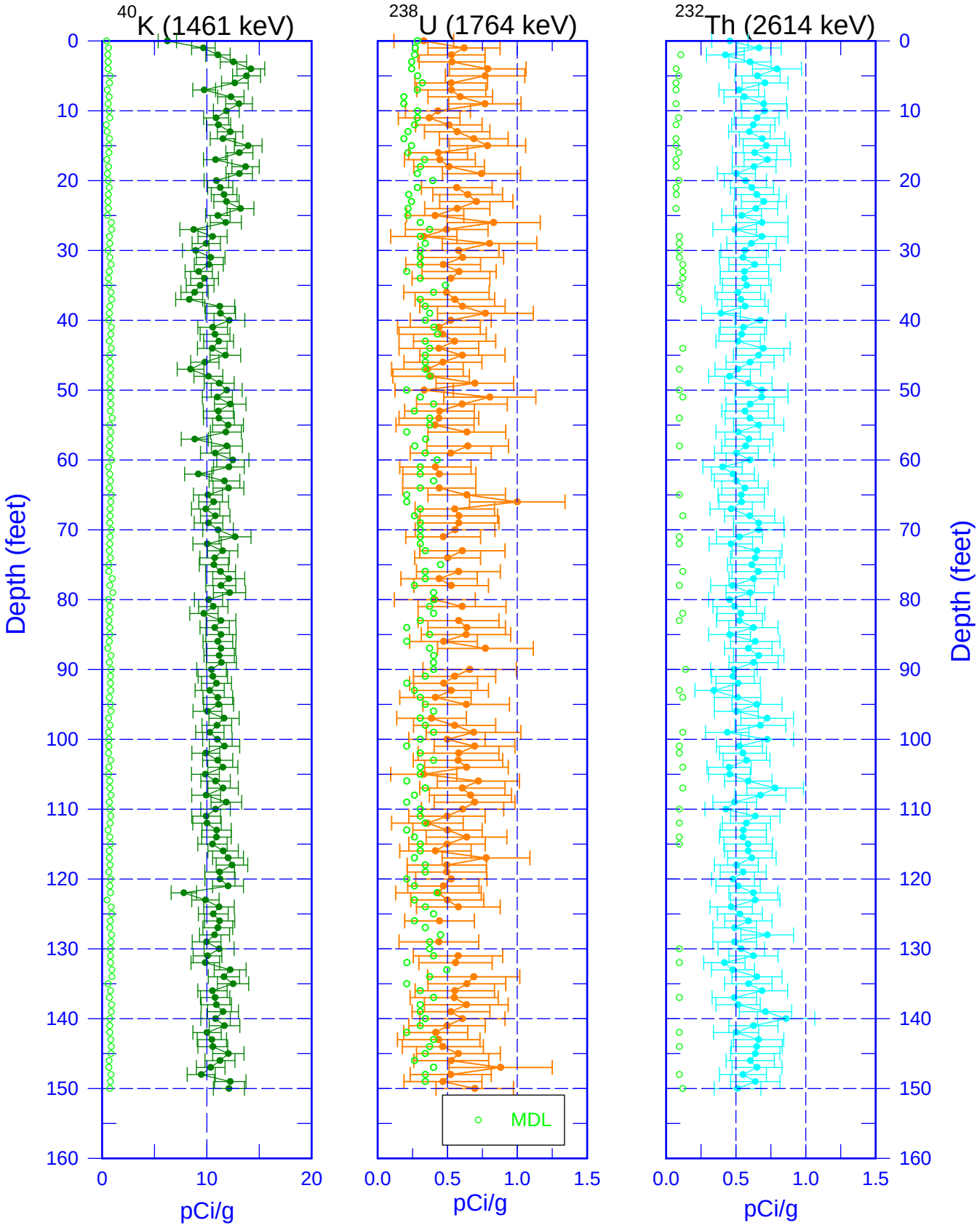
[6] Hanford Gamma Unit

699-60-27 (C9874)
Manmade Radionuclides



Zero Reference - ground surface

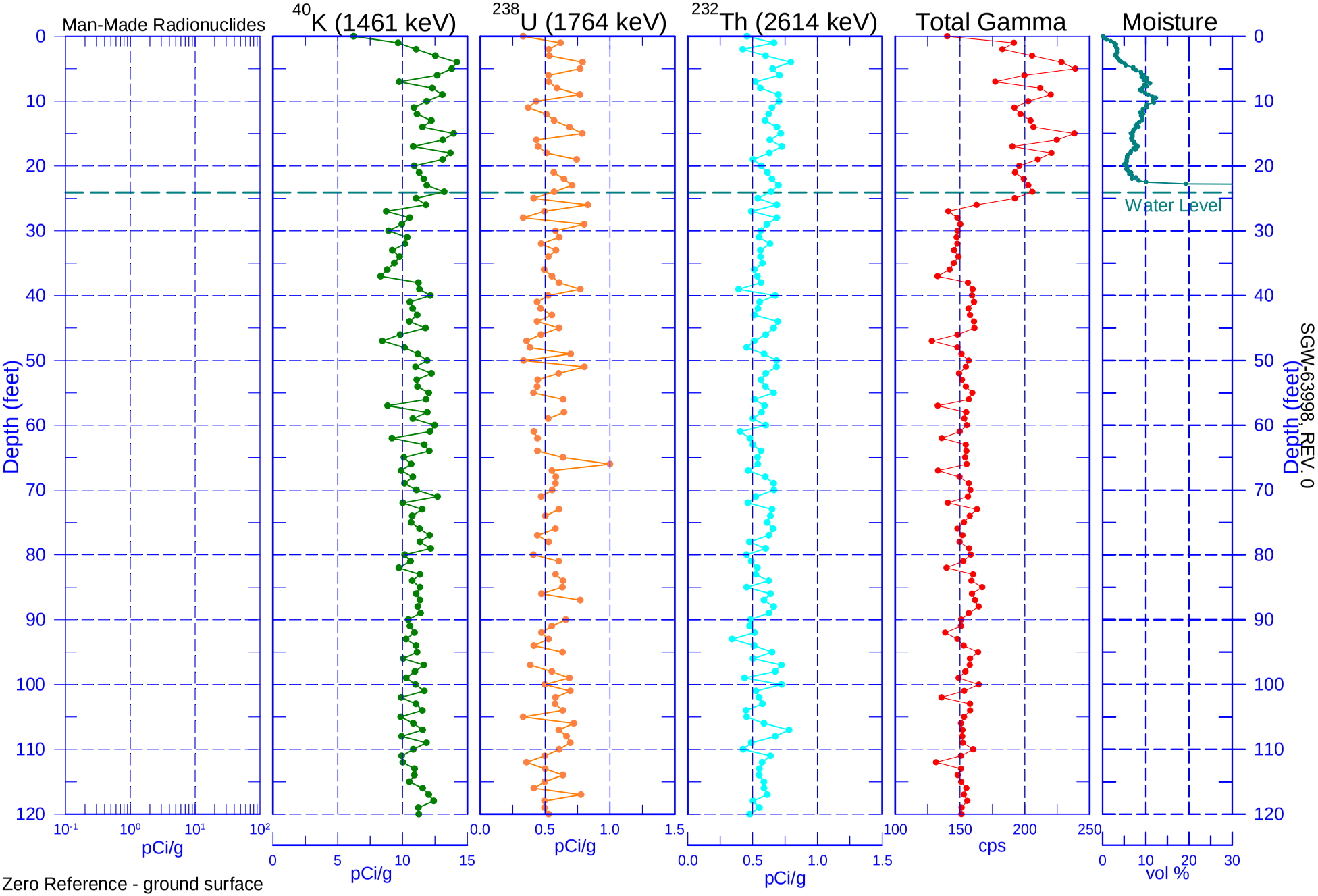
699-60-27 (C9874)
Natural Gamma Logs



Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

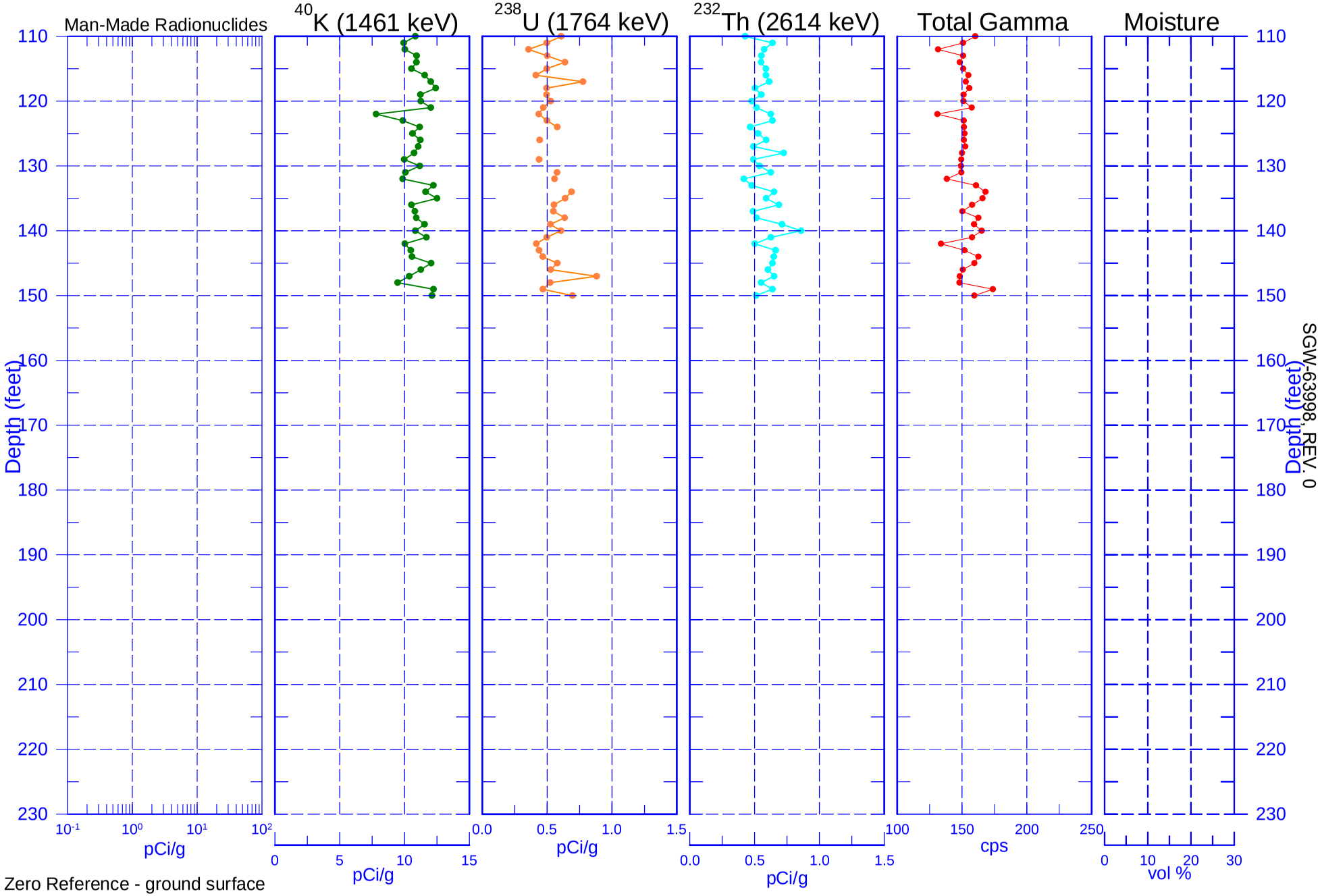
699-60-27 (C9874) Combination Plot



Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

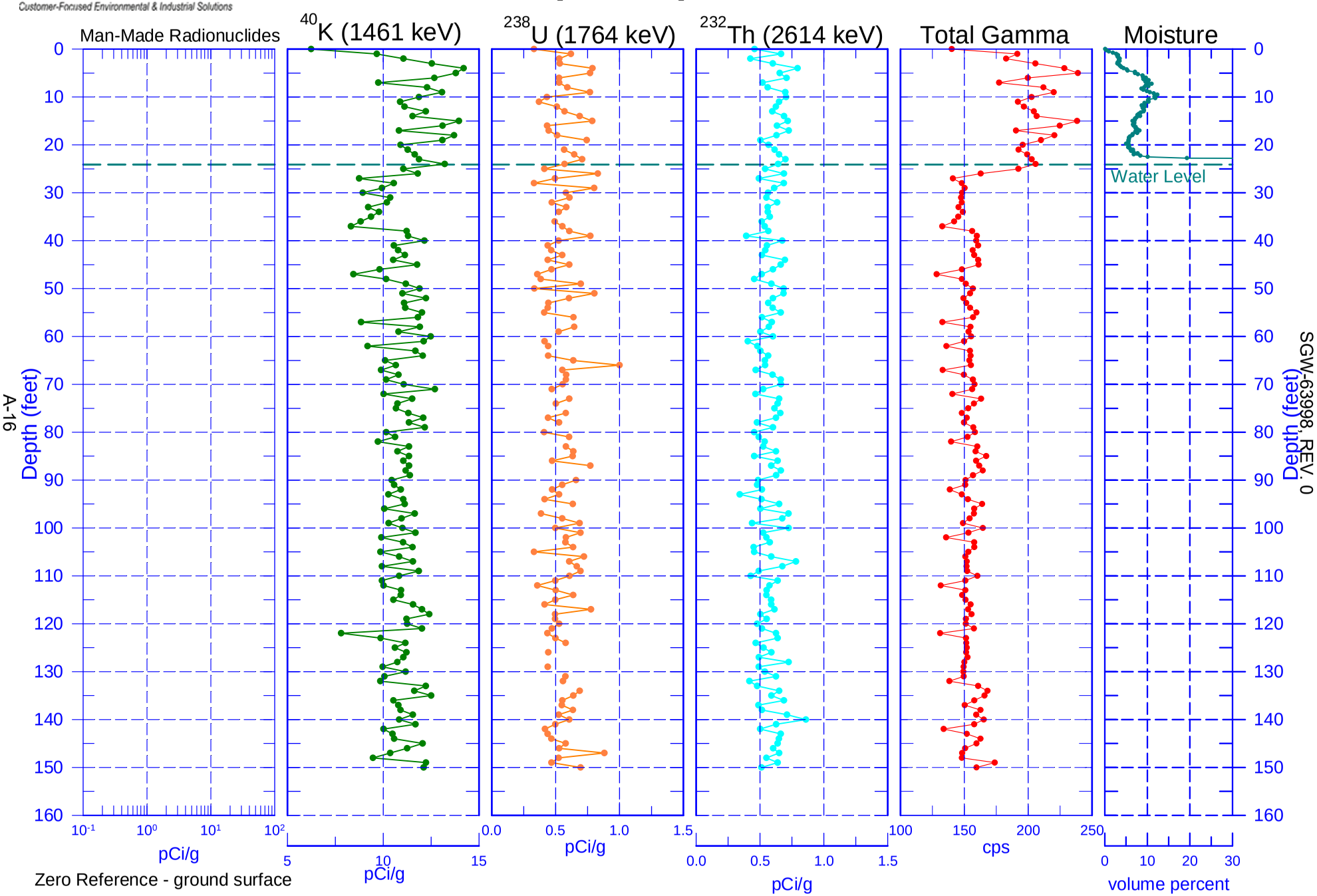
699-60-27 (C9874) Combination Plot



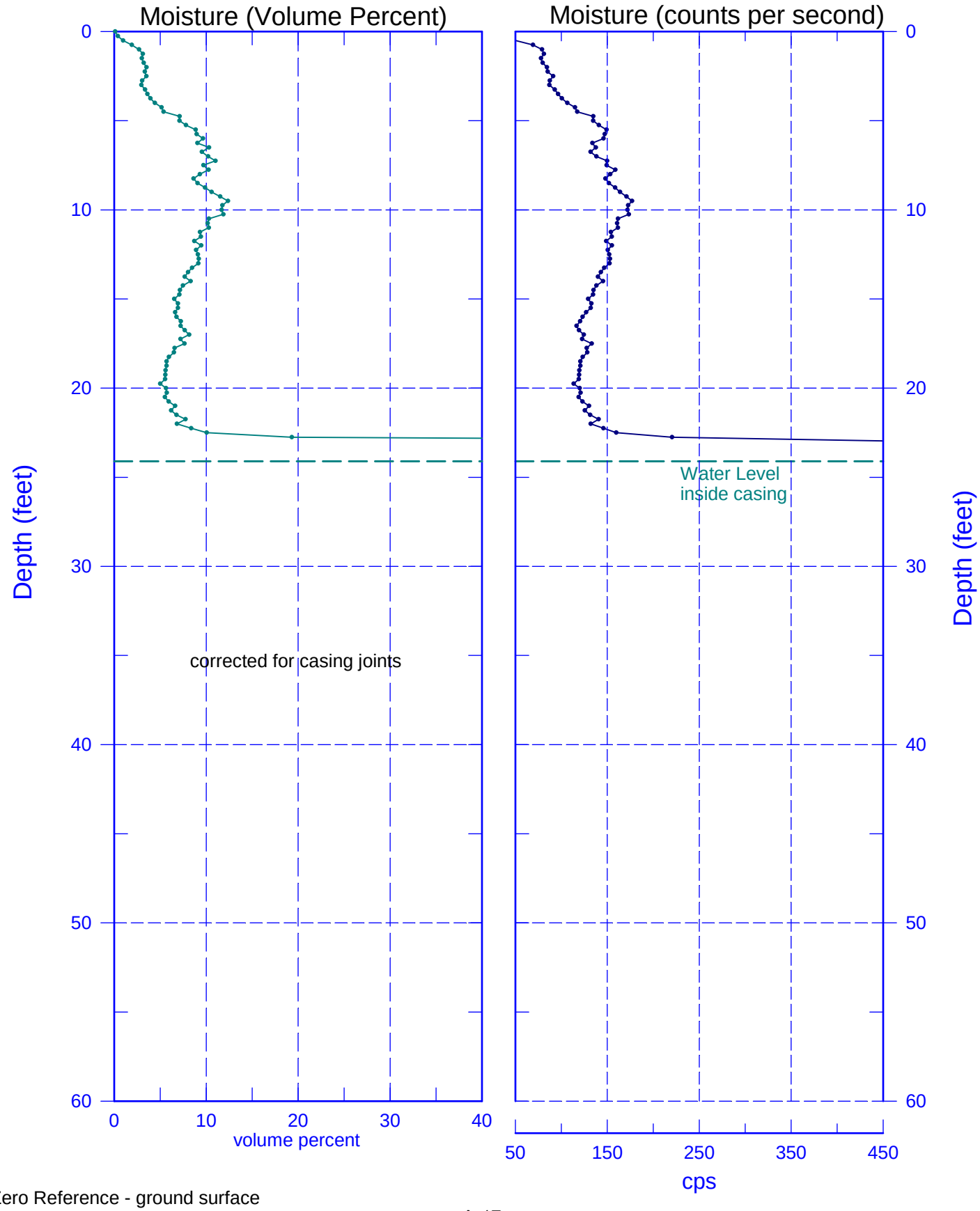
Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

699-60-27 (C9874) Combination Plot

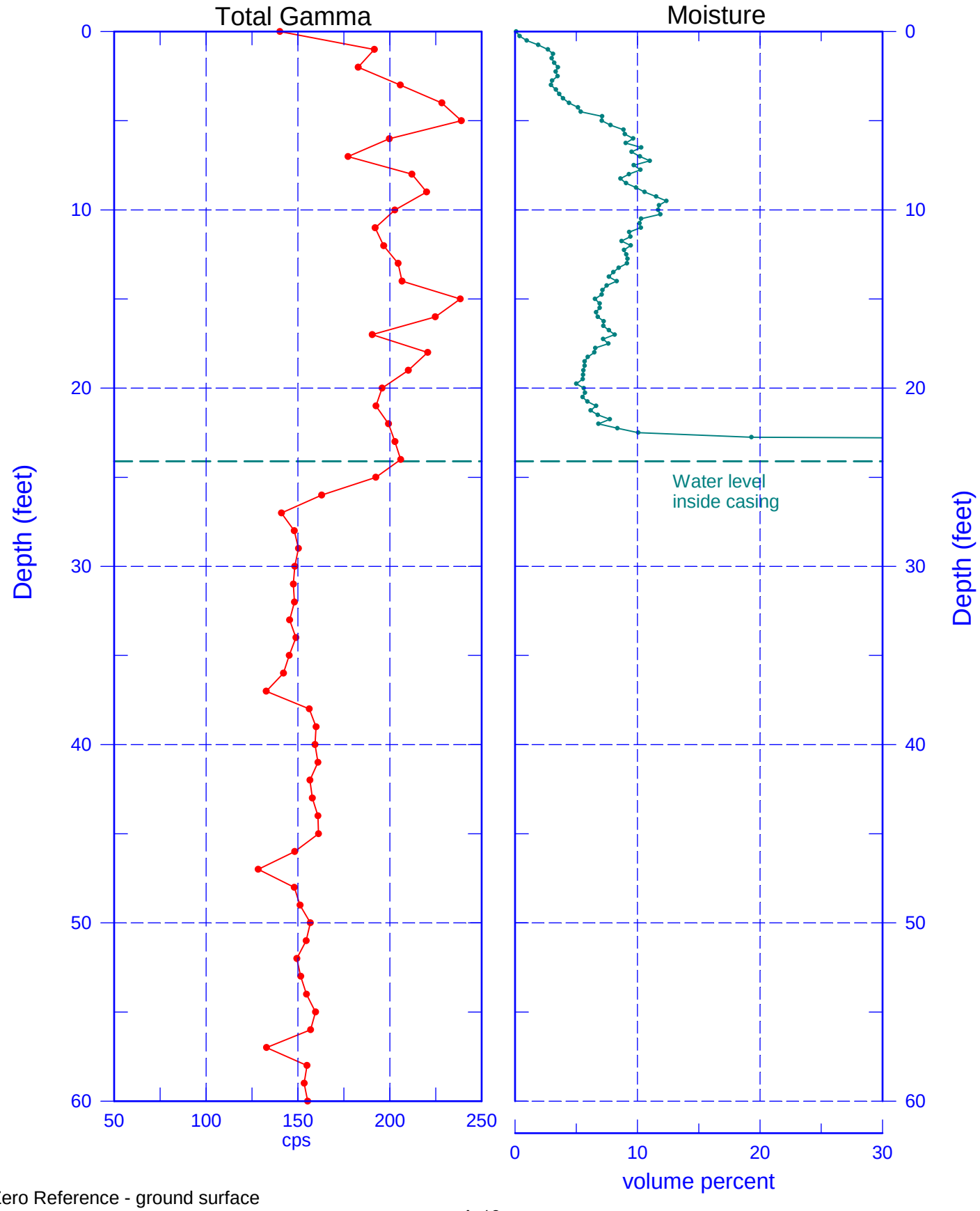


699-60-27 (C9874)
Moisture



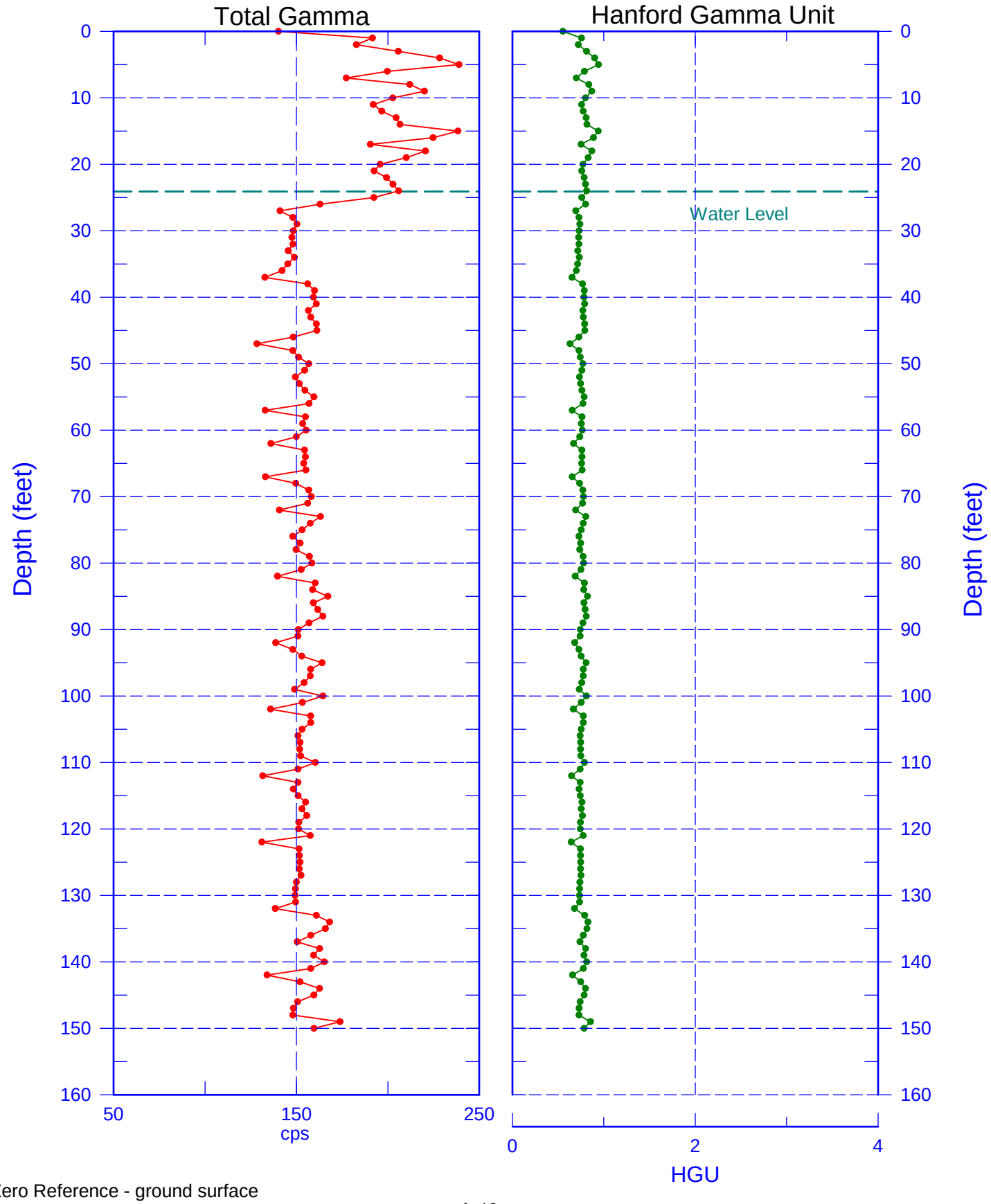
Zero Reference - ground surface

699-60-27 (C9874)
Total Gamma & Moisture



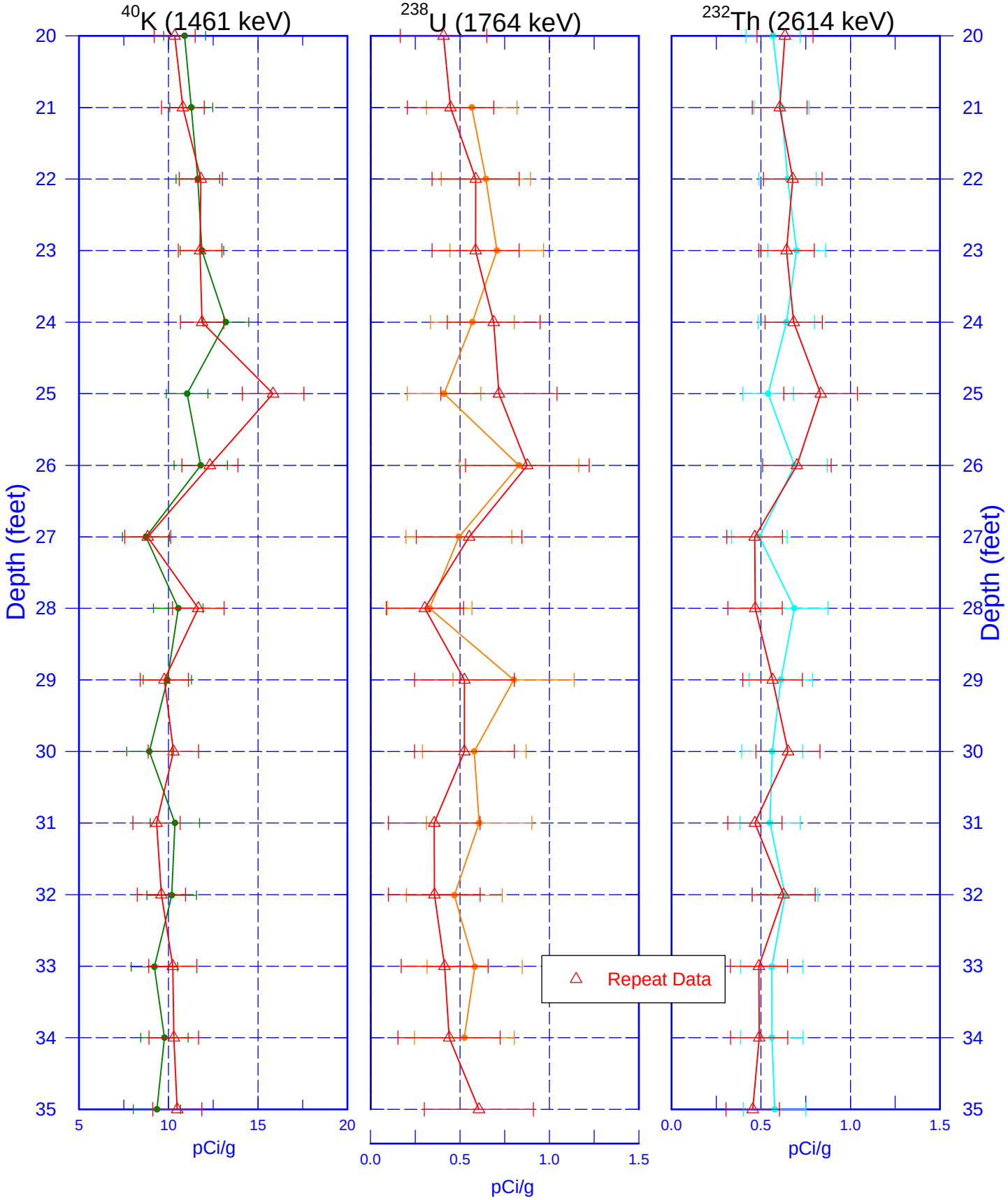
Zero Reference - ground surface

699-60-27 (C9874)
Total Gamma & Hanford Gamma Unit



Zero Reference - ground surface

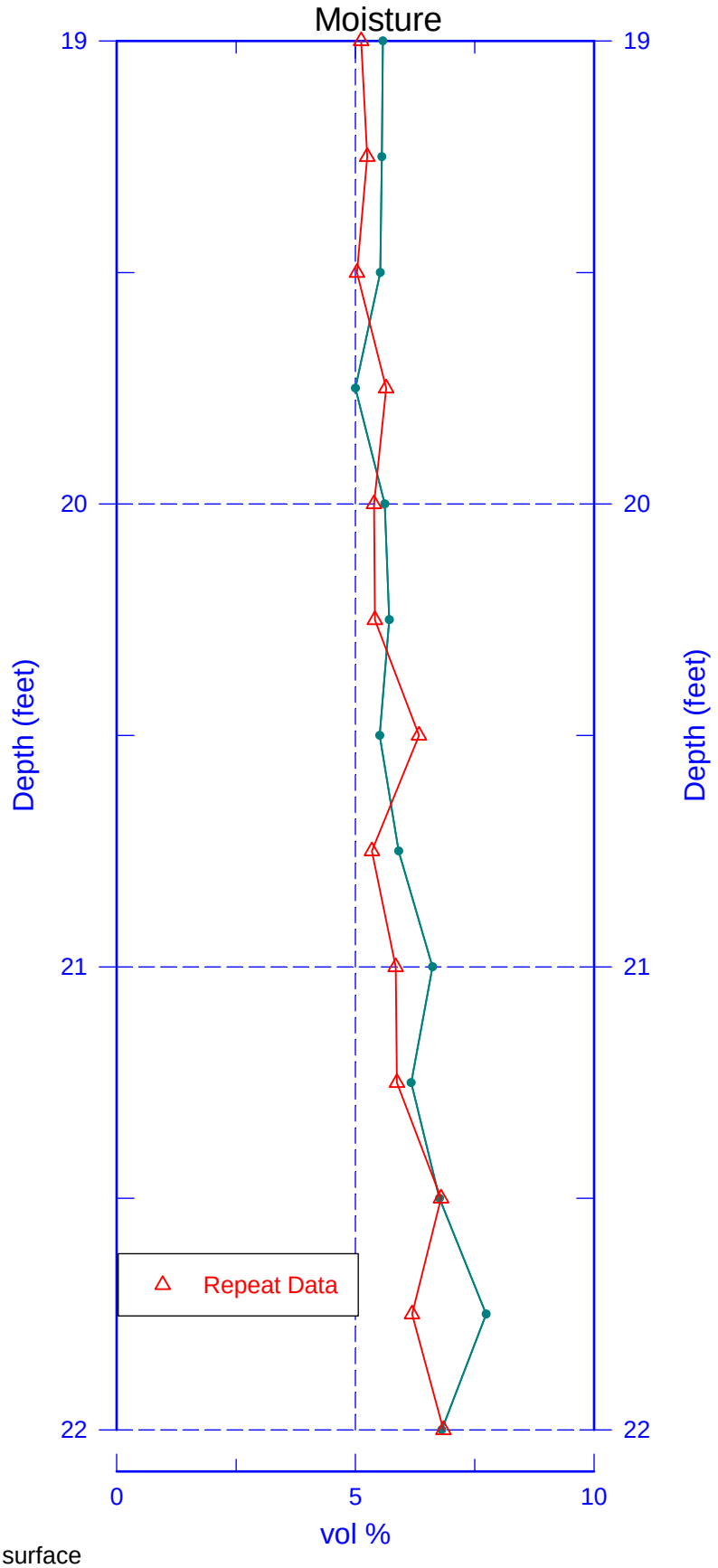
699-60-27 (C9874)
Repeat Section of Natural Gamma Logs



Zero Reference - ground surface

699-60-27 (C9874)

Moisture Repeat Section



Zero Reference - ground surface

This page intentionally left blank.

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 08/20/19	Requestor: James D. Mehrer (CHPRC)
Date of Survey: 10/03/19	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of FR-3 Well C9874 (699-60-27) located South of 100F 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:

HSWB-009 (COE) and HSWB-011 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9874	699-60-27	581838.35	141878.48		Center of Casing
				125.443	Top Inner 4"Casing, N.Edge
				125.824	Top Outer Casing,N.Edge Stamped "X"
				125.058	Brass Survey Marker

Notes:

Brass Survey Marker elevation was taken on top northeast edge of flat 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
10-3-19

This page intentionally left blank.

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9874	Well Name: 699-60-27	Date: 8/19/19

Location: ~5km S of F-Reactor

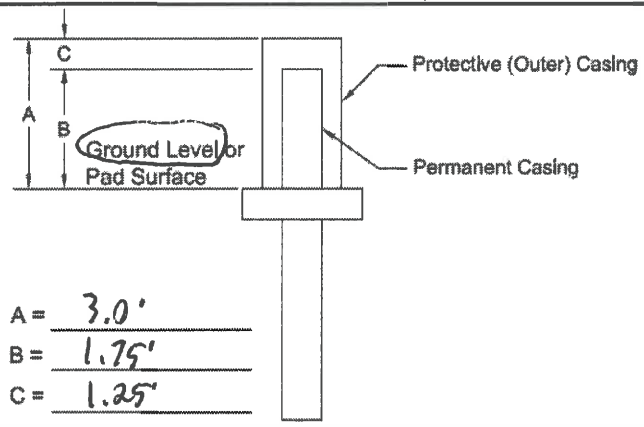
Reference Measuring Point *(unless otherwise noted)*: TOP OF OUTER CASING (TOC)

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: 8/14/19	45.27' bgs	46.1' bgs
Date: —	—	—
DEPTH TO BOTTOM:		
Date: 8/14/19	67.8' bgs	68.2' bgs
Date: —	—	~~68.2~~ DC 8/19/19



A = 3.0'
B = 1.75'
C = 1.25'

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)
61.5	34.3	~~61.9~~ 13.78 DC 8/19/19	62.0	2.76	0851	1055	4.8	0.14

Not Used
8/19/19

Total Pumped: 595.2 gal

Pump Model: Grundfos 96160180 240v 1HP

Troll Serial Number and Pressure Range (PSI and depth): In-Situ LevelTroll 700 s/n: 407065, range: 70m/231ft/99.6PSI

Comments: bgs = below ground surface
Test name: C9874develop 08142019

Prepared By:

Dan Cherbonneux — Print Name
Signature
8/19/19 — Date

Reviewed By:

Jennifer Richart — Print Name
Signature
9/4/19 — Date

For Office Use Only

OR Doc Type:	WMU Code(s):

This page intentionally left blank.

C9874 Archive Photos

0-5 ft bgs

5-10 ft bgs

10-15 ft bgs

15-20 ft bgs

20-25 ft bgs

25-30 ft bgs

30-35 ft bgs

35-40 ft bgs

40-45 ft bgs

45-50 ft bgs

50-55 ft bgs

55-60 ft bgs

60-65 ft bgs

65-70 ft bgs

70-75 ft bgs

75-80 ft bgs

80-85 ft bgs

85-90 ft bgs

90-95 ft bgs

95-100 ft bgs

100-105 ft bgs

105-110 ft bgs

110-115 ft bgs

115-120 ft bgs

120-125 ft bgs

130-135 ft bgs

135-140 ft bgs

140-145 ft bgs

145-148 ft bgs

148-152 ft bgs

This page intentionally left blank.

Appendix B

Well Documentation for 699-68-29 (C9873)

- Well Summary Sheet for C9873
- Borehole Log for C9873
- Geophysical Log Data Report for C9873
- Well Survey Data Report for C9873
- Archive Photo Log for C9873

This page intentionally left blank.

WELL SUMMARY SHEET

Page 1 of 1

Well ID: C9873	Well Name: 699-68-29	Start Date: 7/23/2019
Project: Installation of 6+1 Wells in the 100-FR-3 OU	Location: ~3km S of F Reactor	End Date: 7/29/2019

CONSTRUCTION DATA

Description

WA Ecology Well Tag: None

Surface Construction:

Cement grout up to ground surface with brass survey marker

Temporary Casing Depth:

8" Carbon Steel Thd. joints = 35.5 ft bgs

Permanent Well Materials:

None

Well Construction Materials:

Type I/II Portland Cement:

0.0 - 2.0 ft bgs

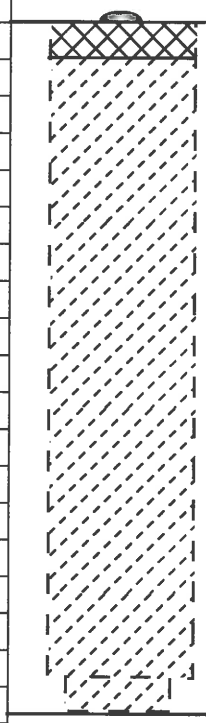
Granular Bentonite:

2.0 - 37.7 ft bgs

Note:

Borehole was decommissioned due to very small amount of water in hole. All 8" temporary casing was removed from hole during decommissioning.

Diagram

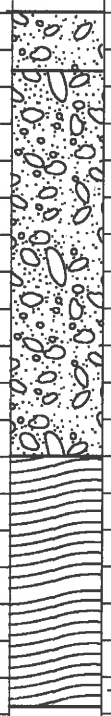


GEOLOGIC/HYDROLOGIC DATA

Depth in Feet

0, 10, 20, 30, 40, 50, 60

Graphic Log



Lithologic Description (ft bgs)

0-3 ft: Gravelly Sand (gS)

3-24 ft: Sandy Gravel (sG)

24-37.7 ft: Clay (M)

Total Depth = 37.7 ft bgs

Acronyms:

ags = above ground surface

bgs = below ground surface

DTW = depth to water

Reported By:			
Dan Charbonneaux	Staff Geologist		8/26/2019
Print Name	*Title*	*Signature*	*Date*
Reviewed By:			
Jennifer Richart	Well Coordinator		9/5/19
Print Name	*Title*	*Signature*	*Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

This page intentionally left blank.

BOREHOLE LOG

Page 1 of 2

Date: 07/23/2019

Well ID: C9873 | Well Name: 699-68-29 | Location: ~3 km S of F reactor

Project: The Installation of 6+1 wells in 100-FR-3 GU. | 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' bgs – 3' bgs Gravelly Sand (gS)	Sonic rig, 8" casing
			Dry. 15% Gravel, 75% Sand, 10% Silt	core barrel 6".
			Gravel: 2mm – 75mm, avg 15mm,	
			moderately sorted 40% M / 60% F	
			Rounded to subangular. Sand: 2.5Y	
5	grab sample 7/23/19		5/3 light olive brown, v fine to v	Archive @ 5' bgs
			coarse, avg med. Moderately sorted.	
			subrounded to subangular, No rxn to HCl.	
			Silt: Same color as sand, no plasticity	
			seen.	
10	grab sample 7/23/19		3' bgs – 24' bgs Sandy Gravel (sG)	
			Dry. 70% Gravel, 25% Sand, 5%	Archive @ 10' bgs
			Silt. Gravel: 2mm – 90mm avg 18mm,	
			rounded to subangular, poorly sorted,	
15	grab sample 7/23/19		60% M, 40% F. Sand: v fine to	Archive @ 15' bgs
			v coarse, avg med, poorly sorted,	
			2.5Y, 5/2 grayish brown.	
			No rxn to HCl. Mostly angular	
			to subangular, 40% M, 60% F,	
20	grab sample 7/23/19		Silt: No plasticity seen, same	
			color as sand.	Archive @ 20' bgs
			@ 10 ft bgs all the same.	
	grab sample 7/23/19		@ 15 ft Damp. Gravel down to 40%,	
			Sand 60%, no silt obvious.	
25			Gravel 2mm – 40mm, mostly	Archive @ 24' bgs
H_2O tagged 7/23/19	grab sample 7/23/19		subrounded, moderately sorted.	Archive @ 25' bgs
			Sand 2.5Y 4/2 dark grayish	H_2O tagged @
			brown. All else the same.	25.3' bgs.
			@ 18 ft Dry. Gravel avg ~ 2.0",	
30	grab sample 7/23/19		more subrounded. Sand decreases,	
			silt present again. Gravel 40%,	Archive @ 30' bgs
			Sand 50%, Silt 10%. All else	
			the same.	
			@ 24 ft Saturated. Gravel larger	
	grab sample 7/23/19		23' clasts again 2mm – 80mm, 50%	Archive @ 34' bgs

Reported By:

Print Name	Title	Signature	Date
Ellen Whitney	Geologist	E	07/23/19

Reviewed By:

Print Name	Title	Signature	Date
Sarah Springer	Sr. Geologist	Sarah Springer	07-24-19

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Page 2 of 2

Date: 07/23/2019

Well ID: C9873 | Well Name: 699-68-29 | Location: ~3km S. of F reactor

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			Gravel, 50% Sand, All else the same.	Sonic rig, 8" casing 6" core barrel.
			24' bgs - 37.7' bgs Clay (M)	TD @ 37.7' bgs
TD 07/23/19			100% silt/clay. 2.5Y 4/2 dark grayish brown, ~~light~~ edw 7/23/19 high plasticity.	
40			@ 30' bgs all stays the same.	
			@ 34' bgs damp. Color gets darker, 10YR 3/1 very dark gray. All else the same.	

