

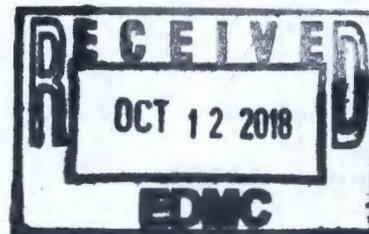
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Borehole Summary Report for the Installation of Five M-24 Groundwater Monitoring Wells, FY2014

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**
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Richland, Washington 99352



Approved for Public Release;
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Borehole Summary Report for the Installation of Five M-24 Groundwater Monitoring Wells, FY2014

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Release Approval

Date

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Terms

ags	above ground surface
bgs	below ground surface
CERCLA	<i>Comprehensive Environmental Response, Compensation, and Liability Act of 1980</i>
CCU	Cold Creek Unit (caliche)
CHPRC	CH2M Hill Plateau Remediation Company
DOE	U. S. Department of Energy
DOW	Description of Work
dpm	disintegrations per minute
Ecology	Washington State Department of Ecology
ERDF	Environmental Restoration and Disposal Facility
ft	feet
gpm	gallons per minute
HCl	Hydrochloric acid
hp	horse power
ID	inner diameter
IH	Industrial Hygentist
in	inch
mm	millimeter
NCO	Nuclear Chemical Operator
NMLS	Neutron Moisture Logging System
NTU	nephelometric turbidity unit
OD	outer diameter
OU	operable unit
ppm	parts per million
PVC	polyvinyl chloride
RCRA	<i>Resource Conservation and Recovery Act of 1976</i>
RCT	radiological control technician
Ringold Unit A	Ringold Formation member of Wooded Island Unit A
Ringold Unit E	Ringold Formation member of Wooded Island Unit E
RLM	Ringold Formation Lower Mud Unit
RMA	radioactive material area
SGLS	Spectral Gamma Logging System
TD	total depth
VOC	Volatile Organic Compound
WAC	<i>Washington Administrative Code</i>
WMA	Waste Management Area

Metric Conversion Chart

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

1 Introduction

This Borehole summary report is written to provide a general overview of the well drilling and construction activities that were performed during the installation of five new groundwater monitoring wells at the Hanford Site. The new monitoring wells are located in the 200-UP-1 Groundwater Operable unit (OU) of the 200 West Area, and the 200-BP-5 OU and 200-PO-1 OU of the 200-East Area of the Site. The document controlling the installation of the new wells is SGW-57811, *Description of Work for the Installation of Five Groundwater Monitoring wells to support M-24 TPA Work in FY2014*. A map of the Hanford site for reference is shown in Figure 1-1.

The wells were drilled, constructed, and developed during the period of July 23, 2014 through January 19, 2015 by StillWater, LLC under the direction of CH2M HILL Plateau Remediation Company (CHPRC). Well-site geology and well drilling and construction documentation services were provided by GRAM, Inc. and Stoller Newport News Nuclear (SN3) provided geophysical logging services.

1.1 Purpose and Scope

The installation of these five wells supports Ecology et al., (1989), Hanford Federal Facility Agreement and Consent Order (hereinafter referred to as the Tri-Party Agreement) and will be in compliance with both Resource Conservation and Recovery Act of 1976 (RCRA) and Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The M-24 TPA milestone requires the installation of groundwater monitoring wells to improve or supplement groundwater monitoring networks across the Hanford Site. Four of these wells were replacement wells and one was a new well. In the 200 West Area wells 299-W18-260 (C8925) and 299-W22-113 (C8943) were drilled to replace existing wells that have gone dry or are going dry. The reason for the existing wells going dry is due to the declining water table. Well C8925 located near Waste Management Area (WMA) U replaced well 299-W18-30 (A4942). Well C8943 located near WMA S-SX replaced well 299-W22-49 (B8813).

In the 200 East Area wells 299-E25-237 (C8922) and 299-E33-360 (C8923) were drilled to replace previously existing wells. Well C8922 located south of WMA A-AX and southwest of the 242-A Evaporator replaced well 299-E25-236. Well C8923 located north of WMA BY replaced already decommissioned well 299-E33-18. Well 299-E33-18 was decommissioned because it was *Washington Administrative Code* (WAC) non-compliant, the well extended through the perched water zone, and it was believed that it was an accelerator for contamination of the perched zone entering the confined aquifer. Well 299-E33-361 (C8924) is a new multi-purpose monitoring well drilled southeast of WMA BY.

Table 1-1 provides the well names, well identification numbers, Washington State Department of Ecology (Ecology) well tag numbers, and drilling dates of the five wells presented in this report. Well Summary Sheets, Borehole Logs, Geophysical Log Data Reports, Variance to Construct, photo logs, and Final Civil Survey Reports for each well, if applicable, can be found in Appendices A (C8922), B (C8923), C (C8924), D (C8925), and E (C8943) respectively. Well locations can be found in Figure 1-2.

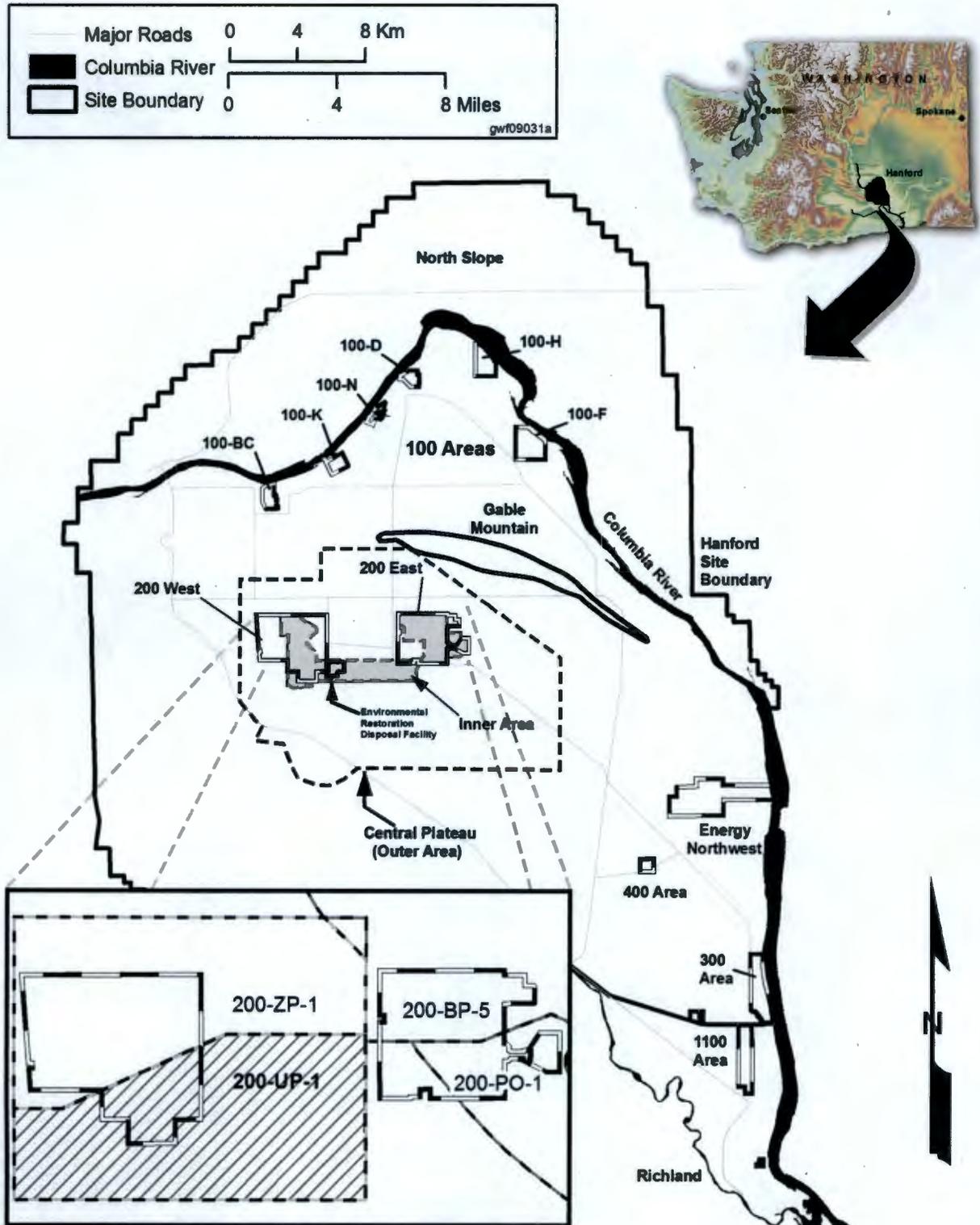


Figure 1-1 Hanford Site Map indicating the 200 Areas

Table 1-1 Project Well Identification and Drilling Date Summary

Well ID Number	Well Name	Drilling Date		Washington Department of Ecology Well Tag
		Start	Finish	
C8922	299-E25-237	November 10, 2014	January 19, 2015	BIN 147
C8923	299-E33-360	July 23, 2014	October 29, 2014	BIF 391
C8924	299-E33-361	August 13, 2014	November 5, 2014	BIF 390
C8925	299-W18-260	August 20, 2014	November 25, 2014	BIN 148
C8943	299-W22-113	July 23, 2014	October 8, 2014	BIF 362

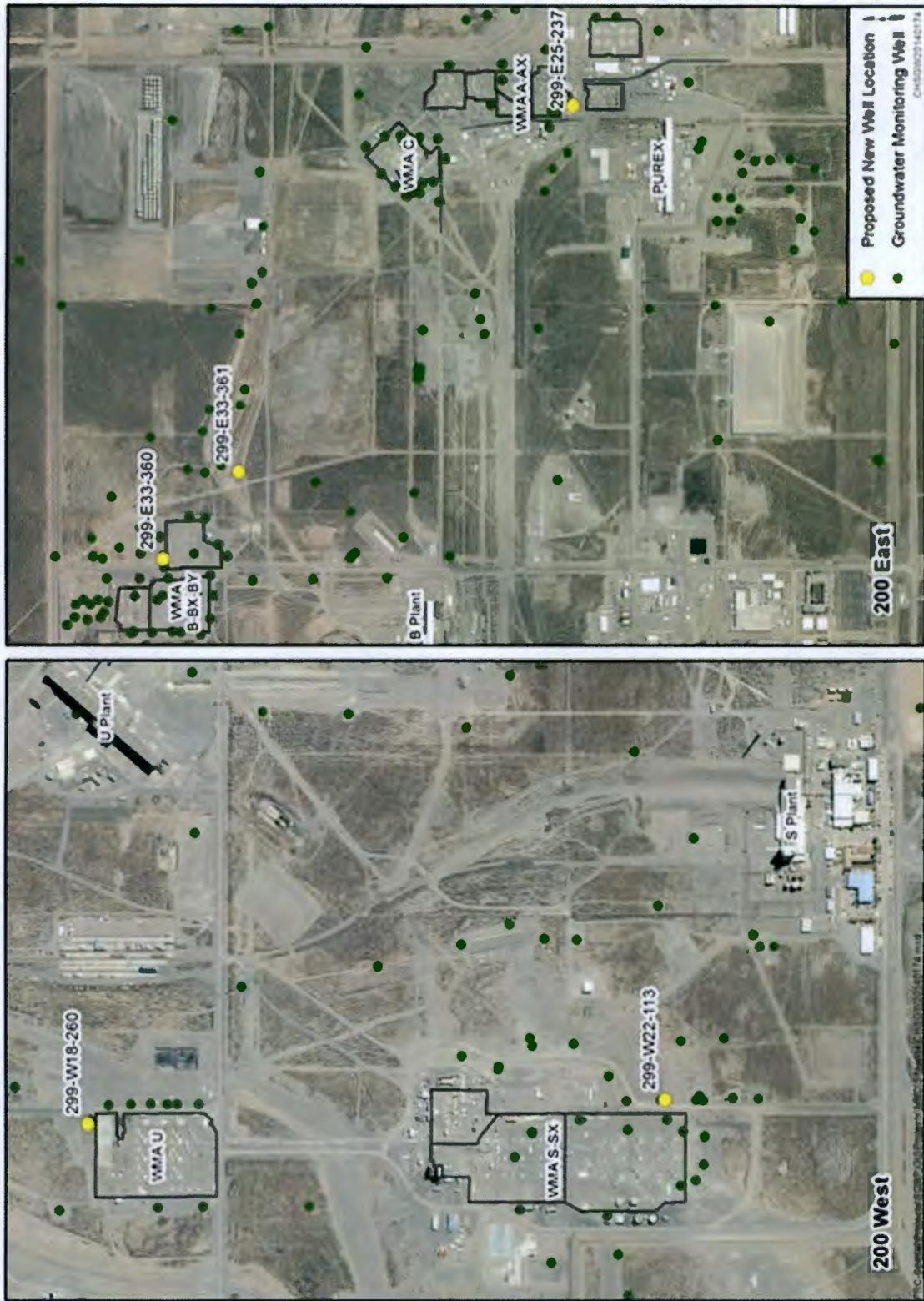


Figure 1-2 Location of Wells Drilled in the 200-East and 200-West Areas

2 Drilling, Sampling, and Well Construction Activities

This section is a summary of the field activities associated with wells 299-E25-237 (C8922), 299-E33-360 (C8923), 299-E33-361 (C8924), 299-W18-260 (C8925), and 299-W22-113 (C8943).