Reported By:

Ellen Whitney — Print Name

Geologist — Title

Signature

07/23/2019 — Date

A-6006-993 (REV 0)

699-68-29 (C9873)
Log Data Report

Borehole Information

Log Date	2019-07-23	Filename	C9873_HG-NM_2019-07-23	Site	100-FR-3
DTW[1] (ft)	**DTW Date**	**DTW Source**	**Drill Date**	**Total Depth (ft)**	**Depth Datum**
None	07/23/19	Bay West	07/23/19	37.5	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded steel	Sonic	TC[2]	8.1	7.58	0.26	0.0 AGS[3]	35.5

Borehole Notes

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing using a dial gauge and circumference tape. The maximum logging depth achieved was 36 ft, approximately 0.5 ft below the casing. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma FTB	Type	60% Coaxial HPGe (SGLS)[4]
Effective Calibration Date	12/12/2018	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-180, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0, Change 2

Logging System	Gamma 5PB	Type	He-3 (CPN 503DR) NMLS[5]
Effective Calibration Date	12/12/2018	Serial No.	H34055445
Calibration Reference	HGLP-CC-177, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0, Change 2

SGLS Log Run Information

Log Run	1	2 Repeat		
HEIS Number	1021212	1021213		
Date	07/23/19	07/23/19		
Logging Engineer	Spatz/McClellan	Spatz/McClellan		
Start Depth (ft)	0.0	24.0		
Finish Depth (ft)	36.0	28.0		
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)	NA	NA		

[1] depth to water inside casing
[2] Temporary casing
[3] Above ground surface
[4] Spectral Gamma Logging System
[5] Neutron Moisture Logging System

Log Run	1	2 Repeat		
Pre-Verification	C9873FTB20190723AV00CAB1	C9873FTB20190723AV00CAB1		
Start File	AD000000	BD002400		
Finish File	AD003600	BD002800		
Post-Verification	C9873FTB20190723BV00CAA1	C9873FTB20190723BV00CAA1		
Depth Return Error (in.)	N/A	0.75 high		
Comments	None	None		

NMLS Log Run Information

Log Run	3	4 Repeat			
HEIS Number	1021214	1021215			
Date	07/23/19	07/23/19			
Logging Engineer	Spatz/McClellan	Spatz/McClellan			
Start Depth (ft)	0.0	24.0			
Finish Depth (ft)	36.0	28.0			
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	C9873FPB20190723AV00CAB1	C9873FPB20190723AV00CAB1			
Start File	AD000000	BD002400			
Finish File	AD003600	BD002800			
Post-Verification	C9873FPB20190723BV00CAA1	C9873FPB20190723BV00CAA1			
Depth Return Error (in.)	N/A	0.0			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on the sondes. Verification measurements passed the acceptance criteria.

Analysis Notes

Analyst	P.D. Henwood	Date	09/16/19
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

A casing correction for a 0.26-in. thick casing was applied to the SGLS log data; no additional correction was made for the thick casing joints.

No water correction was applied as water inside the casing was below the maximum logging depth.

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 FTB20181212 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

Casing diameter and thickness corrections for 0.26-in. thick, 8.1-in. OD casing were applied to the NMLS data acquired through the sonic casing. Integrated with the casing diameter and thickness corrections is an initial count rate correction for a sediment composition of a 50-50% ratio of basalt fragments to quartz sand (HGLP-OTH-028).

NMLS data are reported in counts per second for the entire length of the borehole. NMLS data are also reported in vol% moisture. Conversions from count rate to vol% moisture were performed using an EXCEL template identified as FPB_Cascade_Sonic_MCNP_assay. This template also provides corrections for the thick casing joints typical of sonic drill casings.

HGU[6] 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 generally increases as the sediment becomes more fine-grained. For example, moisture content would be expected to be greater near the top of a fining upward Hanford flood sequence.

Water was not measured inside the casing at the time of logging. It appears static water may be at approximately 24 ft.

Thickened casing joints occur at 5 and 10 ft intervals beginning at approximately 5 ft in depth. No corrections have been made for the joints for the SGLS although corrections for moisture have been made.

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

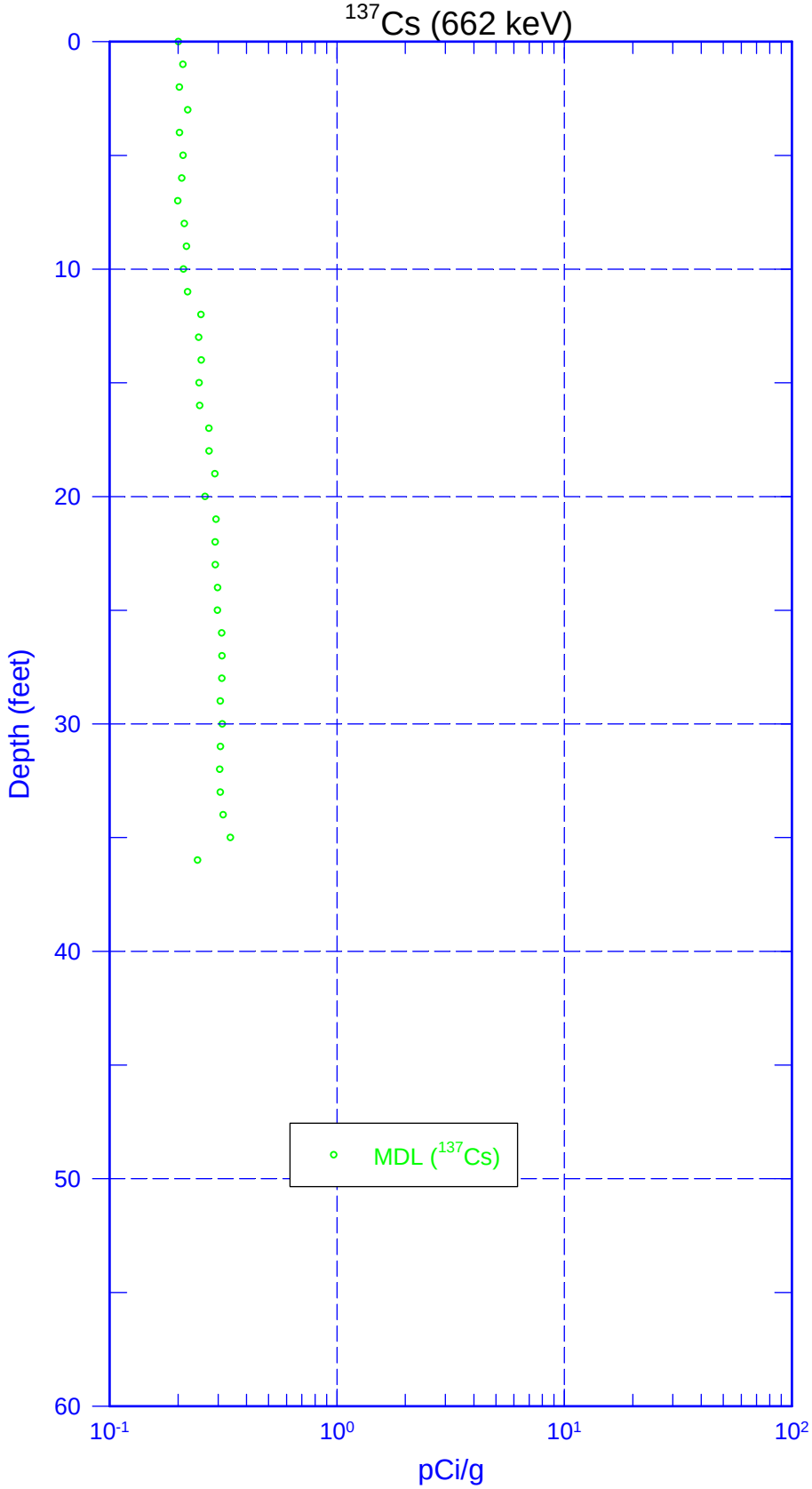
List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-60 ft)
Natural Gamma Logs (0-60 ft)
Combination Plot (0-60 ft)
Moisture (0-60 ft)
Total Gamma & Moisture (0-60 ft)
Total Gamma & Hanford Gamma Unit (0-60 ft)
Repeat Section of Natural Gamma Logs (24-28 ft)
Moisture Repeat Section (24-28 ft)

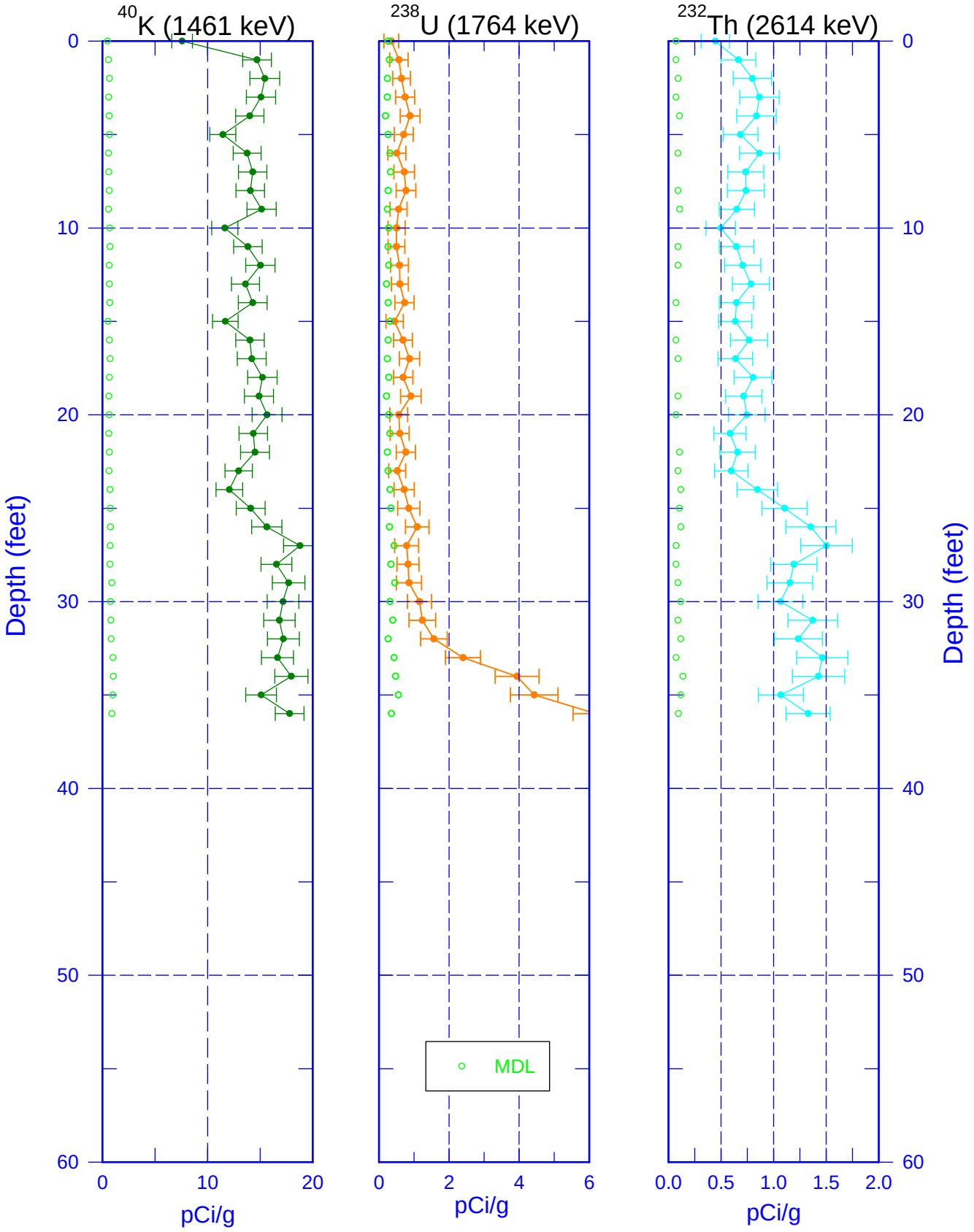
[6] Hanford Gamma Unit

699-68-29 (C9873)
Manmade Radionuclides



Zero Reference - ground surface

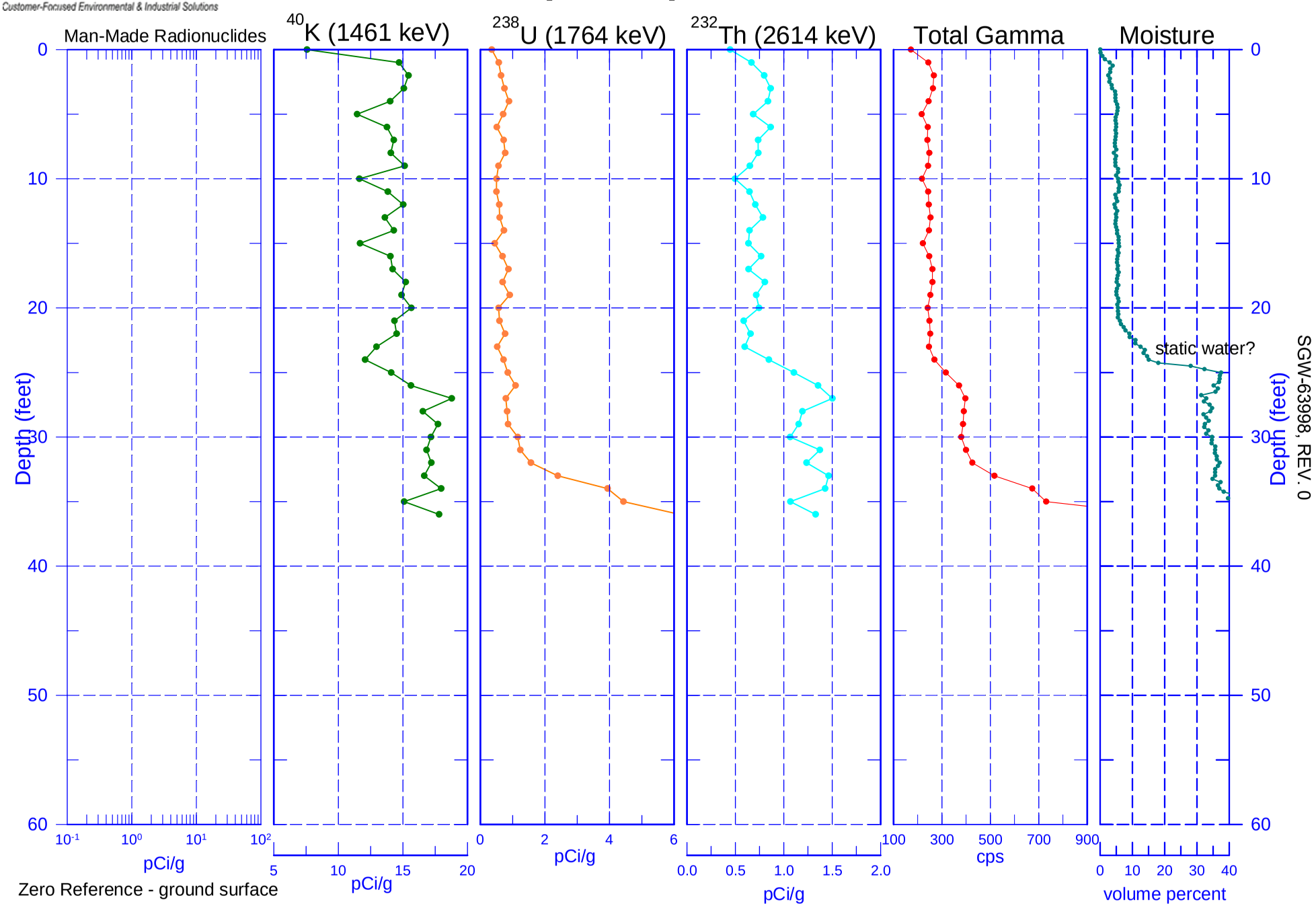
699-68-29 (C9873)
Natural Gamma Logs



Zero Reference - ground surface

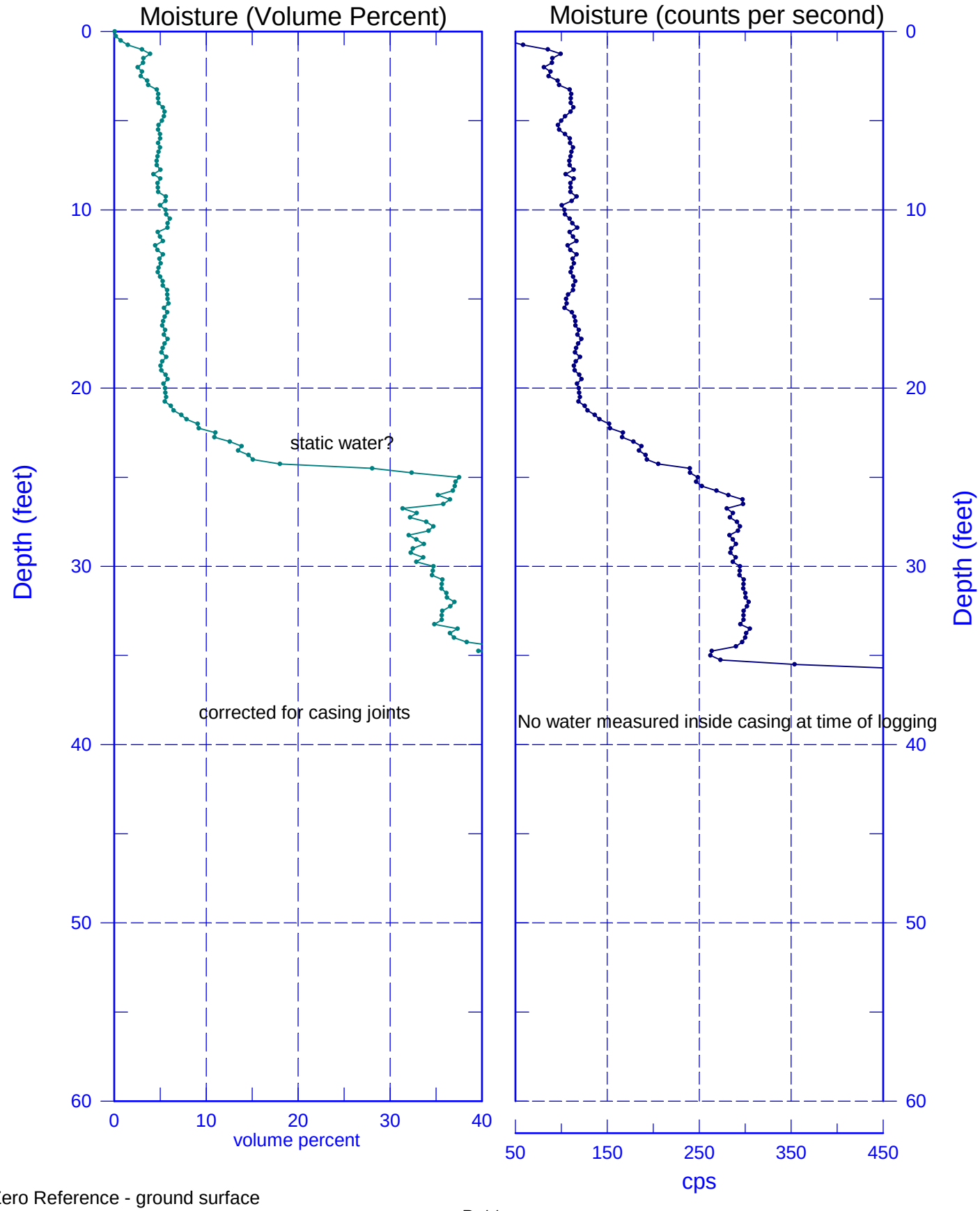
Bay West
Customer-Focused Environmental & Industrial Solutions

699-68-29 (C9873) Combination Plot



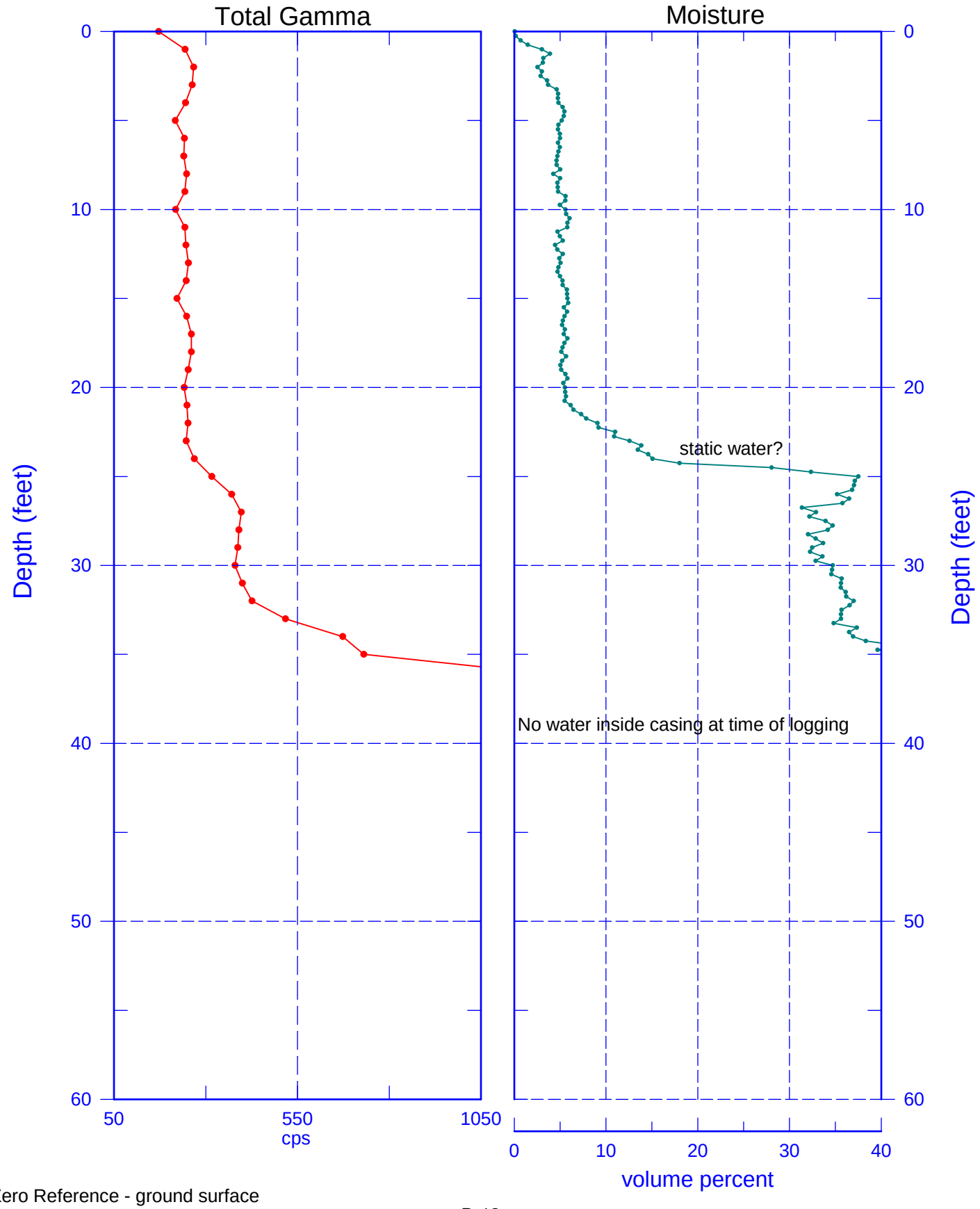
699-68-29 (C9873)

Moisture



Zero Reference - ground surface

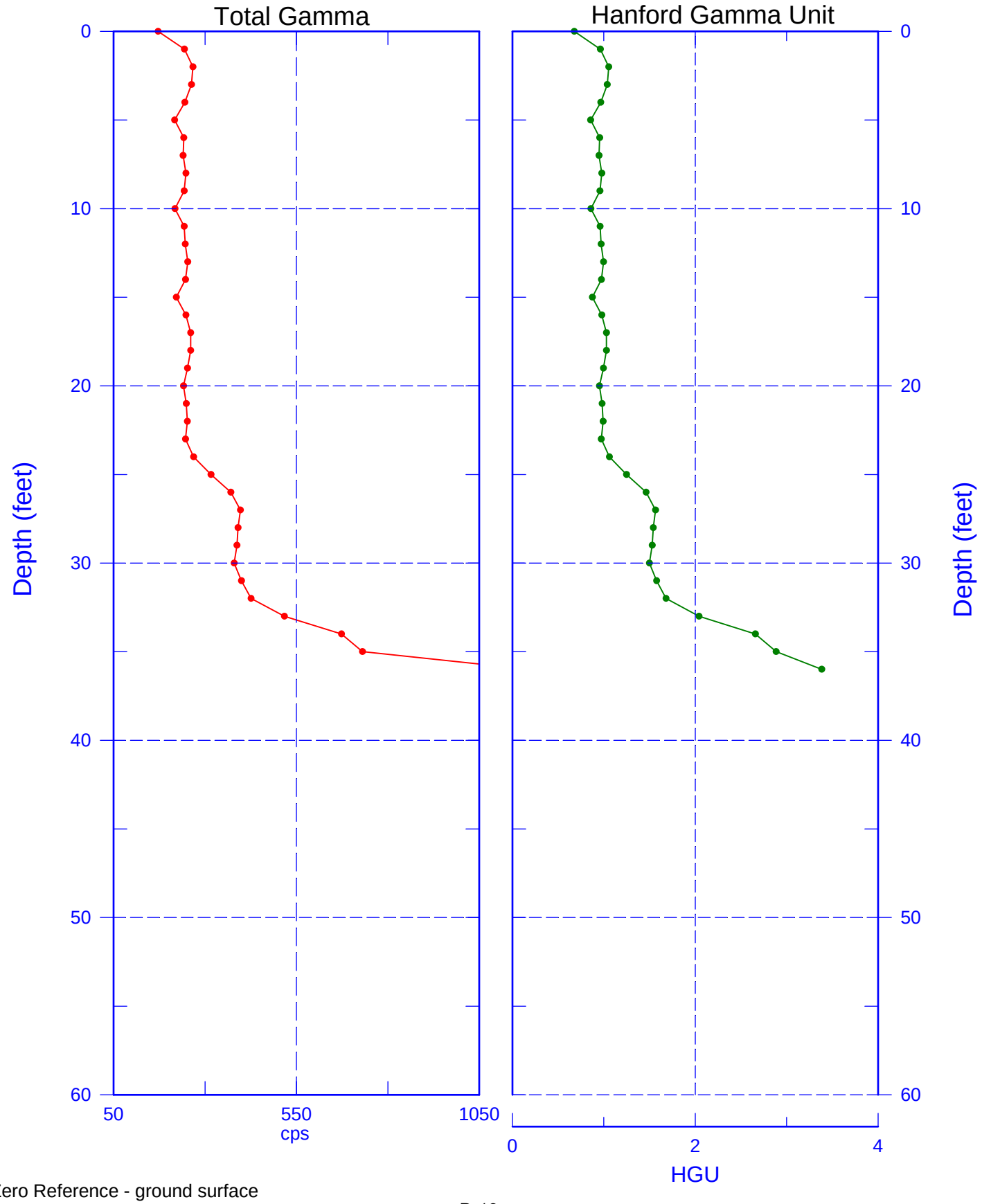
699-68-29 (C9873)
Total Gamma & Moisture



Zero Reference - ground surface

699-68-29 (C9873)

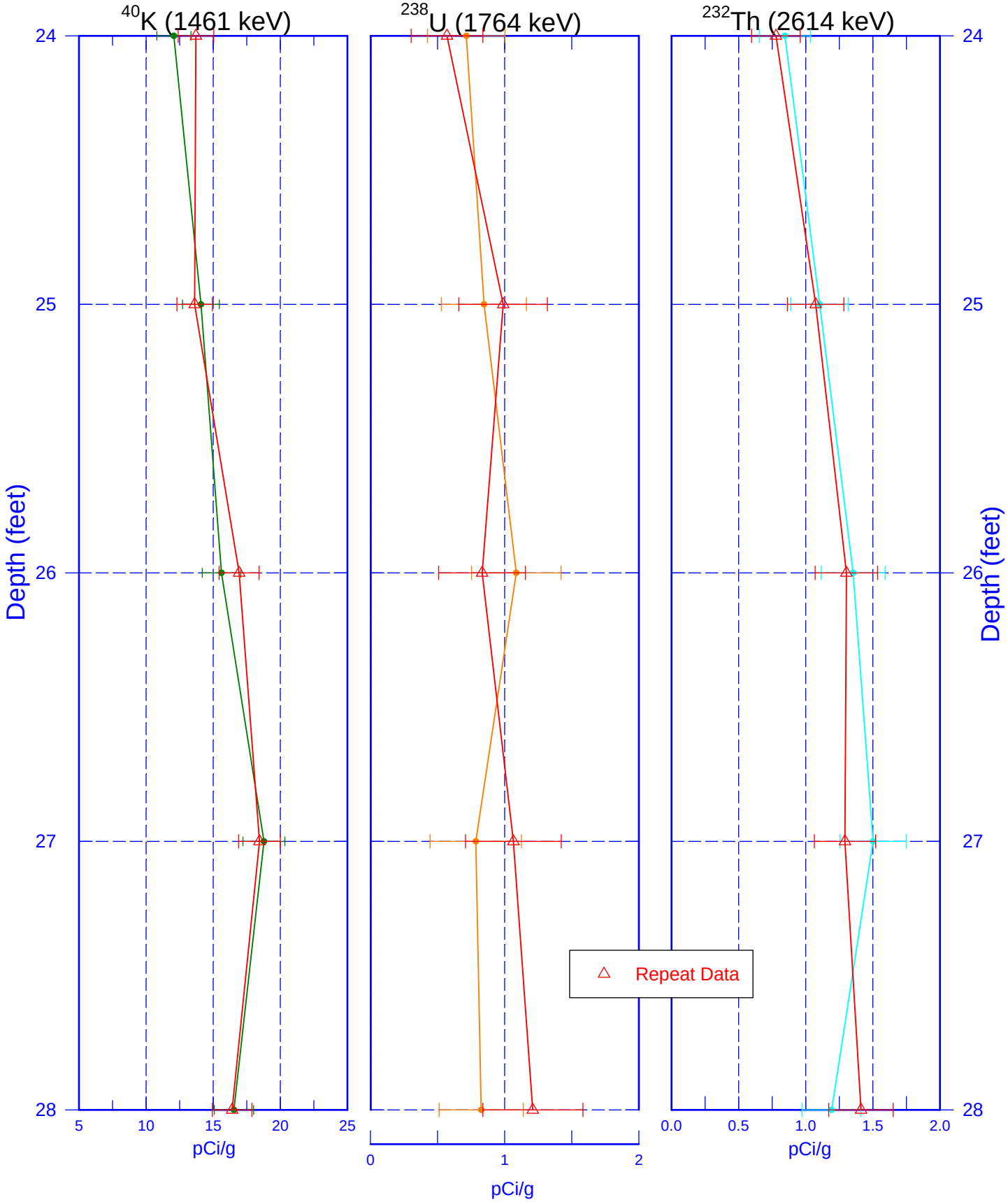
Total Gamma & Hanford Gamma Unit



Zero Reference - ground surface

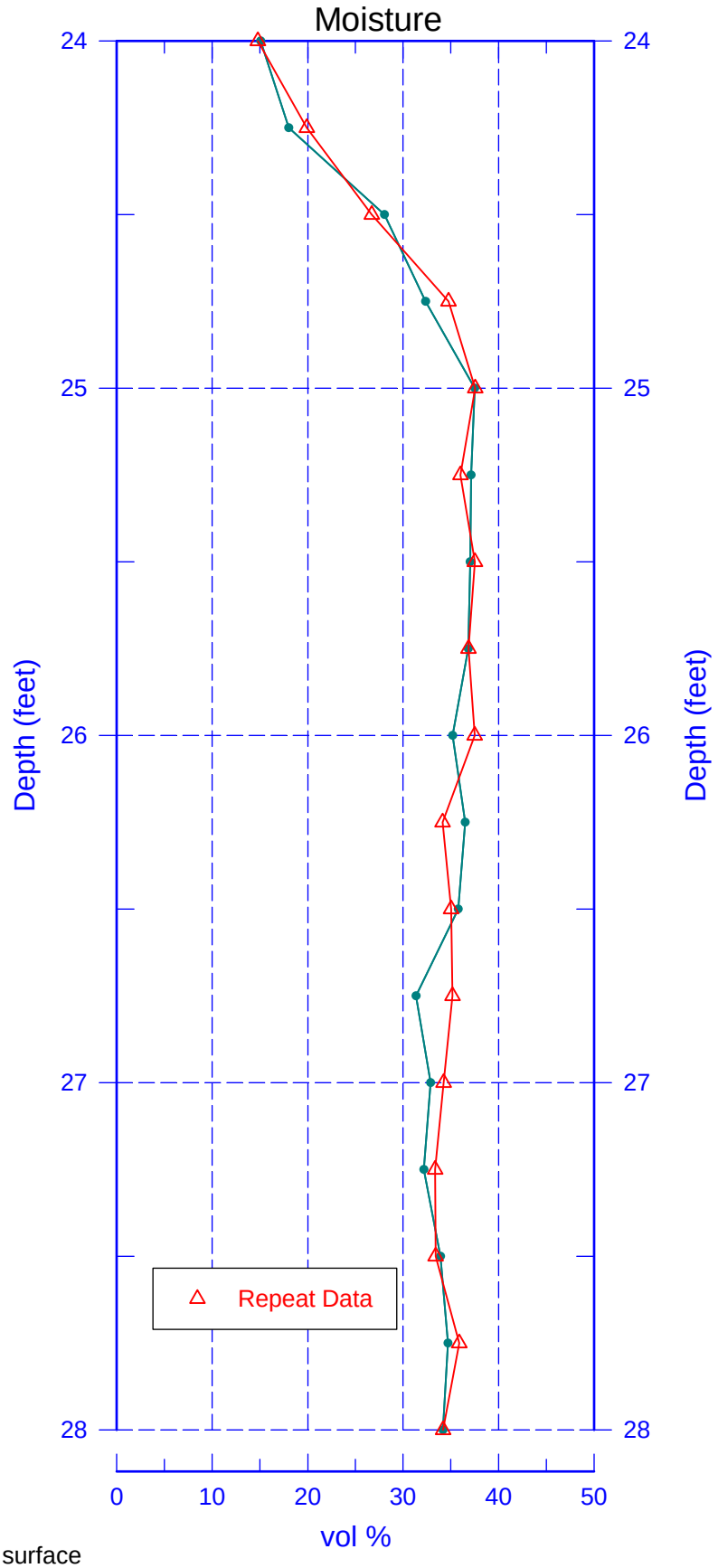
699-68-29 (C9873)

Repeat Section of Natural Gamma Logs



Zero Reference - ground surface

699-68-29 (C9873)
Moisture Repeat Section



Zero Reference - ground surface

This page intentionally left blank.

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 08/20/19	Requestor: James D. Mehrer (CHPRC)
Date of Survey: 10/03/19	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates and elevation of Brass Cap Marker for decommissioned 100-FR-3 Well C9873 (699-68-29) located south of 100F 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:

Washington State Reference Network

Well ID	Well Name	Easting	Northing	Elevation	
C9873	699-68-29	581102.94	144382.90	120.77	Brass survey marker

Notes:

Equipment Used: Trimble R8 RTK GPS

Surveyor Statement:

This page intentionally left blank.

C9873 Archive Photos

0-5 ft bgs

5-10 ft bgs

10-15 ft bgs

15-20 ft bgs

20-24 ft bgs

24-25 ft bgs

25-30 ft bgs

30-34 ft bgs

Appendix C

Well Documentation for 699-70-29 (C9985)

- Well Summary Sheet for C9985
- Borehole Log for C9985
- Geophysical Log Data Report for C9985
- Well Survey Data Report for C9985
- Well Development and Testing Data Sheet C9985
- Archive Photo Log for C9985

This page intentionally left blank.

WELL SUMMARY SHEET

Well ID: C9985	Well Name: 699-70-29	Start Date: 8/6/2019
Project: Installation of 6+1 Wells in the 100-FR-3 OU	Location: ~3km SE of F Reactor	End Date: 8/12/2019

CONSTRUCTION DATA

WA Ecology Well Tag: BLD026

Surface Construction:

4'x4'x6" Concrete pad with brass survey marker and protective monument

Temporary Casing Depth:

8" Carbon Steel Thd. joints = 48.3 ft bgs

Permanent Well Materials:

4.5" OD TP-304 Sch 10s Riser:
2.0 ft ags - 26.25 ft bgs
4.875" OD TP-304 20-slot (0.020") screen:
26.25 - 36.26 ft bgs
4.5" OD TP-304 Sch 10s Sump:
36.26 - 39.48 ft bgs

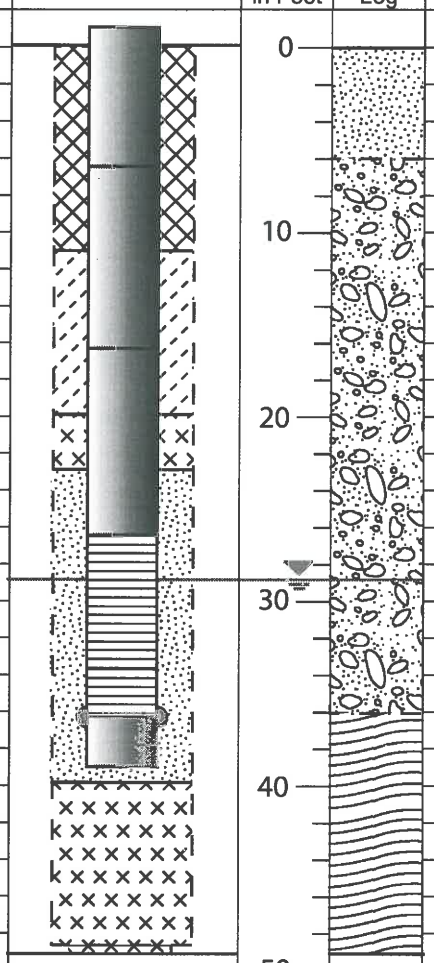
Well Construction Materials:

High Strength Concrete:
0.0 - 0.1 ft bgs
Type I/II Portland Cement:
0.1 - 10.9 ft bgs
Granular Bentonite:
10.9 - 20.0 ft bgs
Bentonite Pellet Seal:
20.0 - 23.0 ft bgs
Colorado Silica Sand 12/20# (Primary Filter Pack):
23.0 - 40.0 ft bgs
Bentonite Pellet Backfill:
40.0 - 48.8 ft bgs
Natural Fill:
48.8 - 49.0 ft bgs

Note:

All 8" temporary casing has been completely removed from the ground.

GEOLOGIC/HYDROLOGIC DATA



0-6 ft: Sand (S)

6-36 ft: Sandy Gravel (sG)

DTW = 28.9 ft bgs (8/12/2019)

36-49.0 ft: Clay (M)

Total Depth: 49.0 ft bgs

Acronyms:

DTW = depth to water
ags = above ground surface
bgs = below ground surface

Reported By:			
Dan Charbonneaux	Staff Geologist		8/27/2019
Print Name	Title	Signature	Date

Reviewed By:			
Jennifer Richart	Well Coordinator		9/4/19
Print Name	Title	Signature	Date

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

This page intentionally left blank.

BOREHOLE LOG

Page 1 of 2
Date: 8/6/19

Well ID: C9945 | Well Name: 699-70-29 | Location: ~3km SE of F-Reactor
Project: Installation of 6+1 wells in the 100-FR-3 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 - 6' bgs Sand (S) 10YR 4/3 Brown 95% sand, 5% gravel. Sand: fine to medium, mod. sorting, sub-round to sub-angular, damp, 60% M / 40% F, no HCl rxn. Gravel: Round to sub-round, mod. sorting, 50% M / 50% F.	Sonic rig, 6" core barrel, 8" casing
	G.S.			G.S. = grab sample
				Archive @ 5' bgs
5	8/6/19		6 - 36' bgs Sandy Gravel (SG) 2.5Y 4/2 dark grayish brown 75% gravel, 25% sand. Gravel: Round to sub-round, 2mm to 8cm, mod. sorting, 65% M / 35% F, gravel surfaces covered w/ some carbonate, strong HCl rxn. Sand: Fine to coarse, well sorted, sub-round to angular, 60% M / 40% F, moist, mild rxn to HCl.	
	G.S.			Archive @ 10' bgs
10	8/6/19			
			@ 16' bgs, ratios change: 40% gravel, 60% sand, sand now v. fine to medium, damp from drillers adding water, all else the same.	< 5 gal water added
	G.S.			Archive @ 15' bgs
15	8/7/19			
			@ 20' bgs, ratio changes: 70% gravel, 30% sand. Wet from driller adding water. Sand fine-medium, v. fines may have been present but washed out.	< 5 gal water added.
	G.S.			Archive @ 20' bgs
20'	8/7/19		@ 24' bgs, ratios change: 65% gravel, ~~77%~~ 32% sand, 3% silt. Sand v. fine to medium, silt: loose, nonplastic, moist. Gravel is round to sub-angular. All else the same.	
25'	G.S.		@ 29' bgs, ratios change: 60% gravel, 35% sand, 5% silt, all else the same.	Archive @ 25' bgs
	8/7/19			
				H_2O @ 29.0' bgs 8/7/19
	G.S.			Archive @ 30' bgs
30'	8/7/19			

Reported By:			
Dan Charboneau	Staff Geologist		8/7/19
Print Name	Title	Signature	Date

Reviewed By:			
Sarah Springer	Sr Geologist		08-27-19
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 2

Date: 8/7/19

Well ID: C9985 | Well Name: 699-70-29 | Location: ~3 km SE of F Reactor

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'	G.S. 8/7/19		@ 32' bgs, ratios change: 70% gravel, 25% sand, 5% silt. Gravel now 2mm to 14cm, sand now saturated, all else the same.	Archive @ 35' bgs
	G.S. 8/7/19			Archive @ 36' bgs
				RUM @ 36' bgs
			36 – 49.0 ft bgs Silt (M) 5Y4/3 olive	
40'	G.S. 8/7/19		100% silt/clay. Plastic – semi-plastic, massive, moist, no HCl rxn.	Archive @ 40' bgs
			39' DC 8/7/19	
			@ 7~~0~~' bgs, major color change: 5G4/1 dark greenish gray, large pieces of caliche present: 10GY6/1 greenish gray. Semi-plastic.	
45'	G.S. 8/7/19			Archive @ 46' bgs
TD				TD @ 49.0' bgs
				Sonic rig, 6" core barrel, 8" casing

Reported By:

Print Name	Title	Signature	Date
Dan Chambonneau	Staff Geologist		8/7/19

A-6006-993 (REV 0)

699-70-29 (C9985)
Log Data Report

Borehole Information

Log Date	2019-08-07	Filename	C9985_HG-NM_2019-08-07	Site	100-FR-3
DTW[1] (ft)	**DTW Date**	**DTW Source**	**Drill Date**	**Total Depth (ft)**	**Depth Datum**
None	08/07/19	Bay West	08/07/19	49	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.)		Thickness (in.)	Top (ft)	Bottom (ft)
			Outer	Inside			
Threaded steel	Sonic	TC[2]	8.1	7.58	0.26	2.08 AGS[3]	48.3

Borehole Notes

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing using a dial gauge and circumference tape. The maximum logging depth achieved was 48 ft, approximately even with the casing depth. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma FTB	Type	60% Coaxial HPGe (SGLS)[4]
Effective Calibration Date	12/12/2018	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-180, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0, Change 2

Logging System	Gamma 5PB	Type	He-3 (CPN 503DR) NMLS[5]
Effective Calibration Date	12/12/2018	Serial No.	H34055445
Calibration Reference	HGLP-CC-177, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0, Change 2

SGLS Log Run Information

Log Run	1	2 Repeat		
HEIS Number	1021231	1021232		
Date	08/07/19	08/07/19		
Logging Engineer	Spatz	Spatz		
Start Depth (ft)	0.0	34.0		
Finish Depth (ft)	48.0	40.0		
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)	NA	NA		

[1] depth to water inside casing
[2] Temporary casing
[3] Above ground surface
[4] Spectral Gamma Logging System
[5] Neutron Moisture Logging System

Log Run	1	2 Repeat		
Pre-Verification	C9985FTB20190807AV00CAB1	C9985FTB20190807AV00CAB1		
Start File	AD000000	BD003400		
Finish File	AD004800	BD004000		
Post-Verification	C9985FTB20190807BV00CAA1	C9985FTB20190807BV00CAA1		
Depth Return Error (in.)	N/A	1.5		
Comments	None	None		

NMLS Log Run Information

Log Run	3	4 Repeat			
HEIS Number	1021233	1021234			
Date	08/07/19	08/07/19			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0.0	26.0			
Finish Depth (ft)	40.0	32.0			
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	C9985FPB20190807AV00CAB1	C9985FPB20190807AV00CAB1			
Start File	AD000000	BD002600			
Finish File	AD004000	BD003200			
Post-Verification	C9985FPB20190807BV00CAA1	C9985FPB20190807BV00CAA1			
Depth Return Error (in.)	N/A	0.0			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on the sondes. Verification measurements passed the acceptance criteria. There was a discrepancy between the geologist's reported DTW of 29 ft and Bay West measurements that indicated no water inside the casing. Consequently logging with the moisture sonde was terminated 10 ft below the geologist's reported depth to preclude the possibility of immersing the sonde in water.