2.1 General Information

With the exception of the well construction variance discussed in this section and in Section 2.2.3, the new wells were constructed in compliance with WAC 173-160, *Minimum Standards for Construction and Maintenance of Wells*, and the CHPRC construction specifications in SGW-57811. Well drilling and construction activities were documented and borehole geology was logged in accordance with CHPRC procedures SGRP-PRO-EN-50030 (GRP-EE-02-14.1), *Drilling, Remediating, and Decommissioning Resource Protection Wells, and Geotechnical Soil Borings*, and SGRP-PRO-EN-50025 (GRP-EE-01-7.0), *Geologic Logging*. Sampling activities for this project are outlined in DOE/RL-2014-30, *Sampling and Analysis Plan for Installation of Single-Shell Tank Waste Management Area S-SX RCRA Monitoring Well 299-W22-113 and Single-Shell Tank Waste Management Area U RCRA Monitoring Well 299-W18-260* and SGW-57810, *Sampling Instruction for Conceptual Model Refinement during the Drilling of Wells 299-E25-237, 299-E33-360, and 299-E33-361 in 200 East*. A variance was obtained from Ecology for the construction of C8924 to allow for a natural formation cave in. The referenced well construction variance is included in Appendix C.

2.1.1 Drilling, Sampling and Borehole Logging

Drilling – The drilling activities of each borehole occurred in two stages. Each borehole was drilled with either a Bucyrus Erie 22-W or a Bucyrus Erie 60L cable-tool drill rig, operated by StillWater, LLC to install the starter casing. Drilling of the starter casing was performed using 8 ⁵/₈-inches (in) to 11-in drive barrel drill bits, and carbon steel temporary starter casing of either 11 ³/₄-in or 13 ⁷/₁₆-in outer diameter (OD), with casing size based on the design of the well.

Following installation of the starter casing, secondary carbon steel temporary casing of either 8 ⁵/₈-in or 11 ¹⁵/₁₆-in OD was used based on the design of the well, to reach a predetermined total depth (TD) or to the basalt. The casing was telescoped within each borehole to facilitate drilling. Each borehole was drilled with a drive barrel drill bit ranging in diameter from 5 ⁷/₁₆-in to 9 ³/₄-in. All temporary casing was removed from the boreholes during well construction.

Sampling – In accordance with the DOW (SGW-57810) and CHPRC procedures previously mentioned, geologic archive grab samples were collected at 5-ft intervals and at major lithology changes throughout each of the boreholes. Archive samples were placed in labeled pint-sized glass mason jars and labeled chip tray compartments for storage. Additional grab samples were collected from the aquifer at all wells as dictated by the DOW for sediment size distribution samples (hereinafter referred to as sieve samples). These samples were collected at 5-ft intervals and composited into one sample. Sieve analyses were performed to indicate sediment size distributing following SGRP-PRO-OP-50037 (GRP-EE-05-1.21), *Particle Size Distribution of Soil- Wet Sieve Analysis*.

Groundwater samples were collected from four of the five boreholes during drilling in the saturated zone. When more than one water sample was requested, water samples were collected in 20-ft intervals. Soil samples were collected at two of the five boreholes, using a split spoon sampler, during drilling. At three of the boreholes a waste grab sample was collected at the top 5 ft of the aquifer for waste profile characterization. In accordance with the DOE/RL-2014-30, SGW-57810, and SGRP-PRO-SMP-50060 (GRP-FS-04-G-028), *Field Characterization and Treatment Monitoring Activities Groundwater Sampling* all samples were collected by CHPRC Nuclear Chemical Operators (NCO).

Geophysical Logging –Geophysical logging was conducted by the CHPRC subcontractor, SN3. All boreholes were logged using a Spectral Gamma Logging System (SGLS) to identify natural and man-made gamma-emitting radionuclides and a Neutron Moisture Logging System (NMLS) to detect moisture within the vadose zone. A casing string was logged prior to downsizing the casing and after drilling was completed.

2.1.2 Health and Safety Screening

Radiological Field Screening – Prior to drilling, four of the five proposed well locations were identified as having a “low radiological hazard potential” in the vadose zone by CHPRC’s Radiological and Safety organization. For the Four wells C8922, C8924, C8925, and C8943 radiological surveys were conducted twice daily, once in the morning and once in the afternoon, during drilling until water was encountered or until a known contaminated depth was encountered on C8922. Once water was encountered continuous radiological coverage was required for all wells.

Well C8923 required full time radiological coverage throughout the entire drilling and construction process. It was expected to see radiological contamination at this well based on surrounding wells. A radiological control technician (RCT) performed radiological surveys of the drill cuttings, geologic samples, temporary casing, samples, development pumps, gloves, drill rig, and driller’s control station using standard radiological field screening instruments.

During drilling and well construction activities radiological contamination was encountered at C9822 and C8923. The details are discussed in Section 2.2.

Air Monitoring for Volatile Chemicals – Air quality monitoring was performed twice daily, once in the morning and once in the afternoon, to check for volatile organic compound (VOC) contamination. Using a photo ionization detector, areas that were monitored for VOCs include the drillers’ breathing zone near the wellhead, at the well head, any fresh drill cuttings, and geologic samples.

Varying amounts of VOCs were detected during drilling activities at C8922, C8923, and C8925. Details are discussed in Section 2.2.

2.1.3 Well Construction and Development

Screen and Casing Materials – The wells were constructed of 8-in inner diameter (ID) or 4-in ID casing. Casing was one of schedule 10, Type 304/304L stainless steel blank, schedule 10, Type 316/316L stainless steel blank or schedule 40 polyvinyl chloride (PVC) blank casing. Screens were either schedule 10, Type 316/316L or schedule 10, Type 304/304L continuous wire-wrap, stainless steel screen. One of the following slot openings were used for the five wells; 20-slot (0.020-in slot opening), 40-slot (0.040-in slot opening), or 65-slot (0.065-in slot opening). Either a 3-ft sump or a cap of schedule 10, Type 316/316L or Type 304/304L stainless steel was used below the screen.

The construction materials for each well will be discussed in greater detail in Section 2.2.

Well Completion – The lower portion of the boreholes C8922 and C8925 were abandoned using 0.75-in bentonite chunks prior to installing the well screen and permanent casing in the boreholes.

The filter pack size was determined by the sieve samples, geologic borehole logs, and intended well use. Both C8922 and C8943 have a filter pack consisting of 10-20 mesh Silica Sand. Both C8923 and C8924 have a filter pack consisting of 8-12 mesh Silica Sand. C8925 has a filter pack consisting of 10-20 mesh Silica Sand and 16-30 mesh Silica Sand. During placement of the filter pack, at 10 ft intervals the screen was surged using a dual surge block. The filter pack level was monitored while surging to make sure that overlap between the temporary casing and the sand was maintained and to achieve CHPRC well

development specifications. Well development specifications are defined as the sand settling less than 0.10 ft in 15 minutes of surging.

The annular seals for C8922, C8924, C8925, and C8943 were constructed with a combination of 0.375-in bentonite pellets, medium bentonite chips, 8-20 mesh #8 granular bentonite (crumbles) and 0.75-in bentonite chunks and were placed immediately above the primary filter pack to approximately 10 ft bgs. Placed directly above the bentonite seal to approximately 2 ft bgs was the cement surface seal. The annular surface seal consisted of Type I-II Portland Cement grout. The final few feet, as well as the well pad were constructed with High Strength Concrete.

C8923 was constructed with 0.375-in bentonite pellet seal followed by a cement seal of Type I-II Portland Cement to seal off the lower water table from the perched water table. Following the cement seal another bentonite seal of medium bentonite chips was added to approximately 10 ft bgs. The Type I-II Portland Cement grout surface seal was placed directly above the bentonite seal to approximately 2 ft bgs. The final two feet, as well as the well pad, was constructed with High Strength Concrete.

The permanent casing was surrounded by either a 10-in ID or 6-in ID stainless steel outer protective monument with the Ecology unique well number on it. A 6-in thick concrete pad constructed was built around the wellhead. The concrete pad for each well was 4 ft by 4 ft and a brass marker indicating the well name and ID was embedded in the pad. The monument has a cap that is able to be locked. The wellhead was protected by 3-in diameter steel posts. These posts were set at each corner of the cement pad with a 3-ft stick up as required by the CHPRC well design specifications outlined in the Statement of Work (REQ-002681-12, *The Installation of Four Tri-Party Agreement M-24 Wells, Plus One Optional Well FY 2014*).

For construction details see section 2.2.

Final Well Development – After construction of each well was completed, final well development began using an electric submersible pump. Each well was separated into 20 ft development intervals and water was pumped while water quality parameters (turbidity, conductivity, pH, and temperature) were taken. Completion of a development interval was indicated when the turbidity read less than 5 nephelometric turbidity units (NTU) and the remaining water quality parameters stabilized. Development was performed in accordance with CHPRC procedure SGRP-PRO-OP-50024 (GRP-EE-01-6.3), *Well Development and Testing*. An In-Situ Inc. LevelTROLL®¹ 700 pressure transducer/data logger was used to record the drawdown during development and recovery once the pump was turned off. See Table 2-1 for final water quality data for each well interval.

Washington State Department of Ecology Well Identification – Each well received an Ecology unique state well identification number that was embossed onto a tag. All well identification tags were fixed to the protective monument. When the monuments were set all identification tags were set facing north. Identification numbers and their associated well can be found in Table 1-1.

2.2 Well-Specific Information

This section summarizes the drilling, air monitoring, sampling, geophysical logging, construction, radiological monitoring, variances, and development activities specific to each well. Well development information can be found in Table 2-1. Well completion, construction, and sample information are summarized in Tables 2-2 through 2-11.

¹ In-Situ Inc. LevelTROLL® is a registered trademark of In-Situ, Inc.®, of Ft. Collins, CO.

Table 2-1 Well Development Data Summary

Well ID Number	Date Developed	Initial Water Level (ft bgs)	Pump Intake Depth (ft bgs)	Duration Pumped (minutes)	Average Flow Rate (gpm)	Maximum Drawdown (ft)	Final Turbidity (NTU)	Specific Conductance (µS/cm)	pH	Temperature (C)	Total Gallons Pumped
C8922	1/19/2015	295.36	317.42	39	20.970	0.12 ^a	2.76	626	8.08	17.3	~820
C8922	1/19/2015	295.36	302.46	28	23.070	0.06 ^a	0.86	614	8.08	17.6	~650
C8923	10/29/2014	255.86	259.11	75	30.000	0.12	0.35	2050	7.69	17.5	~2,280
C8924	11/4/2014	252.7	265.0	75	65.000	0.02	0.26	828	7.93	18.6	~5,000
C8925	11/24/2014	237.0	264.78	211	10.000	13.48	4.15	380	8.24	17.99	~2,110
C8925	11/25/2014	237.0	254.77	214	12.000	2.58	2.69	384	8.14	16.6	~2,570
C8943	10/7/2014	232.7	243.00	304	6.250	0.78	5.01 ^b	361	7.95	19.60	~3,610
C8943	10/7/2014	232.7	253.00	700	6.395	9.47	8.76 ^b	376	8.03	19.66	~5,170

- a. These numbers represent a rise in water level instead of a drawdown. This may be an error in the Troll settings or the well may be producing more water than can be pumped to the surface.
- b. These turbidity values did not meet the requirements but were give a pass by the Buyers Technical Representative (BTR) due to the conditions of the development.

gpm = gallons per minute

ft bgs = feet below ground surface

2.2.1 Well 299-E25-237 (C8922)

Well 299-E25-237 (C8922) was installed between November 10, 2014 and January 19, 2015. The borehole was drilled to a total depth of 374.78 ft bgs.

Drilling began on November 10, 2014 using a Bucyrus Erie 60L drill rig. The temporary casing used was 11 ⁷/₈-in outer diameter (OD) carbon steel, box threaded casing. It was drilled using a 9 ¹¹/₁₆-in OD drive barrel drill bit to advance the casing to 208.66 ft bgs on November 17, 2014. The casing was downsized to 8 ⁵/₈-in OD carbon steel, box threaded casing. This casing was advanced to 373.78 ft bgs on December 23, 2014, using four different drive barrel drill bits ranging from 5 ⁷/₁₆-in OD to 6 ¹⁵/₁₆-in OD. A hard tool drill bit of 6 ¹/₂-in OD was also used to advance the borehole at one point.