Analysis Notes

Analyst	P.D. Henwood	Date	09/25/19
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

A casing correction for a 0.26-in. thick casing was applied to the SGLS log data; no additional correction was made for the thick casing joints.

No water correction was applied.

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 FTB20181212 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

Casing diameter and thickness corrections for 0.26-in. thick, 8.1-in. OD casing were applied to the NMLS data acquired through the sonic casing. Integrated with the casing diameter and thickness corrections is an initial count rate correction for a sediment composition of a 50-50% ratio of basalt fragments to quartz sand (HGLP-OTH-028).

NMLS data are reported in counts per second for the entire length of the borehole. NMLS data are also reported in vol% moisture. Conversions from count rate to vol% moisture were performed using an EXCEL template identified as FPB_Cascade_Sonic_MCNP_assay. This template also provides corrections for the thick casing joints typical of sonic drill casings.

HGU[6] 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 generally increases as the sediment becomes more fine-grained. For example, moisture content would be expected to be greater near the top of a fining upward Hanford flood sequence.

Just before logging, no water was inside the casing. It appears static water may be at approximately 29 ft.

Thickened casing joints occur at 5 and 10 ft intervals beginning at approximately 3 ft in depth. No corrections have been made for the joints for the SGLS although corrections for moisture have been made.

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

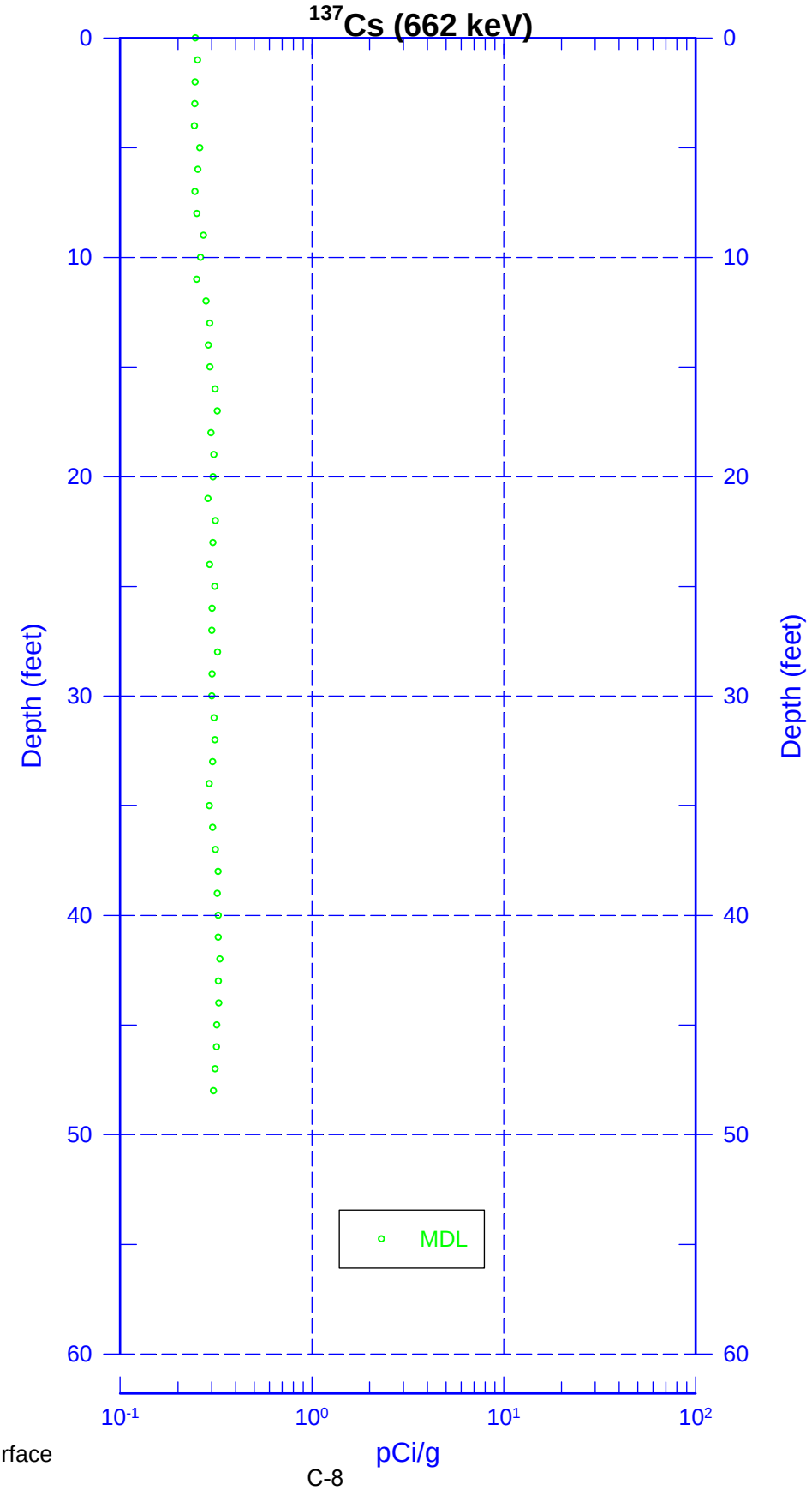
List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-60 ft)
Natural Gamma Logs (0-60 ft)
Combination Plot (0-60 ft)
Moisture (0-60 ft)
Total Gamma & Moisture (0-60 ft)
Total Gamma & Hanford Gamma Unit (0-60 ft)
Repeat Section of Natural Gamma Logs (34-40 ft)
Moisture Repeat Section (26-32 ft)

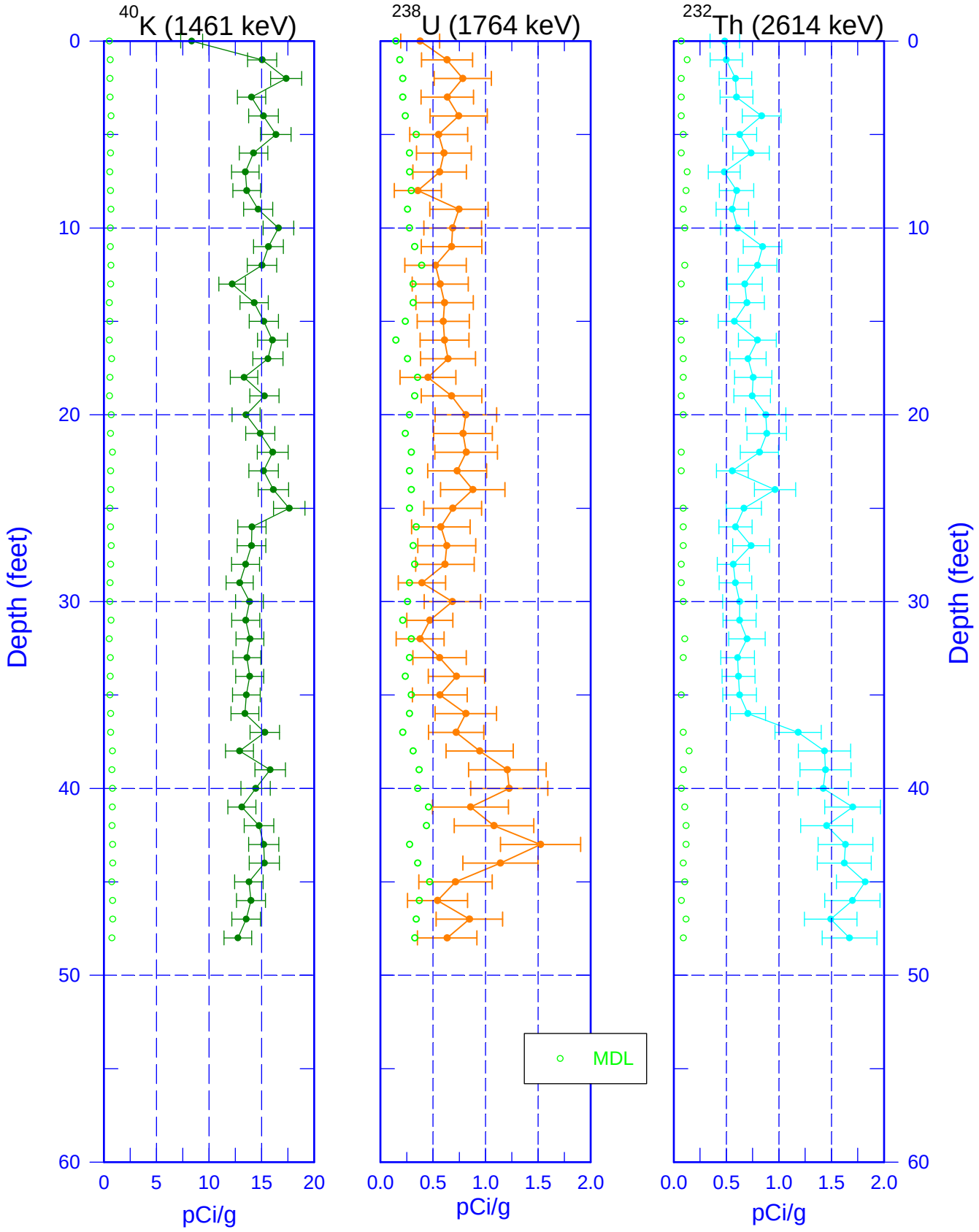
[6] Hanford Gamma Unit

699-70-29 (C9985)
Manmade Radionuclides



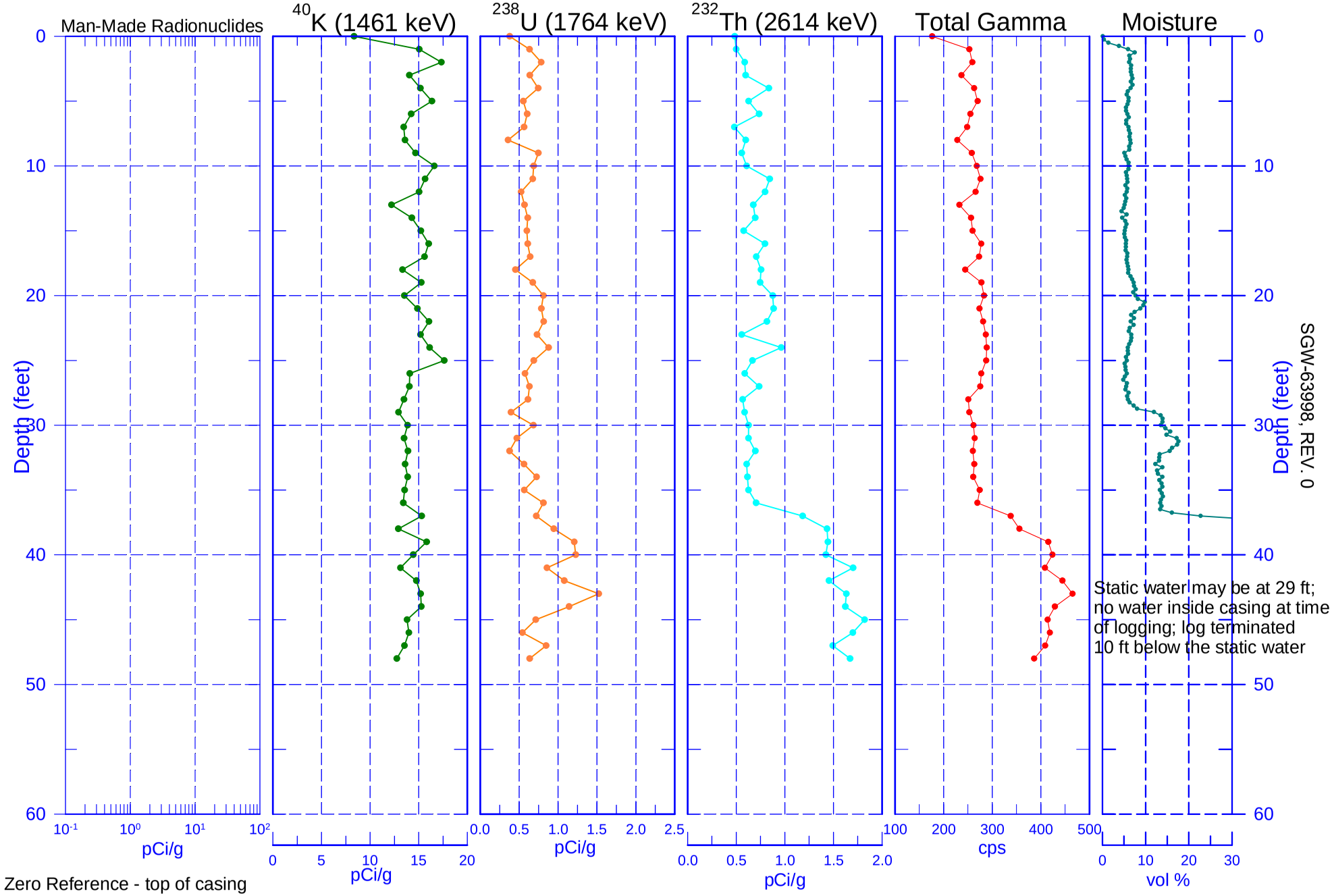
Zero Reference - ground surface

699-70-29 (C9985)
Natural Gamma Logs



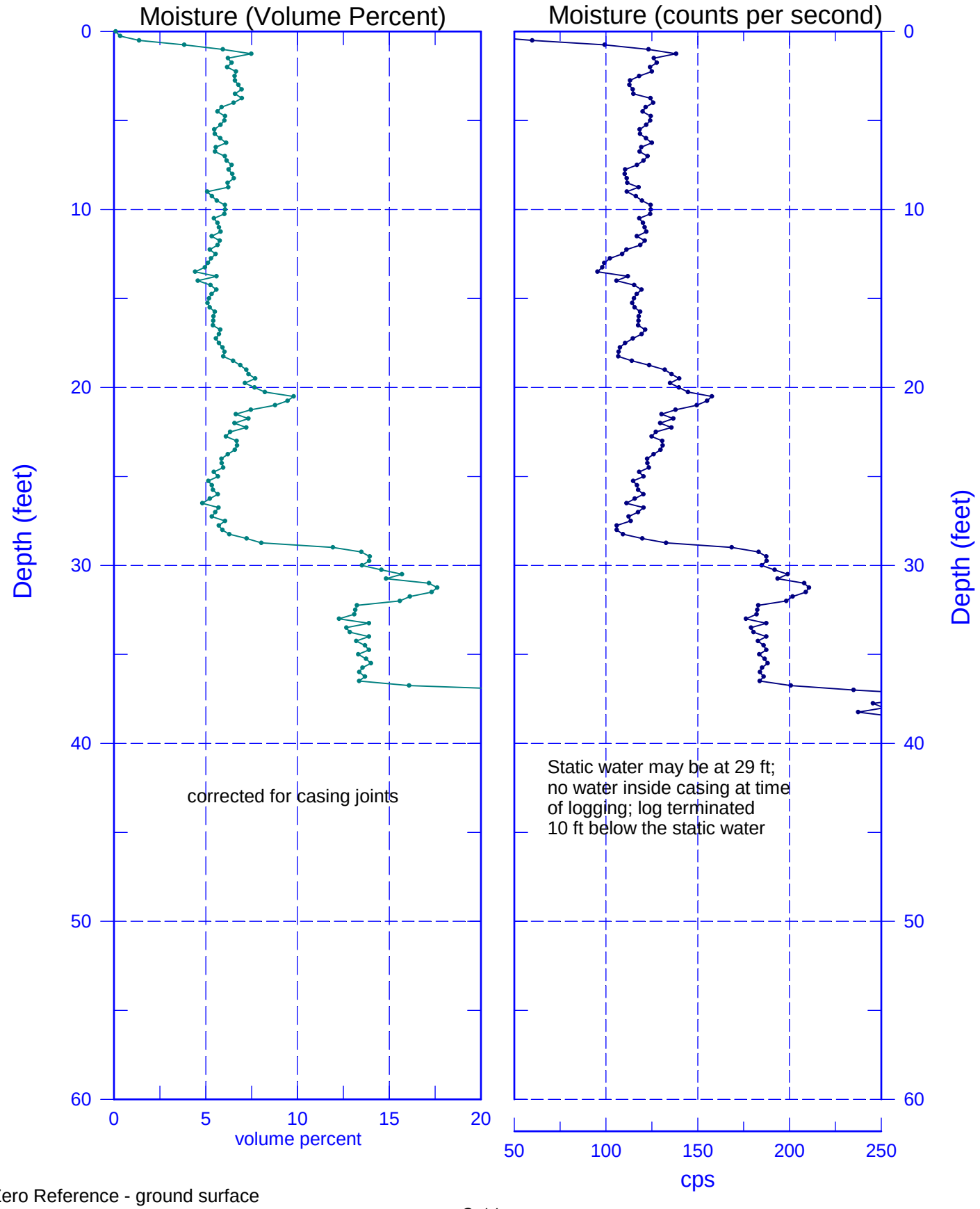
Zero Reference - ground surface

699-70-29 (C9985) Combination Plot



Zero Reference - top of casing

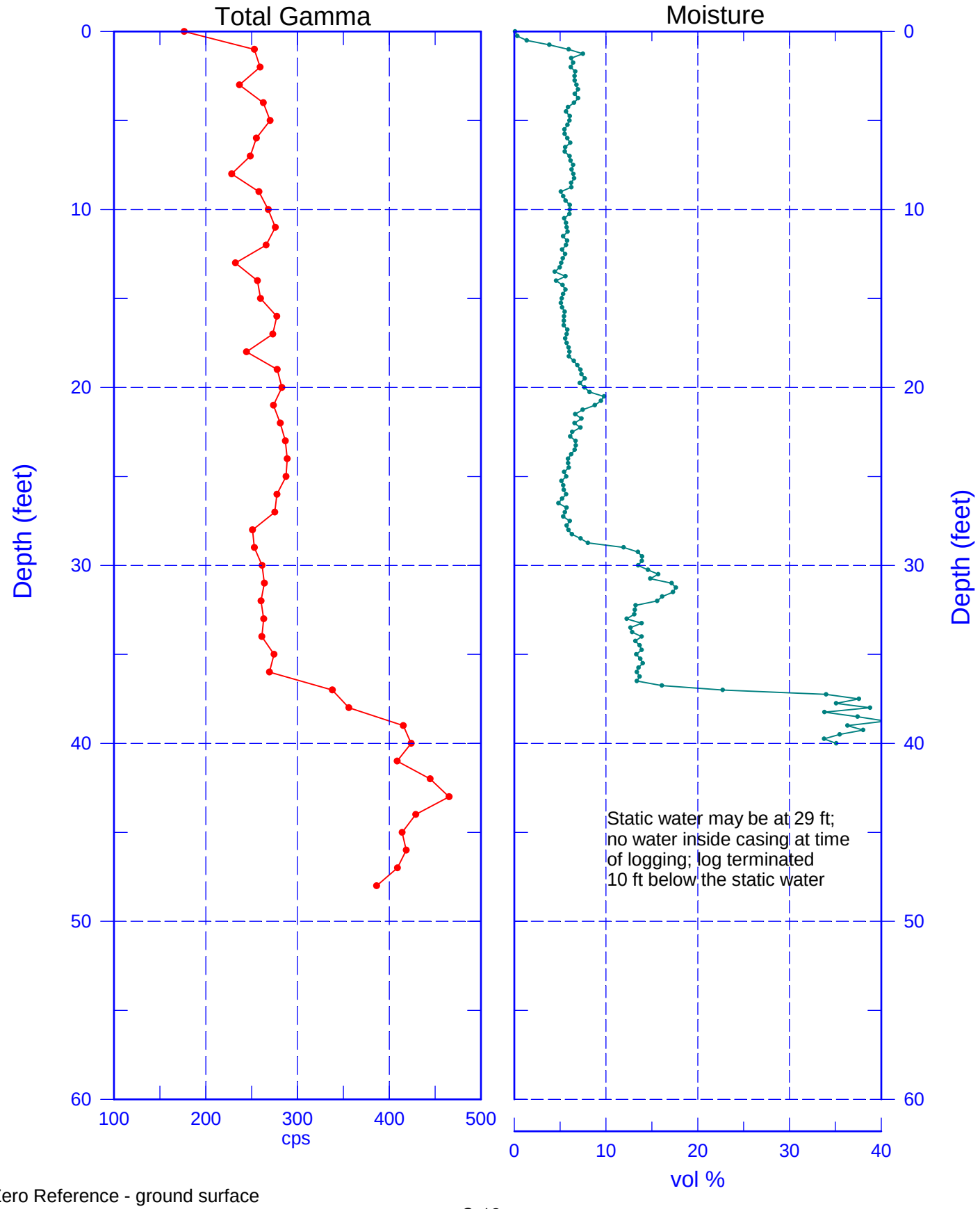
699-70-29 (C9985)
Moisture



Zero Reference - ground surface

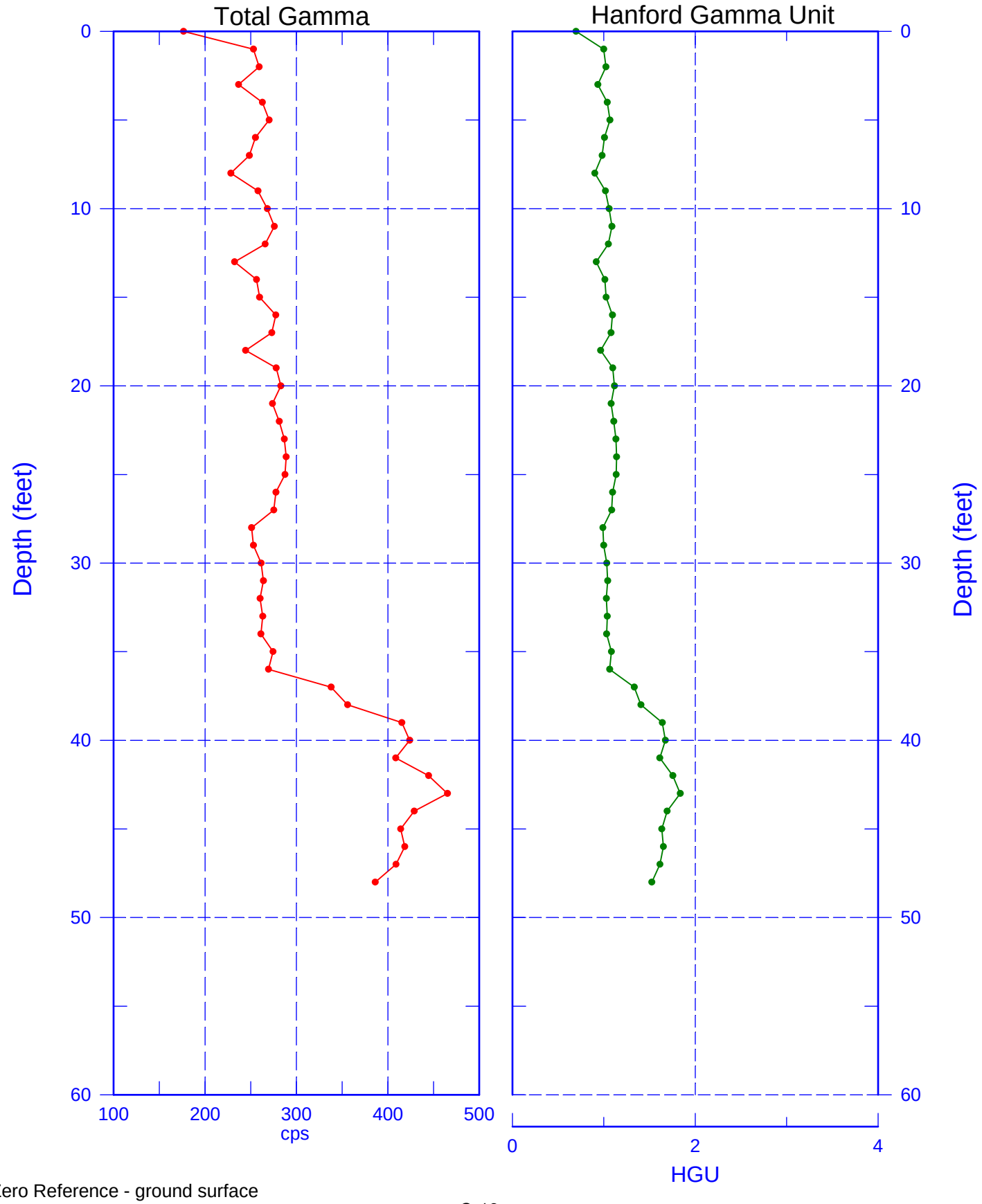
699-70-29 (C9985)

Total Gamma & Moisture



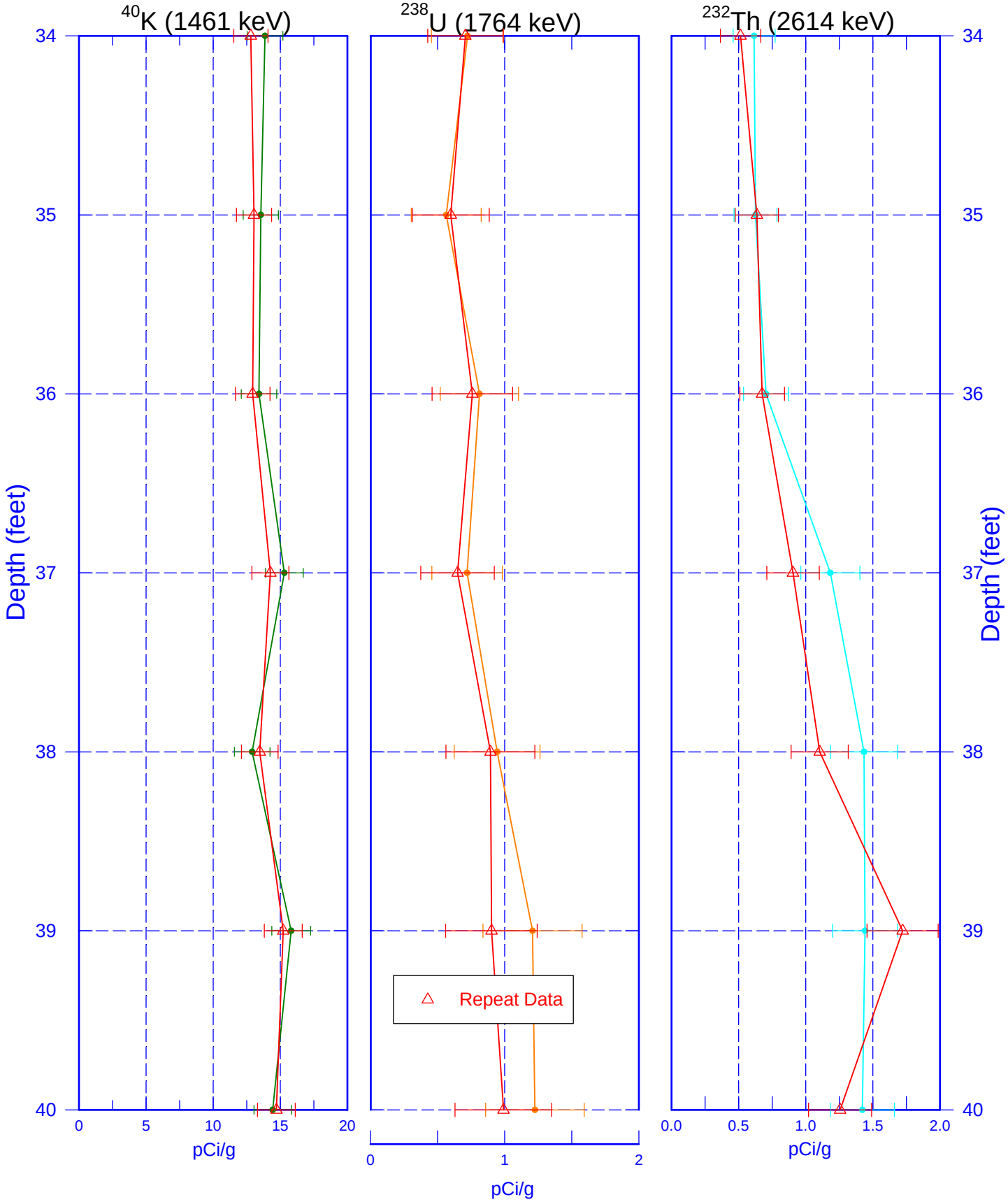
Zero Reference - ground surface

699-70-29 (C9985)
Total Gamma & Hanford Gamma Unit



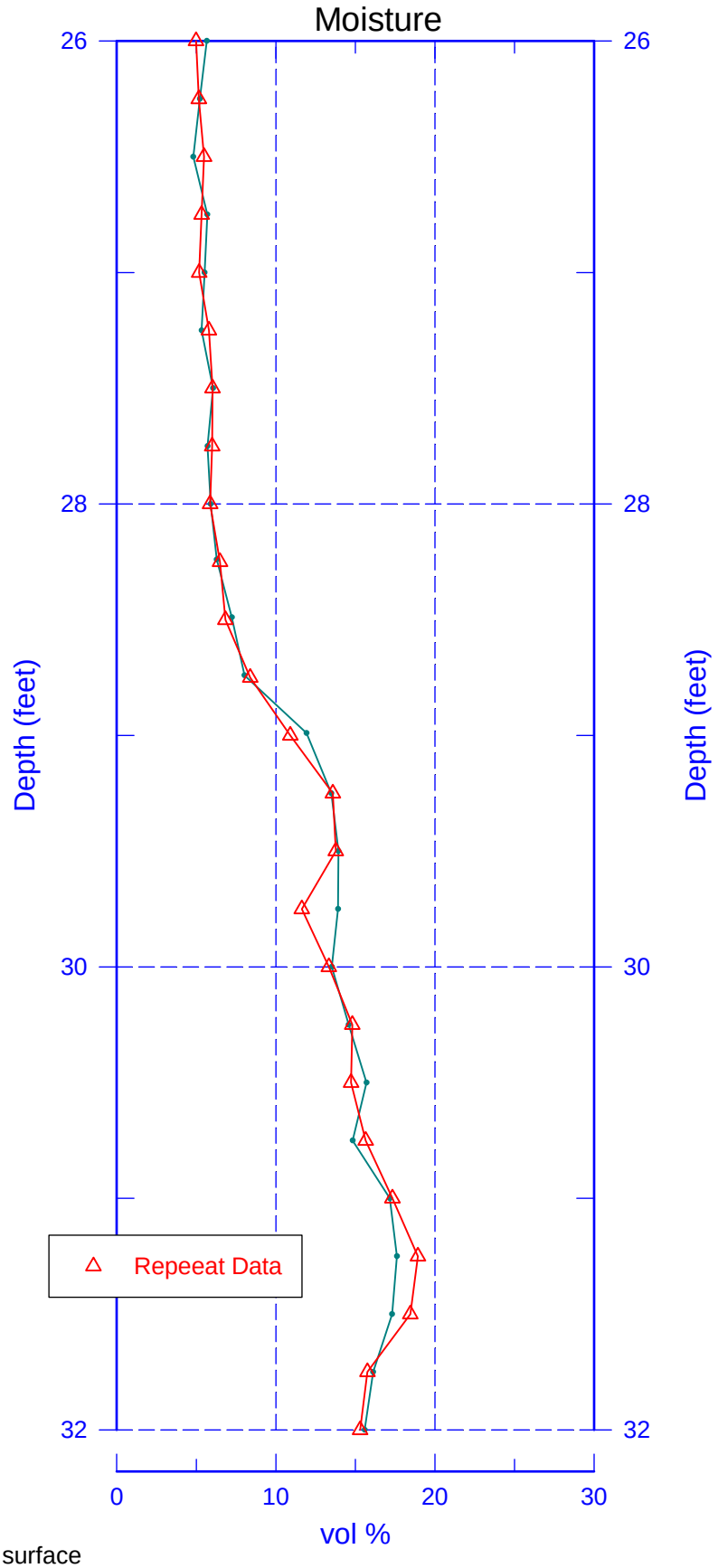
Zero Reference - ground surface

699-70-29 (C9985)
Repeat Section of Natural Gamma Logs



Zero Reference - ground surface

699-70-29 (C9985)
Moisture Repeat Section



Zero Reference - ground surface

This page intentionally left blank.

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 08/20/19	Requestor: James D. Mehrer (CHPRC)
Date of Survey: 10/03/19	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of FR-3 Well C9985 (699-70-29) located south of 100F 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:

L324 (COE) and Bleakley Azimuth (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9985	699-70-29	581195.52	144752.85		Center of Casing
				122.654	Top Inner 4"Casing, N.Edge
				122.962	Top Outer Casing,N.Edge Stamped "X"
				122.221	Brass Survey Marker

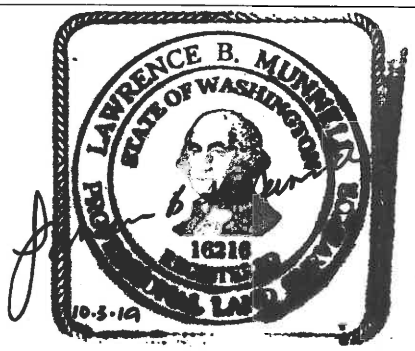
Notes:

Brass Survey Marker elevation was taken on top north edge of flat 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.



This page intentionally left blank.

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9985	Well Name: 699-70-29	Date: 8/19/19

Location: ~3km SE of F-Reactor

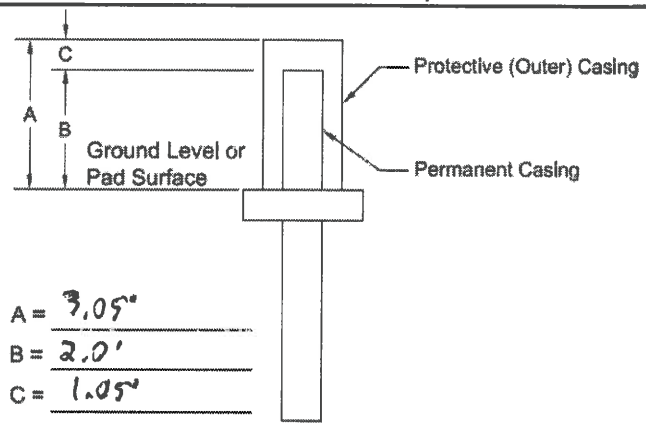
Reference Measuring Point *(unless otherwise noted)*: TOP OF OUTER CASING (TOC)

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: 8/12/19	28.9' bgs	29.1' bgs
Date: —	—	—
DEPTH TO BOTTOM:		
Date: 8/12/19	39.24' bgs	39.6' bgs
Date: —	—	—



A = 3.05'
B = 2.0'
C = 1.05'

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)
35.0	2.45	~~34.5~~ 5.85 DC 8/14/19	10.0	1.25	1127	1233	6.0	2.45
				Not 2x	Used 8/19/19			

Total Pumped: 396 gal

Pump Model: Grundfos 96160180 240v 1HP

Troll Serial Number and Pressure Range (PSI and depth): In-situ Level Troll 700, s/n: 403065, range: 70m / 231ft / 99.6 PSI

Comments: bgs = below ground surface

Test name: C9985 develop 081219

Prepared By:

Dan Charbonneau — Print Name
[signature] — Signature
8/19/19 — Date

Reviewed By:

Jennifer Richart — Print Name
[signature] — Signature
9/4/19 — Date

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6005-205 (REV 2)

This page intentionally left blank.

C9985 Archive Photos

0-5 ft bgs

5-10 ft bgs

10-15 ft bgs

15-20 ft bgs

25-30 ft bgs

30-35 ft bgs

35-36 ft bgs

36-40 ft bgs

40-46 ft bgs

Appendix D

Well Documentation for 699-71-24 (C9872)

- Well Summary Sheet for C9872
- Borehole Log for C9872
- Geophysical Log Data Report for C9872
- Well Survey Data Report for C9872
- Well Development and Testing Data Sheet C9872
- Archive Photo Log for C9872

This page intentionally left blank.

WELL SUMMARY SHEET

Well ID: C9872	Well Name: 699-71-24	Start Date: 7/24/2019
Project: Installation of 6+1 Wells in 100-FR-3 OU	Location: ~3km SE of F Reactor	End Date: 8/8/2019

CONSTRUCTION DATA

WA Ecology Well Tag: BLD025

Surface Construction:

4'x4'x6" Concrete pad with brass survey marker and protective monument

Temporary Casing Depths:

8" Carbon Steel Thd. joints = 58.7 ft bgs

Permanent Well Materials:

4.5" OD TP-304 Sch 10s Riser:
2.10 ft ags - 27.02 ft bgs
4.875" OD TP-304 20-slot (0.020") Screen:
27.02 ft bgs - 46.93 ft bgs
4.5" OD TP-304 Sch 10s End Cap
46.93 ft bgs - 47.25 ft bgs

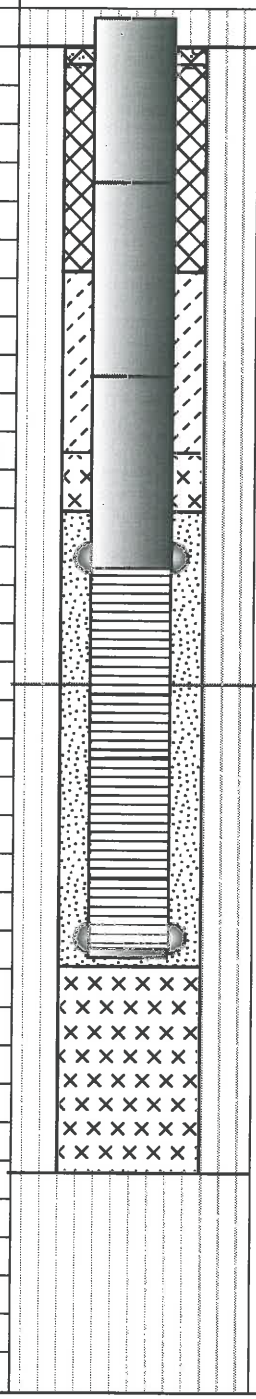
Well Construction Materials:

High Strength Concrete:
0.0 - 0.4 ft bgs
Type I/II Portland Cement:
0.4 ft bgs - 10.9 ft bgs
Granular Bentonite:
10.9 ft bgs - 21.4 ft bgs
Bentonite Pellet Seal
21.4 ft bgs - 24.1 ft bgs
Colorado Silica Sand 12/20# (Primary Filter Pack):
24.1 ft bgs - 48.0 ft bgs
Bentonite Pellet Backfill:
48.0 ft bgs - 58.7 ft bgs

Note:

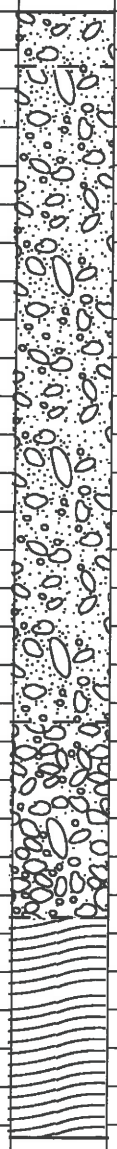
All 8" temporary casing has been completely removed from the ground.

Diagram



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

Graphic Log



GEOLOGIC/HYDROLOGIC DATA

Lithologic Description (ft bgs)

0-3 ft: Gravelly Sand (gS)

3-37 ft: Sandy Gravel (sG)

DTW = 33.2 ft bgs (8/8/2019)

37-47 ft: Gravel (G)

47-58.7 ft: Clay (M)

Total Depth = 58.7 ft bgs

Acronyms:

ags = above ground surface
bgs = below ground surface
DTW = depth to water

Reported By:			
Dan Charbonneaux	Staff Geologist		8/26/2019
Print Name	*Title*	*Signature*	*Date*

Reviewed By:			
Jennifer Richart	Well Coordinator		9/4/19
Print Name	*Title*	*Signature*	*Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

This page intentionally left blank.

BOREHOLE LOG

Page 1 of 2

Date: 07/24/2019

Well ID: C9872 | Well Name: 699-71-24 | Location: ~3km SE of F reactor

Project: The Installation of 6+1 wells in 100-FR-3 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'-3' bgs Gravelly Sand (gS)	Sonic rig. 8" casing 6" core barrel.
			Damp. 10% Gravel, 80% Sand, 10% silt. Gravel: 5mm-70mm avg 60mm, rounded to sub angular 60% M 40% F, moderately sorted, Sand: fine to med sand.	
5	grab sample 7/24/19		Well sorted, sub angular mostly, No rxn to HCl, 10YR 4/3, brown. 15% M 85% F. Silt: same color as sand, No rxn to HCl, some plasticity.	Archive @ 5' bgs
10	grab sample 7/24/19		3'-37' bgs Sandy Gravel (sG)	
			Slightly damp. 70% Gravel, 30% Sand. Gravel: 2mm-95mm, avg 35mm, mostly rounded to subrounded, some subangular. 50% M/50% F,	Archive @ 10' bgs
15	grab sample 7/24/19		moderately sorted. Sand: fine to coarse sand, avg med, moderately sorted, 30% M/70% F, mostly sub angular, No rxn to HCl. 2.5Y 5/3 (light olive brown) and 4/3 (olive brown).	Archive @ 15' bgs
20	grab sample 7/24/19		@ 10' bgs: Mostly dry. Small amount of silt present ~5%. ~~Gravel 30%~~ edw 7/24/19 70% Gravel, 25% Sand. Sand and silt react strongly to HCl. Silt	Archive @ 20' bgs
25	grab sample 7/24/19		has no visible plasticity. All else the same.	Archive @ 25' bgs
			@ 15' bgs: Damp. Back to no silt content. 60% Gravel, 40% Sand. Gravel well sorted 20-50mm,	
30	grab sample 7/24/19		all else stays the same.	Archive @ 30' bgs
			@ 20' bgs: Dry mostly. Gravel poorly sorted 2mm-55mm avg 8mm.	
H_2O tagged 7/24/19			Smaller pieces angular to subrounded. Avg sand fine, moderately sorted.	H_2O tagged 33.8' bgs

Reported By:

Print Name	Title	Signature	Date
Ellen Whitney	Geologist	[signature]	07/24/2019

Reviewed By:

Print Name	Title	Signature	Date
Sarah Springer	Sr. Geologist	[signature]	08-14-2019

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Page 2 of 2

Date: 07/24/2019

Well ID: C9872 | Well Name: 699-71-24 | Location: ~3km SE of F reactor

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	grab sample 7/24/19		2.5Y, 4/2 dark grayish brown. All else the same. @ 25' bgs damp, all stays the same. @ 30' bgs dry, ~5% silt content returns. 50% Gravel, 45% Sand, some larger gravel present up to 110mm. Majority still avg 8mm. All else the same.	Sonic rig 8" casing 6" core barrel. Archive @ 35' bgs.
40	grab sample 7/24/19		@ 35' bgs damp, silt gone. 50% Gravel, 50% Sand. All else the same. edw 07/24/19	Archive @ 40' bgs.
45	grab sample 7/24/19		~~same.~~ 37' bgs - 47' bgs Gravel (G) @ 40' bgs saturated. Sand appears coarser, fines may have washed out. Sand fine to very coarse. Avg coarse. 85% Gravel, 15% Sand.	Archive @ 45' bgs.
	grab sample 7/24/19			Archive @ 47' bgs
50	grab sample 7/24/19		@ 45' bgs saturated. All stays the same. @ 47' bgs saturated. All stays the same. 47' bgs - 58.5' bgs Clay (M)	Archive @ 50' bgs
55	grab sample 7/24/19		Wet. 90% Silt/clay, 5% Gravel, 5% Sand. Gravel 2-15mm subrounded, similar to above gravels. Sand mostly med to coarse, sub angular. Silt/clay, high plasticity. 2.5Y 5/2 grayish brown. Coliche present.	Archive @ 55' bgs
TD 7/24/19 60	grab sample 7/24/19		In 2.5Y 8/1 white. Vigorous rxn to HCl. Non coliche clay rxn mld to HCl. All @ 53' bgs. wet. Plasticity decreases slightly. Gravel and sand gone. Color change 10YR 4/4 dark yellowish brown. Coliche gone. ~~90% Clay, 5% Silt~~ edw 7/24/19 No rxn to HCl, pl edw 7/24/19	Archive @ 58' bgs. TD @ 58.5' bgs 07/24/2019
65			@ 58' bgs wet. Plasticity decreases further. Now semi plastic.	