A concentration of VOCs was detected above action levels during drilling activities at C8922. A level of 7.1 parts per million (ppm) was measured while drilling on November 20, 2014, but was determined to be a non-issue by the industrial hygienist (IH) organization.

Sampling at C8922 included soil samples collected for geologic archive purposes, soil samples collected for chemical analysis (hereinafter referred to as split spoons), water samples collected for chemical analysis, and sieve samples. All samples collected for chemical analysis were collected by NCOs. Geologic samples were collected by the field geologist at 5-ft intervals and at lithology changes throughout the borehole. Water was encountered at 295 ft bgs on December 1, 2014. Water sample I-011 was not collected because an impermeable formation prevented recharge. Water sample I-012 was collected as a bail sample because of slow recharge rate that would not allow for pumping.

For sample information see Table 2-2.

A geophysical survey using SGLS and NMLS was conducted on November 18, 2014 from ground surface to 209 ft bgs through the 11 ⁷/₈-in OD casing. Another geophysical survey was taken from 208 ft bgs to 374 ft bgs using SGLS and NMLS on December 29, 2014 through the 8 ⁵/₈-in OD casing. The Log Data Report by SN3 for C8922 is included in Appendix A.

Well completion operations were initiated on January 5, 2015 with extended depth borehole abandonment from 374.78 ft bgs to 332.3 ft bgs. A straightness test was then conducted using a 21.5 ft long, 6 ⁵/₈-in OD tester and passed through the borehole without binding. The well was set using 4-in ID schedule 10S type 316 Stainless steel Sump and Screen and 4-in ID schedule 40 PVC blank casing. A total of 35.00 ft of type 316 stainless steel screen with 0.020-in apertures was used. Stainless steel centralizers were used; and placed at the bottom and top of the screen, as well as in 40-ft intervals above the screen. Well construction materials and associated depths are summarized in Table 2-3.

Table 2-2 Sample Summary: Well 299-E25-237 (C8922)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
11/24/2014	I-001 A-D	260.40 – 261.90	Soil	Split Spoon	B2YPH1, B2YPH2, B2YPH3, B2YPH4
11/24/2014	I-002 A-D	262.85 – 264.85	Soil	Split Spoon	B2YPH5, B2YPH6, B2YPH7, B2YPH8
11/25/2014	I-003 A-D	265.10 – 267.10	Soil	Split Spoon	B2YPH9, B2YPJ0, B2YPJ1, B2YPJ2
11/25/2014	I-004 A-D	267.90 – 269.90	Soil	Split Spoon	B2YPJ3, B2YPJ4, B2YPJ5, B2YPJ6
11/25/2014	I-005 A-D	270.20 – 272.20	Soil	Split Spoon	B2YPJ7, B2YPJ8, B2YPJ9, B2YPK0
11/25/2014	I-006 A-D	272.80 – 274.80	Soil	Split Spoon	B2YPK1, B2YPK2, B2YPK3, B2YPK4
11/25/2014	I-007 A-D	275.60 – 277.60	Soil	Split Spoon	B2YPK5, B2YPK6, B2YPK7, B2YPK8
11/25/2014	I-008 A-D	278.90 – 280.90	Soil	Split Spoon	B2YPK9, B2YPL0, B2YPL1, B2YPL2
12/3/2014	I-009	310.50	Water	Pump	B2YPL3, B2YPL4, B2YPL5
12/4/2014	I-010	326.08	Water	Pump	B2YPL6, B2YPL7, B2YPL8
12/15/2014	I-012	366.19	Water	Bailer	B2YPM5, B2YPM6, B2YPM7
12/15/2014	I-012 DUP	366.19	Water	Bailer	B2YPM2, B2YPM3, B2YPM4

Table 2-3 Construction Summary: Well 299-E25-237 (C8922)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	4-inch Diameter, Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
374.78	295.36	PVC Blank	+1.98 – 291.00	N/A	Concrete	0.0 – 2.8	N/A
		Stainless Steel Screen	291.00 – 326.00	20	Portland Cement	2.8 – 10.42	Type I/II
		Stainless Steel Sump	326.00 – 329.02	N/A	Bentonite Chips	10.42 – 37.79	Medium
		Bentonite Chunks	37.79 – 46.36			37.79 – 46.36	¾-in
		Bentonite Crumbles	46.36 – 74.76			46.36 – 74.76	8-20
		Bentonite Chips	74.76 – 259.23			74.76 – 259.23	Medium
		Bentonite Crumbles	259.23 – 285.43			259.23 – 285.43	8-20
		Bentonite Pellets	285.43 – 287.27			285.43 – 287.27	¾-in
		Colorado Silica Sand	287.27 – 332.3			287.27 – 332.3	10-20
		Bentonite Pellets	332.3 – 334.1			332.3 – 334.1	¾-in
		Bentonite Chunks	334.1 – 372.04			334.1 – 372.04	¾-in
Natural fill	372.04 – 374.78			372.04 – 374.78	N/A		

Radiological monitoring while back pulling casing for construction found contamination on one piece of the 8 5/8-in OD casing. Readings were found to be 3,000 disintegrations per minute (dpm) direct beta/gamma fixed. The casing was placed in a radioactive material area (RMA) to be disposed of.

Well development at C8922 was performed on January 19, 2015 in accordance with SGRP-PRO-OP-50024. A 3-horsepower (hp) temporary submersible pump was used for two development intervals of no greater than 20 ft. The geologist would take water quality parameter readings during development. Development continued until turbidity readings read less than 5 NTUs and the other parameters stabilized. A total of 1,464 gallons of water was removed during development. Results of development intervals are summarized in Table 2-1.

2.2.2 Well 299-E33-360 (C8923)

Well 299-E33-360 (C8923) was installed between July 23, 2014 and October 29, 2014. The borehole was drilled to a TD of 272.8 ft bgs.

On July 11, 2014 drilling began on C8923 using a Bucyrus Erie 60L drill rig. The casing used was 13 ⁷/₁₆-in OD carbon steel, box threaded casing. This casing string was advanced to a depth of 237.97 ft bgs using a 9 ⁵/₈-in OD drive barrel drill bit. The casing was downsized to 11 ¹⁵/₁₆-in OD carbon steel, box threaded casing. This string of casing was advanced to 259.05 ft bgs on September 3, 2014 using a 9 ⁵/₈-in OD drive barrel drill bit. Once basalt was encountered the borehole was advanced with a hard tool drill bit of 9 ³/₄-in OD to a depth of 272.8 ft bgs on September 10, 2014. Casing was not used for this portion of the borehole.

A concentration of VOCs detected above action levels, during drilling activities at C8923. A level of 5.0 parts ppm was measured on September 9, 2014 while drilling. The readings were recorded after the drillers had used an aerosol spray near the borehole. The IH took multiple readings and found the concentration in the work zone to dissipate over time. The IH organization determined that no action was required and work could continue.

Sampling at C8923 included soil sample collecting for geologic archive purposes, split spoon samples, a water sample for chemical analysis, and a sieve analysis sample for particle size distribution testing. NCO's collected the split spoon samples and the water samples. Geologic archive soil samples were collected by the field geologist at 5-ft intervals and at lithology changes throughout the borehole where radiological readings did not exceed background readings and a RCT permitted the geologist to collect the samples. Water was encountered in the perched zone at 225.97 ft bgs on August 7, 2014. Water sample interval I-003 was bailed because of the lack of water available in the perched water zone. Water was again encountered at 254.20 ft bgs on September 2, 2014 below the perched zone. The sieve sample was collected throughout the zone of saturation from 256 ft bgs to 260 ft bgs.

For sample information see Table 2-4 next.

Table 2-4 Sample Summary: Well 299-E33-360 (C8923)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
8/7/2014	I-001 A-D	226.77 – 228.90	Soil	Split Spoon	B2XM87
8/7/2014	I-002 A-D	233.39 – 235.79	Soil	Split Spoon	B2XM91
8/11/2014	I-003	235.19	Water	Bail	B2XM79, B2XM80, B2XM81, B2XM82
8/11/2014	I-003 DUP	235.19	Water	Bail	B2XM83, B2XM84, B2XM85, B2XM86

A geophysical survey using SGLS and NMLS was performed from surface to 238 ft bgs between August 12, 2014 and August 14, 2014 through the 13 ⁷/₁₆-in OD casing. Another geophysical survey using SGLS and NMLS was performed from 237 ft bgs to 272.67 ft bgs between September 11, 2014 and September 15, 2014 through the 11 ¹⁵/₁₆-in OD casing and the open-hole basalt. The Log Data Report SN3 for C8923 is included in Appendix B.

Well completion was initiated on October 2, 2014 with a straightness test. The tester of length 20.37 ft and an OD of 8 5/8-in passed through the casing without binding but got stuck in the basalt and did not reach the bottom of the borehole. The tester was removed and hard tooling continued from October 2, 2014 to October 16, 2014 to widen and straighten the basalt portion of the borehole. Multiple hard tool bits were used.

Well construction took place between October 20, 2014 and October 28, 2014. On October 20, 2014 a final straightness test was conducted and passed all the way to the bottom of the borehole without binding. The well was constructed with 8 5/8-in. OD, schedule 10, type 304/304L stainless steel permanent blank casing and cap and schedule 10, type 316L screen. A total of 19.93 ft of type 316L stainless steel screen with 0.065-in. apertures were used. Stainless steel centralizers were used. A centralizer was placed at about 8.5 ft from the top of the screen section, roughly the contact between the gravels and the basalt once set in place. Another centralizer was placed at the top of the screen as well as in 40 ft intervals above the screen. Well construction and associated depths are summarized in Table 2-5 next.

Table 2-5 Construction Summary: Well 299-E33-360 (C8923)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	8-inch Diameter, Stainless Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
272.8	252.84	Blank	+1.97 – 251.78	N/A	Concrete	0.0 – 1.40	N/A
		Screen	251.78 – 271.71	65	Portland Cement	1.40 – 9.60	Type I/II
		Cap	271.71 – 272.18	N/A	Bentonite Chips	9.60 – 224.00	Med.
		Portland Cement	224.00 – 238.84	Type I/II			
		Bentonite Pellets	238.84 – 248.05	3/8-in			
		Colorado Silica Sand	248.05 – 272.50	8-12			
		Natural Fill	272.50 – 272.8	N/A			

Full time RCT coverage was required for C8923 as stated in the Description of Work (DOW) (SGW-57811). While sampling the RCT found elevated readings of 6,000 dpm beta/gamma on the bottom of the A liner (235.79 ft bgs) for split spoon sample I-002 collected on August 8, 2014. Appropriate actions were taken by all parties involved. During drilling on August 11, 2014 the RCT found elevated readings of 4,000 dpm on drill cuttings but no action was taken since the action level is 5,000 dpm. On August 12, 2014 the RCT found elevated fixed contamination readings of 4,000 dpm on the tools, again no action was required. While re-drilling the basalt the RCT found readings of 9,000dpm/100 square centimeters on one of the hard tool drill bits and 6,000 dpm/100 square centimeters on a second hard tool drill bit. Both hard tool drill bits were still being used at the time of the readings. During continued use of these bits, the elevated readings were reduced and no action to dispose of them was required. While constructing the

well on October 22, 2014 elevated readings of 7,000 dpm beta/gamma fixed were found on the surge block used for surging the screen. The portion of the surge block that had the elevated readings was disposed of in the ROLL-OFF box. While back pulling the 11 15/16-in OD casing on October 23, 2014, the last three pieces removed found elevated readings with a max of 6,000 dpm beta/gamma, fixed, 10,000 dpm beta/gamma, fixed, and, 118,000 dpm beta/gamma, fixed, respectively. All three pieces were sleeved and placed in the RMA to be disposed of. While back pulling the 13 7/16-in OD casing on October 28, 2014, the second to last piece of casing found elevated readings with a max of 7,000 dpm beta/gamma, fixed. On the last piece of casing to be removed from the borehole elevated readings were found with a max of 24,000 dpm beta/gamma, fixed, and 400 dpm alpha, fixed. Both pieces of casing were sleeved and placed in the RMA to be disposed of.

Well development at C8923 was performed on October 29, 2014 in accordance with procedure SGRP-PRO-OP-50024. A 3-hp temporary submersible pump was used for one interval no greater than 20 ft, to develop this well. The geologist took water quality parameter readings during development. Development continued until turbidity readings read less than 5 NTUs and the other parameters stabilized. A total of 2,280 gallons were removed during development. Results for the development are summarized in Table 2-1.

2.2.3 Well 299-E33-361 (C8924)

Well 299-E33-361(C8924) was installed between August 13, 2014 and November 5, 2014. The borehole was drilled to a TD of 277.89 ft bgs.