Reported By:

Ellen Whitney (Print Name) | Geologist (Title) | Signature | 07/24/2019 (Date)

A-6006-993 (REV 0)

699-71-24 (C9872)
Log Data Report

Borehole Information

Log Date	2019-07-25	Filename	C9872_HG-NM_2019-07-25	Site	100-FR-3
DTW[1] (ft)	**DTW Date**	**DTW Source**	**Drill Date**	**Total Depth (ft)**	**Depth Datum**
35.28	07/25/19	Bay West	07/24/19	58.7	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded steel	Sonic	TC[2]	8.1	7.58	0.26	1.95 AGS[3]	58.5

Borehole Notes

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing using a dial gauge and circumference tape. The maximum logging depth achieved was 58 ft, approximately 0.5 ft above the casing. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma FTB	**Type**	60% Coaxial HPGe (SGLS)[4]
Effective Calibration Date	12/12/2018	**Serial No.**	47-TP-32211A
Calibration Reference	HGLP-CC-180, Rev. 0	**Logging Procedure**	SGRP-PRO-OP-53023, Rev. 0, Change 2

Logging System	Gamma 5PB	**Type**	He-3 (CPN 503DR) NMLS[5]
Effective Calibration Date	12/12/2018	**Serial No.**	H34055445
Calibration Reference	HGLP-CC-177, Rev. 0	**Logging Procedure**	SGRP-PRO-OP-53024, Rev. 0, Change 2

SGLS Log Run Information

Log Run	3	4 Repeat		
HEIS Number	1021220	1021221		
Date	07/25/19	07/25/19		
Logging Engineer	Pope/McClellan	Pope/McClellan		
Start Depth (ft)	0.0	45.0		
Finish Depth (ft)	58.02	51.01		
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)	NA	NA		

[1] depth to water inside casing
[2] Temporary casing
[3] Above ground surface
[4] Spectral Gamma Logging System
[5] Neutron Moisture Logging System

Log Run	3	4 Repeat		
Pre-Verification	C9872FTB20190725AV00CAB1	C9872FTB20190725AV00CAB1		
Start File	AD000000	BD004500		
Finish File	AD005802	BD005101		
Post-Verification	C9872FTB20190725BV00CAA1	C9872FTB20190725BV00CAA1		
Depth Return Error (in.)	N/A	1.5 high		
Comments	None	None		

NMLS Log Run Information

Log Run	1	2 Repeat			
HEIS Number	1021222	1021223			
Date	07/25/19	07/25/19			
Logging Engineer	Pope/McClellan	Pope/McClellan			
Start Depth (ft)	0.0	30.0			
Finish Depth (ft)	35.51	34.0			
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	C9872FPB20190725AV00CAB1	C9872FPB20190725AV00CAB1			
Start File	AD000000	BD003000			
Finish File	AD003551	BD003400			
Post-Verification	C9872FPB20190725BV00CAA1	C9872FPB20190725BV00CAA1			
Depth Return Error (in.)	N/A	0.25 low			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on the sondes. Verification measurements passed the acceptance criteria.

Analysis Notes

Analyst	P.D. Henwood	Date	09/23/19
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

A casing correction for a 0.26-in. thick casing was applied to the SGLS log data; no additional correction was made for the thick casing joints.

A water correction was applied below 35.28.

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 FTB20181212 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

Casing diameter and thickness corrections for 0.26-in. thick, 8.1-in. OD casing were applied to the NMLS data acquired through the sonic casing. Integrated with the casing diameter and thickness corrections is an initial count rate correction for a sediment composition of a 50-50% ratio of basalt fragments to quartz sand (HGLP-OTH-028).

NMLS data are reported in counts per second for the entire length of the borehole. NMLS data are also reported in vol% moisture. Conversions from count rate to vol% moisture were performed using an EXCEL template identified as FPB_Cascade_Sonic_MCNP_assay. This template also provides corrections for the thick casing joints typical of sonic drill casings.

HGU[6] 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 generally increases as the sediment becomes more fine-grained. For example, moisture content would be expected to be greater near the top of a fining upward Hanford flood sequence.

The measured depth to water was at the time of logging. It appears static water may be at approximately 32 ft.

Thickened casing joints occur at 5 and 10 ft intervals beginning at approximately 3 ft in depth. No corrections have been made for the joints for the SGLS although corrections for moisture have been made.

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

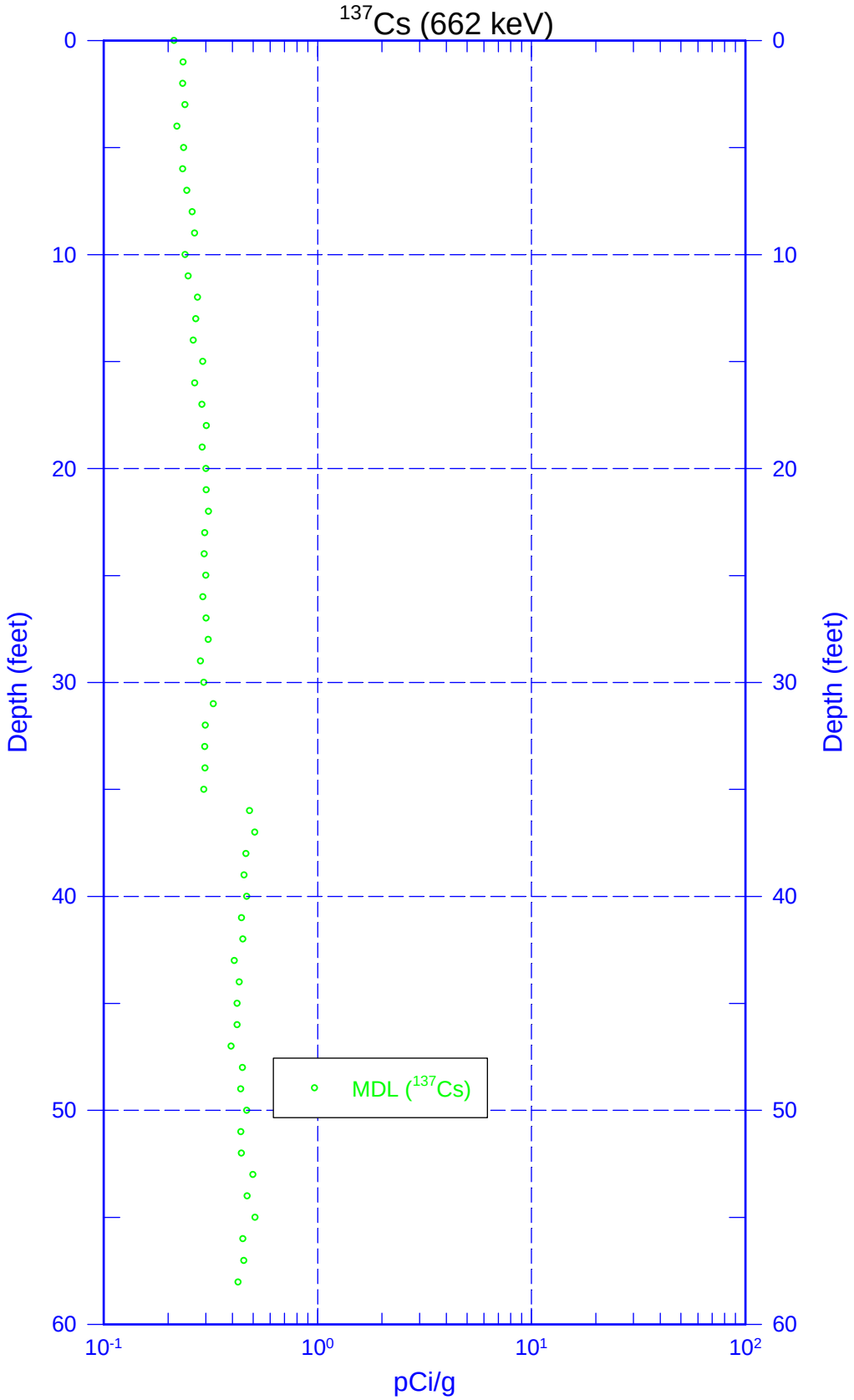
List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-60 ft)
Natural Gamma Logs (0-60 ft)
Combination Plot (0-60 ft)
Moisture (0-60 ft)
Total Gamma & Moisture (0-60 ft)
Total Gamma & Hanford Gamma Unit (0-60 ft)
Repeat Section of Natural Gamma Logs (45-51 ft)
Moisture Repeat Section (30-34 ft)

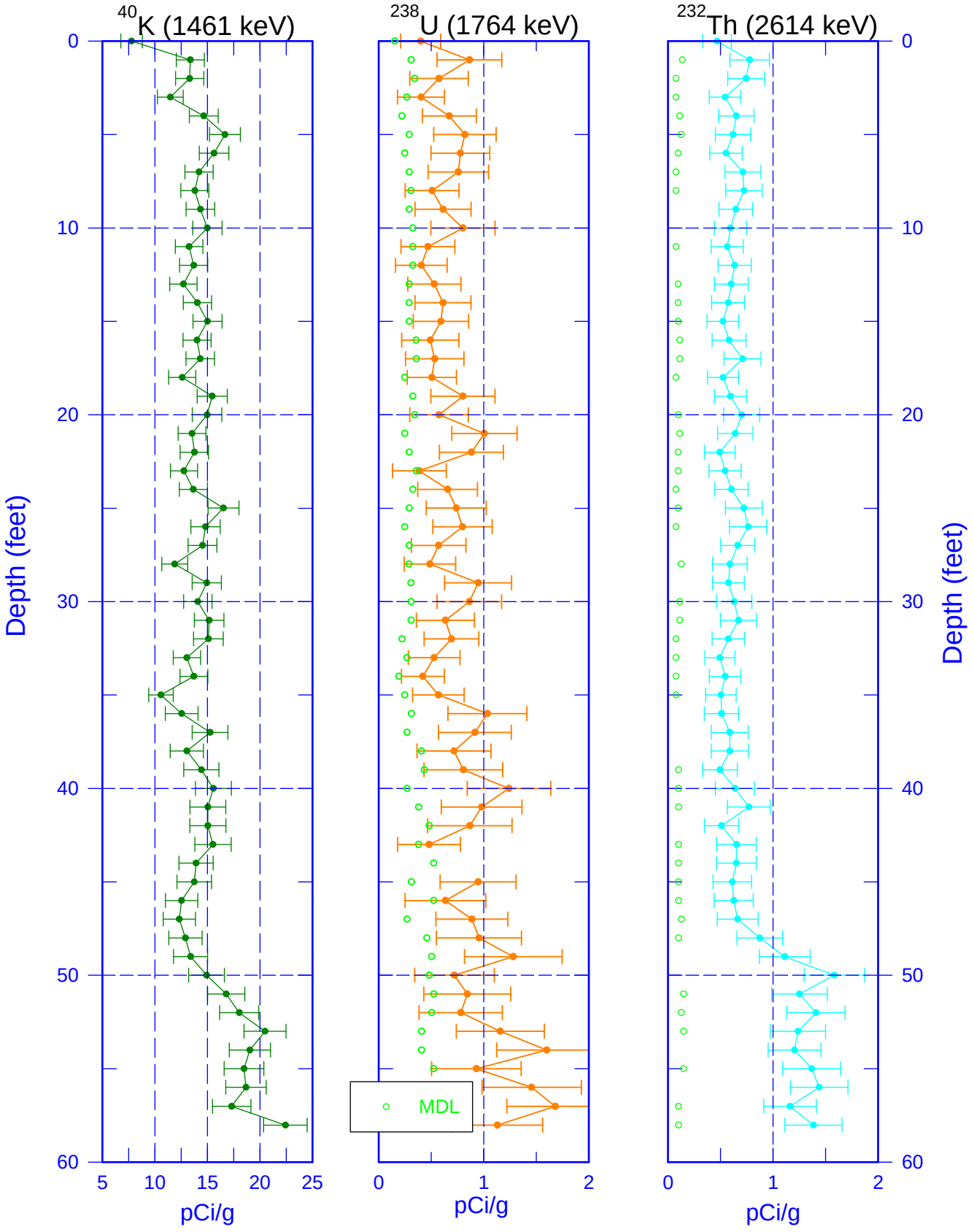
[6] Hanford Gamma Unit

699-71-24 (C9872)
Manmade Radionuclides



Zero Reference - ground surface

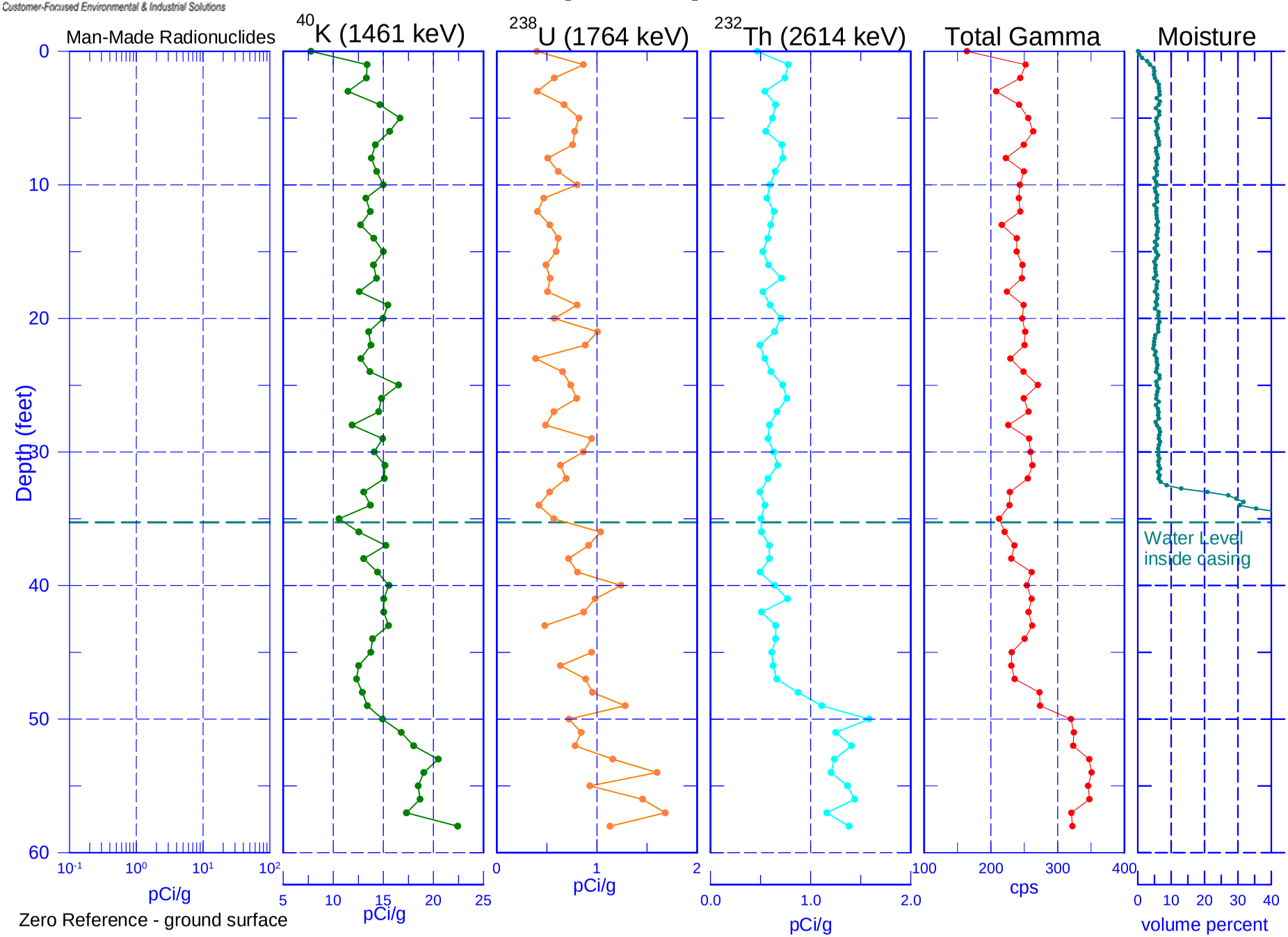
699-71-24 (C9872)
Natural Gamma Logs



Zero Reference - ground surface

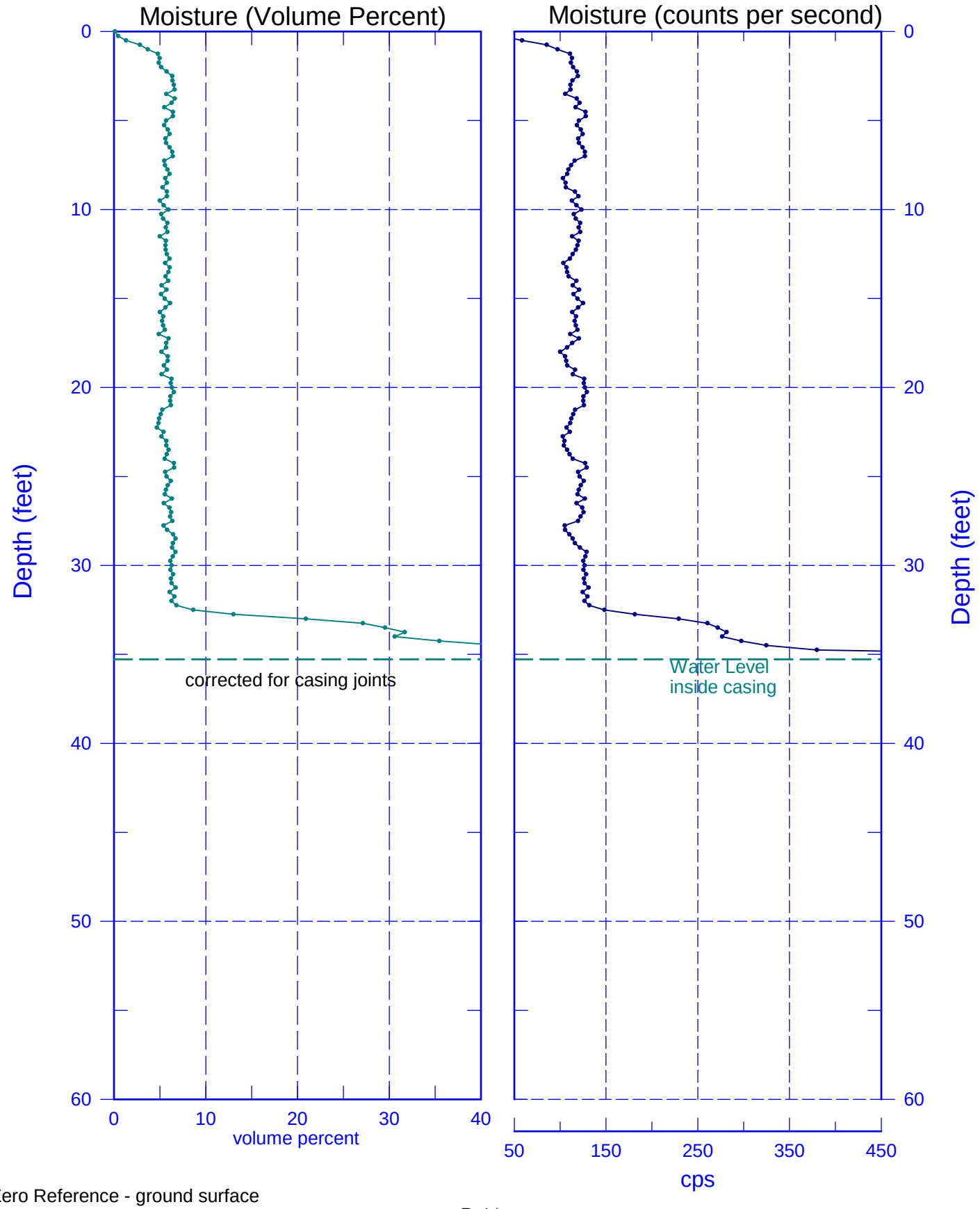
Bay West
Customer-Focused Environmental & Industrial Solutions

699-71-24 (C9872) Combination Plot



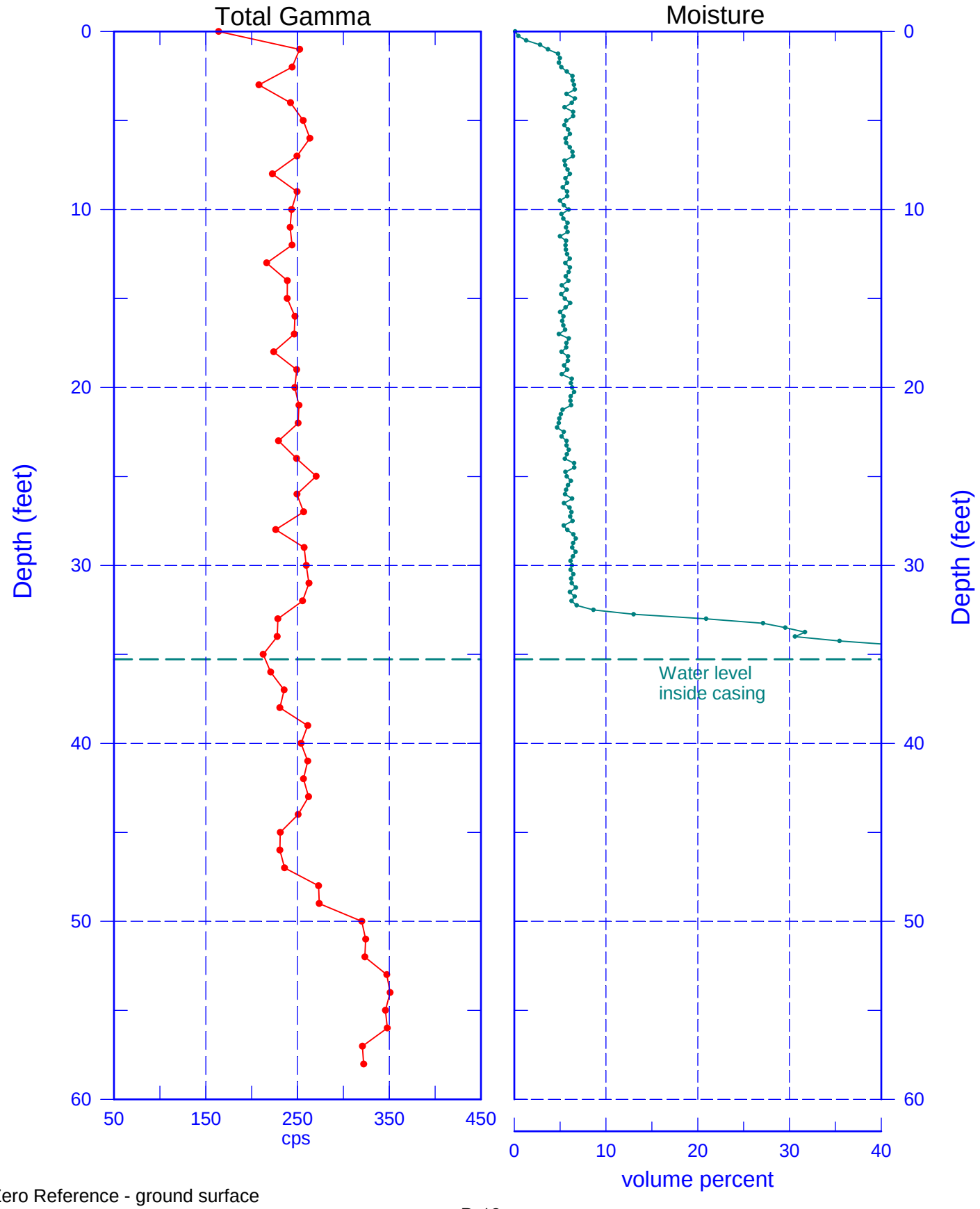
699-71-24 (C9872)

Moisture



Zero Reference - ground surface

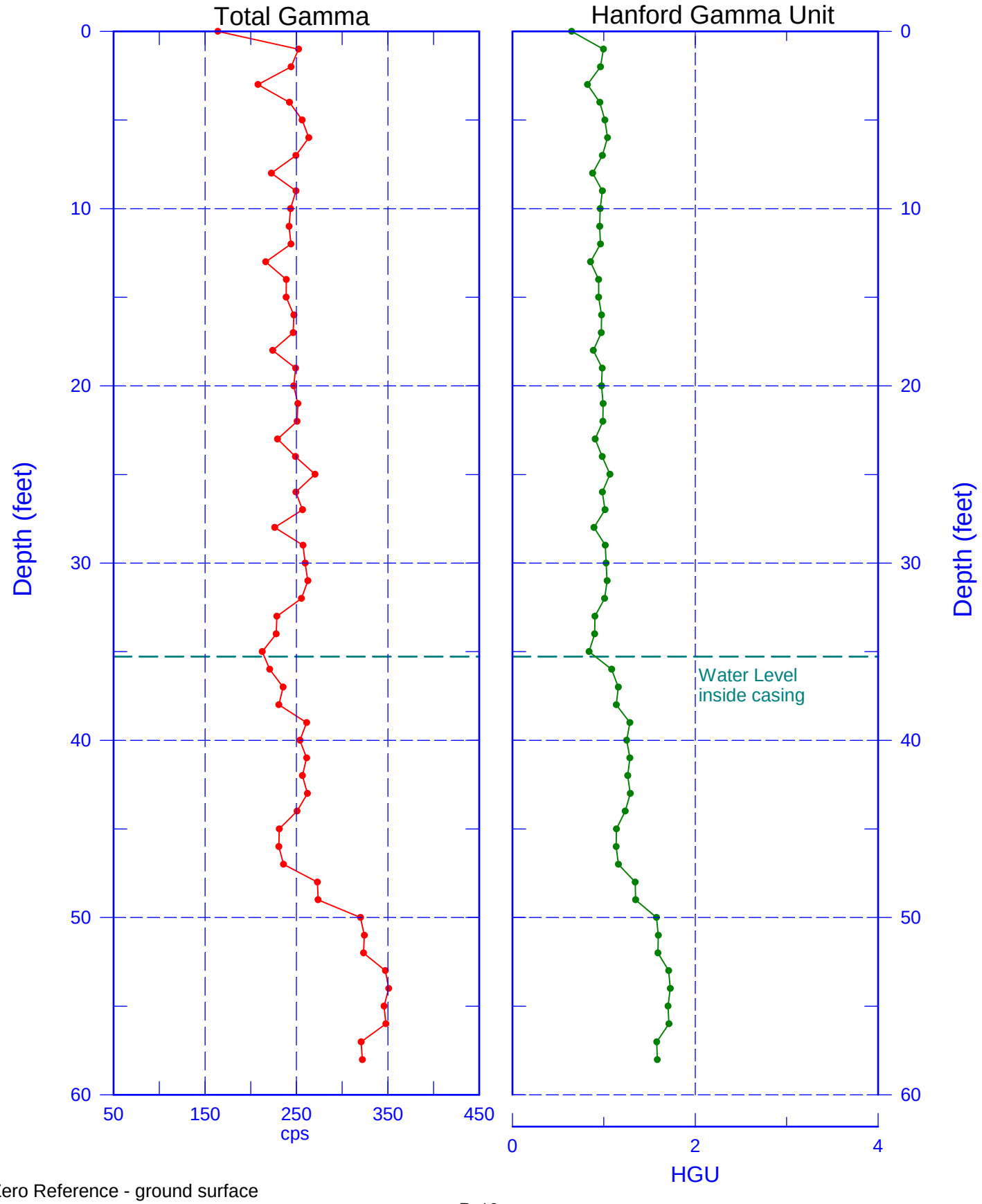
699-71-24 (C9872)
Total Gamma & Moisture



Zero Reference - ground surface

699-71-24 (C9872)

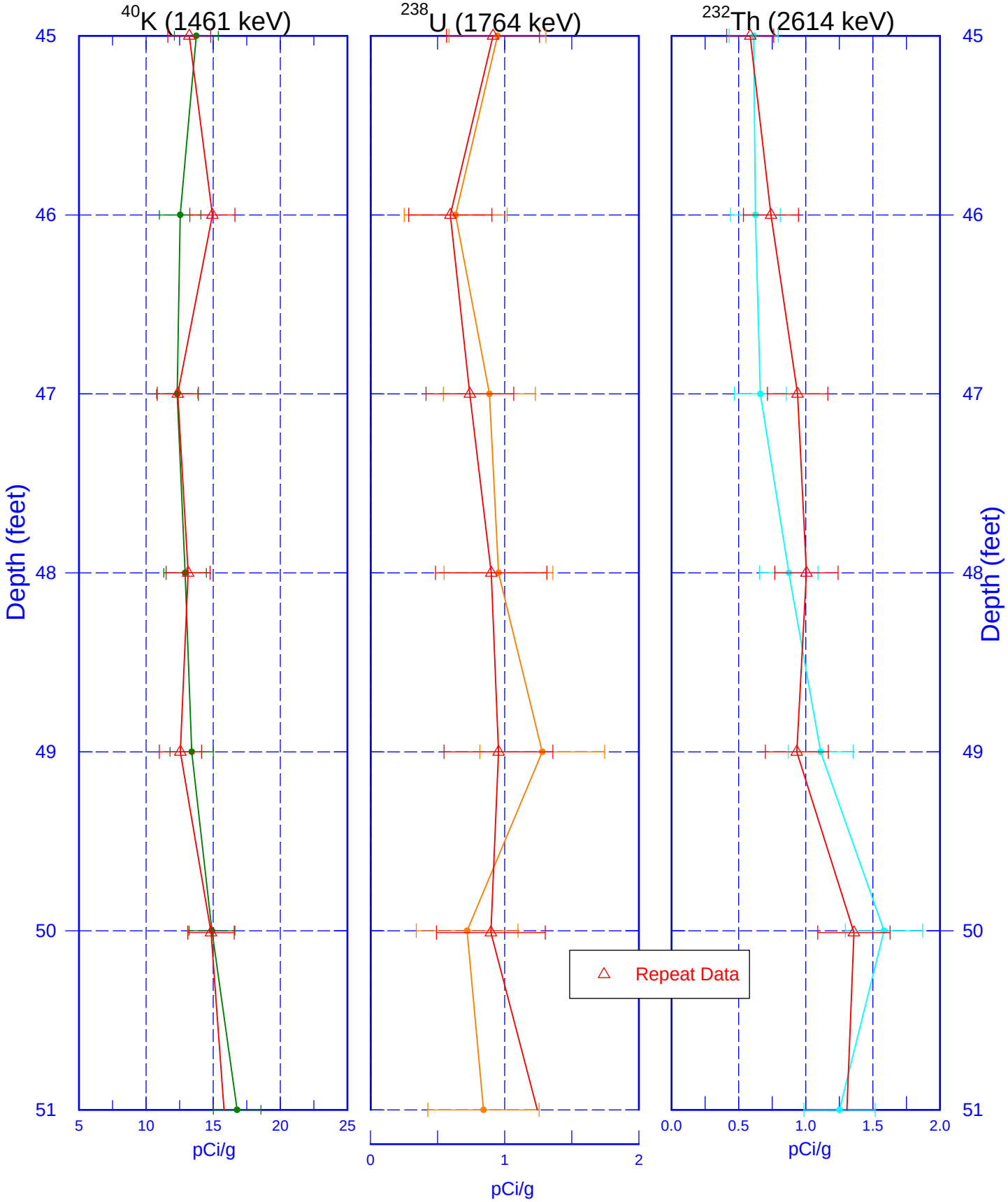
Total Gamma & Hanford Gamma Unit



Zero Reference - ground surface

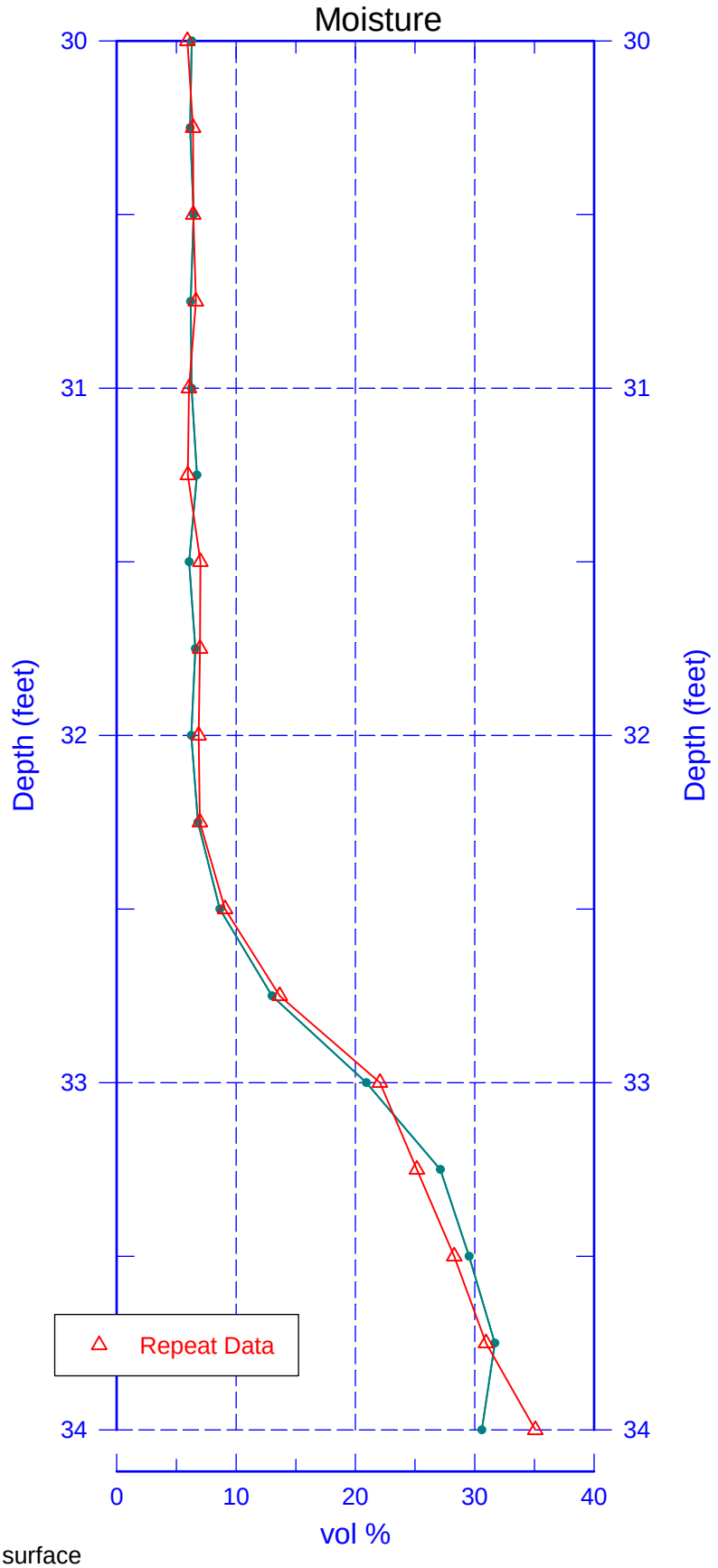
699-71-24 (C9872)

Repeat Section of Natural Gamma Logs



Zero Reference - ground surface

699-71-24 (C9872)
Moisture Repeat Section



Zero Reference - ground surface

This page intentionally left blank.

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 08/20/19	Requestor: James D. Mehrer (CHPRC)
Date of Survey: 10/03/19	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of FR-3 Well C9872 (699-71-24) located South of 100F 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:

L324 (COE) and Bleakley Azimuth (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9872	699-71-24	582414.97	145086.96		Center of Casing
				122.671	Top Inner 4"Casing, N.Edge
				122.930	Top Outer Casing,N.Edge Stamped "X"
				122.207	Brass Survey Marker

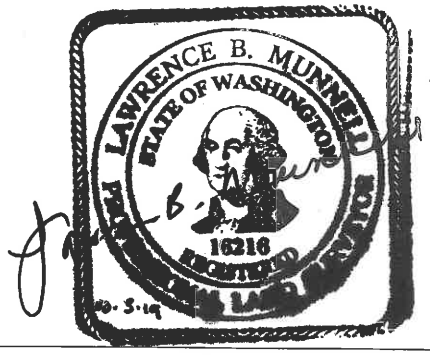
Notes:

Brass Survey Marker elevation was taken on top south edge of flat 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.



This page intentionally left blank.

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9872 | Well Name: 699-71-24 | Date: 08/15/19

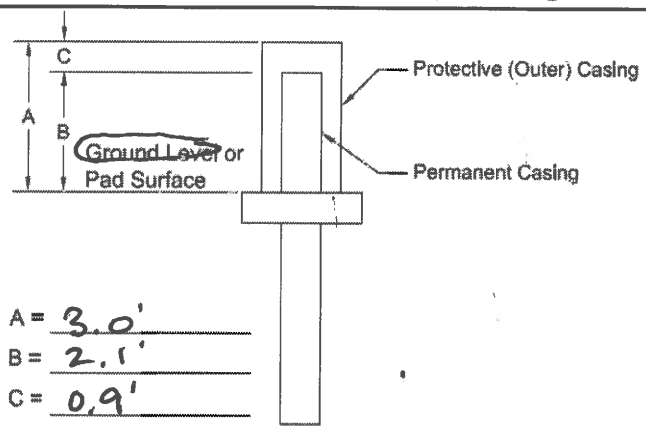
Location: ~3 km SE of F reactor

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: 08/08/19	33.4' bgs	33.2' bgs
Date: —	—	—
DEPTH TO BOTTOM:		
Date: 08/08/19	47.05' bgs	47.1' bgs
Date: —	—	—



A = 3.0'
B = 2.1'
C = 0.9'

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)
36.7	1.95	3.2	4.01	3.12	1308	1405	6.0	3.08

NOT USED 08/27/2019

NOT USED 08/27/2019

Total Pumped: 342 gallons

Pump Model: ~~Redw 9/22/19 In Situ~~ Grundfos model 96160180, 1 HP, 240volt

Troll Serial Number and Pressure Range (PSI and depth): 403065, In-situ Levelroll 700 70m/231 10 403065

Comments:

C9872 develop 8-8-19
bgs = Below ground surface

Prepared By:

Ellen Whitney — *Print Name* | [signature] — *Signature* | 08/22/2019 — *Date*

Reviewed By:

Jennifer Richart — *Print Name* | J. L. Richard — *Signature* | 9/4/19 — *Date*

For Office Use Only

OR Doc Type: | WMU Code(s):

A-6005-205 (REV 2)

This page intentionally left blank.

C9872 Archive Photos

0-5 ft bgs

5-10 ft bgs

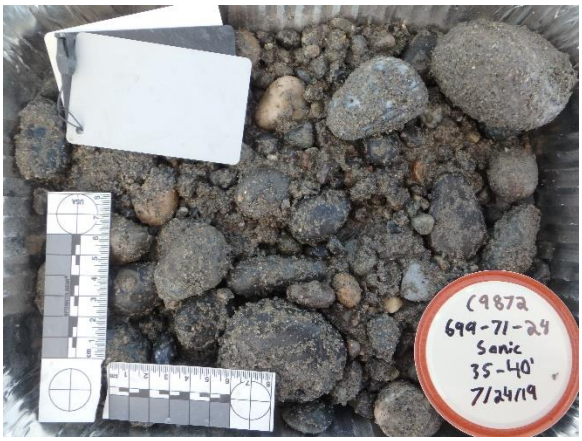
10-15 ft bgs

15-20 ft bgs

20-25 ft bgs

25-30 ft bgs

30-35 ft bgs



35-40 ft bgs

40-45 ft bgs

45-47 ft bgs

47-50 ft bgs

50-55 ft bgs

55-58 ft bgs

This page intentionally left blank.

Appendix E

Well Documentation for 699-71-30B (C9876)

- Well Summary Sheet for C9876
- Borehole Log for C9876
- Geophysical Log Data Report for C9876
- Well Survey Data Report for C9876
- Well Development and Testing Data Sheet C9876
- Archive Photo Log for C9876

This page intentionally left blank.

WELL SUMMARY SHEET

Page 1 of 1

Well ID: C9876	Well Name: 699-71-30B	Start Date: 07/18/2019
Project: Installation of 6+1 Wells 100-FR-3	Location: ~2.5 km S of F reactor	End Date: 08/06/2019

CONSTRUCTION DATA

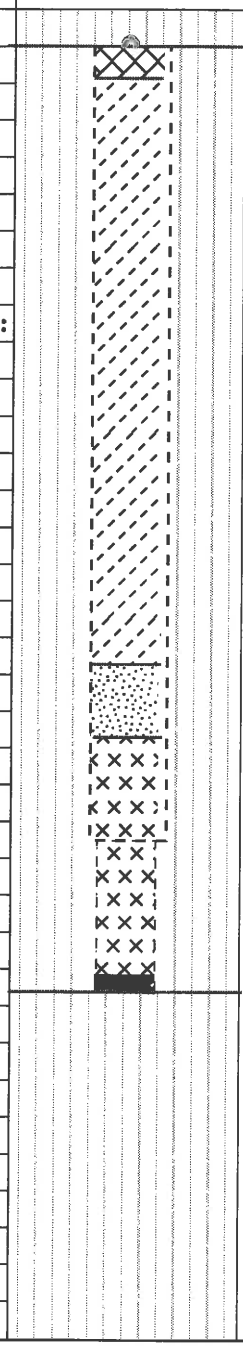
Surface Construction:
Concrete to Surface with Brass Survey Marker

Temporary Casing Depths:
8" Carbon Steel Thd. joints= 43.2 ft bgs

Borehole Decommissioning Materials:
High Strength Concrete:
0.0 ft bgs- 1.6 ft bgs
Granular Bentonite:
1.6 ft bgs - 28.5 ft bgs
Colorado Silica Sand 12/20#
28.5 ft bgs - 37.2 ft bgs
Bentonite Pellet Seal
37.2 ft bgs - 51.0 ft bgs
Natural Fill
51.0 ft bgs - 51.4 ft bgs

Note:
All 8" temporary casing and 4" stainless well casing has been completely removed from the ground.
Borehole was decommissioned due to a lack of water in the well.

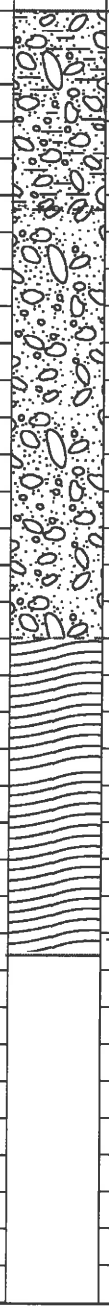
Diagram



GEOLOGIC/HYDROLOGIC DATA

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

Graphic Log



Lithologic Description (ft bgs)

0-11 ft bgs: Silty Sandy Gravel (msG)

11-34 ft bgs: Sandy Gravel (sG)

34- 51.4 ft bgs: Clay (M)

Total Depth = 51.4 ft bgs

Reported By: Ellen Whitney (Print Name)	Staff Geologist (Title)	(Signature)	08/26/2019 (Date)
Reviewed By: Jennifer Richart (Print Name)	Well Coordinator (Title)	(Signature)	9/5/19 (Date)

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

This page intentionally left blank.