On August 13, 2014 drilling using a Bucyrus Erie 60L drill rig began on C8924. The casing that was used was 13 7/16-in OD carbon steel, box threaded casing. The starting casing was advanced to 64.29 ft bgs using an 11-in OD drive barrel drill bit. Casing was down sized to 11 15/16-in OD carbon steel, box threaded casing. The casing was advanced to a depth of 273.44 ft bgs on October 1, 2014 using two different drive barrel drill bits of 8 5/8-in OD and 9 3/4-in OD.

There were no concentrations of VOCs that exceeded action levels at C8924 during drilling or sampling.

Sampling at C8924 included; soil sample collection for geologic archive purposes, a soil grab sample for waste characterization, water samples for chemical analysis, and a sieve analysis sample for particle size distribution testing. The waste grab and water samples were collected by NCO's. Geologic archive samples were collected by the field geologist at 5-ft intervals and at lithology changes throughout the borehole. Water was encountered at 255.24 ft bgs on September 24, 2014.

See sample details in Table 2-6 below.

Table 2-6 Sample Summary: Well 299-E33-361 (C8924)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
9/25/2014	I-002 ^a	260.00	Soil	Grab	B2XNP3, B2XNP4, B2XNP5
9/29/2014	I-001	264.44	Water	Pump	B2XNN2, B2XNN3, B2XNN4
9/29/2014	I-001 DUP	264.44	Water	Pump	B2XNN5, B2XNN6, B2XNN7
9/30/2014	I-003	272.97	Water	Pump	B2XNN8, B2XNN9, B2XNP0

a. This sample was as a waste profile sample grab

A geophysical survey using SGLS and NMLS was conducted from ground surface to 64 ft bgs on August 15, 2014 through the 13 ⁷/₁₆-in OD casing. A second geophysical survey was conducted from 63 ft bgs to 275 ft bgs on between October 2, 2014 and October 6, 2014 through the 11 ¹⁵/₁₆-in OD casing. The Log Data Report by SN3 for C8924 is included in Appendix C.

Well completion for C8924 was initiated on October 22, 2014 with a straightness test. The tester of length 20.37 ft and an OD of 8 ⁵/₈-in passed through the casing and basalt without binding. Construction of the well took place between October 27, 2014 and November 3, 2014. The well was constructed using 8-inch ID schedule 10 Type 304 stainless steel blank casing and sump. A total of 20.01 ft of type 316 stainless steel screen with 0.065-in. apertures was used. Stainless steel centralizers were used; and placed at the bottom and top of the screen, as well as in 40-ft intervals above the screen. For construction details see Table 2-7 next.

Table 2-7 Construction Summary: Well 299-E33-361 (C8924)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	8-inch Diameter, Stainless Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
277.89	255.25	Blank	+1.40 – 253.60	N/A	Concrete	0.0 – 1.60	N/A
		Screen	253.60 – 273.60	65	Portland Cement	1.60 – 7.40	Type I/II
		Sump	273.60 – 276.60	N/A	Natural Sluff	7.40 – 10.70	N/A
		Bentonite Chips	10.70 – 66.00	Med.			
		Bentonite Crumbles	66.00 – 109.30	8-20			
		Bentonite Chips	109.30 – 245.60	Med.			
		Bentonite Pellets	245.60 -249.00	³ / ₈ -in			
		Colorado Silica Sand	249.00 – 276.0	8-12			

An Ecology approved construction variance was issued for this well. The variance was issued due to a cave in of the natural formation against the permanent well before pouring the cement seal.. A copy of the variance can be located in Appendix C.

Development of C8924 took place between November 4, 2014 and November 5, 2014 in accordance with procedure SGRP-PRO-OP-50024. A 15-hp temporary pump was used for one development interval of no greater than 20 ft. The geologist took water quality parameter readings during development. Development continued until turbidity readings read less than 5 NTUs and the other parameters stabilized. A total of 5,000 gallons of water was removed during development. Results for the development are summarized in Table 2-1.

2.2.4 Well 299-W18-260 (C8925)

Well 299-W18-260 (C8925) was installed between August 20, 2014 and November 25, 2014. The borehole was drilled to a TD of 326.3 ft bgs.

On August 20, 2014 drilling began with a Bucyrus Erie 22-W drill rig using 11 3/4-in OD, carbon steel, box threaded casing. The casing was advanced to 129.87 ft bgs using two drive barrel drill bits of 10 13/16-in and 10 9/16-in OD drive barrel drill bit. Casing was downsized to 8 5/8-inch OD carbon steel, box threaded casing. The casing was advanced to 323.12 ft bgs and the borehole was advanced to 326.3 ft bgs on October 16, 2014 using a 7-in OD drive barrel drill bit and a hard tool drill bit.

Elevated concentrations of VOCs were detected during drilling activities at C8925. On September 15, 2014 a level of 2.6 ppm at the well head was detected. After continued readings that dropped below action levels the IH organization determined the readings to be from the exhaust and drilling activities continued. During sampling operations on October 7, 2014 and on October 8, 2014 concentrations of VOCs were detected at levels of 4.5 ppm, 6.6 ppm, and 7.5 ppm. All three of these elevated readings were determined to be caused by the adhesive used on the green duct tape. The duct tape is used to strap the pump wires and data logger cable on the tremie pipe used for pumping the water. According to the IH the tape has affected VOC readings in the past. The IH organization determined no action was required and the sampling operations continued.

Sampling at C8925 included soil grab samples for geologic archive purposes, a soil grab for chemical analysis used for waste profiling, water samples for chemical analysis, and a sieve analysis sample for particle size distribution testing. The waste sample and the water samples were collected by the NCO's. The geologic grab archive samples were collected by the field geologist at 5-ft intervals and at lithology changes throughout the borehole. Water was encountered at 236.06 ft bgs on September 18, 2014. One waste characterization sample was collected in the top 5 ft of the water table on September 22, 2014. The sieve sample was collected every 5 ft within the water table (45 ft) and composited into a single sample. Water sample I-002 was bailed due to there being only 5 ft of water available for the sample.

For sample information see Table 2-8 next.

Table 2-8 Sample Summary: Well 299-W18-260 (C8925)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
9/22/2014	I-001 ^a	239.95	Soil	Grab	B2XPL9, B2XPM0, B2XPM1
9/22/2014	I-002	247.00	Water	Bail	B2XPM2, B2XPM3, B2XPM4
10/2/2014	I-003	264.90	Water	Pump	B2XPM5, B2XPM6, B2XPM7
10/8/2014	I-004	285.10	Water	Pump	B2XPM8, B2XPM9, B2XPN0
10/14/2014	I-005	289.50	Water	Pump	B2XPN1, B2XPN2, B2XPN3
10/20/2014	I-006	324.30	Water	Pump	B2XPN4, B2XPN5, B2XPN6

a. This sample was a waste profile sample grab.

A geophysical survey using SGLS and NMLS was performed from ground surface to 131 ft bgs between August 28, 2014 and August 29, 2014 through the 11 3/4-in OD casing. A second geophysical survey using

SGLS and NMLS was performed from 130 ft bgs to 324 ft bgs between October 20, 2014 and October 21, 2014 through the 8 ⁵/₈-inch OD casing. The Log Data Report by SN3 for C8925 is included in Appendix D.

Well completion for C8925 was initiated on November 6, 2014. A straightness test was run before the second geophysical logging sweep on October 20, 2014 and passed. The well was constructed using 4-in. ID Schedule 10S, type 304 stainless steel blank casing and sump. A total of 30.02 ft of type 304 stainless steel screen with 0.020-in. apertures was used. Stainless steel centralizers were used and placed at the bottom and top of the screen, as well as in 40-ft intervals above the screen. For construction details see the table 2-9.

Development occurred on November 24, 2014 and November 25, 2014 in accordance with procedure SGRP-PRO-OP-50024. A temporary 3-hp pump was used for the development of 2 intervals of no greater than 20 ft. The geologist took water quality parameter readings during development of each interval. Development continued until turbidity readings read less than 5 NTUs and the other parameters stabilized. Approximately 6,700 gallons were purged during development. Results of the well development are summarized in Table 2-1.

Table 2-9 Construction Summary: Well 299-W18-260 (C8925)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	4-inch Diameter, Stainless Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
326.3	237.1	Blank	+2.00 – 239.77	N/A	Concrete	0 – 2.5	Slurry
		Screen	239.77 – 269.77	20	Portland Cement	2.5 – 14.1	Type I/II
		Sump	269.77 – 272.77	N/A	Bentonite Crumbles	14.1 – 233.4	N/A
					Bentonite Pellets	233.4 – 235.8	3/8-in
					Colorado Silica Sand	235.8 – 274.4	16-30
					Premier Silica Sand	274.4 – 278.6	10-20
					Bentonite Chips	278.6 – 322.2	3/4-in
					Natural Fill	322.2 – 326.3	N/A

2.2.5 Well 299-W22-113 (C8943)

Well 299-W22-113 (C8943) was installed between July 23, 2014 and October 8, 2014. The borehole was drilled to a TD of 271.30 ft bgs.

On July 23, 2014 drilling began with a Bucyrus Erie 22-W drill rig using 11 3/4-in OD carbon steel, rope and box threaded casing. The casing was advanced to 105 ft bgs using an 8 5/8-in OD drive barrel drill bit. Casing was downsized to 8 11/16-in OD carbon steel, box threaded casing. The casing was advanced to 271.00 ft bgs on August 20, 2014 using a combination of drive barrel drill bits ranging from 6 1/2-in OD to 7-in OD.

There were no concentrations of VOCs that exceeded action levels at C8943 during drilling or sampling.

Sampling at C8943 included soil grab samples for archive purposes, a soil grab sample for chemical analysis for waste profiling, and a sieve analysis sample for particle size distribution testing. The waste grab sample was collected by NCO's. The geologic archive samples were collected by the field geologist at 5-ft intervals and at lithology changes throughout the borehole. Water was encountered at 235.9 ft bgs on August 12, 2014. A waste profile sample was collected in the water. Sieve samples were collected at 5-ft intervals throughout the zone of saturation (35 ft) and composited into one bulk sample. There were no samples collected for chemical analysis at this borehole.

For waste grab information see Table 2-10.

Table 2-10 Sample Summary: Well 299-W22-113 (C8943)

Sample Date	Sample Interval	Sample Depth (ft bgs)	Sample Medium	Sample Method	HEIS#
8/13/2014	I-001 ^a	238.00	Soil	Grab	B2XM63, B2XM64, B2XM65, B2XM66

a. This sample was a waste profile sample grab.

A geophysical survey using SGLS and NMLS was conducted from ground surface to 105 ft bgs on July 29, 2014 through the 11 3/4-in OD casing. A second geophysical survey using SGLS and NMLS was conducted from 100 ft bgs to 273 ft bgs on between August 20, 2014 and August 22, 2014 through the 8 11/16-in OD. The Log Data Report by SN3 for C8943 is included in Appendix D.

Well construction for C8943 occurred between September 23, 2014 and October 1, 2014. A straightness test was conducted on September 23, 2014 and passed through the temporary casing without binding. The well was constructed using 4-inch ID schedule 10S type 316L stainless steel blank casing and sump. A total of 30.01 ft of type 316 stainless steel screen with 0.040-in. apertures was used. Stainless steel centralizers were used and placed at the bottom and top of the screen, as well as in 40-ft intervals above the screen. Construction materials and associated depths can be found in Table 2-11.

Table 2-11 Construction Summary: Well 299-W22-113 (C8943)

Borehole Total Depth (ft bgs)	Static Water Level (ft bgs)	4-inch Diameter, Stainless Steel Well Materials			Annular Materials		
		Material	Interval (ft bgs)	Screen Mesh	Material	Interval (ft bgs)	Mesh Size
271.30	232.5	Blank	+2.0 – 233.9	N/A	Concrete	0.0 – 2.2	N/A
		Screen	233.9 – 264.0	40	Portland Cement	2.2 – 11.1	Type I/II
		Sump	264.0 – 267.0	N/A	Bentonite Chips	11.1 – 104.2	Medium
					Bentonite Pellets	104.2 – 227.1	3/8-in
					Colorado Silica Sand	227.1 – 230.0	10-20

Development occurred between October 2, 2014 and October 7, 2014 in accordance with procedure SGRP-PRO-OP-50024. There were a total of two development intervals of no greater than 20 ft for this well. The first interval was attempted twice due to the water not clearing up to procedure SGRP-PRO-OP-50024 water quality requirements. A 3-hp temporary submersible pump was used initially for the first development interval, but was swapped out for a 0.5-hp pump half way through the development due to a malfunction with the 3-hp pump. The second development interval and the second attempt of the first development interval also used the 0.5-hp pump for final development. The first interval which was

pumped over the course of two days, averaged 7.64 gallons per minute (gpm) while using the 3-hp pump (intake at 261.5 ft bgs) and 6.66 gpm while using the 0.5-hp pump (intake at 260 ft bgs).