BOREHOLE LOG

Page 1 of 2

Date: 07/18/2019

Well ID: C9876 | Well Name: 699-71-30B | Location: ~2.5 Km S of F reactor

Project: The Installation of 6+1 wells in the 100-FR-3 GU. | 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'-11' bgs Silty Sandy Gravel (mG)	Sonic rig, 8" casing
			@ 5ft: 70% Gravel, 15% Sand, 15% Silt. Gravel 2mm-90mm avg 12mm Moderately sorted, rounded to subangular, 60% F/40% M. Sand: Dry, very fine to very coarse sand, moderately sorted, 2.5Y, 6/2 light brownish gray, strong rxn to HCL, mostly sub angular. Silt same color and HCL rxn.	6" core barrel
5	grab sample 07/18/19			Archive @ 5ft bgs
10	grab sample 07/18/19		@ 10ft: Dry, all same as above.	Archive @ 10ft bgs
			11'-34' bgs Sandy Gravel (sG) @ 11ft Slightly damp. 65% Gravel 35% Sand. Gravel 2mm-85mm avg 12mm. Moderately sorted, rounded to subangular, 60% F 40% M. Sand: 2.5Y 5/2 grayish brown. Med to coarse sand, higher content of mafics, from none obvious to ~40% M (in sand). No HCL rxn.	
15	grab sample 07/18/19			Archive @ 15ft bgs
20	grab sample 07/18/19		@ 15ft Mostly dry. Color change back to 2.5Y 6/2, light brownish gray, v fine to v coarse sand. Strong rxn to HCL, similar to 5-10ft but f sand instead of silt.	Archive @ 20ft bgs
25	grab sample 07/18/19		@ 20ft Dry. Gravel poorly sorted 2mm-130mm. All else the same.	Archive @ 25ft bgs
30 H_2O tagged 07/18/19	grab sample 07/18/19		@ 25ft 60% Gravel, 30% Sand, 10% Silt. Gravel same as above, Sand and silt same as above. Moderate HCL rxn.	Archive @ 30ft bgs; H_2O tagged @ 30.5ft bgs
	grab sample			Archive @ 34' bgs

Reported By: 07/18/19

Print Name	Title	Signature	Date
Ellen Whitney	Geologist		07/18/2019

Reviewed By:

Print Name	Title	Signature	Date
Sarah Springer	Sr. Geologist	Sarah Springer	07-24-2019

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Date: 07/18/2019

Well ID: C9876 | Well Name: 699-71-30B | Location: ~2.5 km S of F reactor

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			@ 30 ft: Damp 60% Gravel, 40% Sand. Mild HCL rxn. All else the same.	Sonic rig, 8" casing 6" core barrel
			@ 34 ft: All stays the same.	
			34' - 46.6' bgs Clay (M)	
40	grab sample 07/18/19		@ 40' bgs: 100% Silt, no rxn to HCL, 2.5Y 5/2 grayish brown. Plasticity high.	Archive @ 40 ft bgs
			@ 41' - 43' Caliche present, vigorous rxn to HCL.	
45	grab sample 07/18/19		@ 44' all stays the same. No Caliche here.	Archive @ 44 ft bgs
	TD 07/18/19			TD @ 46.6 ft bgs
50				
55				
60				
65				
70				

Reported By:

Ellen Whitney — Print Name

Geologist — Title

Signature

07/18/2019 — Date

A-6006-993 (REV 0)

699-71-30B (C9876)
Log Data Report

Borehole Information

Log Date	2019-07-22	Filename	C9876_HG-NM_2019-07-22	Site	100-FR-3
DTW[1] (ft)	**DTW Date**	**DTW Source**	**Drill Date**	**Total Depth (ft)**	**Depth Datum**
45.9	07/22/19	Bay West	07/18/19	46.6	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded steel	Sonic	TC[2]	8.1	7.58	0.26	0.2 AGS[3]	42.9

Borehole Notes

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing using a dial gauge and circumference tape. The maximum logging depth achieved was 45 ft, approximately 2 ft below the casing. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma FTB	**Type**	60% Coaxial HPGe (SGLS)[4]
Effective Calibration Date	12/12/2018	**Serial No.**	47-TP-32211A
Calibration Reference	HGLP-CC-180, Rev. 0	**Logging Procedure**	SGRP-PRO-OP-53023, Rev. 0, Change 2

Logging System	Gamma 5PB	**Type**	He-3 (CPN 503DR) NMLS[5]
Effective Calibration Date	12/12/2018	**Serial No.**	H34055445
Calibration Reference	HGLP-CC-177, Rev. 0	**Logging Procedure**	SGRP-PRO-OP-53024, Rev. 0, Change 2

SGLS Log Run Information

Log Run	1	2 Repeat		
HEIS Number	1021200	1021201		
Date	07/22/19	07/22/19		
Logging Engineer	Spatz	Spatz		
Start Depth (ft)	0.0	31.0		
Finish Depth (ft)	45.0	36.0		
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)	NA	NA		

[1] depth to water inside casing
[2] Temporary casing
[3] Above ground surface
[4] Spectral Gamma Logging System
[5] Neutron Moisture Logging System

Log Run	1	2 Repeat		
Pre-Verification	C9876FTB20190722AV00CAB1	C9876FTB20190722AV00CAB1		
Start File	AD000000	BD003100		
Finish File	AD004500	BD003600		
Post-Verification	C9876FTB20190722BV00CAA1	C9876FTB20190722BV00CAA1		
Depth Return Error (in.)	N/A	0.0		
Comments	None	None		

NMLS Log Run Information

Log Run	3	4 Repeat			
HEIS Number	1021202	1021203			
Date	07/22/19	07/22/19			
Logging Engineer	Spatz/McClellan	Spatz/McClellan			
Start Depth (ft)	0.0	30.25			
Finish Depth (ft)	45.0	35.25			
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	C9876FPB20190722AV00CAB1	C9876FPB20190722AV00CAB1			
Start File	AD000000	BD003025			
Finish File	AD004500	BD003525			
Post-Verification	C9876FPB20190722BV00CAA1	C9876FPB20190722BV00CAA1			
Depth Return Error (in.)	N/A	1.5 high			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on the sondes. Verification measurements passed the acceptance criteria.

Analysis Notes

Analyst	P.D. Henwood	Date	09/11/19
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

A casing correction for a 0.26-in. thick casing was applied to the SGLS log data; no additional correction was made for the thick casing joints.

No water correction was applied as water inside the casing was below the maximum logging depth.

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 FTB20181212 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

Casing diameter and thickness corrections for 0.26-in. thick, 8.1-in. OD casing were applied to the NMLS data acquired through the sonic casing. Integrated with the casing diameter and thickness corrections is an initial count rate correction for a sediment composition of a 50-50% ratio of basalt fragments to quartz sand (HGLP-OTH-028).

NMLS data are reported in counts per second for the entire length of the borehole. NMLS data are also reported in vol% moisture. Conversions from count rate to vol% moisture were performed using an EXCEL template identified as FPB_Cascade_Sonic_MCNP_assay. This template also provides corrections for the thick casing joints typical of sonic drill casings.

HGU[6] 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 generally increases as the sediment becomes more fine-grained. For example, moisture content would be expected to be greater near the top of a fining upward Hanford flood sequence.

The measured depth to water was at the time of logging. It appears static water may be at approximately 34 ft.

Thickened casing joints occur at 5 and 10 ft intervals beginning at approximately 2 ft in depth. No corrections have been made for the joints for the SGLS although corrections for moisture have been made.

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

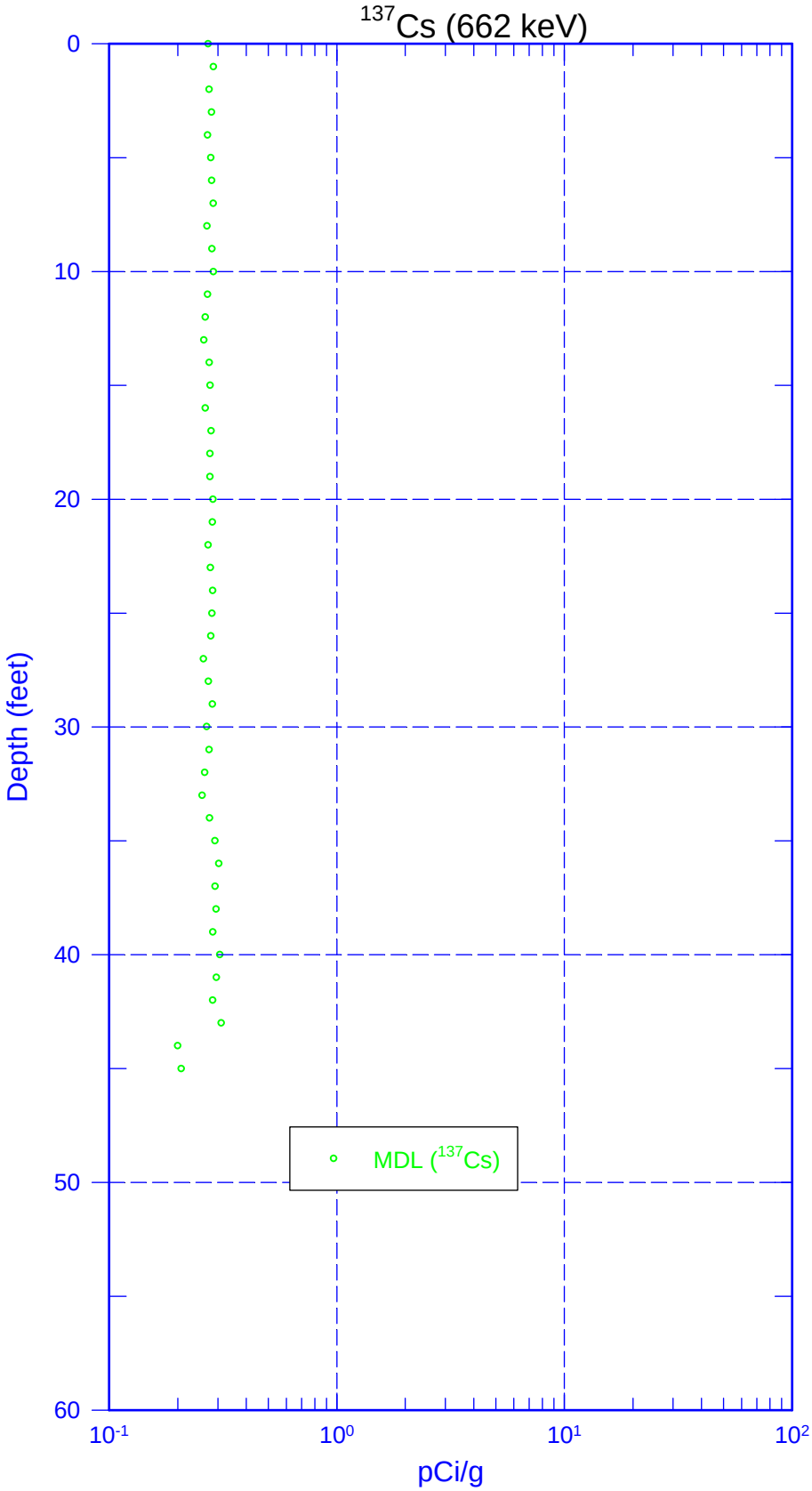
List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-60 ft)
Natural Gamma Logs (0-60 ft)
Combination Plot (0-60 ft)
Moisture (0-60 ft)
Total Gamma & Moisture (0-60 ft)
Total Gamma & Hanford Gamma Unit (0-60 ft)
Repeat Section of Natural Gamma Logs (31-36 ft)
Moisture Repeat Section (30-36 ft)

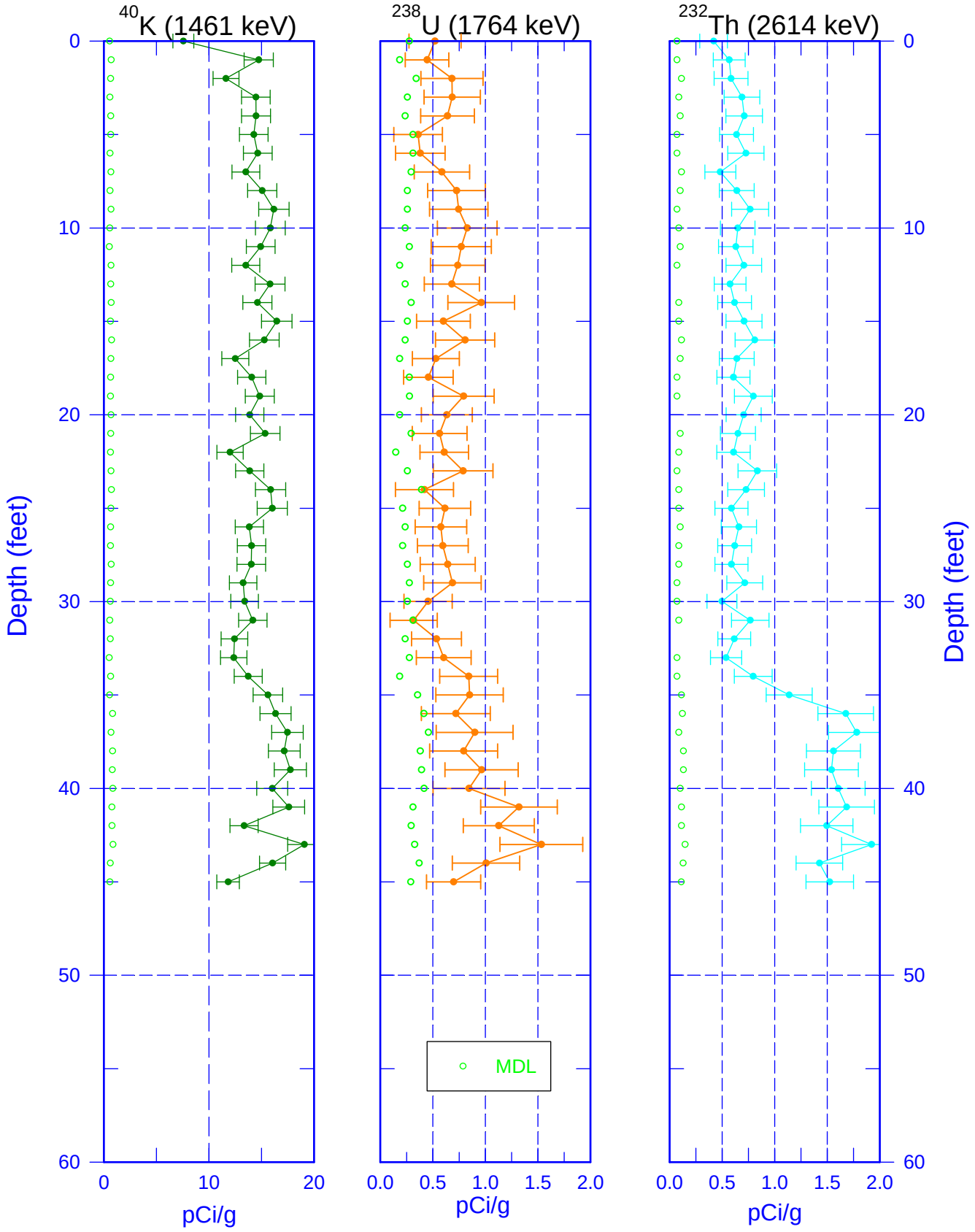
[6] Hanford Gamma Unit

699-71-30B (C9876)
Manmade Radionuclides



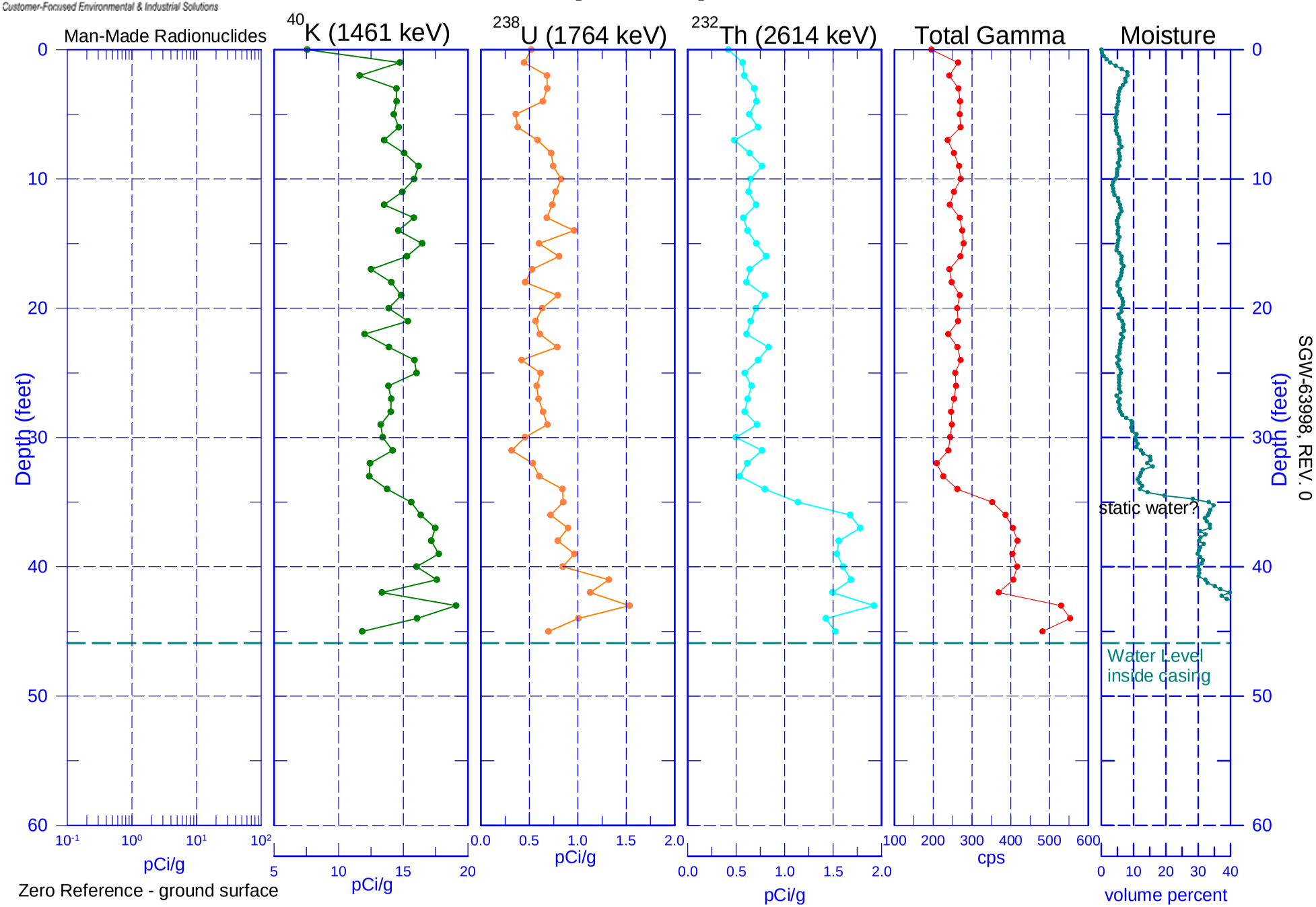
Zero Reference - ground surface

699-71-30B (C9876)
Natural Gamma Logs



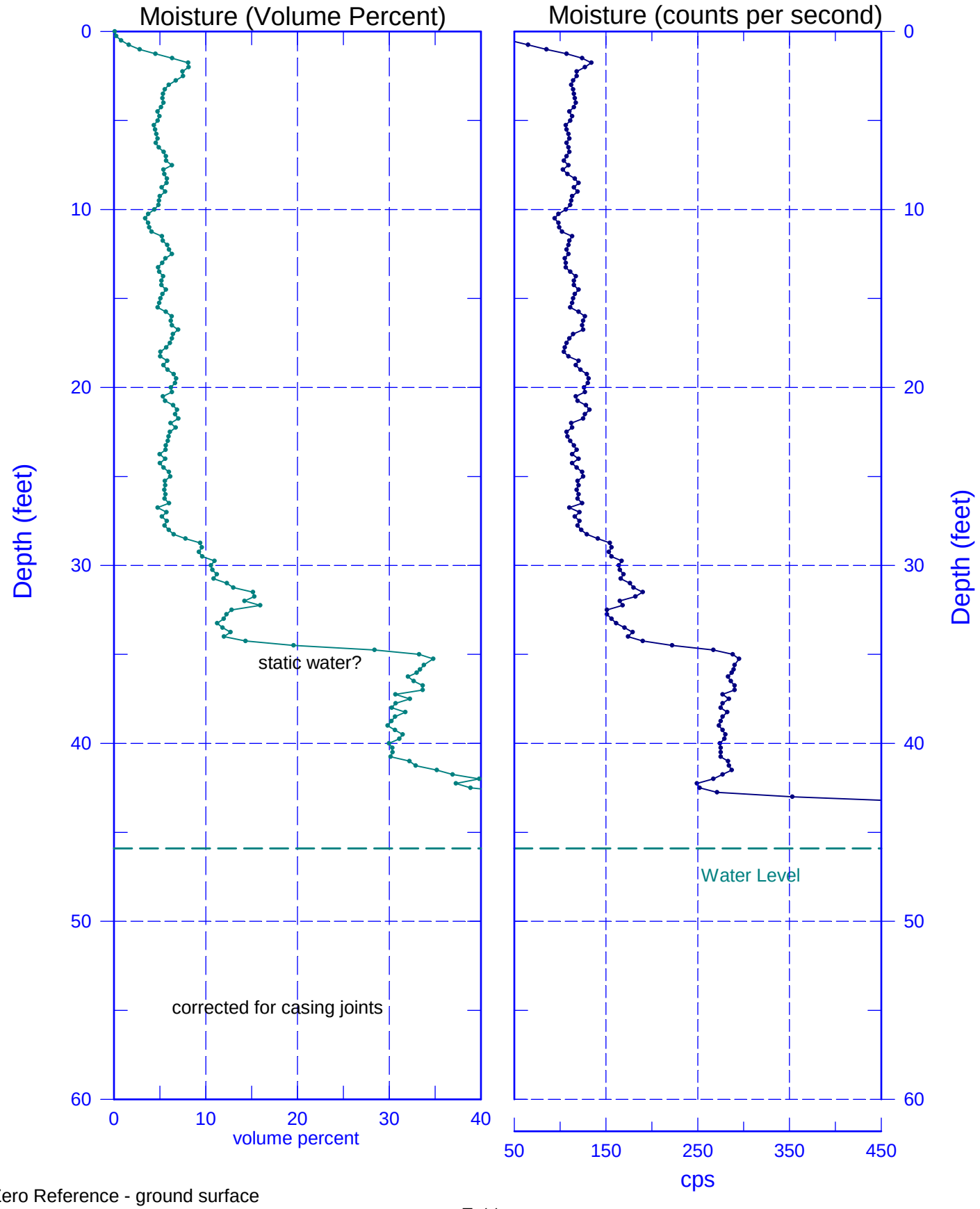
Zero Reference - ground surface

699-71-30B (C9876) Combination Plot



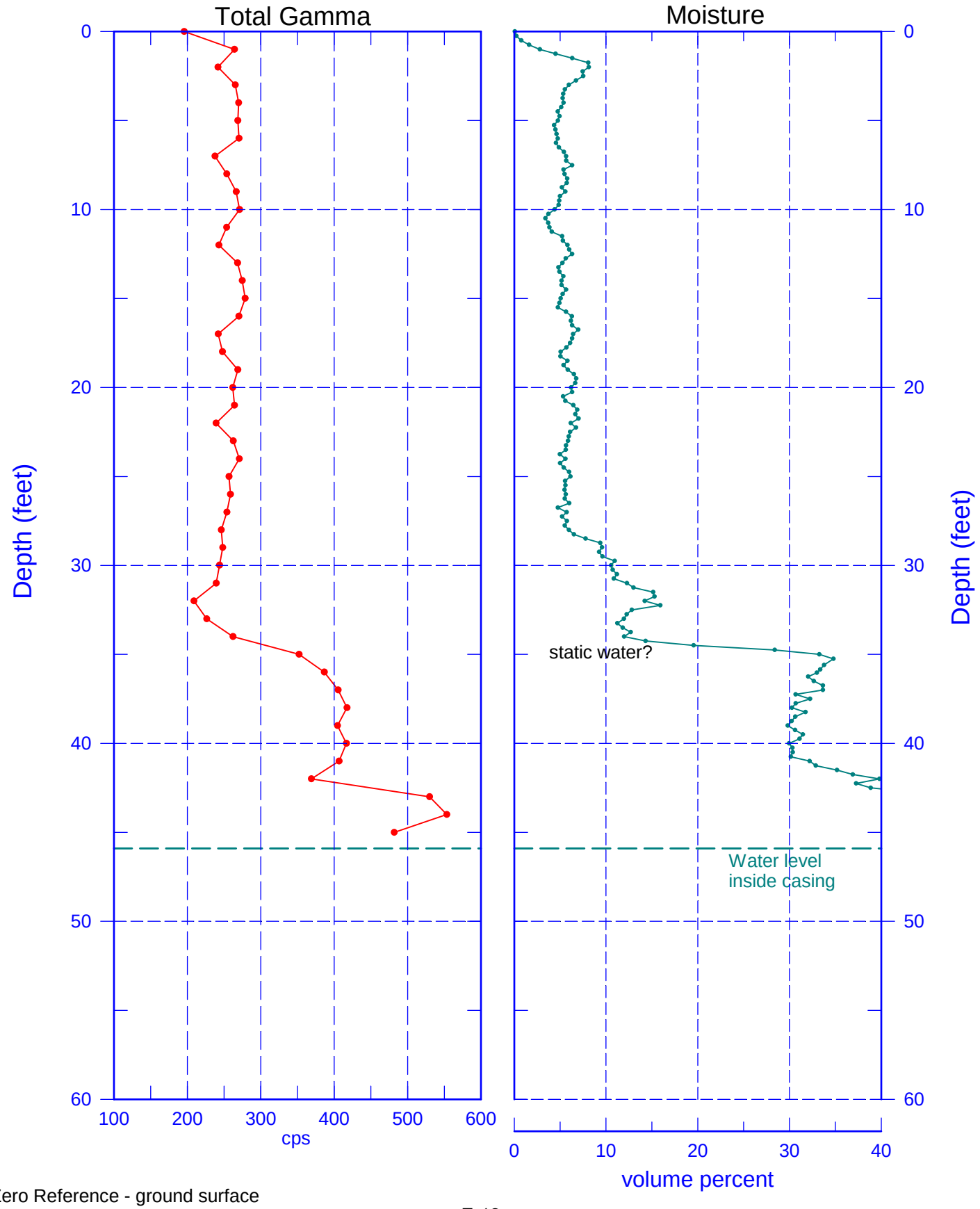
699-71-30B (C9876)

Moisture



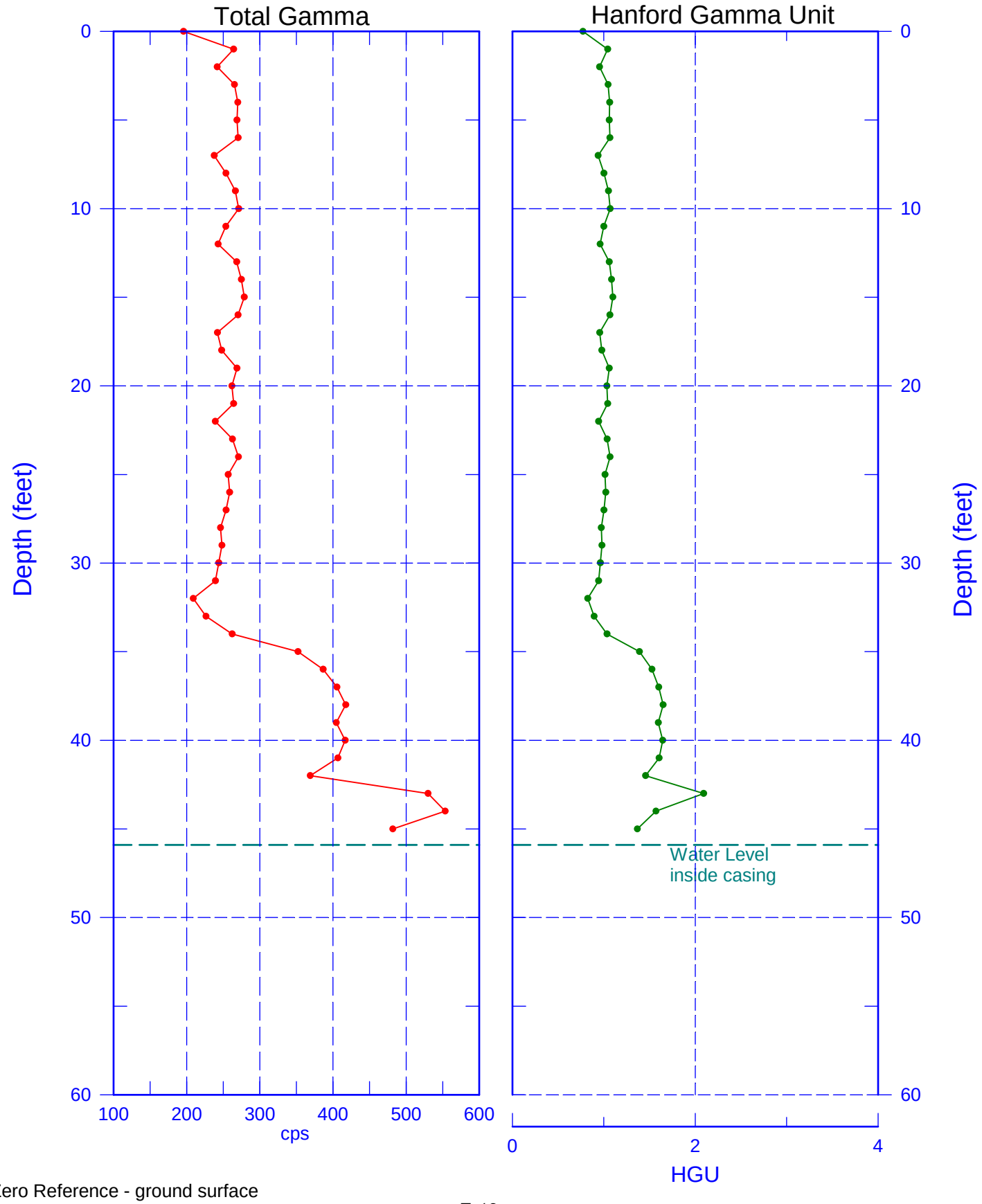
Zero Reference - ground surface

699-71-30B (C9876)
Total Gamma & Moisture



Zero Reference - ground surface

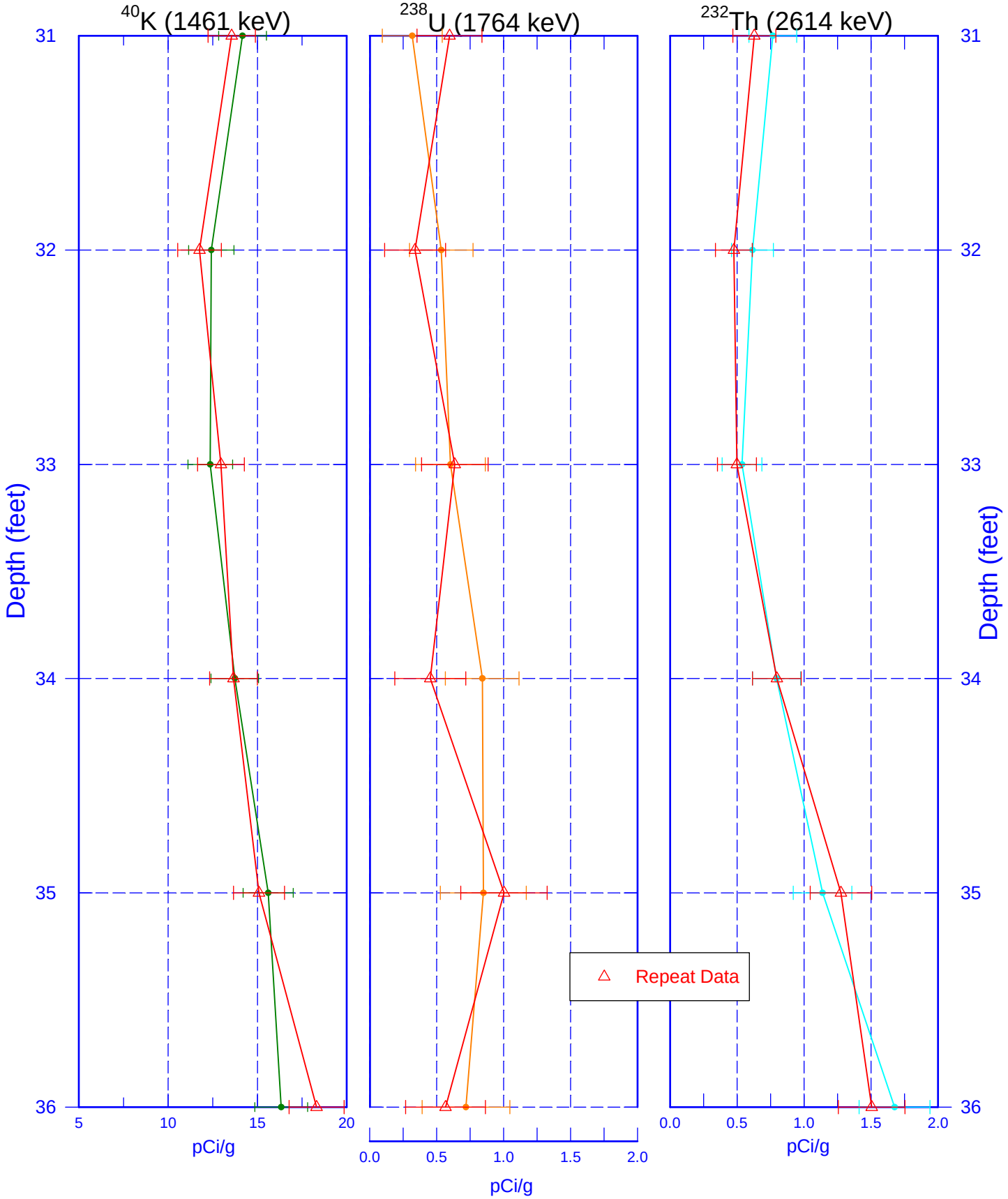
699-71-30B (C9876)
Total Gamma & Hanford Gamma Unit



Zero Reference - ground surface

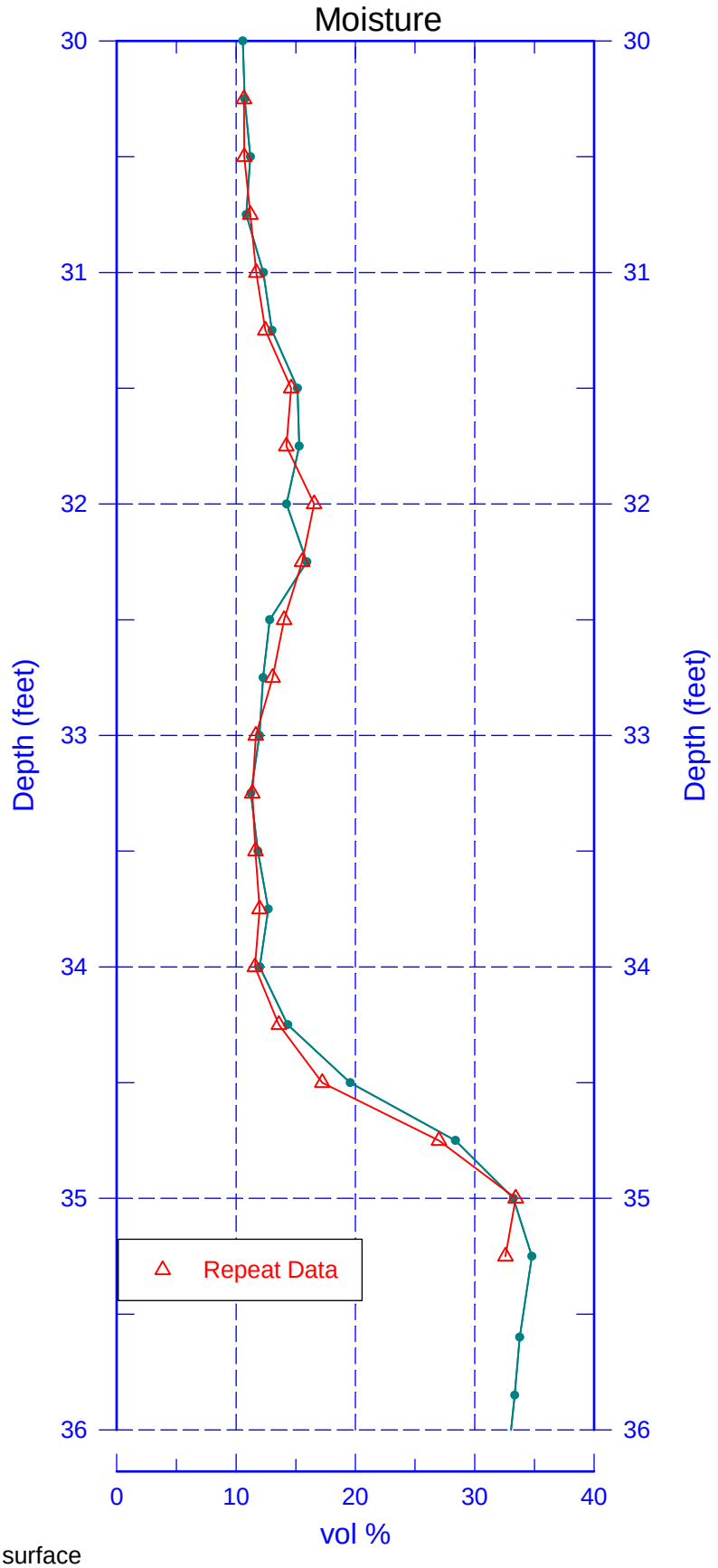
699-71-30B (C9876)

Repeat Section of Natural Gamma Logs



Zero Reference - ground surface

699-71-30B (C9876)
Moisture Repeat Section



Zero Reference - ground surface

This page intentionally left blank.

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 08/20/19	Requestor: James D. Mehrer (CHPRC)
Date of Survey: 10/03/19	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates and elevation of Brass Cap Marker for decommissioned 100-FR-3 Well C9876 (699-71-30B) located south of 100F 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:
Washington State Reference Network

Well ID	Well Name	Easting	Northing	Elevation	
C9876	699-71-30B	580710.85	145242.64	122.84	Brass survey marker

Notes:

Equipment Used: Trimble R8 RTK GPS

Surveyor Statement:

This page intentionally left blank.

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9876	Well Name: 699-71-30B	Date: 8/28/19

Location: ~2.5 km S of F Reactor

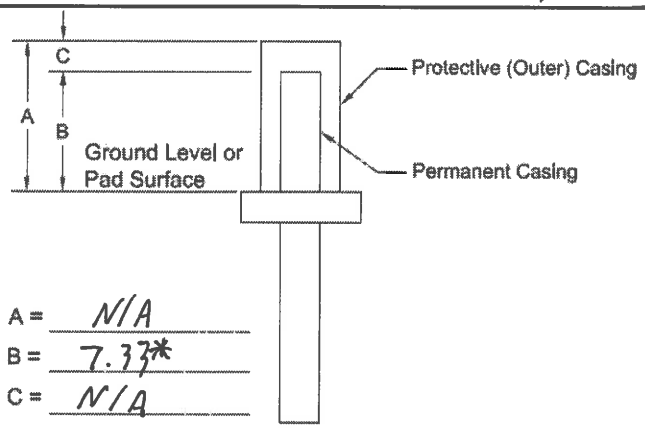
Reference Measuring Point *(unless otherwise noted)*: TOP OF OUTER CASING (TOC)

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: 7/31/19	29.72' bgs	N/A
Date: —	—	—
DEPTH TO BOTTOM:		
Date: 7/31/19	37.28' bgs	N/A
Date: —	—	—



A = N/A
B = 7.33*
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)
33.95	2.05	32.85	18.7	4.81	1028	1134	5.0	2.44

Not Used 8/28/19

Total Pumped: 330 gal

Pump Model: Grundfos 96160180 240v 1HP

Troll Serial Number and Pressure Range (PSI and depth): In-Situ Levelltroll 700 S/N403065, range: 70m/231 ft/ 99.6 PSI

Comments: bgs = below ground surface

File name: C9876-develop-7-31-19

* Hole & well were decommissioned, stickup was 7.33' during development. All temp & permanent casing was removed during decommissioning

Prepared By:

Dan Charbonneaux — Print Name | Signature | 8/28/19 Date

Reviewed By:

Jennifer Richart — Print Name | Signature | 9/3/19 Date

For Office Use Only

OR Doc Type:	WMU Code(s):

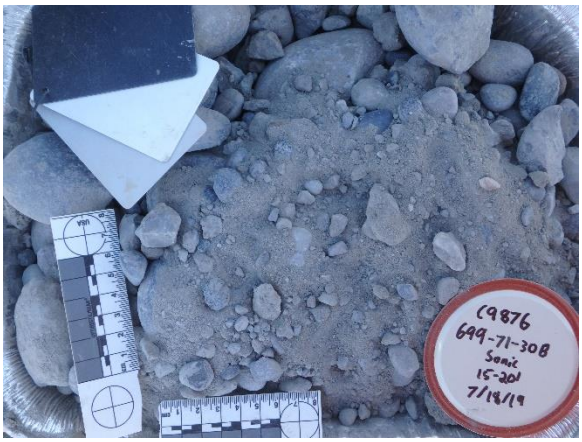
This page intentionally left blank.

C9876 Archive Photos

0-5 ft bgs

5-10 ft bgs

10-15 ft bgs



15-20 ft bgs

20-25 ft bgs

25-30 ft bgs (collected 7/18/19)

30-34 ft bgs (collected 7/18/19)

34-40 ft bgs

Appendix F

Well Documentation for 699-71-30C (D0130)

- Well Summary Sheet for D0130
- Borehole Log for D0130
- Geophysical Log Data Report for D0130
- Well Survey Data Report for D0130
- Well Development and Testing Data Sheet D0130
- Archive Photo Log for D0130

This page intentionally left blank.

WELL SUMMARY SHEET

Well ID: D0130	Well Name: 699-71-30C	Start Date: 08/06/2019
Project: Installation of 6+1 Wells 100-FR-3	Location: ~2.5 km S of F reactor	End Date: 08/07/2019

CONSTRUCTION DATA

Description

WA Ecology Well Tag: BLD023

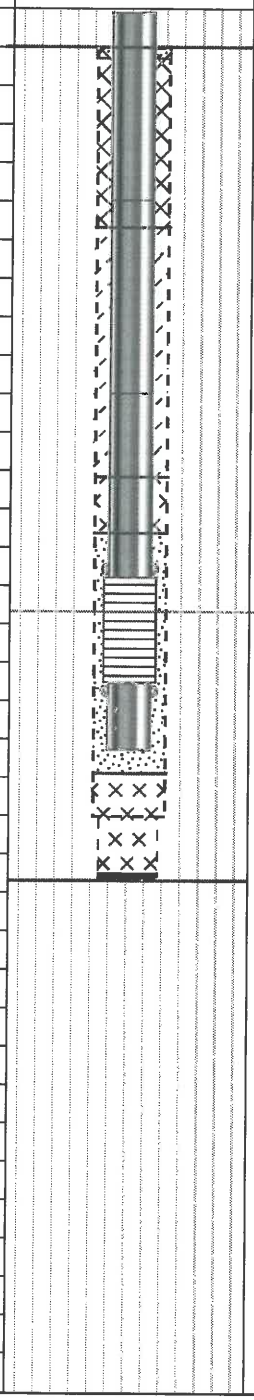
Surface Construction:
4'x4'x6" Concrete pad with brass survey marker and protective monument

Temporary Casing Depths:
8" Carbon Steel Thd. joints = 37.9 ft bgs

Permanent Well Materials:
4.5" OD TP-304 Sch 10s Riser:
1.90 ft ags - 28.10 ft bgs
4.875" OD TP-304 20-slot (0.020")
Screen: 28.10 ft bgs - 33.11 ft bgs
4.5" OD TP-304 Sch 10s End Cap
33.11 ft bgs - 36.34 ft bgs

Well Construction Materials:
High Strength Concrete:
0.0 - 0.6 ft bgs
Type I/II Portland Cement:
0.6 ft bgs - 9.9 ft bgs
Granular Bentonite:
9.9 ft bgs - 22.5 ft bgs
Bentonite Pellet Seal
22.5 ft bgs - 25.0 ft bgs
Colorado Silica Sand 12/20#
(Primary Filter Pack):
25.0 ft bgs - 38.0 ft bgs
Bentonite Pellet Backfill:
38.0 ft bgs - 43.1 ft bgs
Natural Fill:
43.1 ft bgs - 43.4 ft bgs

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet

Lithologic Description (ft bgs)

0 - 33 ft bgs: Sandy Gravel (sG)

DTW= 29.4 ft bgs

33 - 43.4 ft bgs: Clay (M)

Total Depth = 43.4 ft bgs

Acronyms:
DTW = depth to water
ags = above ground surface
bgs = below ground surface

Note:
This well is a replacement well for the decommisioned C9876 well.
All 8" temporary casing has been removed from the ground.

Reported By:			
Ellen Whitney	Staff Geologist		08/26/2019
Print Name	*Title*	*Signature*	*Date*
Reviewed By:			
Jennifer Richart	Well Coordinator		9/4/19
Print Name	*Title*	*Signature*	*Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

This page intentionally left blank.

BOREHOLE LOG

Page 1 of 2

Date: 8/6/19

Well ID: D0130 | Well Name: 699-71-30C | Location: ~ 2.5km S of F-Reactor

Project: Installation of 6th Wells in the 100-FR-3 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 - 33' Sandy Gravel (SG) 5Y 5/2 Olive gray 60% Gravel, 40% sand. Gravel: 2mm - 9cm, Rounded to sub-angular (mostly rounded), mod. sorting, 55% M / 45% F. Sand: fine to medium, mod. sorting, sub-round to angular, 60% M / 40% F, strong rxn to HCl, dry.	Sonic rig, 6" core barrel, 8" casing
				Archive @ 5' bgs
5'	G.S. 8/6/19		6' DC 8/6/19 @ 8', percentages change: 65% Gravel, ~~75% sand~~ 30% sand, 5% silt DC 8/6/19, all else the same, silt: loose, nonplastic	
				Archive @ 10' bgs
10'	G.S. 8/6/19		@ 13', percentages change: 60% Gravel, 40% sand, sand now medium to coarse, damp from drillers adding water, weak HCl rxn, all else same, color change: 5Y 5/3 Olive	G.S. = grab sample <5 gal water added
15'	G.S. 8/6/19		@ 20', percentages change: 55% gravel, 35% sand, 10% silt. Sand now very fine to medium, all else same. Silt: loose, nonplastic, slightly damp from drillers adding water	Archive @ 15' bgs <5 gal water added
20'	G.S. 8/6/19		@ 27', percentages change: 70% gravel, 25% sand, 5% silt. Soil is very damp - saturated. Color: 5Y 4/1 Dark gray. all else the same.	Archive @ 20' bgs
25'	G.S. 8/6/19		DC 8/6/19 @ 33 - 43.41' ~~Clay~~ DC 8/6/19 silt (CM). 2.5Y 4/2 dark grayish brown 100% silt/clay. Massive, plastic, no HCl rxn, mostly clay, little silt, slightly damp.	Archive @ 25' bgs
H2O 8/6/19 30'	G.S. 8/6/19			H2O level 29.4' bgs 8/6/19 Archive @ 30' bgs
	G.S. 8/6/19			RUM @ 33' bgs Archive @ 33' bgs

Reported By:			
Dan Charboneau	Staff Geologist		8/6/19
Print Name	Title	Signature	Date
Reviewed By:			
Sarah Springer	Sr Geologist		08-27-19
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 2

Date:

Well ID: D0130 | Well Name: 699-71-30C | Location: ~2.5 Km S of F-Reactor

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'	G.S. 8/6/19		@37' bgs, more silt, less clay, semi-plastic, massive, veins of caliche present, soil color: 10Y 4/2 dark grayish olive, caliche color: 10YR 9.5/1 white	Archive @ 35' bgs Sonic rig, 6" core barrel, 8" casing
40'	G.S. 8/6/19			Archive @ 40' bgs
	G.S. 8/6/19			Archive @ 43' bgs
TD				TD @ 43.4' bgs

Reported By:

Print Name	Title	Signature	Date
Dan Charbonneau	Staff Geologist		6/6/19

A-6006-993 (REV 0)

699-71-30C (D0130)
Log Data Report

Borehole Information

Log Date	2019-08-07	Filename	D0130_HG-NM_2019-08-07	Site	100-FR-3
DTW[1] (ft)	**DTW Date**	**DTW Source**	**Drill Date**	**Total Depth (ft)**	**Depth Datum**
None	08/07/19	Bay West	08/06/19	43.4	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded steel	Sonic	TC[2]	8.1	7.58	0.26	2.58 AGS[3]	37.9

Borehole Notes

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing using a dial gauge and circumference tape. The maximum logging depth achieved was 40 ft, approximately two ft below the casing depth. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma FTB	Type	60% Coaxial HPGe (SGLS)[4]
Effective Calibration Date	12/12/2018	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-180, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0, Change 2

Logging System	Gamma 5PB	Type	He-3 (CPN 503DR) NMLS[5]
Effective Calibration Date	12/12/2018	Serial No.	H34055445
Calibration Reference	HGLP-CC-177, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0, Change 2

SGLS Log Run Information

Log Run	3	4 Repeat		
HEIS Number	1021235	1021236		
Date	08/07/19	08/07/19		
Logging Engineer	Spatz	Spatz		
Start Depth (ft)	0.0	32.0		
Finish Depth (ft)	40.0	38.0		
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)	NA	NA		

[1] depth to water inside casing
[2] Temporary casing
[3] Above ground surface
[4] Spectral Gamma Logging System
[5] Neutron Moisture Logging System

Log Run	3	4 Repeat		
Pre-Verification	D0130FTB20190807AV00CAB1	D0130FTB20190807AV00CAB1		
Start File	AD000000	BD003200		
Finish File	AD004000	BD003800		
Post-Verification	D0130FTB20190807BV00CAA1	D0130FTB20190807BV00CAA1		
Depth Return Error (in.)	N/A	0.5		
Comments	None	None		

NMLS Log Run Information

Log Run	1	2 Repeat			
HEIS Number	1021237	1021238			
Date	08/07/19	08/07/19			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0.0	26.0			
Finish Depth (ft)	38.0	32.0			
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	D0130FPB20190807AV00CAB1	D0130FPB20190807AV00CAB1			
Start File	AD000000	BD002600			
Finish File	AD003800	BD003200			
Post-Verification	D0130FPB20190807BV00CAA1	D0130FPB20190807BV00CAA1			
Depth Return Error (in.)	N/A	0.0			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on the sondes. Verification measurements passed the acceptance criteria. There was a discrepancy between the geologist's reported DTW of 29 ft and Bay West measurements that indicated no water inside the casing. Moisture logging was terminated at 38 ft, approximately at the reported casing depth.

Analysis Notes

Analyst	P.D. Henwood	Date	09/26/19
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

A casing correction for a 0.26-in. thick casing was applied to the SGLS log data; no additional correction was made for the thick casing joints.

No water correction was applied.

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 FTB20181212 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

Casing diameter and thickness corrections for 0.26-in. thick, 8.1-in. OD casing were applied to the NMLS data acquired through the sonic casing. Integrated with the casing diameter and thickness corrections is an initial count rate correction for a sediment composition of a 50-50% ratio of basalt fragments to quartz sand (HGLP-OTH-028).

NMLS data are reported in counts per second for the entire length of the borehole. NMLS data are also reported in vol% moisture. Conversions from count rate to vol% moisture were performed using an EXCEL template identified as FPB_Cascade_Sonic_MCNP_assay. This template also provides corrections for the thick casing joints typical of sonic drill casings.

HGU[6] 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 generally increases as the sediment becomes more fine-grained. For example, moisture content would be expected to be greater near the top of a fining upward Hanford flood sequence.

Just before logging, no water was inside the casing. It appears static water may be at approximately 29 ft which depth was reported by the geologist August 6.

Thickened casing joints occur at 5 and 10 ft intervals beginning at approximately 3 ft in depth. No corrections have been made for the joints for the SGLS although corrections for moisture have been made.

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

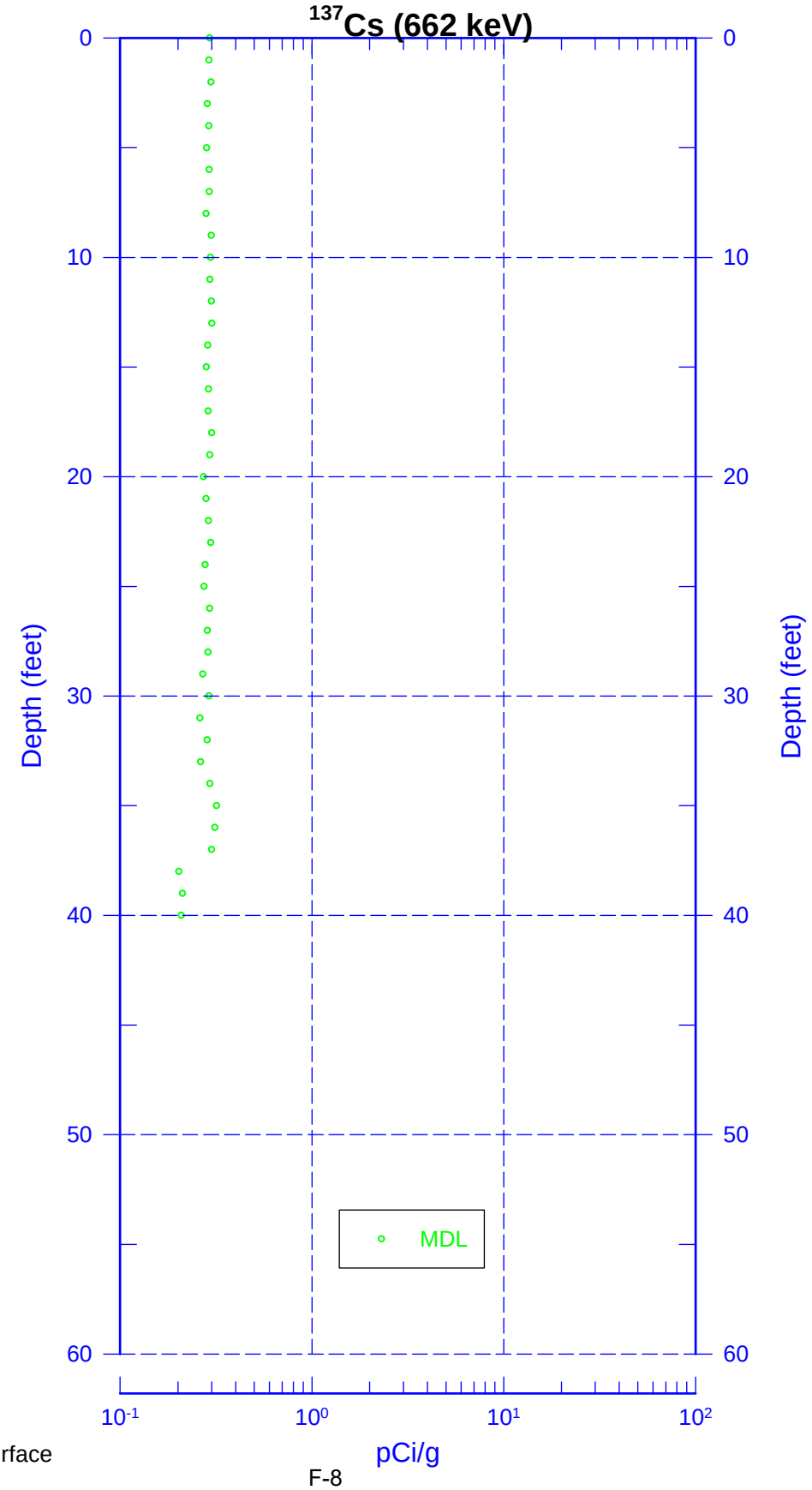
List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-60 ft)
Natural Gamma Logs (0-60 ft)
Combination Plot (0-60 ft)
Moisture (0-60 ft)
Total Gamma & Moisture (0-60 ft)
Total Gamma & Hanford Gamma Unit (0-60 ft)
Repeat Section of Natural Gamma Logs (32-38 ft)
Moisture Repeat Section (26-32 ft)

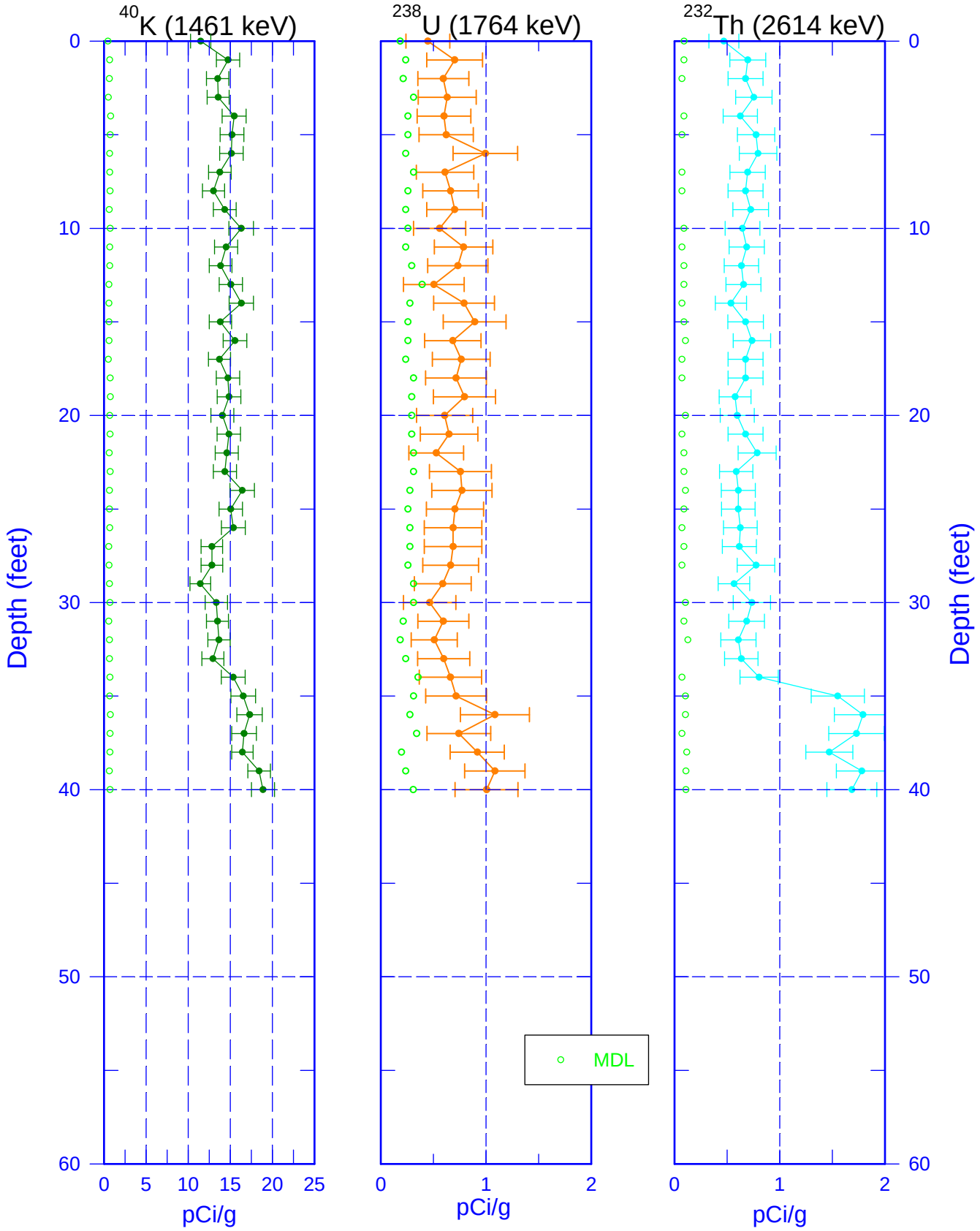
[6] Hanford Gamma Unit

699-71-30C (D0130)
Manmade Radionuclides



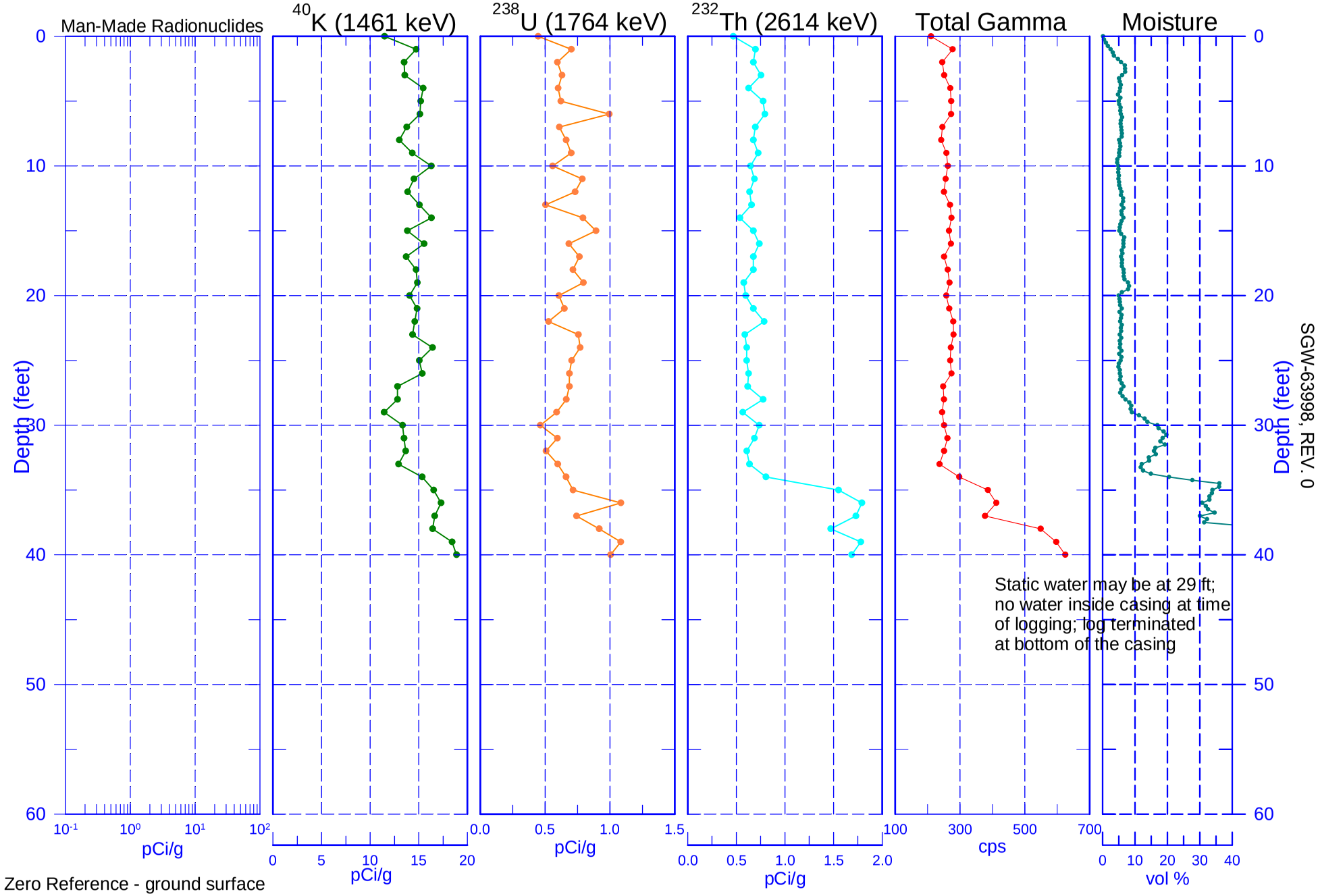
Zero Reference - ground surface

699-71-30C (D0130)
Natural Gamma Logs



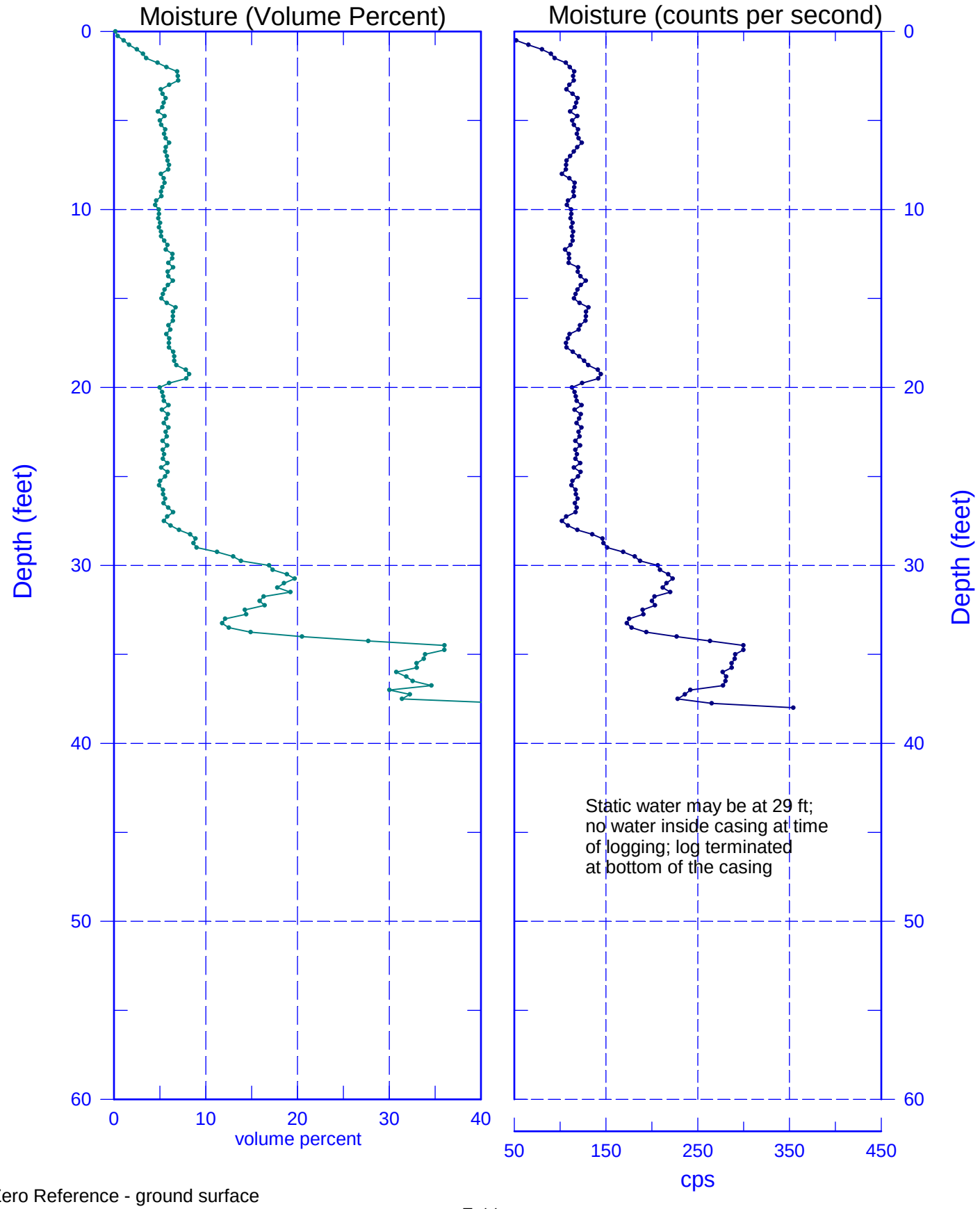
Zero Reference - ground surface

699-71-30C (D0130) Combination Plot



Zero Reference - ground surface

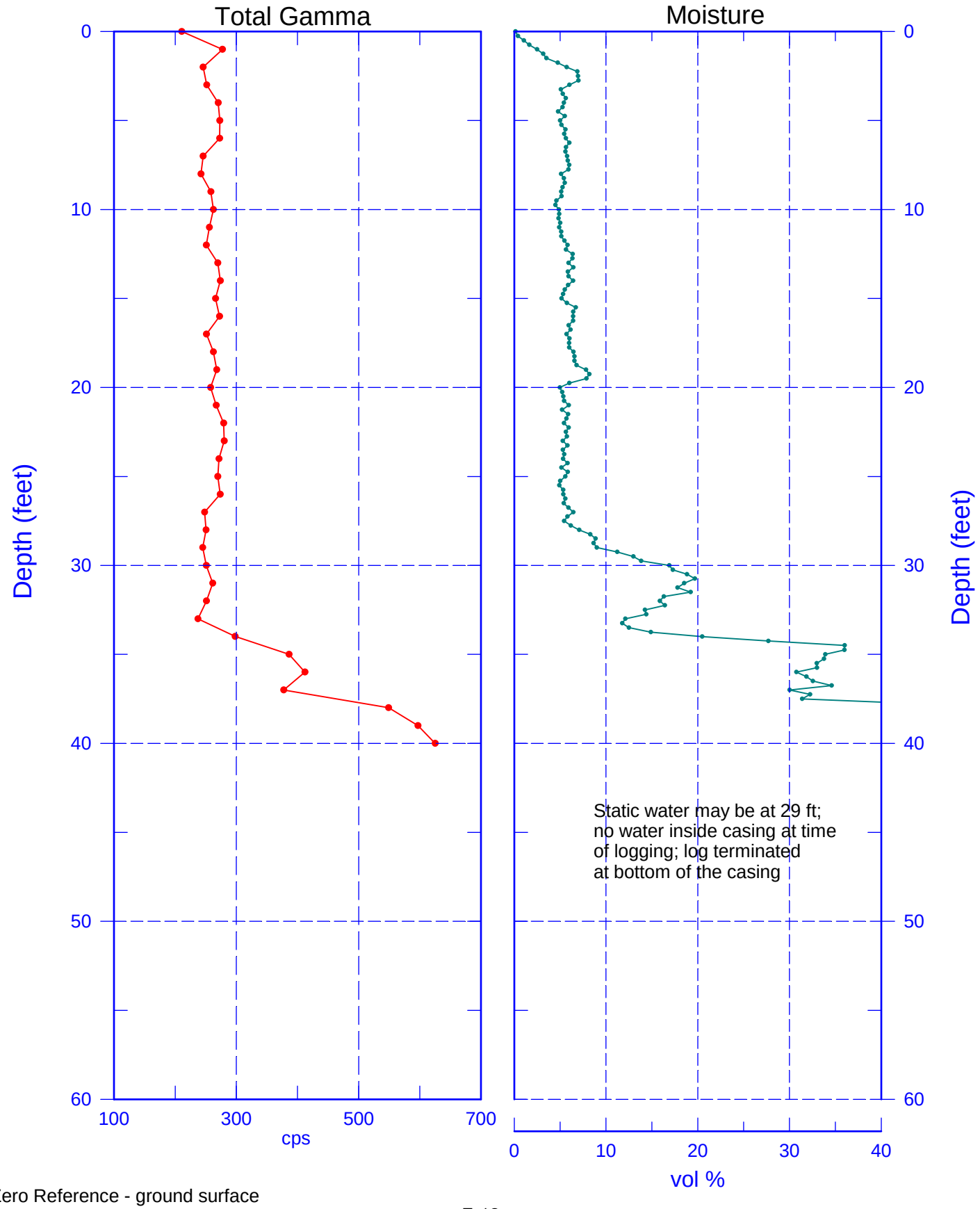
699-71-30C (D0130)
Moisture



Zero Reference - ground surface

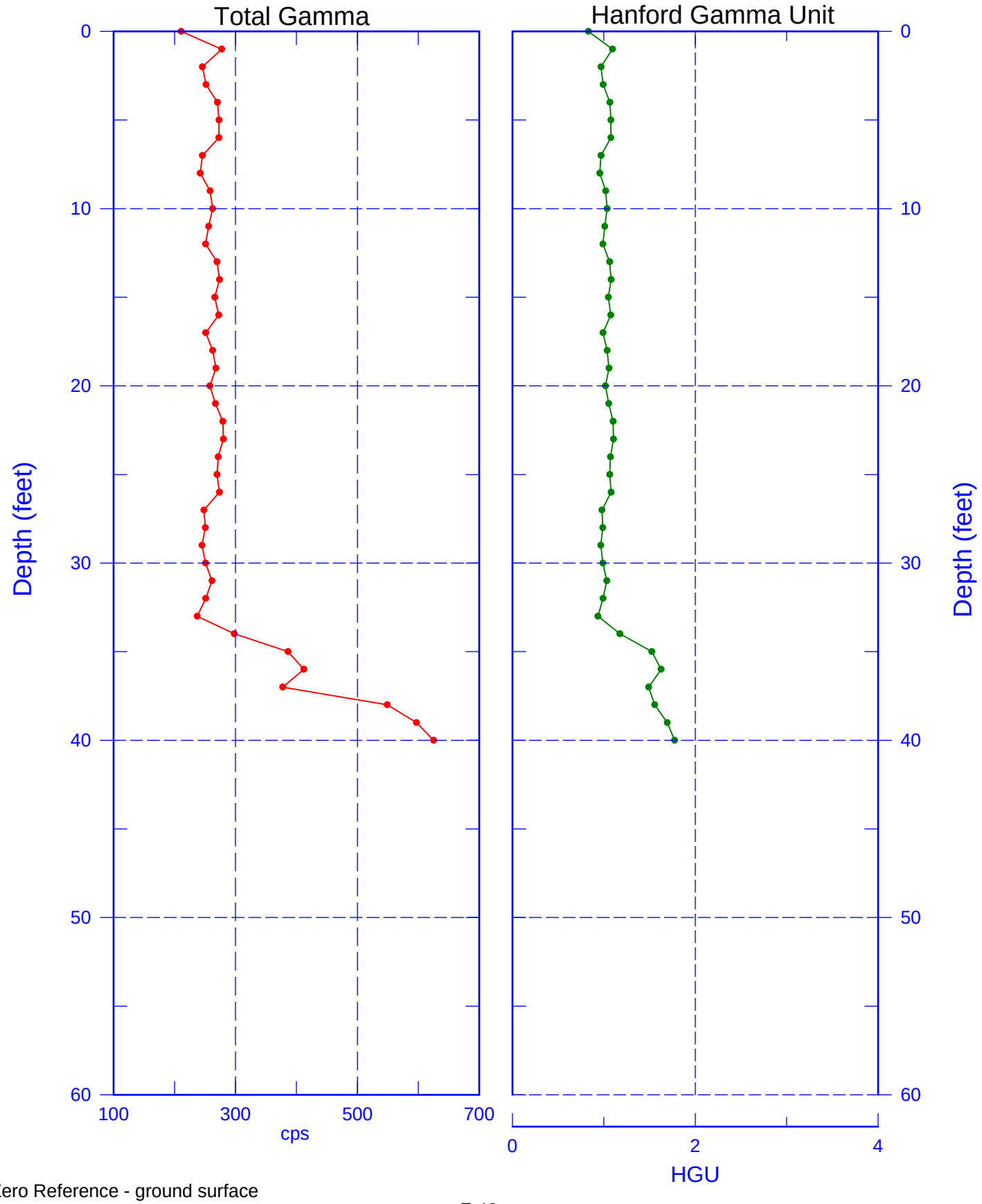
Bay West
Customer-Focused Environmental & Industrial Solutions

699-71-30C (CD0130)
Total Gamma & Moisture



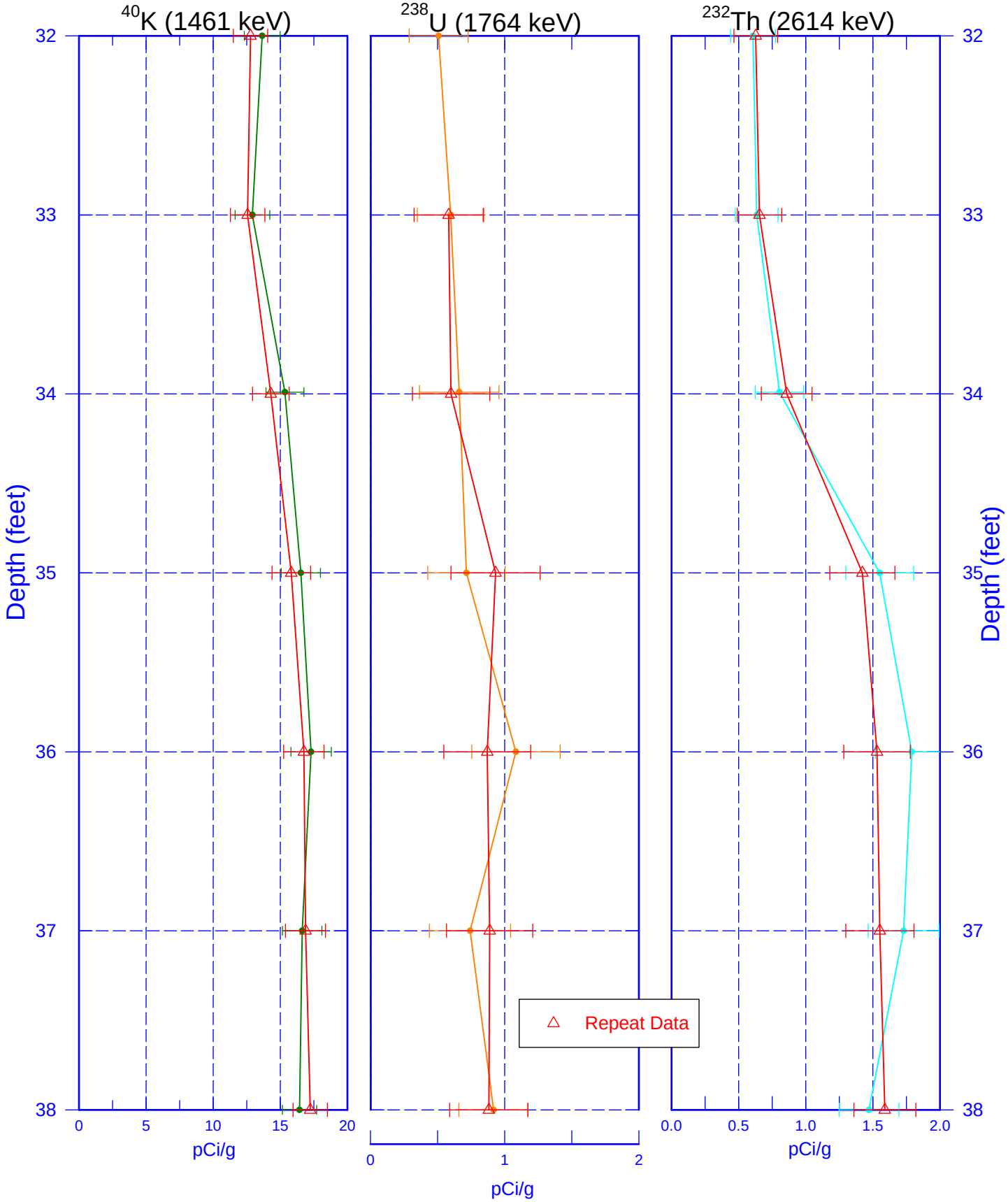
Zero Reference - ground surface

699-71-30C (D0130)
Total Gamma & Hanford Gamma Unit



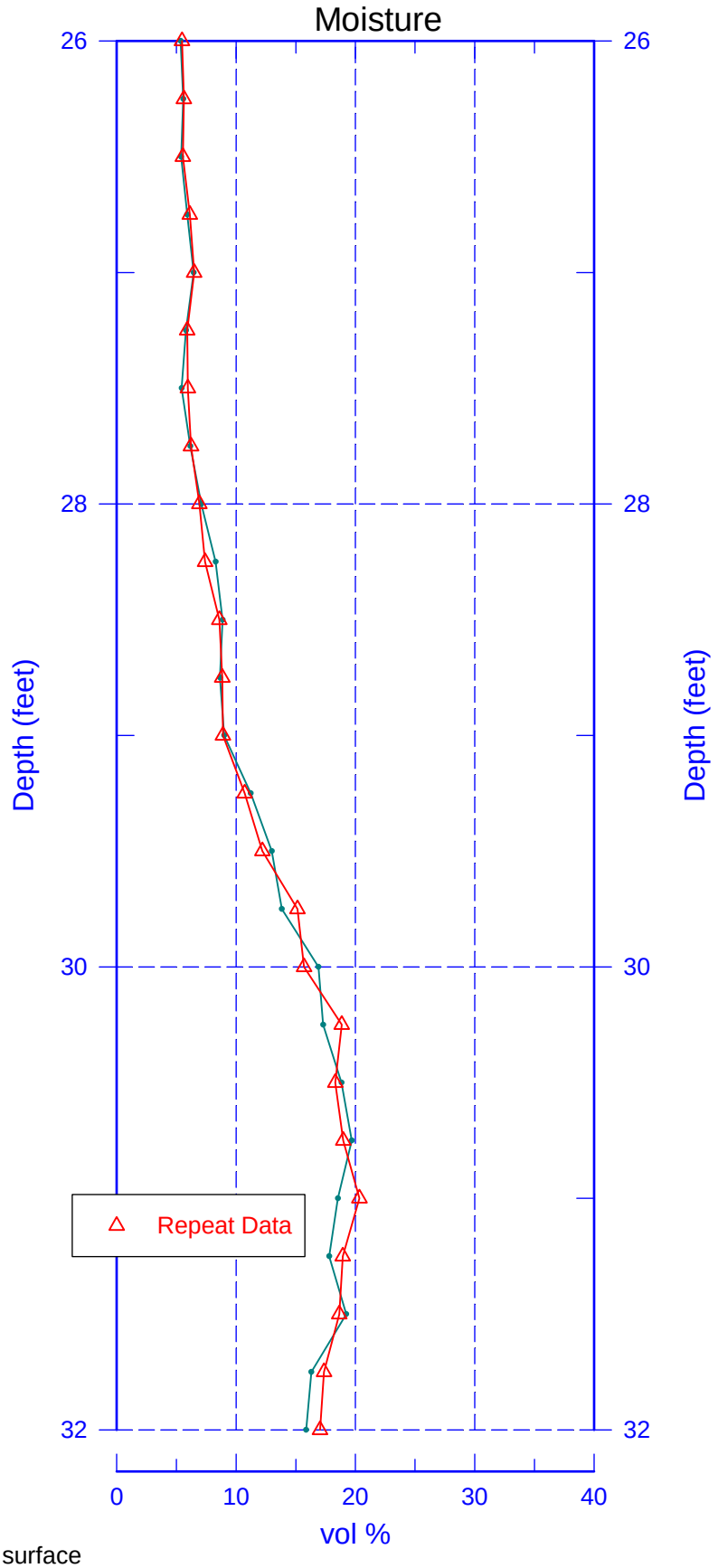
Zero Reference - ground surface

699-71-30C (D0130)
Repeat Section of Natural Gamma Logs



Zero Reference - ground surface

699-71-30C (D0130)
Moisture Repeat Section



Zero Reference - ground surface

This page intentionally left blank.

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 08/20/19	Requestor: James D. Mehrer (CHPRC)
Date of Survey: 10/03/19	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of FR-3 Well D0130 (699-71-30C) located south of 100F 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:

L324 (COE) and Bleakley Azimuth (COE)

Well ID	Well Name	Easting	Northing	Elevation	
D0130	699-71-30C	580709.69	145238.78		Center of Casing
				123.410	Top Inner 4"Casing, N.Edge
				123.740	Top Outer Casing,N.Edge Stamped "X"
				123.036	Brass Survey Marker

Notes:

Brass Survey Marker elevation was taken on top north edge of flat 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
10-5-19

A-6003-659 (REV 1)

This page intentionally left blank.

WELL DEVELOPMENT AND TESTING DATA

Well ID: D0130	Well Name: 699-71-30C	Date: 8/19/19
Location: ~2.5km S of F-Reactor		

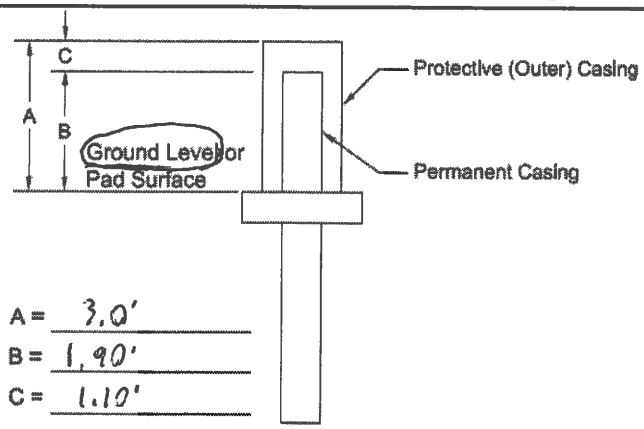
Reference Measuring Point *(unless otherwise noted)*: TOP OF OUTER CASING (TOC)

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: 8/7/19	29.5' bgs	—
Date: 8/8/19	—	29.31' bgs
DEPTH TO BOTTOM:		
Date: 8/7/19	36.23' bgs	—
Date: 8/8/19	—	~~36~~ DC 8/19/19 35.8' bgs



A = 3.0'
B = 1.90'
C = 1.10'

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)
32.0	1.75	~~31.9~~ 2.75 DC 8/19/19	10.6	4.70	1224	1340	4.0	2.28

Not Used DC 8/19/19

Total Pumped: 304 gal

Pump Model: Grundfos 96160180 240v 1HP

Troll Serial Number and Pressure Range (PSI and depth): In-Situ Level Troll 700 s/n: 403065, range: 70m/231ft/99.6 PSI

Comments: bgs = below ground surface

Test name: D0130 develop 8-7-19

Prepared By:

Dan Charbonneau — Print Name
[signature] — Signature
8/19/19 — Date

Reviewed By:

Jennifer Richart — Print Name
[signature] — Signature
9/4/19 — Date

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6005-205 (REV 2)

This page intentionally left blank.

C9985 Archive Photos

0-5 ft bgs

5-10 ft bgs

10-15 ft bgs

15-20 ft bgs

20-25 ft bgs

25-30 ft bgs

30-33 ft bgs

33-35 ft bgs

35-40 ft bgs

40-43 ft bgs

Appendix G

Well Documentation for 699-73-30 (C9875)

- Well Summary Sheet for C9875
- Borehole Log for C9875
- Geophysical Log Data Report for C9875
- Well Survey Data Report for C9875
- Well Development and Testing Data Sheet C9875
- Archive Photo Log for C9875

This page intentionally left blank.

WELL SUMMARY SHEET

Well ID: C9875	Well Name: 699-73-30	Start Date: 07/17/2019
Project: Installation of 6+1 Wells 100-FR-3	Location: ~2km S of F reactor	End Date: 07/31/2019

CONSTRUCTION DATA

Description

WA Ecology Well Tag: BLD024

Surface Construction:
4' x 4' x 6" Concrete Pad with brass survey marker and protective monument

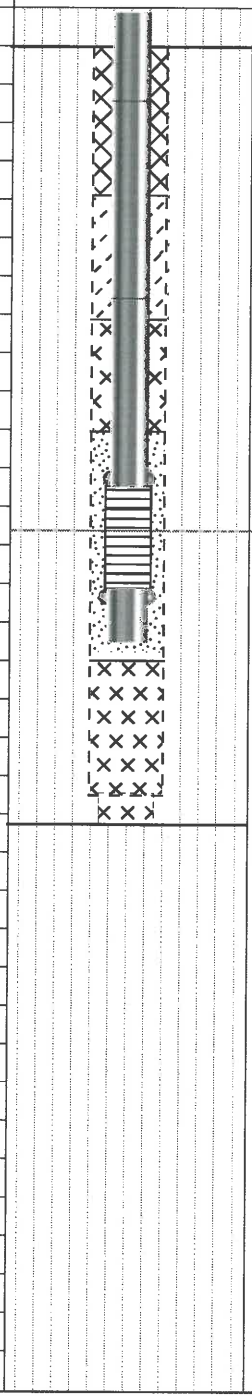
Temporary Casing Depths:
8" Carbon Steel Thd. joints=
38.7 ft bgs

Permanent Well Materials:
4.5" OD TP-304 Sch 10s Riser:
1.85 ft ags-23.14 ft bgs
4.875" OD TP-304 20 slot (0.020")
Screen: 23.14 ft bgs - 28.14 ft bgs
4.5" OD TP-304 Sch 10s End Cap
28.14 ft bgs - 31.36 ft bgs

Well Construction Materials:
Type I/II Portland Cement
0.0 ft bgs- 8.0 ft bgs
Granular Bentonite:
8.0 ft bgs - 14.5 ft bgs
Bentonite Pellet Seal:
14.5 ft bgs - 20.1 ft bgs
Colorado Silica 12/20# (Primary Filter Pack)
20.1 ft bgs - 31.7 ft bgs
Bentonite Pellet Seal
31.7 ft bgs - 40.5 ft bgs

Note:
All 8" temporary casing has been completely removed from the ground.