A second attempt of the first development interval (intake at 253.0 ft bgs) was conducted to try to bring the water clarity under 5 NTUs. The final turbidity for both intervals did not drop below 5 NTUs for any attempt; however, the BTR gave the go ahead to end developing the well due to the circumstances of the development. Approximately 6,907 gallons of water were removed during development. Results of the well development are summarized in Table 2-1.

3 Geologic Observations

The following sections summarize the general geology in the area of the five new wells and present the stratigraphy encountered during the drilling of each well.

3.1 Geology of the 200-UP-1, 200-BP-5, and 200-PO-1 OUs

The 200-UP-1 OU lies within the 200 West Area, and the 200-BP-5 OU as well as the 200-PO-1 OU lie within the 200 East Area of the Hanford Site. These areas are similar to other locations on the Hanford Site with the two-tiered stratigraphy. It consists of basalt/basalt-related volcanic and sedimentary rock and overlying unconsolidated sedimentary deposits (SGW-57811). The principal units found on the Hanford Site and 200 Areas include, from youngest to oldest:

- Holocene surficial deposits
- Pleistocene Hanford formation (fm.) sediments
- Post-Ringold/Pre-Hanford deposits (Cold Creek Unit)
- Miocene-Pliocene Ringold Formation (Fm.) sediments
- Miocene Columbia River Basalt Group basalt flows

The generalized stratigraphy in the local vicinity of the new well locations may include some surficial sediments consisting of unconsolidated and un-weathered Holocene aeolian sands and loess as well as construction fill material.

The Hanford formation consists of Pleistocene-age, cataclysmic flood and inter-flood deposits comprised mostly of a sand-dominated facies consisting of fine-to coarse-grained sand with interbedded gravel lenses and a gravel-dominated facies consisting of pebble to cobble sized clasts within a sand matrix. In the OUs that were drilled the sand-dominated facies were mostly encountered. These lithofacies commonly intercalate with each other, as well as grade both laterally and vertically into each other.

Generally, fine-grained calcareous sediments of the Post Ringold/Pre Hanford sediments or Cold Creek Unit (CCU) locally separate the Hanford formation from the Ringold Formation and represent mainstream alluvial, calcic paleosol, side stream alluvial, colluvial, and overbank-aeolian environments marginal to the ancestral Columbia River. The CCU is formed of two facies, shallow fine-grained silt or sandy silt and a deeper carbonate cemented coarse-grained sand and gravel usually referred to as the caliche.

The CCU sediments unconformably overlie fine-to coarse-grained sediments of the Miocene to Pliocene aged Ringold Formation. The Ringold Formation is primarily comprised of fluvial sand and gravel. The Ringold Formation of the 200 Areas consists of the Ringold Formation member of Wooded Island, Unit E (Ringold, Unit E) (primarily felsic coarse-grained sandy gravels with a varying degree of cementation), the Ringold Lower Mud (RLM), and the Ringold Formation member of Wooded Island, Unit A (Ringold, Unit A) (primarily mafic coarse-grained sandy gravels). The RLM pinches out to the southern portion of the 200 West Area and extends under the west and central portion of the 200 West Area and was not expected to be present in any of the new wells.

The Ringold, Unit A underlies sediments of the RLM or, in its absence, Unit A underlies Ringold, Unit E in various thicknesses, and extends to the top of the Columbia River Basalt Group. The Elephant Mountain Member of the Saddle Mountain Basalt is the uppermost basalt unit in the Columbia River Basalt Group beneath the 200 Areas and is the base of the unconfined aquifer.

Some formations mentioned above may not be present due to erosion.

3.2 Borehole Geology

This section describes the geologic characteristics and stratigraphic units observed during drilling of the five boreholes. Borehole geologic logs were prepared in accordance with CHPRC procedure SGRP-PRO-EN-50025 and are included in Appendices A through E.

Stratigraphic unit interpretations included in this document were based on field examination of drill cuttings (i.e., lithology, texture, color, reaction to hydrochloric acid, etc.). As such, the unit contacts included herein should be considered estimates. Final stratigraphic unit contacts will be determined during the remedial investigation data review and will incorporate the field observations, borehole geophysical logging data and regional stratigraphic interpretations. The basis for determination of the estimated stratigraphic unit contacts is included in the individual borehole summaries below.

3.2.1 Well 299-E25-237 (C8922)

Well 299-E25-237 (C8922) is located south of the Waste Management Area (WMA) A-AX and west of the 242-A Evaporator in the 200 East Area. Prominent stratigraphic units that were encountered while drilling were the Hanford fm., Cold Creek Unit (CCU), Re-worked Ringold Fm., Unit A, Ringold Fm., Unit A, and the Elephant Mountain Member basalt.

The Hanford fm. was encountered under the 0.5 ft thick gravel pad to a depth of 270 ft bgs. The classifications of the Hanford fm. included; sand, gravelly sand, sandy gravel, slightly silty gravelly sand, and slightly silty sand. The overall felsic composition for the sand of this formation ranged from 55-65 percent. The gravel had an overall mafic composition ranging from 60 percent to 80 percent. The first 15 ft and the last 50 ft of the encountered formation had a strong to very strong reaction to 10% diluted Hydrochloric acid (HCl). The majority of the encountered formation ranged from a weak reaction to a strong reaction. The angularity of the sediment ranged from sub-angular to sub-rounded. The maximum gravel size was 66 millimeters (mm), a small cobble. The contact with the underlying CCU was mostly indistinct at 270 ft bgs.

The CCU extended from 270 ft bgs to 332 ft bgs and included both the Upper CCU silt dominated unit and the Lower CCU gravel dominated unit. The Upper CCU ranged from 270 ft bgs to 285 ft bgs and the classifications were sand, sandy silt, and gravelly silty sand. The composition was mostly felsic and ranged from 55 to 80 percent for the sands, the limited gravel was mostly mafic at 65 percent. A high calcic content was indicated by the mostly strong reactions to 10% dilute HCl. The angularity ranged from sub-angular to sub-rounded and the maximum gravel size was 50 mm. Between 270 and 278 there was some cementation of the sediment. The Lower CCU ranged from 285 ft bgs to 332 ft bgs. The classifications were gravelly silty sand, silty sandy gravel, and sand. The gravel ranged from 50 to 75 percent mafic composition while the sand ranged from 45 to 65 percent mafic composition. The portion of the unit that was above the water table had strong reactions to the 10% dilute HCl and indicated a high calcic content. The reactions, if there were any, weakened greatly in the water. The angularity ranged from angular to rounded with a maximum gravel size of 150 mm, a large cobble. A somewhat distinct contact with the underlying re-worked Ringold Fm. was at approximately 332 ft bgs.

The Ringold Fm. is present from approximately 332 ft bgs to 374.5 ft bgs. There is a possibility that the re-worked Ringold Fm., Unit A was encountered from 332 ft bgs to 360 ft bgs. Due to the drilling method of hard tooling, the bottom of the formation is very approximate. The silt and cementation began to increase at 332 ft bgs. The classification for this unit was silty sandy gravel. The gravel and sand both became more felsic and ranged 65 to 75 percent up to 345 ft bgs. Around 345 ft bgs the composition of

the hard tool slurry ranged from 35 to 70 percent felsic material. The angularities ranged from sub-angular to rounded with a maximum gravel size of 67 mm, a small cobble. This was thought to be re-worked Ringold Fm. because of the amount of different colors of sediment that appeared and the density of the formation. At approximately 360 ft bgs the density of the formation lessened and may be the contact between the re-worked Ringold Fm., Unit A with the underlying Ringold Fm., Unit A.

What is believed to be Ringold Fm., Unit A extended from approximately 360 ft bgs to 374.5 ft bgs. Between 360 ft bgs and 366 ft bgs the drilling method of hard tooling, reduced the ability to identify the formation that was being encountered. The slurry ranged from 35 to 70 percent felsic material. At 366 ft bgs the classification was silty sandy gravel. Both the sand and gravel for this formation had a 70 to 80 percent felsic composition. The reactions to 10% dilute HCl were weak to no reaction in the water. The angularities of the formation ranged from angular to sub-rounded with a maximum gravel size of 75 mm, a small cobble. There was an increase in clay composition due to weathering prior to the contact with the underlying Elephant Mountain Member basalt at 374.5 ft bgs.

The Elephant Mountain Member basalt was encountered from 374.5 ft bgs to a TD of 374.78 ft bgs. The basalt was weathered and fractured. There was no reaction with 10% dilute HCl.

Static water levels were measured at 295.66 ft bgs (12/2/2014) and at 295.36 ft bgs (1/19/2015). The borehole log for C8922 is presented in Appendix A.

3.2.2 Well 299-E33-360 (C8923)

Well 299-E33-360 (C8923) is located east of WMA B-BX-BY, off Baltimore Ave. in the 200 East Area. Prominent stratigraphic units that were encountered while drilling were fill material, the Hanford fm., the CCU, and the Elephant Mountain basalt.

The fill material was first encountered and extended to a depth of 34 ft bgs; it was classified as silty sandy gravel. The Hanford fm. was encountered from a depth of 34 ft bgs to a depth of 214 ft bgs. The Hanford fm. classifications consisted of sandy gravel, silty sand, silty sandy gravel, slightly silty sand, sand, gravelly sand, and slightly silty gravelly sand. The angularity of this formation ranged from angular to sub-rounded. The mostly mafic content ranged from 40 percent to 70 percent throughout the depth of the formation. This formation also had a high calcic content as the average HCl reaction was strong throughout the depth of the formation. The limited amount of gravel throughout ranged in size up to 65mm, a small cobble. A large cobble or boulder of basalt was also encountered at 131 ft bgs. A mostly distinct contact with a silty layer at 214 ft bgs may indicate the CCU.

The CCU contact was encountered and included the Upper CCU and Lower CCU. The Upper CCU silt dominated layer was encountered from 214 ft bgs to 246 ft bgs. The Upper CCU classifications consisted of gravelly silty sand, sandy silt and silty sand. The small amount of gravels present through the depth of the Upper CCU had a mostly mafic composition of 50 to 60 percent and their angularity ranged from angular to sub-rounded. The maximum gravel size was 30 mm, course pebble, around the contact with the overlying Hanford fm. A strong to very strong reaction to diluted HCl indicated a high calcic content. The Lower CCU gravel dominated layer was encountered from 246 ft bgs to 260.5 ft bgs. The classifications of the lower CCU consisted of slightly silty gravelly sand and silty sandy gravel. The mafic content of the gravels decreased with depth from 95 to 45 percent. The sand mafic content also generally decreased with depth from 70 to 40 percent. Angularity of the sediment ranged from sub-angular to sub-rounded throughout the depth. The calcic content was strong to very strong, weakening in the water and at the distinct contact with the underlying Elephant Mountain Member basalt at 260.5 ft bgs.

The Elephant Mountain Member basalt was encountered from 260.5 ft bgs to a TD of 272.8 ft bgs. The basalt was massive, but because a hard tool was used, it came up in small chips. There was no reaction to the HCL.

Static water levels were measured at 253.99 ft bgs (9/3/2014) and at 255.86 ft bgs (10/29/2014). The borehole log for C8923 is presented in Appendix B.

3.2.3 Well 299-E33-361 (C8924)

Well 299-E33-361 (C8924) is located northeast of B-Plant about half a mile in the 200 East Area. Prominent stratigraphic units that were encountered while drilling were the Hanford fm., CCU, Ringold Fm., Unit A, and the Elephant Mountain Member basalt.

The Hanford fm. was encountered under the 1.5 ft thick gravel pad to a depth of 170 ft bgs. The classifications of the Hanford fm. included silty sand, silty sandy gravel, sand, and gravelly sand. The overall mafic composition of this formation ranged from 90 to 65 percent until 31 ft bgs when it switched to a 50 to 70 percent felsic composition through the rest of the formation. A mostly moderate to very strong reaction to diluted HCl indicated a fairly high amount of calcic content. The angularity of the sediment ranged from angular to sub-rounded. The maximum gravel size was 108 mm, a small cobble. The contact with the underlying CCU was slightly distinct at 170 ft bgs.

The CCU extended from 170 ft bgs to 273.6 ft bgs and included both the Upper CCU silt dominated unit and the Lower CCU gravel dominated unit. The Upper CCU ranged from 170 ft bgs to 190 ft bgs and the classifications were slightly silty sand and sand. The composition mostly was felsic and ranged from 55 to 60 percent. A somewhat high calcic content was indicated by a moderate to strong HCL reaction. The angularity ranged from angular to sub-rounded and the maximum gravel size was 11 mm, a medium pebble. The Lower CCU ranged from 190 ft bgs to 273.6 ft bgs. The classifications were gravelly sand, slightly silty gravelly sand, sand, sandy gravel, and silty sandy gravel. The composition of the gravel was slightly mafic which ranged from 50 to 65 percent, the sand composition ranged from 50 to 60 percent felsic material. A somewhat high calcic content was indicated by a medium to very strong reaction to HCL up to 260 ft bgs; the reaction weakened in the water. Angularity ranged from angular to rounded with a maximum gravel size of 148 mm, a large cobble. At 260 ft bgs the gravels became predominately sub-rounded to rounded. The CCU had a distinct contact with the Elephant Mountain Member basalt at 273.6 ft bgs.

The Elephant Mountain Member basalt was encountered from 273.6 ft bgs to a TD of 277.89 ft bgs. The basalt was massive, but because a hard tool was used to drill, the basalt came up in small chips. There was no reaction to the HCL.

Static water levels were measured at 255.24 ft bgs (9/24/2014) and at 252.7 ft bgs (11/4/2014). The borehole log for C8924 is presented in Appendix C.

3.2.4 Well 299-W18-260 (C8925)

Well 299-W18-260 (C8925) is located north of the WMA U tank farm in the 200 West Area. Prominent units that were encountered while drilling were the Hanford fm., CCU, and the Ringold Fm., Unit E.

The Hanford fm. was encountered about 4 feet below the drill pad fill material and continued to about 110ft bgs. Sediment descriptions within this formation were sand, sandy gravel, gravel, and sandy silt. Angularity of the gravels was primarily sub angular to round. The mafic content of the Hanford fm. was about 60% leaving a 40% felsic content. From about 48 ft bgs to roughly 100 ft bgs a dominant sand layer was present. Grain size distribution of this formation was anywhere from silt to large gravel. Sizes of

gravel were from 5 mm to 50 mm pebbles. A distinct contact was observed between the Hanford fm. and the Upper Cold Creek Unit.

The Upper Cold Creek Unit was observed from about 110 ft bgs to 136 ft bgs. Primary sediment descriptions of this formation were sandy silt, silt and caliche. The sand in this unit was quartz rich with traces of mica. Silt in the Upper CCU also had about 30% mica. Caliche was observed at 131ft bgs and continued to 136 ft bgs. Grain size distribution ranged from silt to sand. Transition to the Lower CCU occurred at 136ft bgs right after the caliche layer. The Lower CCU sediment descriptions included gravelly silt, silty sandy gravel, and sandy gravel. Angularities of the gravels were mostly angular to sub-rounded. Gravels were more mafic (80%) than felsic (20%). Grain size distribution for the Lower CCU was silt to larger gravels. Gravel sizes were from 2 mm to 60 mm pebbles. The contact between the lower CCU and Ringold Fm., Unit E was distinguished by larger gravels and cementation.

The Ringold Fm., Unit E was observed from 155ft bgs to 325ft bgs. Sediment descriptions within this formation were sandy gravel, gravelly sand, and silty sandy gravel. Sand in this formation was mostly medium to fine grained and quartz rich. Overall there was about a 65% felsic composition. Angularity of the gravels was primarily sub-rounded to rounded. Grain size distribution of the Ringold Formation was silt to larger gravels. Sizes of gravels ranged from 2 mm to 200 mm large cobbles. A micaceous subarkose sandstone layer was present from 286 ft bgs to 288 ft bgs. This layer was a silty sandy gravel that was highly oxidized. The sand was very coarse and the silt was non-plastic. This layer also reacted violently with HCl.

Static water levels were measured at 236.06 ft bgs (9/18/2014) and at 237.4 ft bgs (11/25/2014). The borehole log for C8925 is presented in Appendix D.

3.2.5 Well 299-W22-113 (C8943)

Well 299-W22-113 (C8943) is located East of WMA S-SX tank farm in the 200 West Area. Observed units and formations encountered while drilling include the Hanford fm., the CCU, and the Ringold Fm., Unit E.

The Hanford fm. was encountered about a foot below the drill pad and continued on to 90 ft bgs. Sediment descriptions within this formation included gravelly sand, silty sandy gravel, sandy gravel, sand, silt, silty sand, and slightly silty sand. Particle sizes ranged from silt to 200 mm large cobbles. Angularity of the sand was angular to sub-angular and gravel was angular to rounded. The majority of this formation was composed of sands. The mafic content observed in this formation was about 60% while the felsic content was about 40%. There was no defined contact between the Hanford fm. and the Cold Creek Unit silts.

There was an increase of silt at about 90 ft bgs which suggested the possible beginning of the Upper CCU. Higher silt content continued to about 145 ft bgs where caliche was present in about a 6 inch layer. The Lower CCU gravel contact was observed at about 150 ft bgs and continued on to 185 ft bgs. The Lower CCU was made up of mostly, gravelly sand, slightly silty gravelly sand, and sandy gravel. Sediments within the Lower CCU had about a 10% mafic content and a high felsic content of about 90%. Grain size distribution ranged from silt to larger gravels. Sizes of the gravels were 5 mm to 65 mm gravel. Angularities of the gravels were mostly sub-angular to rounded. The contact between the CCU and the Ringold Fm., Unit E at 185 ft bgs was more prominent than previous contacts within the borehole.

The Ringold Formation, Unit E was observed with the encounter of cemented gravels. Group names of this formation included sandy gravel, silty sandy gravel, slightly silty sandy gravel and gravelly sand. Cementation that was encountered did not react with HCl. The sand in this formation was mostly medium

to fine grained and quartz rich. The felsic content observed was about 85% and the mafic content was about 15% throughout this formation. Angularities of the gravels were angular to rounded. Sizes of gravels ranged from 2 mm to 100 mm pebbles.

Static water levels were measured at 235.9 ft bgs (8/14/2014) and at 232.5 ft bgs (10/8/2014). The borehole log for C8943 is presented in Appendix E.

4 Waste Management

Waste generated during the installation of the five new wells included drill cuttings, purgewater, and miscellaneous solid waste. Waste was managed in accordance to DOE/RL-2000-51, Rev. 6 *Interim Action Waste Management Plan for the 200-UP-1 Operable Unit*, DOE/RL-2003-30, Rev. 3 *Waste Control Plan for the 200-BP-5 Operable Unit*, DOE/RL-2004-18, Rev. 1, *Waste Control Plan for the 200-PO-1 Operable Unit*, and the Waste Packaging/Labeling Instruction Sheets (WP/LIS). Waste generated during drilling activities included drill cuttings, decontamination water, and miscellaneous solid waste.

4.1 Drill Cuttings

Drill cuttings from the vadose zone were collected in designated spoils piles with the exception of C8923. All drill cuttings from C8923 were placed in ROLL-OFF boxes. Before the final well acceptance, all drill cuttings contained in the spoils piles had been approved for "Return to Earth" and had been spread out across the drill pad. Drill cuttings from below the water table were collected, dewatered when necessary, and placed in designated ROLL-OFF boxes, provided by Environmental Restoration and Disposal Facility (ERDF), which were periodically surveyed by RCT and IH personnel with the exception of C8922. For C8922 55-gal drums were used instead of ROLL-OFF boxes. The 55-gal drums were used from 260 ft bgs to TD. Miscellaneous solid waste, associated with sampling activities, was contained in clear plastic bags in the ROLL-OFF boxes. ROLL-OFF boxes were transported to the ERDF for disposal. This decision was made following the process established by CHPRC procedure SGRP-PRO-OP-50034 (GRP-EE-02-14.5), *Returning Vadose Zone Drill Cuttings/Soils to the Environment*.

4.2 Purgewater

Purgewater was generated during well drilling, sampling, and development activities. All purgewater was collected and contained at the wellhead until it was transported to the Purgewater Modular Storage Units in accordance with DOE/RL-2009-39, Rev. 0, *Investigation-Derived Waste Purgewater Management Action Memorandum* and DOE/RL-2009-80, Rev 0, *Investigation-Derived Waste Purgewater Management Work Plan*.

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5 Civil Survey

The well locations were surveyed on February 11, 2015 following the CHPRC procedure SGRP-PRO-SMP-52857 (GRP-EE-01-1.6), *Survey Requirements and Techniques*. The equipment used to collect the coordinates was a Trimble R8 RTK GPS and a Trimble DiNi 12 Level. The Washington State Plane (South Zone) *North American Datum of 1983* (NAD83), with the 1991 adjustment was used to record the horizontal coordinates and the *North American Vertical Datum of 1988* (NAVD88) was used to record the vertical survey data. The locations of the surveyed boreholes are presented in Table 5-1. Find the survey reports in Appendices A-E.

Table 5-1 Civil Survey Summary

Well ID Number	Well Name	Northing ^a (m)	Easting ^a (m)	Brass Survey Marker Elevation ^b (m)	Top of Casing ^{b,c} Elevation (m)
C8922	299-E25-237	135965.27	575323.84	211.872	212.625
C8923	299-E33-360	137386.86	573772.05	198.949	199.701
C8924	299-E33-361	137122.32	574069.25	199.632	200.385
C8925	299-W18-260	135196.89	566862.54	205.052	205.777
C8943	299-W22-113	134192.75	566904.52	204.041	N/A ^d

- 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
- d Information was not provided in final Civil Survey Report.

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6 Well Acceptance

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

Well inspections for the five wells were conducted by Representatives from CHPRC and StillWater, LLC. Well C8943 was walked down on December 2, 2014 and the remaining wells were walked down on February 2, 2015. The representatives of the drilling contractor and CHPRC documented the final well acceptance by completing the checklist and providing signatures. To document the well acceptance a Quality Assurance Work Site Assessment was created.

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7 References

CH2M Hill Plateau Remediation Company Soil and Groundwater Remediation Project Procedures:

SGRP-PRO-EN-50025 (GRP-EE-01-7.0), *Geologic Logging*

SGRP-PRO-EN-50030 (GRP-EE-02-14.1), *Drilling, Remediating, and Decommissioning Resource Protection Wells and Geotechnical Soil Borings*

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

SGRP-PRO-OP-50034 (GRP-EE-02-14.5), *Returning Vadose Zone Drill Cuttings/Soils to the Environment*

SGRP-PRO-OP-50037 (GRP-EE-05-1.21), *Particle Size Distribution of Soil- Wet Sieve Analysis*

SGRP-PRO-SMP-50060 (GRP-FS-04-G-028), *Field Characterization and Treatment Monitoring Activities Groundwater Sampling*

SGRP-PRO-SMP-52857 (GRP-EE-01-1.6), *Survey Requirements and Techniques*

Other References:

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, Public Law 96-150, 94 Stat. 2767, 42 USC 9601 et seq.

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DOE/RL-2003-30, 2007, *Waste Control Plan for the 200-BP-5 Operable Unit*, Rev. 3, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2004-18, 2008, *Waste Control Plan for the 200-PO-1 Operable Unit*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

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

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

REQ-002681-12, Statement of Work, *The Installation of Four Tri-Party Agreement M-24 Wells, Plus One Optional Well FY 2014*, CH2M HILL Plateau remediation Company, Richland, Washington.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at:
<http://epw.senate.gov/rcra.pdf>.

SGW-57810, 2014, *Sampling Instruction for Conceptual Model Refinement during the Drilling of Wells 299-E25-237, 299-E33-360, and 299-E33-361 in 200 East*, Draft, CH2M Hill Plateau Remediation Company, Richland, Washington.

SGW-57811, 2014, *Description of Work for the Installation of Five Groundwater Monitoring Wells to Support M-24 TPA Work in FY2014*, 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>.