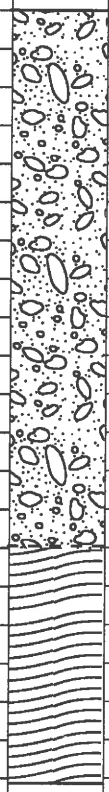
Diagram



Depth in Feet

0, 10, 20, 30, 40, 50, 60

Graphic Log



GEOLOGIC/HYDROLOGIC DATA

Lithologic Description (ft bgs)

0-28 ft bgs: Sandy Gravel (sG)

DTW = 25.5 ft bgs

28 - 40.5 ft bgs: Clay (M)

Acronyms:
DTW = depth to water
ags = above ground surface
bgs = below ground surface

Reported By:			
Ellen Whitney	Staff Geologist	EL	08/26/2019
Print Name	Title	Signature	Date

Reviewed By:			
Jennifer Richart	Well Coordinator	J Richart	9/4/19
Print Name	Title	Signature	Date

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

This page intentionally left blank.

BOREHOLE LOG

Page 1 of 2
Date: 07/17/2019

Well ID: C9875 | Well Name: 699-73-30 | Location: ~2km S of F reactor
Project: The Installation of 6+1 Wells in the 100-FR-3 | 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			0-28' bgs Sandy Gravel (sG)	Sonic rig, 8" casing 6" core barrel.
			@5': slightly damp. 30% Gravel, 70% Sand. Gravel 2mm-95mm, avg 15mm, poorly sorted, rounded to subangular, mixed lithology and composition of clasts. 70% M, 30% F	
5	grab sample 7/17/19		~~40% M, 60% F~~ edw 8/8/19. Sand, very fine to very coarse, avg fine sand, well sorted. 2.5Y, 5/3, light olive brown. Strong rxn to HCl, subrounded to subangular. 40% M/60% F.	Archive @ 5' bgs
10	grab sample 7/17/19		@10': slightly more damp. 50% Gravel, 50% Sand. Gravel 2mm-75mm avg 25mm, mod/well sorted. Sand 2.5Y 3/2 very dark grayish brown, ~~60% M 40% F~~ edw 8/8/19 50% M/50% F weak rxn to HCl, all else stays the same. Gravel 70% M/30% F	Archive @ 10' bgs
15	grab sample 7/17/19		@15': slightly more damp. 60% Gravel, 40% Sand. Gravel clasts poorly sorted again, up to 90mm, avg 25mm, 70% M/30% F. Sand 2.5Y, 4/2, dark grayish brown. Moderate RXN to HCl. 45% M/55% F. All else stays the same.	Archive @ 15' bgs
20	grab sample 7/17/19		@20': Dry. 60% Gravel, 40% Sand, Gravel 70% M/30% F, Sand 50% M/50% F. All else stays the same.	Archive @ 20' bgs
25 H_2O	grab sample 7/17/19		@25': Dry. More poorly sorted up to 130mm, avg 30mm all else stays the same.	Archive @ 25' bgs; H_2O tagged @ 25.5' bgs
	grab sample 7/17/19			Archive @ 28' bgs
30	grab sample 7/17/19		28' - 40.5' bgs Clay (M)	Archive @ 30' bgs
35			@30': Clumped, Damp. 97% silt	

Reported By: Ellen Whitney (Print Name) | Geologist (Title) | [signature] (Signature) | 08/08/2019 (Date)

Reviewed By: Sarah Springer (Print Name) | Sr Geologist (Title) | [signature] (Signature) | 08-27-19 (Date)

For Office Use Only

OR Doc Type: | WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Page 2 of 2

Date: 07/17/2019

Well ID: C9875 | Well Name: 699-73-30 | Location: ~2km S of F reactor

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	grab sample 7/17/19		3% Sand, steaming as it left the barrel. High plasticity, 2.5Y, 5/2 grayish brown, mild rxn to HCL, 3% sand may just be small dumps.	Sonic rig, 8" casing 6" core barrel
	grab sample 7/17/19		@ 35' slight color change. 2.5Y, 4/2 dark grayish brown. NO HCL rxn. Increased plasticity. All else the same.	Archive @ 35' bgs
40			@ 38' plasticity decreases slightly. All else stays the same.	Archive @ 38' bgs
TD 40.5' bgs				TD @ 40.5' bgs
45				
50				

NOT USED

08/08/2019

Reported By:

Ellen Whitney — Print Name

Geologist — Title

Signature

08/08/2019 — Date

A-6006-993 (REV 0)

699-73-30 (C9875)
Log Data Report

Borehole Information

Log Date	2019-07-22	Filename	C9875_HG-NM_2019-07-22	Site	100-FR-3
DTW[1] (ft)	**DTW Date**	**DTW Source**	**Drill Date**	**Total Depth (ft)**	**Depth Datum**
29.15	07/22/19	Bay West	07/17/19	40.5	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded steel	Sonic	TC[2]	8.1	7.58	0.26	1.75 AGS[3]	38.7

Borehole Notes

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing using a dial gauge and circumference tape. The maximum logging depth achieved was 39 ft, approximately even with the casing. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma FTB	Type	60% Coaxial HPGe (SGLS)[4]
Effective Calibration Date	12/12/2018	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-180, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0, Change 2

Logging System	Gamma 5PB	Type	He-3 (CPN 503DR) NMLS[5]
Effective Calibration Date	12/12/2018	Serial No.	H34055445
Calibration Reference	HGLP-CC-177, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0, Change 2

SGLS Log Run Information

Log Run	1	2 Repeat		
HEIS Number	1021204	1021205		
Date	07/22/19	07/22/19		
Logging Engineer	Spatz/McClellan	Spatz/McClellan		
Start Depth (ft)	0.0	27.0		
Finish Depth (ft)	39.0	32.0		
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)	NA	NA		

[1] depth to water inside casing
[2] Temporary casing
[3] Above ground surface
[4] Spectral Gamma Logging System
[5] Neutron Moisture Logging System

Log Run	1	2 Repeat		
Pre-Verification	C9876FTB20190722AV00CAB1	C9876FTB20190722AV00CAB1		
Start File	AD000000	BD002700		
Finish File	AD003900	BD003200		
Post-Verification	C9875FTB20190722BV00CAA1	C9875FTB20190722BV00CAA1		
Depth Return Error (in.)	N/A	0.5 high		
Comments	Pre verification from prior borehole 2 hrs before	Pre verification from prior borehole 2 hrs before		

NMLS Log Run Information

Log Run	3	4 Repeat			
HEIS Number	1021206	1021207			
Date	07/22/19	07/22/19			
Logging Engineer	Spatz/McClellan	Spatz/McClellan			
Start Depth (ft)	0.0	24.0			
Finish Depth (ft)	29.25	28.0			
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	C9875FPB20190722AV00CAB1	C9875FPB20190722AV00CAB1			
Start File	AD000000	BD002400			
Finish File	AD002925	AD002800			
Post-Verification	C9875FPB20190722BV00CAA1	C9875FPB20190722BV00CAA1			
Depth Return Error (in.)	N/A	0.5 high			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on the sondes. Verification measurements passed the acceptance criteria.

Analysis Notes

Analyst	P.D. Henwood	Date	09/11/19
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

A casing correction for a 0.26-in. thick casing was applied to the SGLS log data; no additional correction was made for the thick casing joints.

A water correction was applied below 29.15 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 FTB20181212 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

Casing diameter and thickness corrections for 0.26-in. thick, 8.1-in. OD casing were applied to the NMLS data acquired through the sonic casing. Integrated with the casing diameter and thickness corrections is an initial count rate correction for a sediment composition of a 50-50% ratio of basalt fragments to quartz sand (HGLP-OTH-028).

NMLS data are reported in counts per second for the entire length of the borehole. NMLS data are also reported in vol% moisture. Conversions from count rate to vol% moisture were performed using an EXCEL template identified as FPB_Cascade_Sonic_MCNP_assay. This template also provides corrections for the thick casing joints typical of sonic drill casings.

HGU[6] 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 generally increases as the sediment becomes more fine-grained. For example, moisture content would be expected to be greater near the top of a fining upward Hanford flood sequence.

The measured depth to water inside the casing of 29.15 ft was at the time of logging. It appears static water may be at approximately 26 ft.

Thickened casing joints occur at 5 and 10 ft intervals beginning at approximately 8 ft in depth. No corrections have been made for the joints for the SGLS although corrections for moisture have been made.

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

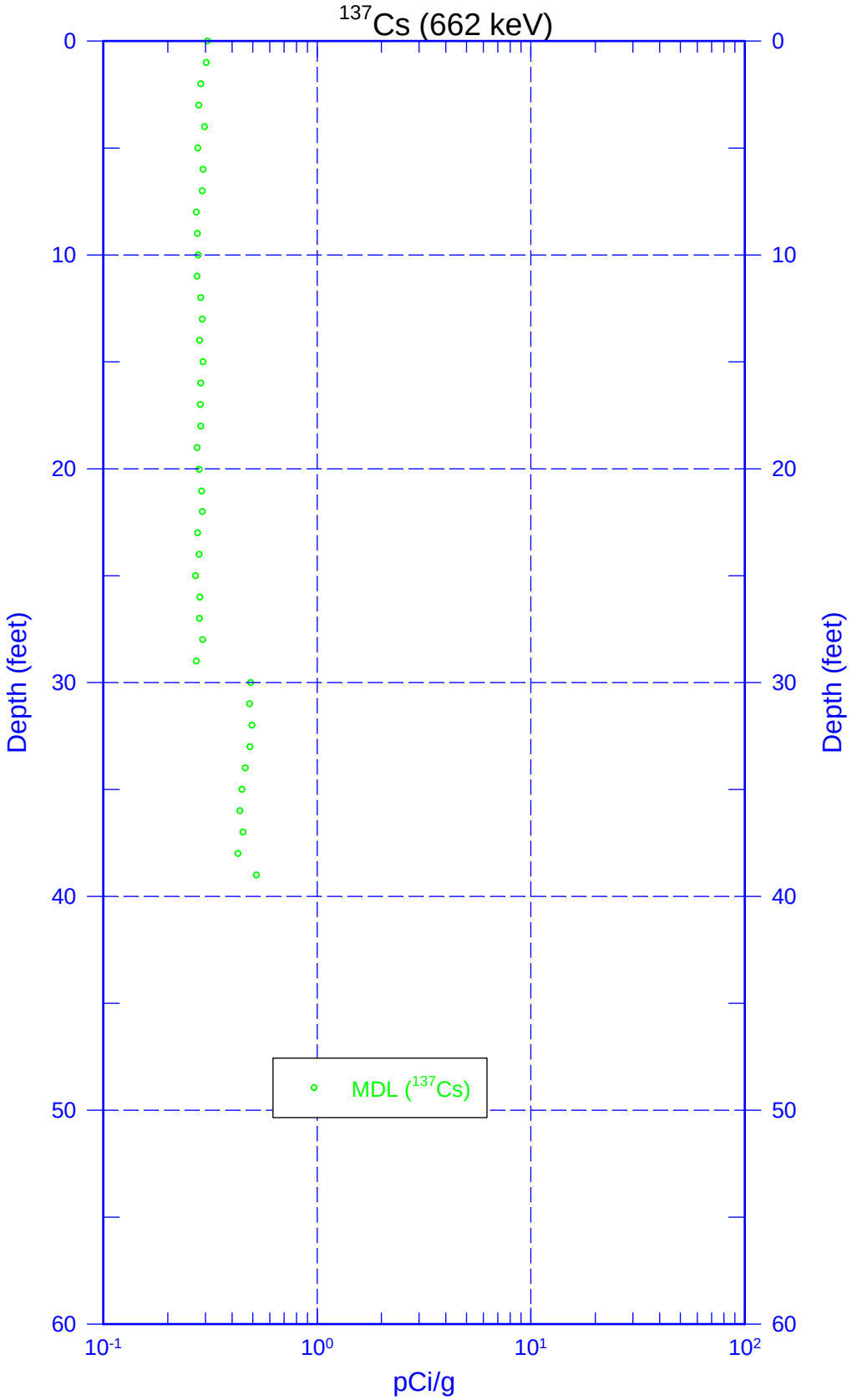
List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-60 ft)
Natural Gamma Logs (0-60 ft)
Combination Plot (0-60 ft)
Moisture (0-60 ft)
Total Gamma & Moisture (0-60 ft)
Total Gamma & Hanford Gamma Unit (0-60 ft)
Repeat Section of Natural Gamma Logs 27-32 ft)
Moisture Repeat Section (24-28 ft)

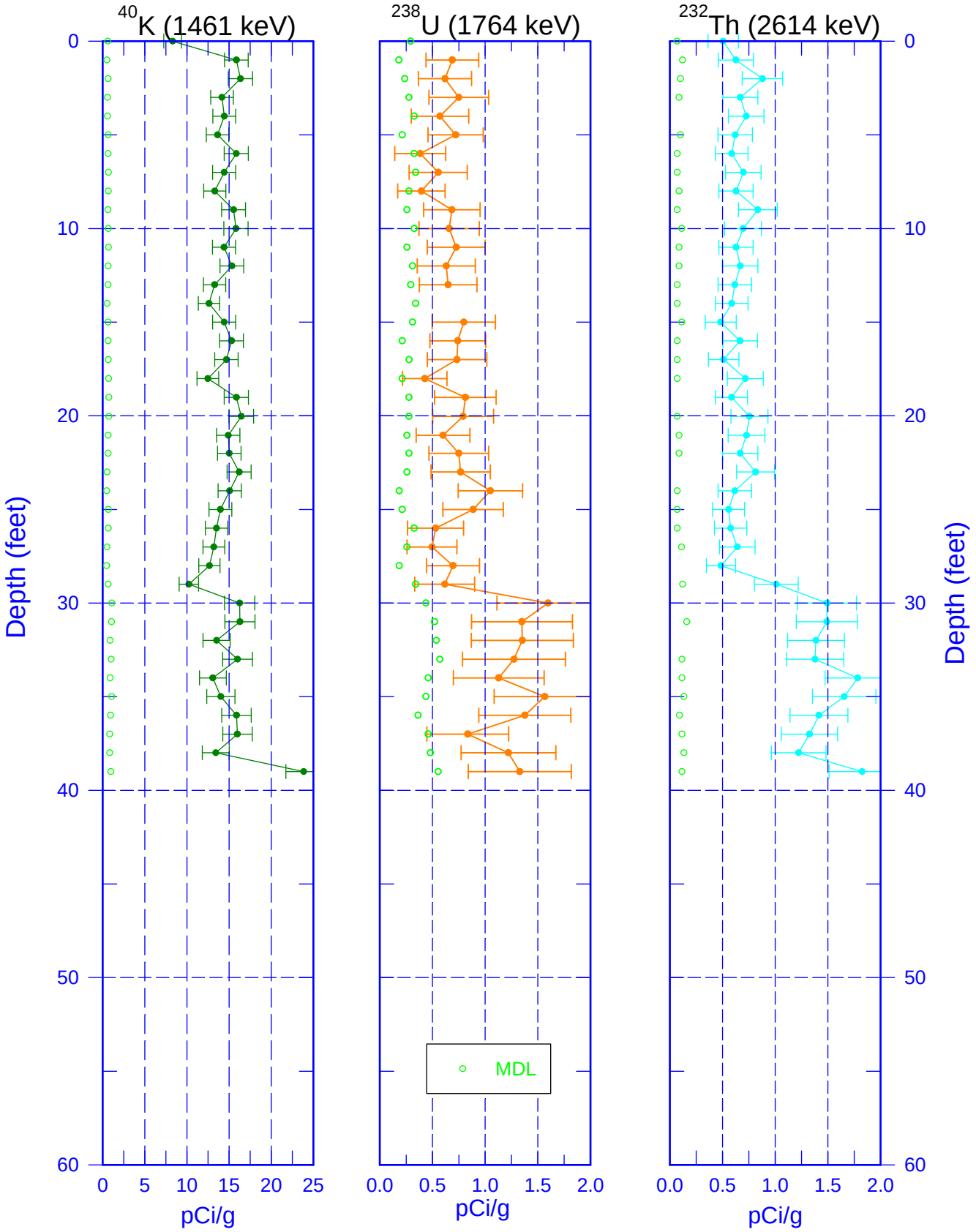
[6] Hanford Gamma Unit

699-73-30 (C9875)
Manmade Radionuclides



Zero Reference - ground surface

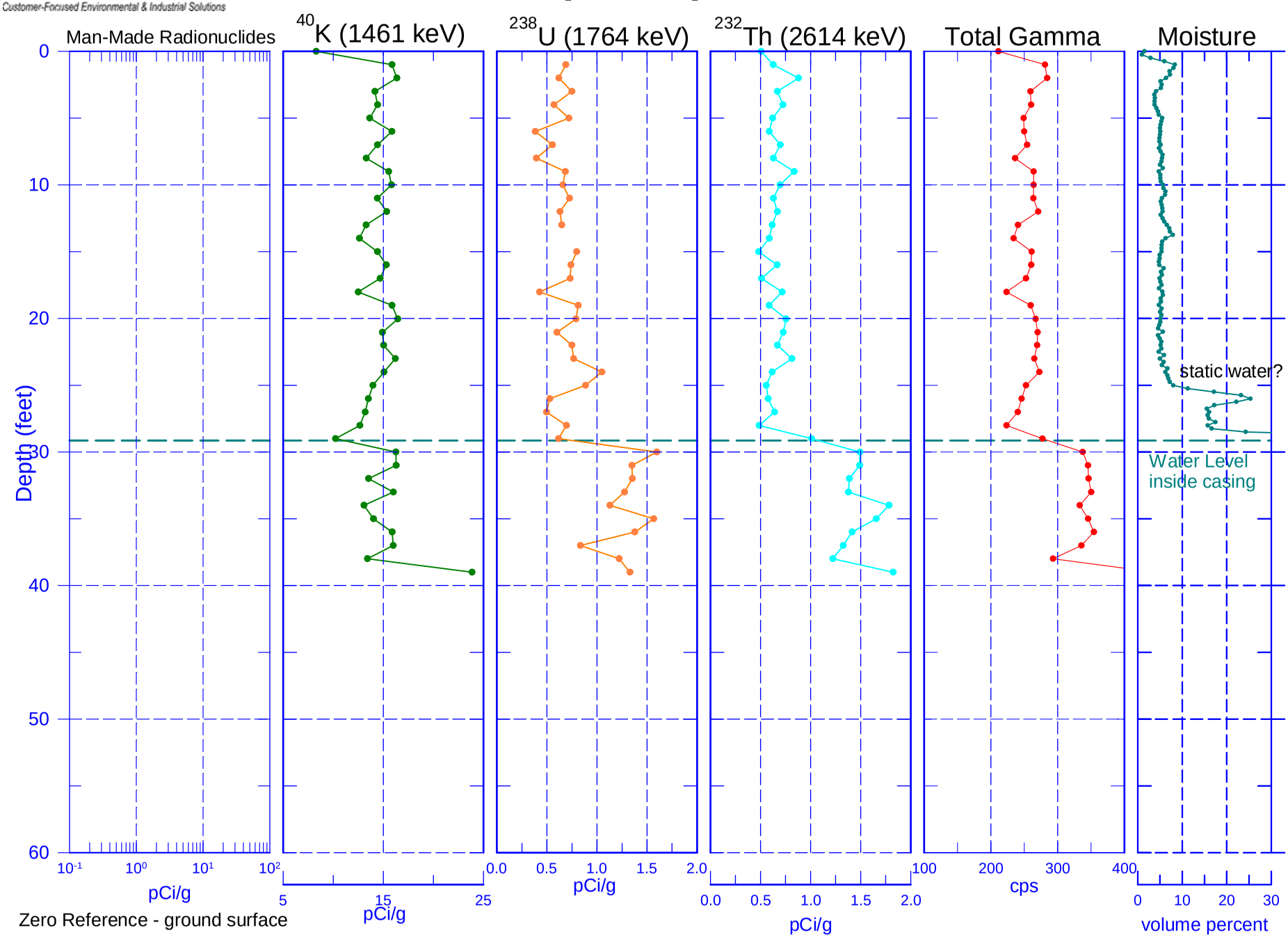
699-73-30 (C9875)
Natural Gamma Logs



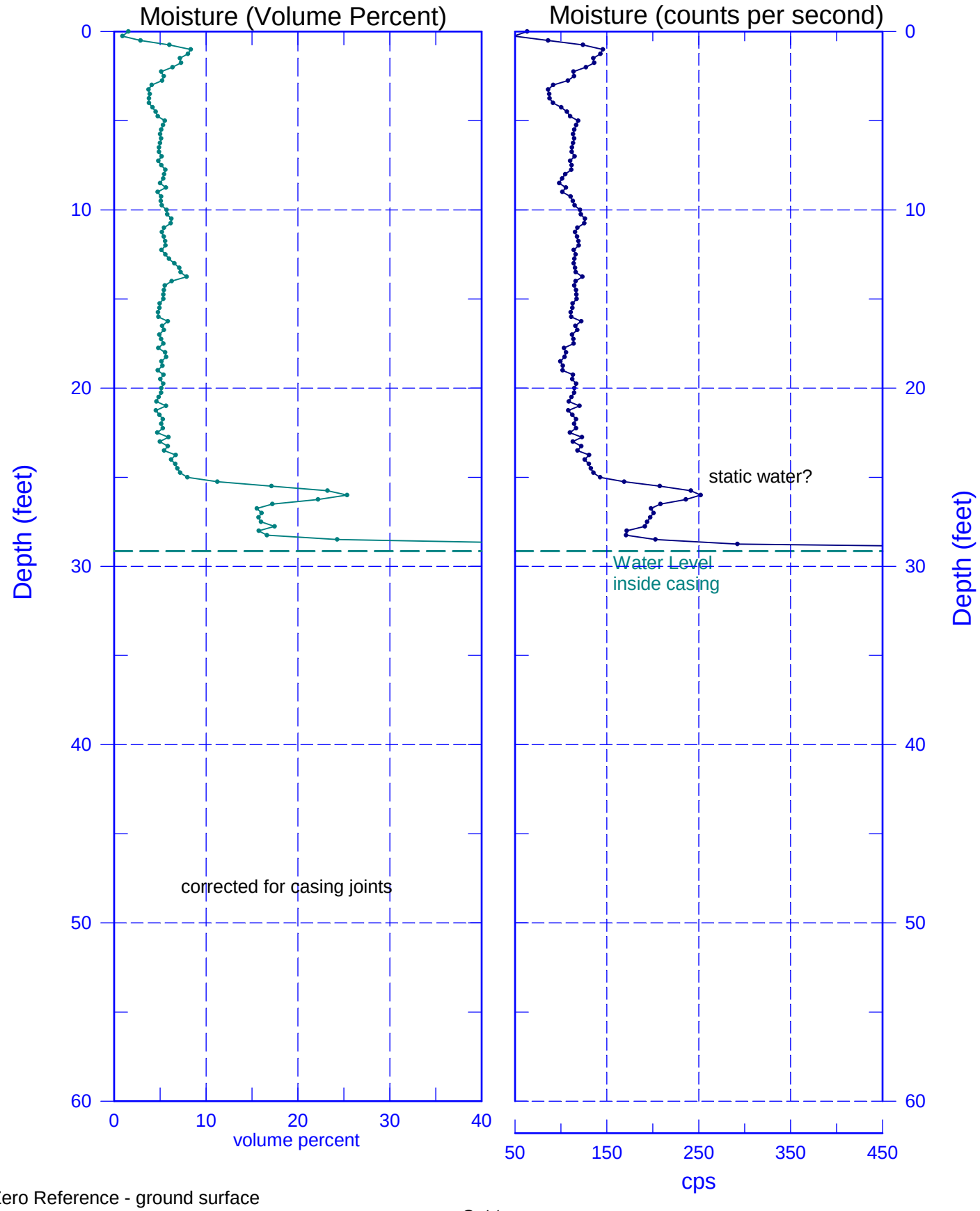
Zero Reference - ground surface

Bay West
Customer-Focused Environmental & Industrial Solutions

699-73-30 (C9875) Combination Plot

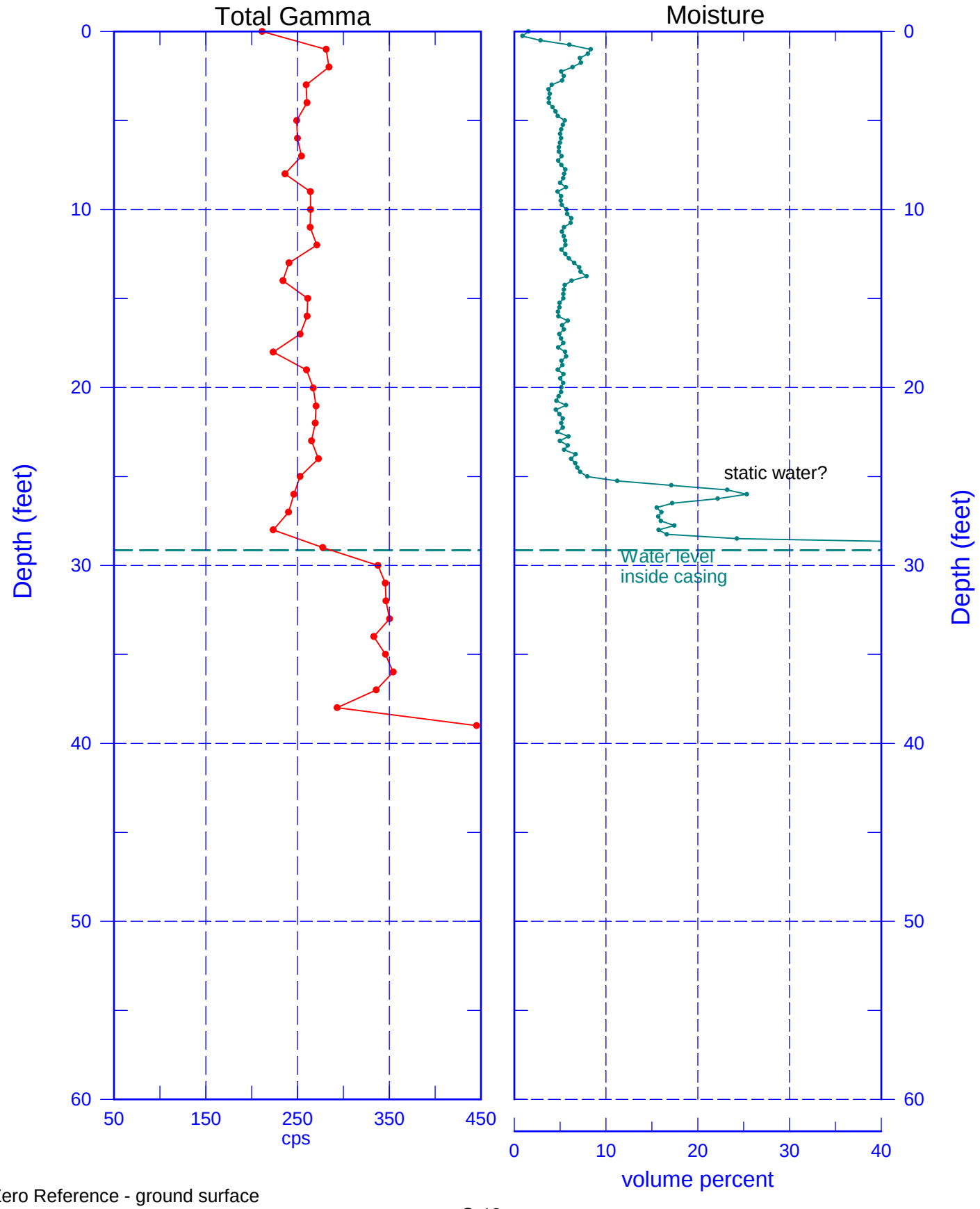


699-73-30 (C9875)
Moisture



Zero Reference - ground surface

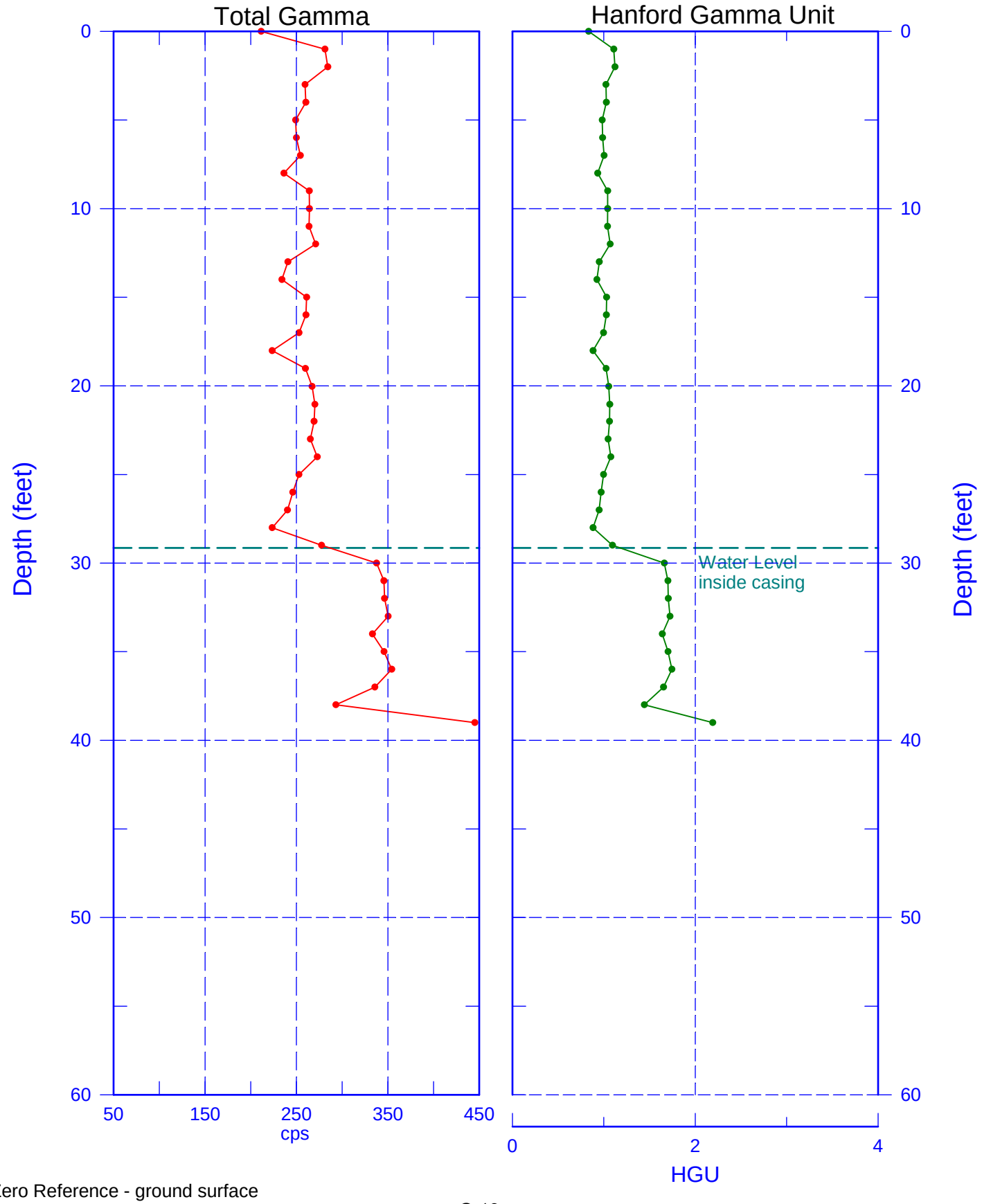
699-73-30 (C9875)
Total Gamma & Moisture



Zero Reference - ground surface

699-73-30 (C9875)

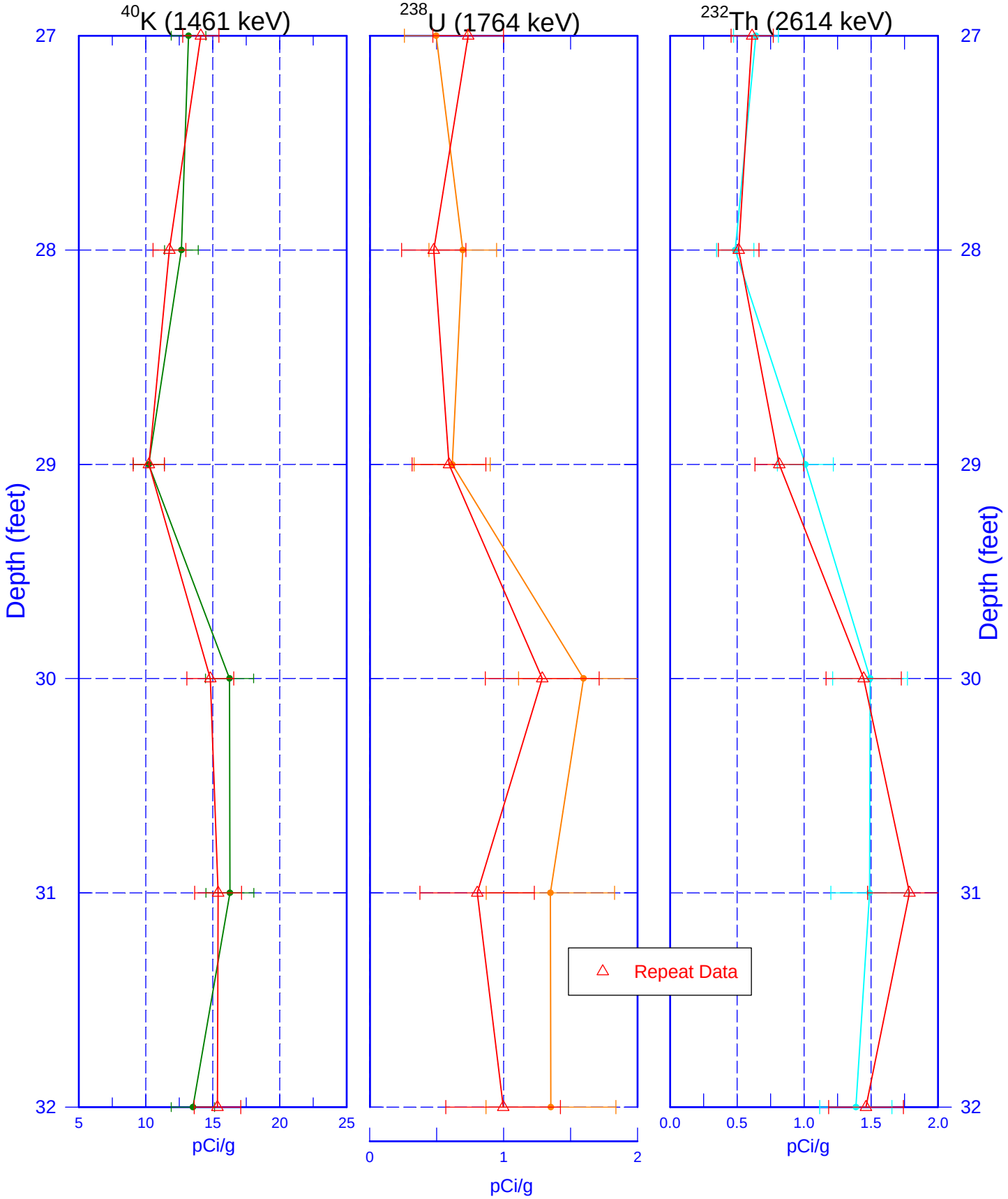
Total Gamma & Hanford Gamma Unit



Zero Reference - ground surface

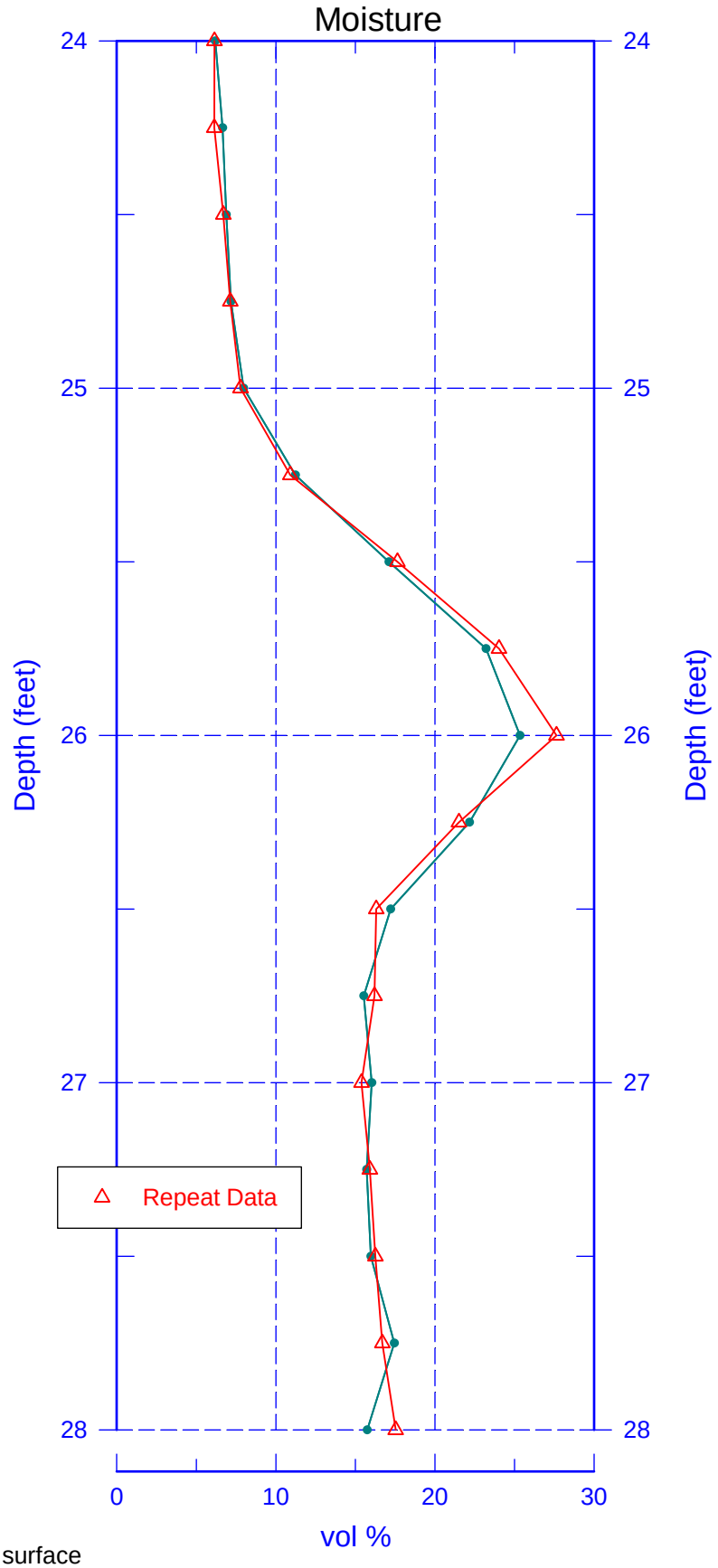
699-73-30 (C9875)

Repeat Section of Natural Gamma Logs



Zero Reference - ground surface

699-73-30 (C9875)
Moisture Repeat Section



Zero Reference - ground surface

This page intentionally left blank.

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 08/20/19	Requestor: James D. Mehrer (CHPRC)
Date of Survey: 10/03/19	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of FR-3 Well C9875 (699-73-30) located South of 100F 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:

L324 (COE) and Bleakley Azimuth (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9875	699-73-30	580687.11	145873.73		Center of Casing
				122.062	Top Inner 4"Casing, N.Edge
				122.447	Top Outer Casing,N.Edge Stamped "X"
				121.688	Brass Survey Marker

Notes:

Brass Survey Marker elevation was taken on top south edge of flat 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
10-3-19

This page intentionally left blank.

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9875	Well Name: 699-73-38	Date: 8/5/19

Location: ~2km S of F Reactor

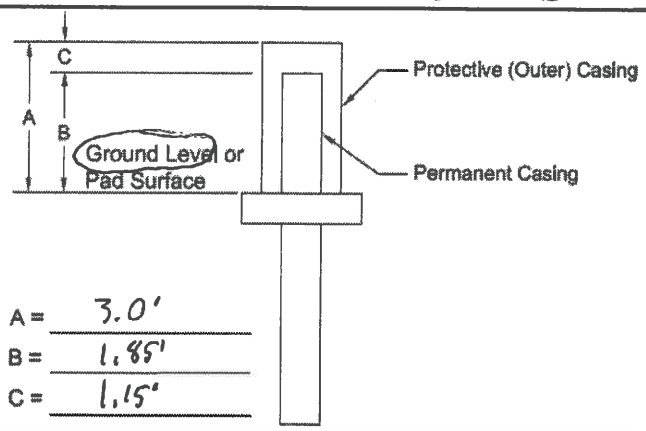
Reference Measuring Point *(unless otherwise noted)*: TOP OF OUTER CASING (TOC)

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: 7/31/19	25.6' bgs	N/A
Date: 8/5/19	N/A	25.6' bgs
DEPTH TO BOTTOM:		
Date: 7/31/19	31.5' bgs	N/A
Date: 8/5/19	N/A	~~25.6'~~ 31.5' bgs DC 8/5/19



A = 3.0'
B = 1.85'
C = 1.15'

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)
28.0	2.20	2.58	50.0	9.66	1221	1243	5.4	2.46
28.0	2.16	2.58	9.66	2.43	1243	1330	5.0	2.31

Not used DC 8/27

Total Pumped: 353.8 gal

Pump Model: Grundfos 96160180 240v 1HP

Troll Serial Number and Pressure Range (PSI and depth): S/N: 403065, ranges: 70m/231ft/99.6 psi, In-Situ Level Troll 700

Comments: Test name: C9875-development-7-31-19
bgs: below ground surface

Prepared By:

Dan Chuzbomewuk (Print Name) — Signature — 8/5/19 (Date)

Reviewed By:

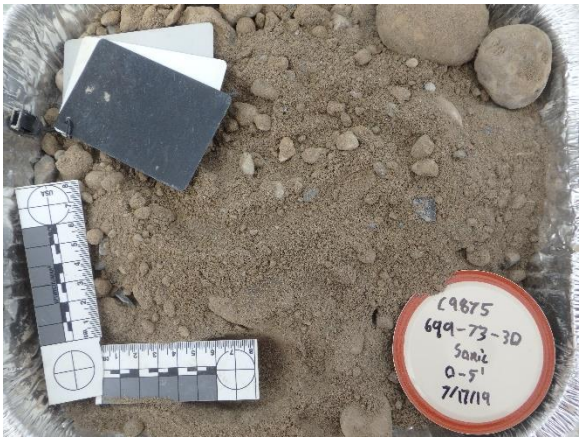
Jennifer Richart (Print Name) — Signature — 9/4/19 (Date)

For Office Use Only

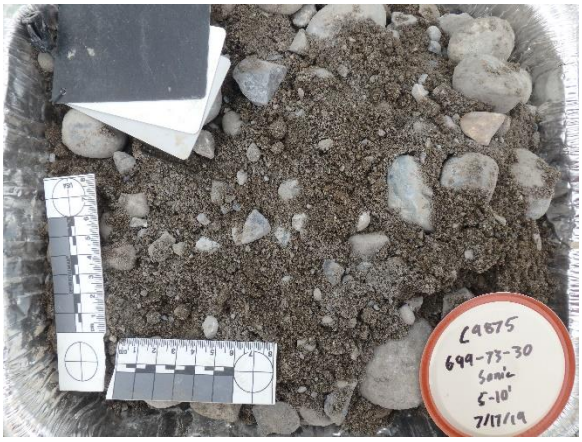
OR Doc Type:	WMU Code(s):

This page intentionally left blank.

C9875 Archive Photos



0-5 ft bgs



5-10 ft bgs

10-15 ft bgs

15-20 ft bgs

20-25 ft bgs

28 ft bgs

28-30 ft bgs (mislabeled in photo)

30-35 ft bgs

35-38 ft bgs

Appendix H

Well Documentation for 699-77-34B (C9877)

- Well Summary Sheet for C9877
- Borehole Log for C9877
- Geophysical Log Data Report for C9877
- Well Survey Data Report for C9877
- Well Development and Testing Data Sheet C9877
- Archive Photo Log for C9877

This page intentionally left blank.

WELL SUMMARY SHEET

Page 1 of 1

Well ID: C9877	Well Name: 699-77-34B	Start Date: 7/22/2019
Project: Installation of 6+1 Wells in the 100-FR-3 OU	Location: 1km SW of F Reactor	End Date: 8/5/2019

CONSTRUCTION DATA

WA Ecology Well Tag: BLD022

Surface Construction:

4'x4'x6" Concrete pad with brass survey marker and protective monument

Temporary Casing Depth:

8" Carbon Steel Thd. joints = 38.5 ft bgs

Permanent Well Materials:

4.5" OD TP-304 Sch 10s Riser:
1.85 ft ags - 14.20 ft bgs

4.875" OD TP-304 20-slot (0.020") screen:
14.20 - 24.21 ft bgs

4.5" OD TP-304 Sch 10s Cap:
24.21 - 24.53 ft bgs

Well Construction Materials:

High Strength Concrete:
0.0 - 0.4 ft bgs

Type I/II Portland Cement:
0.4 - 9.2 ft bgs

Bentonite Pellet Seal:
9.3 - 11.8 ft bgs

Colorado Silica Sand 12/20# (Primary Filter Pack):
11.8 - 25.9 ft bgs

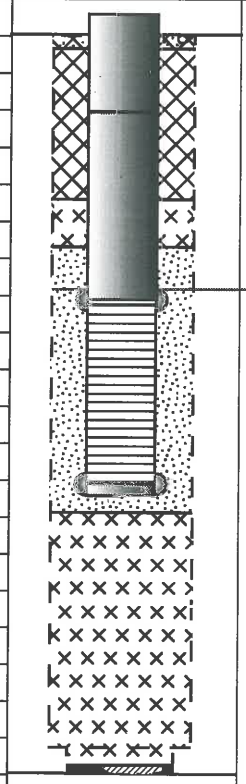
Bentonite Pellet Backfill:
25.9 - 39.7 ft bgs

Natural Fill:
39.7 - 40.0 ft bgs

Note:

All 8" temporary casing has been completely removed from the ground.

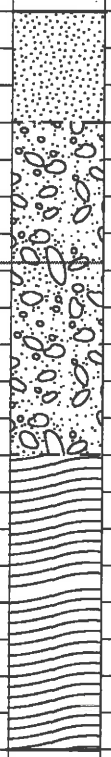
Diagram



GEOLOGIC/HYDROLOGIC DATA

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

Graphic Log



Lithologic Description (ft bgs)

0-6 ft: Sand (S)

6-24 ft: Sandy Gravel (sG)

DTW = 13.8 ft bgs (8/12/2019)

24-40 ft: Clay (M)

Total Depth = 40.0 ft bgs

Acronyms:

DTW = depth to water
ags = above ground surface
bgs = below ground surface

Reported By:			
Dan Charbonneaux	Staff Geologist		8/26/2019
Print Name	Title	Signature	Date

Reviewed By:			
Jennifer Richart	Well Coordinator		9/4/19
Print Name	Title	Signature	Date

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

This page intentionally left blank.

BOREHOLE LOG

Page 1 of 2

Date: 07/22/2019

Well ID: C9877 | Well Name: 699-77-34B | Location: 1 km SW of F reactor

Project: Installation of 6+1 wells in 100-FR-3 GU | 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' - 6' bgs Sand (S)	Sonic rig, 8" casing
			@ 5 ft bgs, Damp. 100% Sand. v fine to medium sand. Avg fine sand. Well sorted, subangular to subrounded 2.5Y 4/3 olive brown, No rxn to HCL, 60% M/40% F	6" core barrel
5	grab sample + waste sample 07/22/19			Archive @ 5 ft bgs
			6' - 24' bgs Sandy Gravel (SG)	Waste sample @ 5 ft bgs. (B3R481)
			@ 10 ft bgs, Damp, 60% Gravel, 40% Sand, Gravel: 2mm - 75mm, avg 10mm, moderately sorted, rounded to subangular mostly subrounded. 80% M 20% F	HEIS # B3R481
10	grab sample 07/22/19		Sand: fine to v coarse. Avg med. well sorted, mostly subrounded, 2.5Y 4/3 olive brown, mild to no rxn to HCL. 45% M, 55% F.	Archive @ 10 ft bgs
H_2O tagged 7/22/19				H_2O tagged 14.5' bgs 07/22/2019
15	grab sample 07/22/19		@ 15 ft bgs, saturated. Sand appears to be coarser, but could be due to fines being washed out. All else appears the same.	Archive @ 15 ft bgs
20	grab sample 07/22/19		@ 20 ft bgs, saturated. 30% Gravel, 65% Sand, 5% silt. 2.5Y 3/1 very dark gray, clumpy, Gravel rounded to angular, all else the same.	Archive @ 20 ft bgs
25	grab sample 07/22/19		@ 24 ft all stays the same.	Archive @ 24 ft bgs. Archive @ 25 ft bgs
			24' - 40' bgs Clay (M)	
			@ 25 ft bgs 90% clay, 10% Sand Damp. In fairly solid chunks. 2.5Y 4/1 dark gray, plasticity high, moderate rxn to HCL.	
30	grab sample 07/22/19		@ 30 ft bgs some Caliche present (lighter color, vigorous rxn to HCL) all else stays the same.	Archive @ 30 ft bgs

Reported By:

Print Name	Title	Signature	Date
Ellen Whitney	Geologist	E	07/22/2019

Reviewed By:

Print Name	Title	Signature	Date
Sarah Springer	Sr. Geologist	Sarah Springer	07-24-19

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Page 2 of 2

Date: 07/22/2019

Well ID: C9877 | Well Name: 699-77-34B | Location: 1 km SW of F reactor

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	grab sample 7/22/19		@ 35 ft bgs plasticity decrease, mostly dry	Archive @ 35 ft bgs
	grab sample 7/22/19		@ 36 ft bgs same as above.	Archive @ 36 ft bgs
40 TD 7/22/19				TD 40 ft bgs
45				

Reported By:

Ellen Whitney (Print Name) — Geologist (Title) — [signature] (Signature) — 07/22/2019 (Date)

A-6006-993 (REV 0)

699-77-34B (C9877)
Log Data Report

Borehole Information

Log Date	2019-07-23	Filename	C9877_HG-NM_2019-07-23	Site	100-FR-3
DTW[1] (ft)	**DTW Date**	**DTW Source**	**Drill Date**	**Total Depth (ft)**	**Depth Datum**
None	07/22/19	Bay West	07/22/19	40.0	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded steel	Sonic	TC[2]	8.1	7.58	0.26	2.0 AGS[3]	38.5

Borehole Notes

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing using a dial gauge and circumference tape. The maximum logging depth achieved was 39 ft, approximately 0.5 ft below the casing. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma FTB	Type	60% Coaxial HPGe (SGLS)[4]
Effective Calibration Date	12/12/2018	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-180, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0, Change 2

Logging System	Gamma 5PB	Type	He-3 (CPN 503DR) NMLS[5]
Effective Calibration Date	12/12/2018	Serial No.	H34055445
Calibration Reference	HGLP-CC-177, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0, Change 2

SGLS Log Run Information

Log Run	1	2 Repeat		
HEIS Number	1021208	1021209		
Date	07/23/19	07/23/19		
Logging Engineer	Spatz/McClellan	Spatz/McClellan		
Start Depth (ft)	0.0	22.0		
Finish Depth (ft)	39.0	27.0		
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)	NA	NA		

[1] depth to water inside casing
[2] Temporary casing
[3] Above ground surface
[4] Spectral Gamma Logging System
[5] Neutron Moisture Logging System

Log Run	1	2 Repeat		
Pre-Verification	C9877FTB20190723AV00CAB1	C9877FTB20190723AV00CAB1		
Start File	AD000000	BD002200		
Finish File	AD003900	BD002700		
Post-Verification	C9877FTB20190723BV00CAA1	C9877FTB20190723BV00CAA1		
Depth Return Error (in.)	N/A	1.0 high		
Comments	None	None		

NMLS Log Run Information

Log Run	3	4 Repeat			
HEIS Number	1021210	1021211			
Date	07/23/19	07/23/19			
Logging Engineer	Spatz/McClellan	Spatz/McClellan			
Start Depth (ft)	0.0	22.0			
Finish Depth (ft)	39.0	27.0			
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	C9877FPB20190723AV00CAB1	C9877FPB20190723AV00CAB1			
Start File	AD000000	BD002200			
Finish File	AD003900	BD002700			
Post-Verification	C9877FPB20190723BV00CAA1	C9877FPB20190723BV00CAA1			
Depth Return Error (in.)	N/A	0.75 high			
Comments	None	None			

Logging Operation Notes

A centralizer was installed on the sondes. Verification measurements passed the acceptance criteria.

Analysis Notes

Analyst	P.D. Henwood	Date	09/12/19
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

A casing correction for a 0.26-in. thick casing was applied to the SGLS log data; no additional correction was made for the thick casing joints.

No water correction was applied as water inside the casing was below the maximum logging depth.

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 FTB20181212 using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

Casing diameter and thickness corrections for 0.26-in. thick, 8.1-in. OD casing were applied to the NMLS data acquired through the sonic casing. Integrated with the casing diameter and thickness corrections is an initial count rate correction for a sediment composition of a 50-50% ratio of basalt fragments to quartz sand (HGLP-OTH-028).

NMLS data are reported in counts per second for the entire length of the borehole. NMLS data are also reported in vol% moisture. Conversions from count rate to vol% moisture were performed using an EXCEL template identified as FPB_Cascade_Sonic_MCNP_assay. This template also provides corrections for the thick casing joints typical of sonic drill casings.

HGU[6] 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 generally increases as the sediment becomes more fine-grained. For example, moisture content would be expected to be greater near the top of a fining upward Hanford flood sequence.

The measurement for depth to water at the time of logging indicated no water inside the casing. It appears static water may be at approximately 24 ft. Volume percent moisture cannot be properly determined below 24 ft.

Thickened casing joints occur at 5 and 10 ft intervals beginning at approximately 4 ft in depth. No corrections have been made for the joints for the SGLS although corrections for moisture have been made.

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

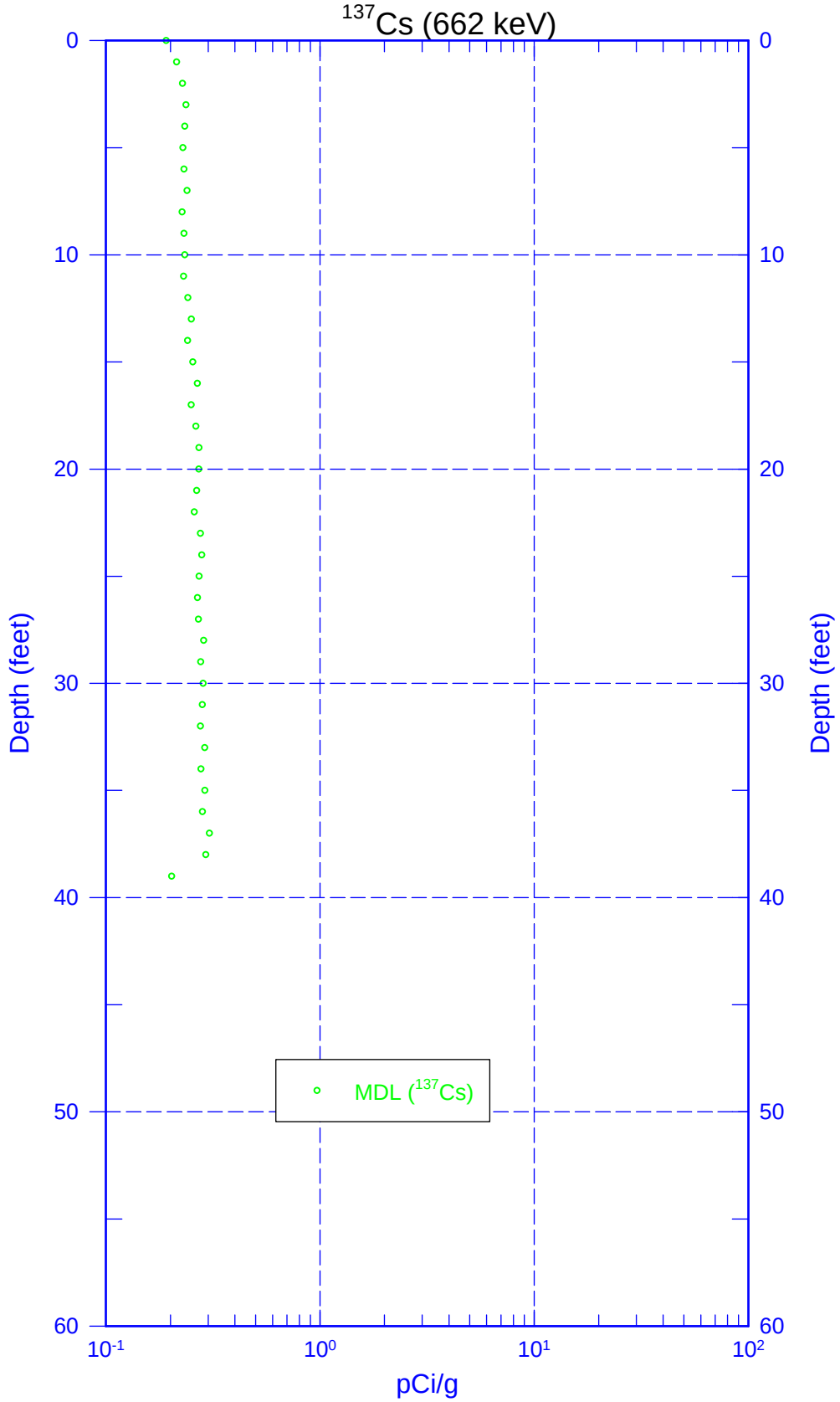
List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-60 ft)
Natural Gamma Logs (0-60 ft)
Combination Plot (0-60 ft)
Moisture (0-60 ft)
Total Gamma & Moisture (0-60 ft)
Total Gamma & Hanford Gamma Unit (0-60 ft)
Repeat Section of Natural Gamma Logs (22-27 ft)
Moisture Repeat Section (22-27 ft)

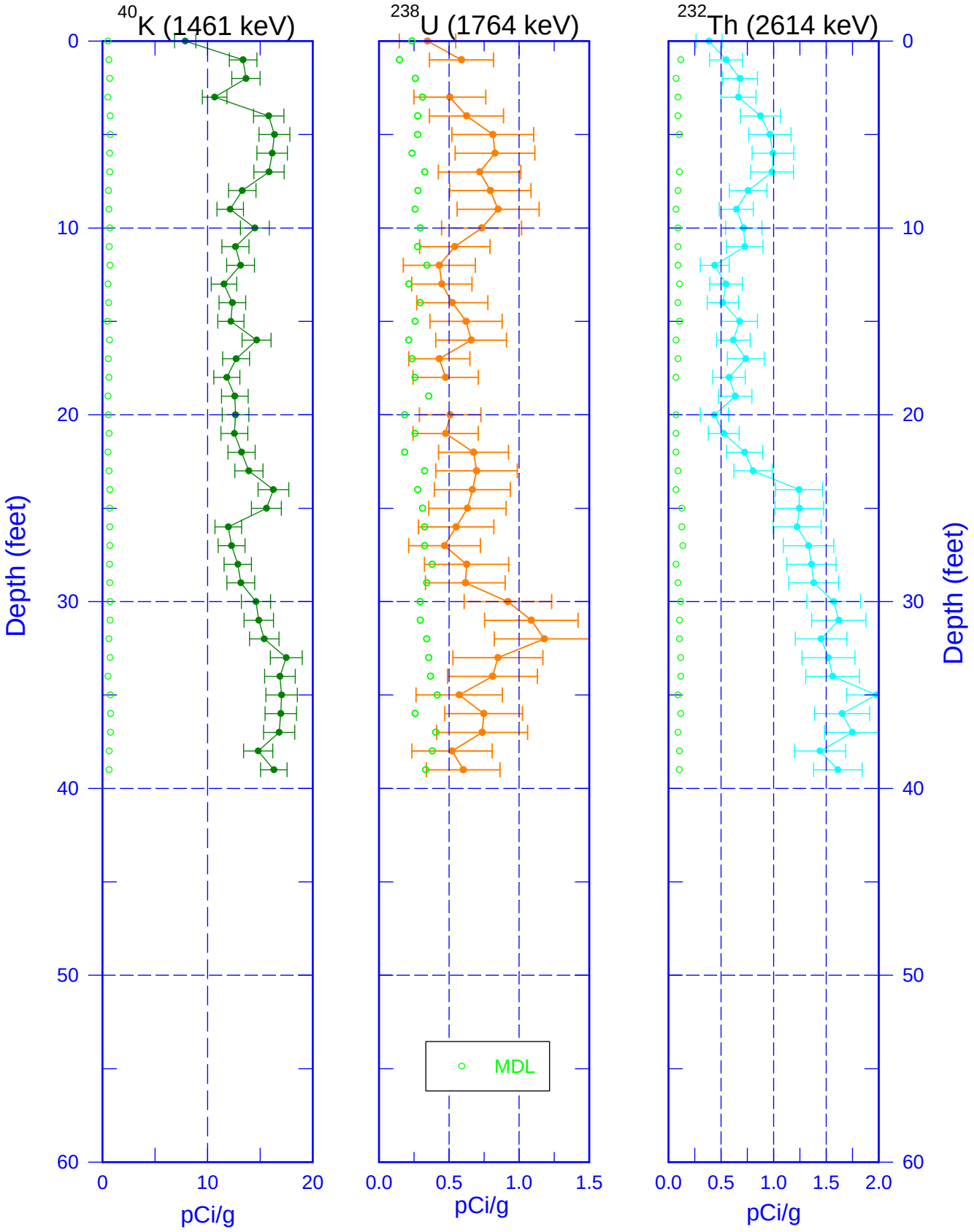
[6] Hanford Gamma Unit

699-77-34B (C9877)
Manmade Radionuclides



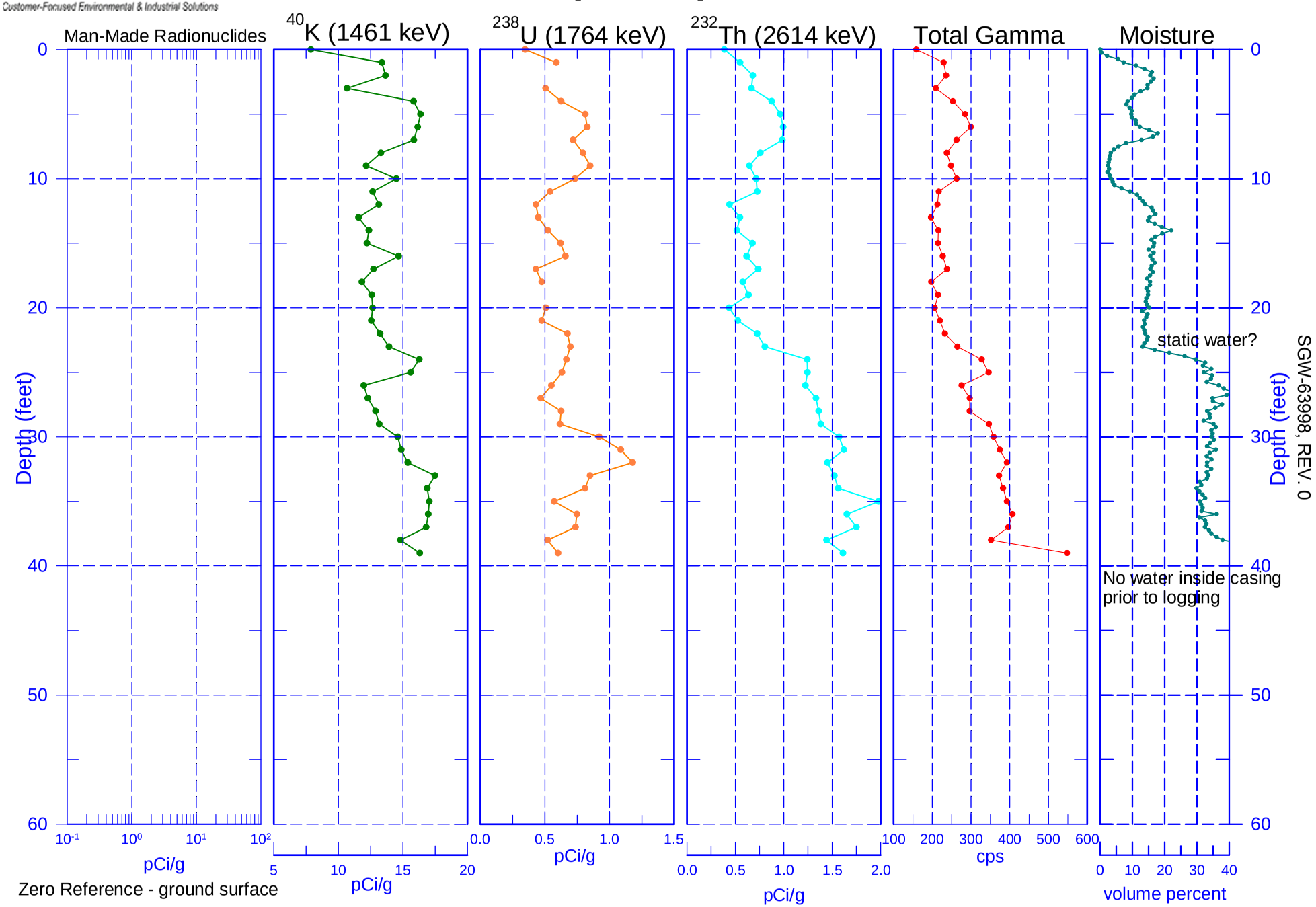
Zero Reference - ground surface

699-77-34B (C9877)
Natural Gamma Logs



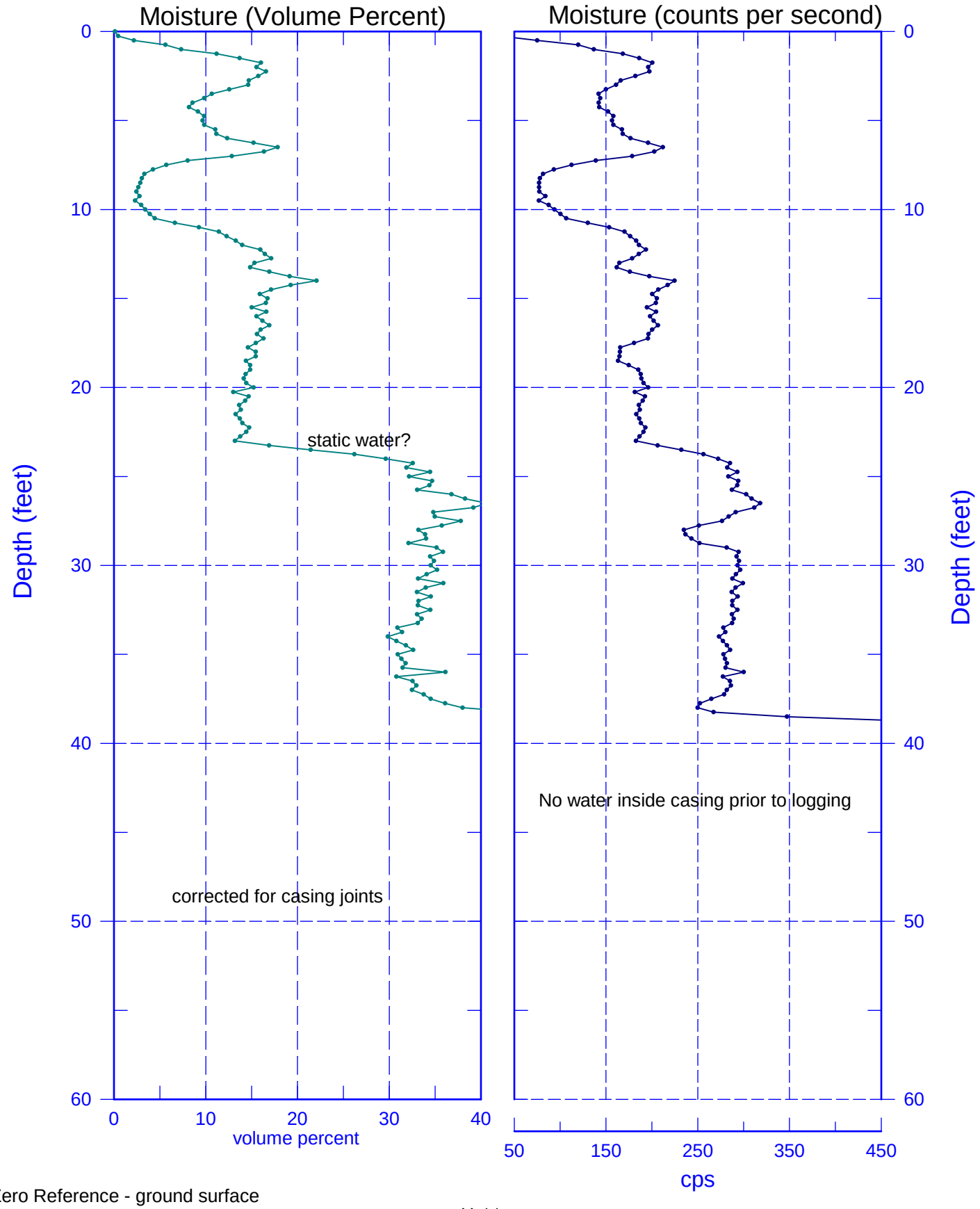
Zero Reference - ground surface

699-77-34B (C9877) Combination Plot



699-77-34B (C9877)

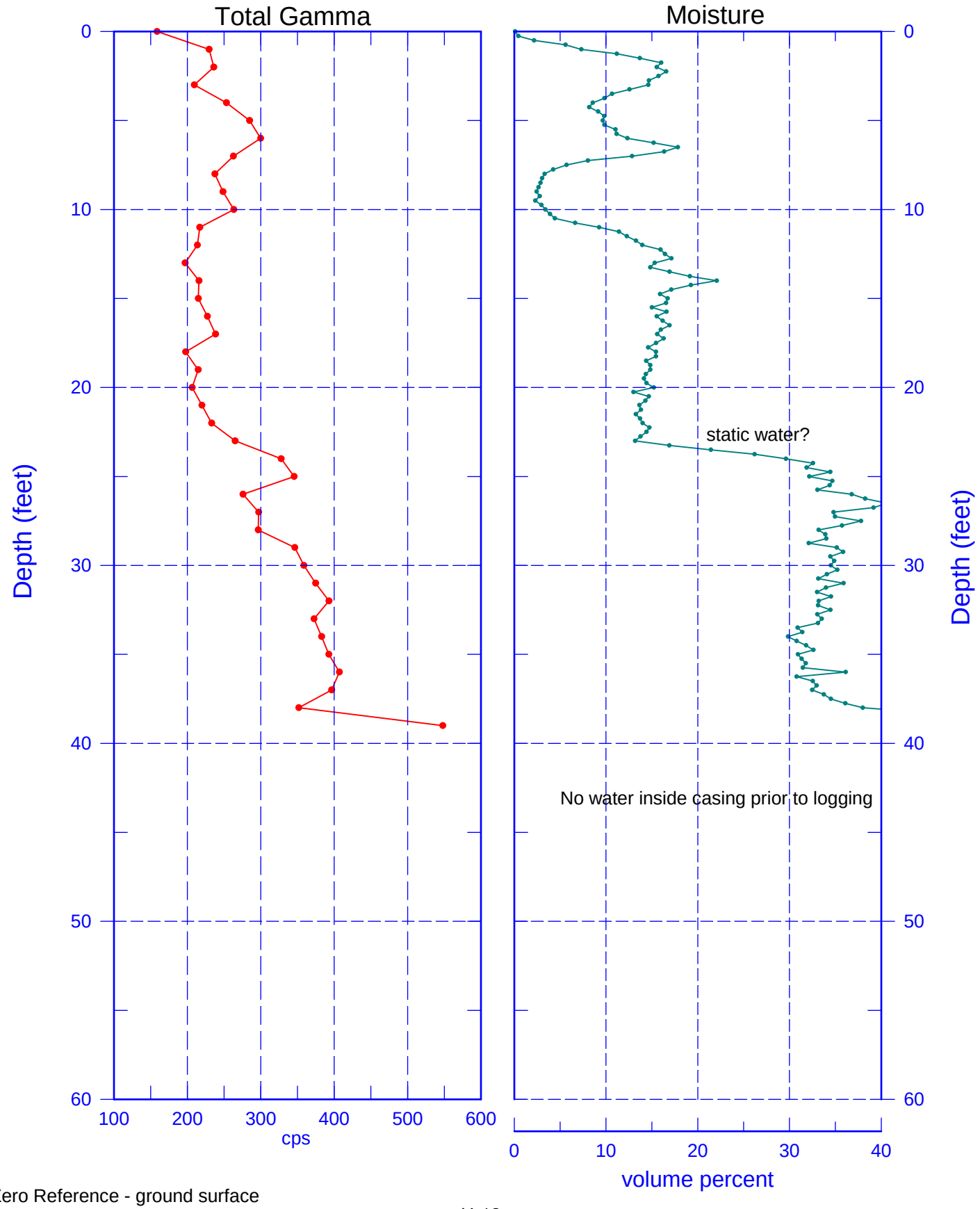
Moisture



Zero Reference - ground surface

699-77-34B (C9877)

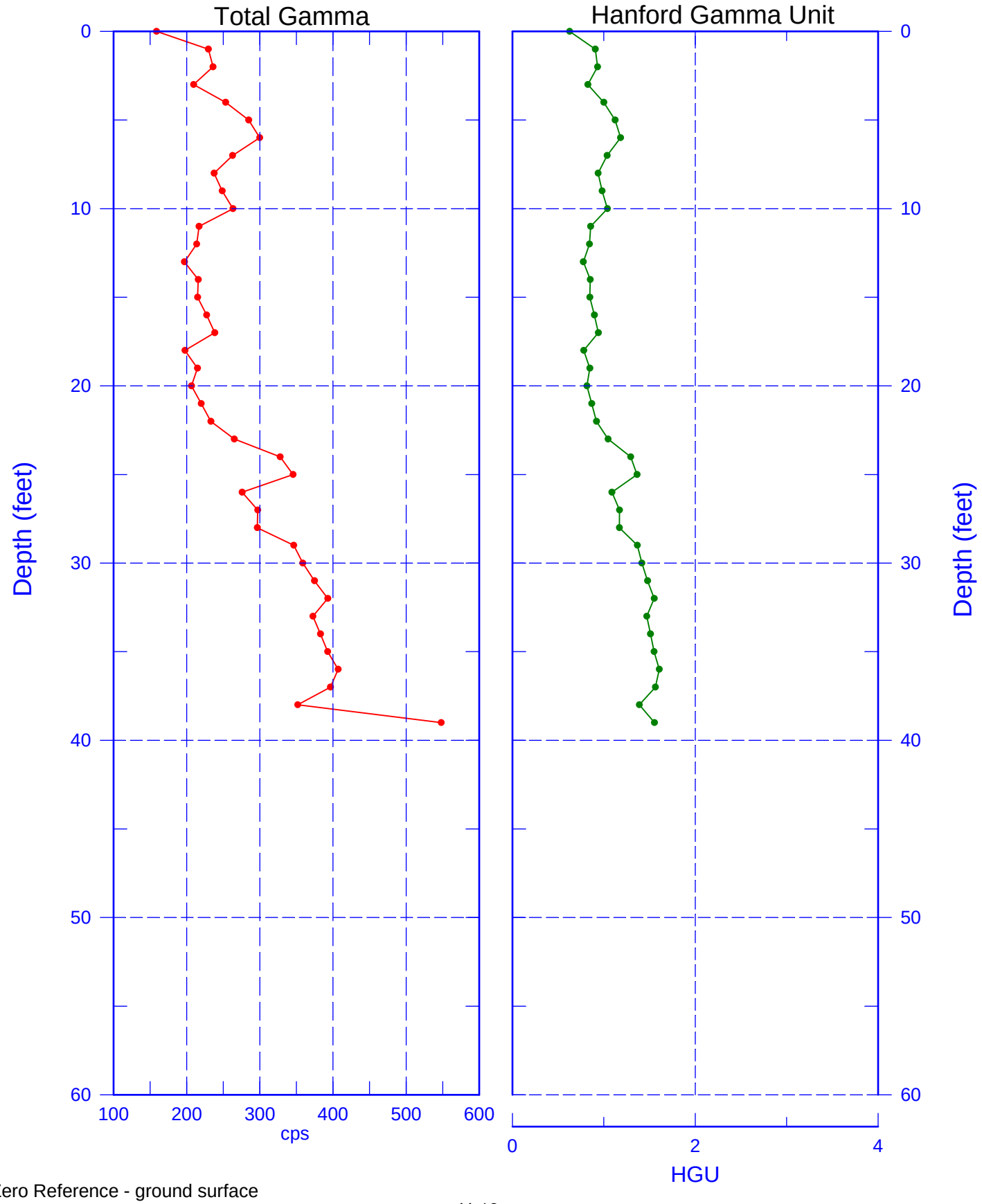
Total Gamma & Moisture



Zero Reference - ground surface

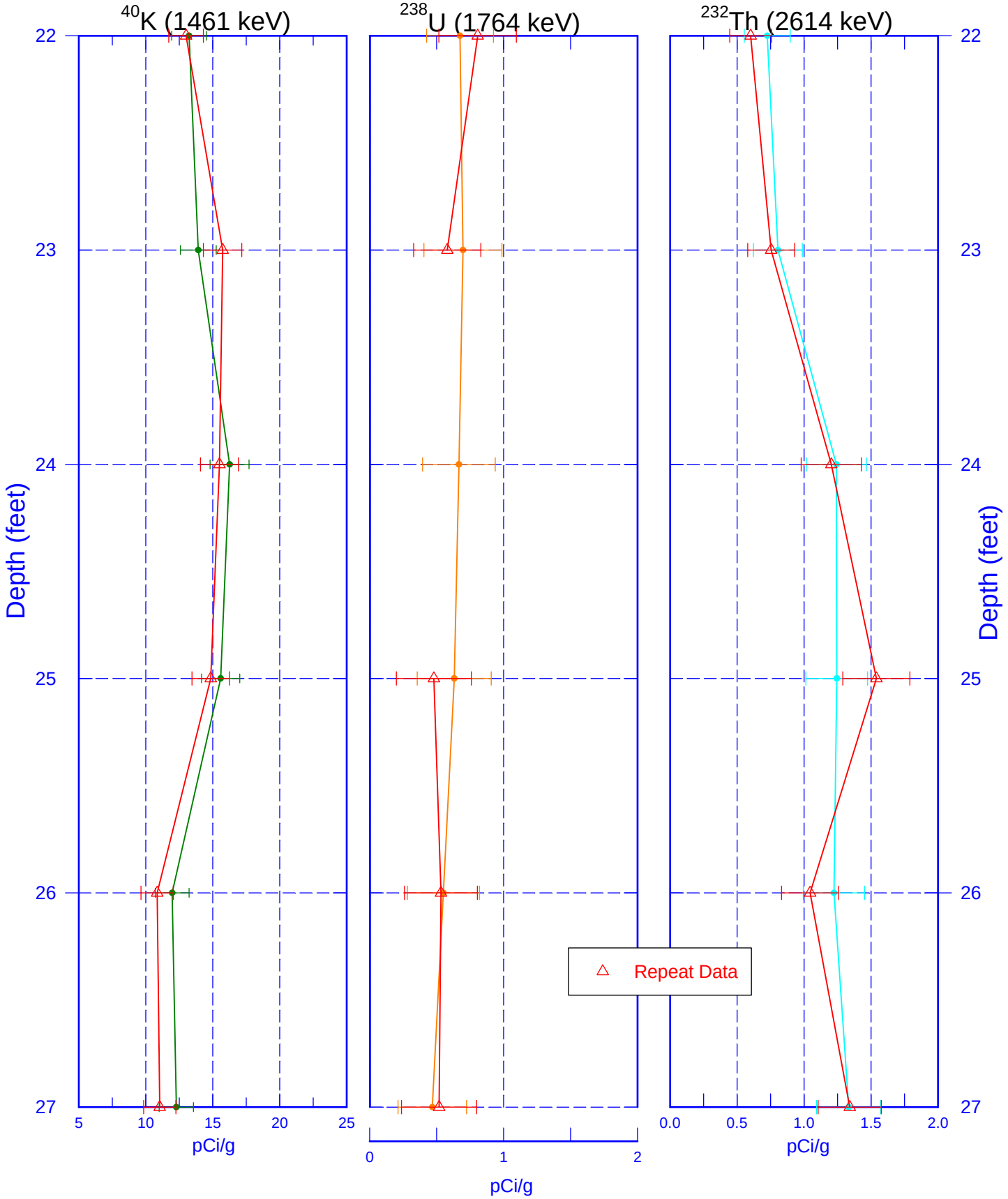
699-77-34B (C9877)

Total Gamma & Hanford Gamma Unit



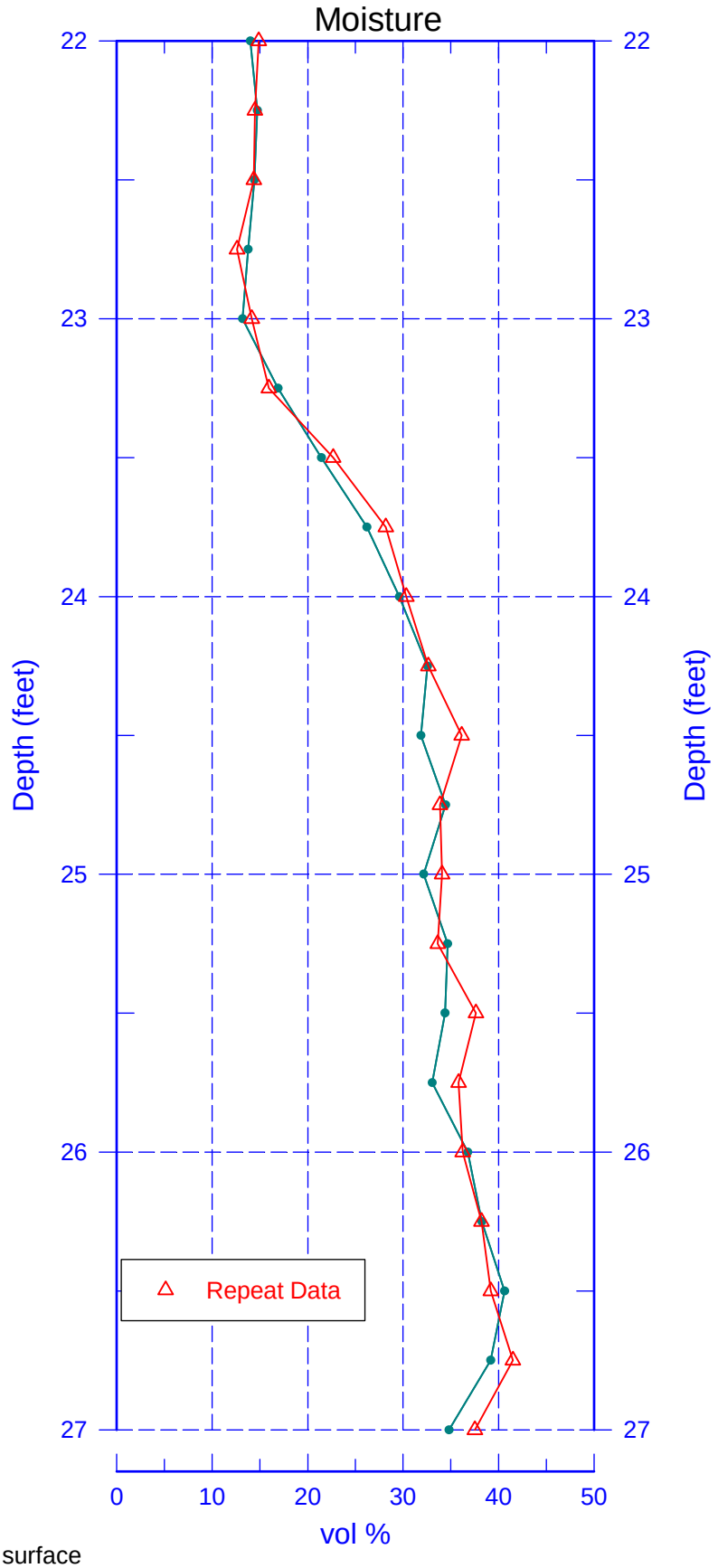
Zero Reference - ground surface

699-77-34B (C9877)
Repeat Section of Natural Gamma Logs



Zero Reference - ground surface

699-77-34B (C9877)
Moisture Repeat Section



Zero Reference - ground surface

This page intentionally left blank.

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 08/20/19	Requestor: James D. Mehrer (CHPRC)
Date of Survey: 10/03/19	Surveyor / Company: Lawrence B. Munnell / CHPRC
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of FR-3 Well C9877 (699-77-34B) located southwest of 100F 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:

L324 (COE) and HSWB-023 (COE)

Well ID	Well Name	Easting	Northing	Elevation	
C9877	699-77-34B	579538.04	146970.73		Center of Casing
				119.655	Top Inner 4"Casing, N.Edge
				119.957	Top Outer Casing,N.Edge Stamped "X"
				119.265	Brass Survey Marker

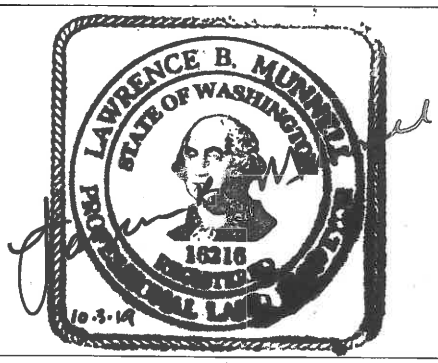
Notes:

Brass Survey Marker elevation was taken on top south edge of flat 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.



This page intentionally left blank.

WELL DEVELOPMENT AND TESTING DATA

Well ID: C9877	Well Name: 699-77-34B	Date: 8/19/19

Location: 1 km SW of F Reactor

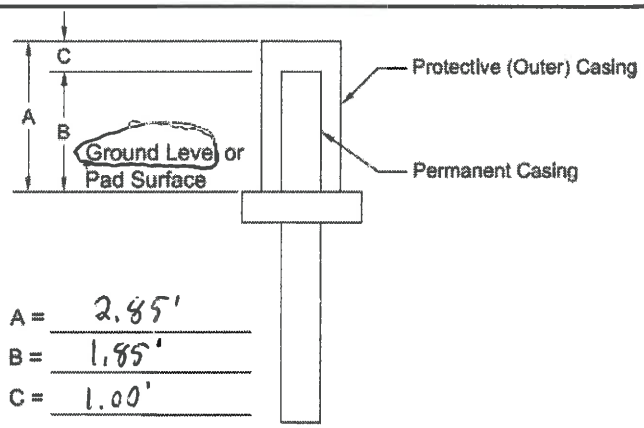
Reference Measuring Point *(unless otherwise noted)*: TOP OF OUTER CASING (TOC)

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: 8/1/19	14.0' bgs	N/A
Date: 8/12/19	N/A	13.8' bgs
DEPTH TO BOTTOM:		
Date: 8/1/19	24.5' bgs	N/A
Date: 8/12/19	N/A	24.3' bgs



A = 2.85'
B = 1.85'
C = 1.00'

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)
21.5	1.79	DC 8/19/19 ~~21.3~~ 7.89	17.8	6.33	1457	1622	6.0	3.36
21.5	1.93	~~21.3~~ 7.22 DC 8/19/19	3.73	1.10	0804	0920	5.45	2.83
				Not Used				
			8/19/19	8/19/19				

Total Pumped: 912.2 gal

Pump Model: Grundfos 96160180 240v 1HP

Troll Serial Number and Pressure Range (PSI and depth): S/N: 403065, range: 70m/231ft/99.6 psi, In-Situ Levelt~~roll~~ troll

Comments: bgs = below ground surface

Test names: C9877-develop-080119, C9877-development-080519

Prepared By:

Dan Charbonneau — Print Name | Signature | 8/19/19 — Date

Reviewed By:

Jennifer Richart — Print Name | Signature | 9/4/19 — Date

For Office Use Only

OR Doc Type:	WMU Code(s):

This page intentionally left blank.

C9877 Archive Photos

0-5 ft bgs

5-10 ft bgs

10-15 ft bgs

15-20 ft bgs

20-24 ft bgs

24-25 ft bgs

25-30 ft bgs

30-25 ft bgs

35-36 ft bgs