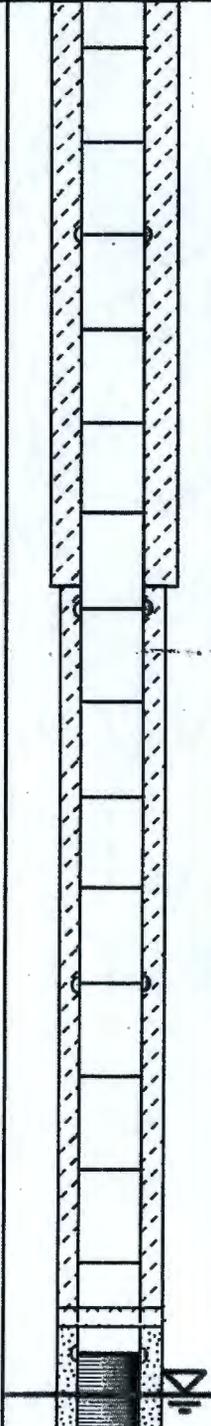
Appendix A

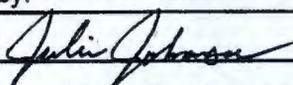
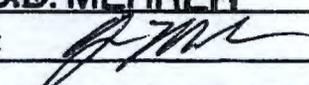
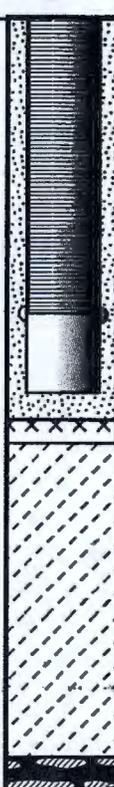
Well Documentation for 299-E25-237 (C8922)

- Well Summary Sheet
- Borehole Log
- Log Data Report
- Photographic Logs
- Final Survey Report

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WELL SUMMARY SHEET		Start Date: 11-10-2014		Page <u>1</u> of <u>3</u>	
		Finish Date: 1-19-2015			
Well ID: C8922			Well Name: <u>299-E25-237</u>		
Location: S. of WMA A-AX			Project: <u>M24 Drilling</u>		
Prepared by: Julie Johanson		Date: 12-17-14	Reviewed by: <u>J.D. MEHRER</u>		Date: <u>1/21/15</u>
Signature: <u>Julie Johanson</u>			Signature: <u>[Signature]</u>		
CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA		
Description	Diagram		Graphic Log	Lithologic Description	
<p>Surface Completion: 4'x4'x6" Concrete Pad with brass survey marker and 6 9/16" protective monument (3.00' ags)</p> <p>Well Completion material: High Strength Concrete 0.0' bgs - 2.8' bgs</p> <p>Type I/II Portland Cement 2.8' bgs - 10.42' bgs</p> <p>Granular Bentonite (Medium Chips, 8-20 Crumbles, 3/4" Chunks) 10.42' bgs - 285.43' bgs</p> <p>3/8" Bentonite Pellets 285.43' bgs - 287.27' bgs</p> <p>10-20 Colorado Silica Sand 287.27' bgs - 332.3' bgs</p> <p>3/8" Bentonite Pellets 332.3' bgs - 334.1' bgs</p> <p>3/4" Bentonite Chunks 334.1' bgs - 372.04' bgs</p> <p>Natural Fill 372.04' bgs - 374.78' bgs</p> <p>Permanent Well: 4" ID PVC Blank 1.98' ags - 291.00' bgs</p> <p>4" ID Stainless Steel 0.020 Slot Screen 291.00' bgs - 326.00' bgs</p> <p>4" ID Stainless Steel Sump 326.00' bgs - 329.02' bgs</p> <p>All temporary casing completely removed from ground on 1/15/2015</p> <p>ags = above ground surface bgs = below ground surface</p>				<p>0 0-0.5: Gravelly Sand (gS) Drill Pad. 0.5-9: Sand (S)</p> <p>9-18: Gravelly Sand (gS)</p> <p>18-30: Sand (S)</p> <p>25</p> <p>30-36: Gravelly Sand (gS)</p> <p>36-58: Sandy Gravel (sG)</p> <p>50</p> <p>58-70: Sand (S)</p> <p>70-75: Gravelly Sand (gS)</p> <p>75-80: Sandy Gravel (sG)</p> <p>80-90: Gravelly Sand (gS)</p> <p>90-100: Sandy Gravel (sG)</p> <p>100</p> <p>100-105: Gravelly Sand (gS)</p> <p>105-120: Sandy Gravel (sG)</p> <p>120-123: Slightly Silty Gravelly Sand((m)gS)</p> <p>123-167: Sand (S)</p> <p>125</p>	

WELL SUMMARY SHEET		Start Date: 11-10-2014																	
		Finish Date: 1-19-2015																	
		Page <u>2</u> of <u>3</u>																	
Well ID: C8922		Well Name: 299-E25-257																	
Location: S. of WMA A-AX		Project: M24 Drilling																	
Prepared by: Julie Johanson	Date: 12-17-14	Reviewed by: J.D. MEHRER	Date: 1/21/15																
Signature: <i>Julie Johanson</i>		Signature: <i>J.D. Meherer</i>																	
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA																	
Description	Diagram	Depth in Feet	Lithologic Description																
Well Completion material: High Strength Concrete 0.0' bgs - 2.8' bgs Type I/II Portland Cement 2.8' bgs - 10.42' bgs Granular Bentonite (Medium Chips, 8-20 Crumbles, 3/4" Chunks) 10.42' bgs - 285.43' bgs 3/8" Bentonite Pellets 285.43' bgs - 287.27' bgs 10-20 Colorado Silica Sand 287.27' bgs - 332.3' bgs 3/8" Bentonite Pellets 332.3' bgs - 334.1' bgs 3/4" Bentonite Chunks 334.1' bgs - 372.04' bgs Natural Fill 372.04' bgs - 374.78' bgs Permanent Well: 4" ID PVC Blank 1.98' ags - 291.00' bgs 4" ID Stainless Steel 0.020 Slot Screen 291.00' bgs - 326.00' bgs 4" ID Stainless Steel Sump 326.00' bgs - 329.02' bgs			<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="text-align: center;">150</td> <td style="text-align: center;">123-167: Sand (S)</td> </tr> <tr> <td style="text-align: center;">175</td> <td style="text-align: center;">167-170: Gravelly Sand (qS) 170-220: Sand (S)</td> </tr> <tr> <td style="text-align: center;">200</td> <td></td> </tr> <tr> <td style="text-align: center;">225</td> <td style="text-align: center;">220-230: Slightly Silty Sand ((m)S)</td> </tr> <tr> <td style="text-align: center;">250</td> <td style="text-align: center;">230-235: Sand (S) 235-243: Slightly Silty Sand ((m)S) 243-248: Slightly Silty Gravelly Sand((m)qS) 248-278: Sand (S)</td> </tr> <tr> <td style="text-align: center;">275</td> <td style="text-align: center;">278-280.7: Sandy Silt (sM) 280.7-290: Gravelly Silty Sand (gmS)</td> </tr> <tr> <td></td> <td style="text-align: center;">290-305: Silty Sandy Gravel (msG)</td> </tr> <tr> <td></td> <td style="text-align: center;">DTW: 295.36' bgs</td> </tr> </table>	150	123-167: Sand (S)	175	167-170: Gravelly Sand (qS) 170-220: Sand (S)	200		225	220-230: Slightly Silty Sand ((m)S)	250	230-235: Sand (S) 235-243: Slightly Silty Sand ((m)S) 243-248: Slightly Silty Gravelly Sand((m)qS) 248-278: Sand (S)	275	278-280.7: Sandy Silt (sM) 280.7-290: Gravelly Silty Sand (gmS)		290-305: Silty Sandy Gravel (msG)		DTW: 295.36' bgs
150	123-167: Sand (S)																		
175	167-170: Gravelly Sand (qS) 170-220: Sand (S)																		
200																			
225	220-230: Slightly Silty Sand ((m)S)																		
250	230-235: Sand (S) 235-243: Slightly Silty Sand ((m)S) 243-248: Slightly Silty Gravelly Sand((m)qS) 248-278: Sand (S)																		
275	278-280.7: Sandy Silt (sM) 280.7-290: Gravelly Silty Sand (gmS)																		
	290-305: Silty Sandy Gravel (msG)																		
	DTW: 295.36' bgs																		

WELL SUMMARY SHEET		Start Date: 11-10-2014	Page <u>3</u> of <u>3</u>
		Finish Date: 1-19-2015	
Well ID: C8922		Well Name: <u>299-E25-237</u>	
Location: S. of WMA A-AX		Project: <u>M24 Drilling</u>	
Prepared by: Julie Johanson	Date: 12-17-14	Reviewed by: <u>J.D. MEHRER</u>	Date: <u>1-21-15</u>
Signature: 		Signature: 	
CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA
Description	Diagram	Graphic Log	Lithologic Description
<p>Well Completion:</p> <p>High Strength Concrete 0.0' bgs - 2.8' bgs</p> <p>Type I/II Portland Cement 2.8' bgs - 10.42' bgs</p> <p>Granular Bentonite (Medium Chips, 8-20 Crumbles, 3/4" Chunks) 10.42' bgs - 285.43' bgs</p> <p>3/8" Bentonite Pellets 285.43' bgs - 287.27' bgs</p> <p>10-20 Colorado Silica Sand 287.27' bgs - 332.3' bgs</p> <p>3/8" Bentonite Pellets 332.3' bgs - 334.1' bgs</p> <p>3/4" Bentonite Chunks 334.1' bgs - 372.04' bgs</p> <p>Natural Fill 372.04' bgs - 374.78' bgs</p> <p>Permanent Well:</p> <p>4" ID PVC Blank 1.98' ags - 291.00' bgs</p> <p>4" ID Stainless Steel 0.020 Slot Screen 291.00' bgs - 326.00' bgs</p> <p>4" ID Stainless Steel Sump 326.00' bgs - 329.02' bgs</p>			<p>290-305: Silty Sandy Gravel (msG)</p> <p>305-306: Sand (S)</p> <p>306-345.78: Silty Sandy Gravel (msG)</p> <p>345.78-366.19: Silty Sandy Gravel (msG) (Hard tool Slurry)</p> <p>366.19-374.5: Silty Sandy Gravel (msG)</p> <p>374.5-375: Basalt</p> <p>TD: 374.78' bgs</p>

BOREHOLE LOG

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Date: 11-10-14

Well ID: C9922

Well Name: 299-E25-237

Location: S. of WMA A-9X

Project: M-24 Monitoring Wells

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0					Cable tool w/dive barrel.
0-0.5				<u>0-0.5 : Gravelly Sand Drill Pad</u>	
5	G.S.			<u>0.5' - 9' : Sand (S)</u> @5' bgs: 25% silt, < 90% v.f.n. - v.crs. sand (mostly v.f.n. - fn.); 5% v.f.n. - med. peb.; max 12mm; well sorted, moist, sub ang. - sub. rd.; sand: 60% f/40% m, gravel: 30% m/20% f; v. strong HCl rxn; 2.54 4/2 dark grayish brown.	Archive @ 5' bgs
10	G.S.			<u>9' - 19' : Gravelly Sand (gS)</u> @10' bgs: 5% silt; 80% v.f.n. - v.crs. sand (crs. - v.crs.), 15% v.f.n. peb. - sm. cob.; max 16mm; med. - poorly sorted, slightly moist; sub. ang. - sub. rd.; s: 60% f/40% m, g: 80% m/20% f; strg. HCl rxn; 2.54 4/1 dark gray	Archive @ 10' bgs
15	G.S.			@15' bgs: 5% silt, 75% v.f.n. - v.crs. sand (med. - v.crs.), 20% v.f.n. - v.crs. peb.; max 42mm; s: 60% m/40% f, g: 70% m/30% f; med. HCl rxn;	Archive @ 15' bgs
20	G.S.				Archive @ 19' bgs
25	G.S.			<u>19' - 30' : Sand (S)</u> @19' bgs: 8% silt, 90% v.f.n. - v.crs. sand (med.); 5% v.f.n. - crs. peb.; max 21mm; well sorted, moist; sub. ang.; s: 55% f/45% m; med. HCl rxn; 104R 4/2 dark grayish brown	
25	G.S.			@25' bgs: sand (crs. - v.crs.); max 15mm; slightly moist; s: 60% f/40% m; weak - med. HCl rxn; 104R 4/1 dark gray.	Archive @ 25' bgs
30	G.S.			<u>30' - 36' : Gravelly Sand (gS)</u> 1% silt, 74% v.f.n. - v.crs. sand (med. - v.crs.); 25% v.f.n. - crs. peb.; max 23mm; slightly moist, med. sorted, sub. ang. - sub. rd.; s: 65% f/35% m, g: 80% m/20% f; weak HCl rxn, 2.54 4/2 dark grayish brown	Archive @ 30' bgs
35	G.S.			@35' bgs: 5% silt, 75% v.f.n. - v.crs. sand (med. - v.crs.); 20% v.f.n. - v.crs. peb.; max 37mm; s: 60% f/40% m, g: 70% m/30% f; med. HCl rxn;	Archive @ 35' bgs
	G.S.				Archive @ 36' bgs
				<u>36' - 58' : Sandy Gravel (sG) (see page 2)</u>	

Reported By: <u>Julie Johanson</u>	Reviewed By: <u>Kevin Bergstrom</u>
Title: <u>Geologist</u>	Title: <u>Sr. Geologist</u>
Signature: <u>Julie Johanson</u>	Signature: <u>Kevin Bergstrom</u>
Date: <u>11-11-14</u>	Date: <u>3-10-2015</u>

BOREHOLE LOG

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Date: 11-11-14

Well ID: C8922

Well Name: 299-E25-237

Location: S. of WMA A-AK

Project: M-24 Monitoring Wells

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	G.S.			<p><u>36-58: Sandy Gravel (sG)</u> 25% silt, 65% v.f. - v.crs. sand (med-crs.), 80% v.f. - v.crs. peb.; max 52mm; med. sorted; slightly moist-dry; sub. ang. - sub. rad.; s: 60%F/40%G, g: 70%G/30%F; weak HCl rxn; 2.5Y 4/2 dark grayish brown.</p>	<p>Cable tool w/drive barrel Archive @ 40' bgs</p>
45	G.S.			<p>@ 40' bgs: 5% silt, 60% v.f. - v.crs. sand, 35% v.f. - v.crs. peb. max 40mm; g: 65%G/35%F, med. HCl rxn.</p>	<p>Archive @ 43' bgs</p>
50	G.S.			<p>@ 50' bgs: 5% silt, 65% v.f. - v.crs. sand, 30% v.f. - crs. peb. max 29mm; med. - strg. HCl rxn, 2.5Y 5/2 grayish brown</p>	<p>Archive @ 50' bgs</p>
55	G.S.			<p>@ 55' bgs: 5% silt, 60% v.f. - v.crs. sand, 35% v.f. peb. - sm. cob. max 65mm; poorly sorted, 2.5Y 4/2 dark grayish brown</p>	<p>Archive @ 55' bgs</p>
60	G.S.			<p><u>58-70: Sand (S)</u> @ 59' bgs: 25% silt, 95% v.f. - v.crs. sand (med-crs.); max 2mm; well sorted; slightly moist-dry; sub. ang.; 60%F/40%G; wk. HCl, 2.5Y 4/2 dark grayish brown.</p>	<p>Archive @ 59' bgs</p>
65	G.S.			<p>@ 65' bgs: wk-med. HCl rxn</p>	<p>Archive @ 65' bgs</p>
70	G.S.			<p><u>70-75: Gravelly Sand (s)</u> 5% silt, 90% v.f. - v.crs. sand (med-crs.), 15% v.f. - v.crs. peb.; max 40mm; med. sorted; slightly moist-dry; sub. ang. - sub. rad.; s: 55%F/45%G, g: 70%G/30%F; med. - strg. HCl rxn; 2.5Y 5/2 grayish brown</p>	<p>Archive @ 70' bgs</p>
75	G.S.			<p><u>75-80: Sandy Gravel (sG)</u> 5% silt, 65% v.f. - v.crs. sand (med-crs.), 30% v.f. - crs. peb.; max 29mm; med. sorted; slightly moist-dry; sub. ang. - sub. rad.; s: 60%F/40%G; g: 65%G/35%F; med. - strg. HCl rxn; 2.5Y 5/1 gray</p>	<p>Archive @ 75' bgs</p>

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: Julie Johanson

Date: 11-11-14

Signature: Kevin Bergstrom

Date: 3-10-2015

BOREHOLE LOG

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Date: 11-11-14

Well ID: C8922

Well Name: 299-E25-237

Location: S. of WMA A-AK

Project: M-24 Monitoring Wells

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type No.	Blows Recovery			
80	G.S.			80-90: Gravelly Sand (GS)	Cable tool w/ drive barrel Archive @ 80' bgs
				57% silt, 70% vfn - v.crs. sand (med - v.crs.), 25% vfn - crs. pb.	
				(vfn - fn), max 28mm; med. sorted; slightly moist - dry; sub ang. - sub rd.;	
				sub rd.; s: 60% / 40% m, g: 60% m / 40% f; med - strg. HCl rxn;	
85	G.S.			2.54 5/1 gray	
				@ 85' bgs: 7% silt; 68% vfn - v.crs. sand (med - v.crs.), 25% vfn - crs. pb. (vfn - fn); max 20mm; 55% f / 45% m; 2.54 5/2 grayish brown	Archive @ 85' bgs
90	G.S.		90-100: Sandy Gravel (SG)	Archive @ 90' bgs	
			77% silt, 68% vfn - v.crs. sand (med), 20% vfn - crs. pb.; max 23mm; med - poorly sorted, slightly moist - dry; sub ang. - sub rd.;		
			s: 55% f / 45% m, g: 80% m / 20% f; med - strg. HCl rxn; 2.54 4/2 dark grayish brown		
95	G.S.		@ 95' bgs: max 12mm; pb. vfn - med (vfn); med sorted, g: 70% m / 30% f; 2.54 5/2 grayish brown	Archive @ 95' bgs	
100	G.S.		100-105: Gravelly Sand (GS)	Archive @ 100' bgs	
			57% silt, 75% vfn - v.crs. sand (crs), 20% vfn - crs. pb.; max 27mm; med sorted; slightly moist; sub ang. - sub rd.; s: 60% f / 40% m, g: 70% m / 30% f; med. HCl rxn; 2.54 4/1 dark gray		
105	G.S.		105-120: Sandy Gravel (SG)	Archive @ 105' bgs	
			57% silt, 65% vfn - v.crs. sand (med - crs), 20% vfn - crs. pb.; max 25mm; med - poorly sorted; slightly moist - dry; sub ang. - sub rd.; s: 60% f / 40% m, g: 60% m / 40% f; med - strg. HCl rxn; 2.54 4/2 dark grayish brown		
110	G.S.		@ 110' bgs: 5% silt, 60% vfn - v.crs. sand (med), 35% vfn - v.crs. pb. max 60mm; poorly sorted, g: 65% m / 35% f; 2.54 5/2 grayish brown	Archive @ 110' bgs	
115	G.S.		@ 115' bgs: 7% silt; 58% vfn - v.crs. sand (med - crs); 35% vfn - v.crs. pb.; max 36mm; g: 70% m / 30% f;	Archive @ 115' bgs	

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr Geologist

Signature: *Julie Johanson*

Date: 11-12-14

Signature: *Kevin Bergstrom*

Date: 3-10-2015

BOREHOLE LOG

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Date: 11-12-14

Well ID: C8922

Well Name: 299-E25-237

Location: S. of WMA A-AX

Project: M-24 Monitoring Wells

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
120	G.S.			Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				120-123: Slightly Silty Gravelly Sand (G.S.) 10% silt, 70% vfn - v.crs. sand, (fa - crs), 20% vfn - crs. pcb; max 23mm; med. - poorly sorted; dry; sub. ang. - sub. md.; 5: 60% 40% m, g: 45% m / 55% f; strg. HCl rxn; 5.4 5/1 gray	Archive @ 120' bgs
125	G.S.			123-125: Sand (S) @ 125' bgs: 7% silt, 43% vfn - v.crs. sand (med.); well sorted; slightly moist - dry; 60% f / 40% m; med. - strg. HCl; 5.4 5/1 gray; sub. ang. - sub. md.	Archive @ 125' bgs
130	G.S.			@ 130' bgs: 7% silt, 85% vfn - v.crs. sand (crs - v.crs); 8% vfn - med. pcb (vfn); max 11mm, med. sorted; 55% f / 45% m;	Archive @ 130' bgs
135	G.S.			@ 135' bgs: 45% silt, 290% vfn - v.crs. sand (crs - v.crs); 5% vfn - fa. pcb; max 8mm, slightly moist, well sorted; 60% f / 40% m; sub. ang. - sub. md. 2.54 5/2 grayish brown	Archive @ 135' bgs
140	G.S.			@ 140' bgs: 5% silt, 90% vfn - v.crs. sand (crs - v.crs); 5% vfn - med. pcb; max 11mm; med. HCl rxn;	Archive @ 140' bgs
145	G.S.		@ 145' bgs: 45% silt, 290% vfn - v.crs. sand (crs - v.crs); 5% vfn - fa. pcb; max 8mm; slightly moist - dry;	Archive @ 145' bgs	
150	G.S.		@ 150' bgs: sand mostly crs., pcb size increase to crs.; max 18mm weak - med. HCl rxn.	Archive @ 150' bgs	
155	G.S.		@ 155' bgs: 45% silt, 290% vfn - v.crs. sand (crs); 17% vfn - fa. pcb; max 6mm, med. - strg. HCl rxn; 2.54 6/1 light brownish gray	Archive @ 155' bgs	

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: Julie Johanson

Date: 11-13-14

Signature: Kevin Bergstrom

Date: 3-10-2015

BOREHOLE LOG

Well ID: C8922

Well Name: 299-E25-237

Location: S. of WMA A-Ax

Project: M-24 Monitoring Wells

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
160	G.S.			Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
				123' - 167' : Sand (S)	Cable tool w/drive barrel
				@160' bgs: <5% silt, >90% vfn - v.crs sand (crs), 5% vfn - med. pb;	Archive @ 160' bgs
				max 12mm; slightly moist-dry; well sorted; sub ang. - sub rnd.; 60% F/40% m; med. - strg. HCl rxn; 2.54 6/8 light brownish gray	
165	G.S.			@166' bgs: <5% silt, >85% vfn - v.crs sand (crs - v.crs), 7% vfn - med. pb;	Archive @ 165' bgs
	G.S.			max 31mm; well - med. sorted; 2.54 5/2 grayish brown	
				167' - 170' : Gravelly Sand (GS)	Archive @ 167' bgs
				5% silt; >85% vfn - v.crs sand (crs), 10% vfn - crs. pb; max 25mm;	
170	G.S.			med. sorted, slightly moist - dry; sub ang. - sub rnd.; 65% F/35% m;	Archive @ 170' bgs
				med. HCl rxn; 2.54 5/2 grayish brown	
			170' - 220' : Sand (S)		
			<5% silt; >85% vfn - v.crs sand (crs - v.crs); 7% vfn - crs. pb; max 20mm;		
			slightly moist-dry; well - med. sorted; sub ang. - sub rnd.; 60% F/40% m;		
175	G.S.		med. - strg. HCl rxn; 2.54 5/2 grayish brown		
			@175' bgs: <5% silt, >90% vfn - v.crs sand (crs), 5% vfn - med. pb;	Archive @ 175' bgs	
			max 9mm; well sorted; med. HCl rxn		
180	G.S.		@180' bgs: <5% silt, >94% vfn - v.crs sand (fa - med), <1% vfn - fa	Archive @ 180' bgs	
			pb; max 6mm; med. - strg. HCl rxn; 2.54 6/8 light brownish gray		
185	G.S.		@185' bgs: <5% silt, >94% vfn - v.crs sand (med - v.crs), <1% vfn - fa	Archive @ 185' bgs	
			pb; max 5mm; slightly moist; strg. HCl rxn		
190	G.S.		@190' bgs: <5% silt, >90% vfn - v.crs sand (crs - v.crs), 5% vfn -	Archive @ 190' bgs	
			med. pb; max 12mm; med. HCl rxn; 2.54 5/8 light olive brown		
195	G.S.		@195' bgs: pb. vfn - fa, max 5mm;	Archive @ 195' bgs	

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr Geologist

Signature: Julie Johanson

Date: 11-17-14

Signature: Kevin Bergstrom

Date: 3-10-2015

BOREHOLE LOG

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Date: 11-17-14

Well ID: C8922

Well Name: 299-E25-237

Location: S. of WMA A-AX

Project: M-24 Monitoring Wells

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
200	G.S.			<u>170' - 220' : Sand (S)</u> 55% silt, 29% v.f.n. - v.crs. sand, 5% v.f.n. - fn. pebb; slightly moist; well sorted; sub. ang. - sub. rnd.; 60% F/40% m; med. HCl rxn; 2.54 5/3 light olive brown	<u>Cable tool w/drive barrel</u> <u>Archive @ 200' bgs</u>
205	G.S.			<u>@ 205' bgs: sand mostly crs.; max 8mm; 2.54 5/2 grayish brown</u>	<u>Archive @ 205' bgs</u>
210	G.S.			<u>@ 210' bgs: 55% silt, 88% v.f.n. - v.crs. sand (crs. - v.crs.), 7% v.f.n. - med. peb; max 15mm; well - med. sorted;</u>	<u>Archive @ 210' bgs</u>
215	G.S.			<u>@ 215' bgs: 82% silt, 94% v.f.n. - v.crs. sand (med. - crs.), 1% v.f.n. - fn. peb; max 5mm; well sorted; med. - strg. HCl rxn; 2.54 5/3 light olive brown</u>	<u>Archive @ 215' bgs</u>
220	G.S.			<u>220' - 230' : Slightly Silty Sand (LMS)</u> 10% silt, 85% v.f.n. - v.crs. sand (med.), 5% v.f.n. - med. peb; max 9mm; slightly moist - dry; sub ang. - sub. rnd.; well - med. sorted; 65% F/35% m; strg. - v. strg. HCl; 2.54 5/2 grayish brown	<u>Archive @ 221' bgs</u>
225	G.S.			<u>@ 225' bgs: 10% silt, 88% v.f.n. - v.crs. sand (med. - crs.), 2% v.f.n. - fn. peb; max 7mm; dry; well sorted, 2.54 6/2 light brownish gray</u>	<u>Archive @ 225' bgs</u>
230	G.S.			<u>230' - 235' : Sand (S)</u> 7% silt, 88% v.f.n. - v.crs. sand (med. - crs.) 5% v.f.n. - fn. peb; max 6mm; slightly moist - dry; well sorted; 60% F/40% m; sub. ang. - sub. rnd.; strg. - v. strg. HCl rxn; 2.54 6/2 light brownish gray	<u>Archive @ 230' bgs</u>
235	G.S.			<u>235 - 243' : Slightly Silty Sand (L) m S</u> 10% silt, 85% v.f.n. - v.crs. sand (med. - crs.), 5% v.f.n. - med. peb; max 12mm; slightly moist - dry; well - med. sorted; sub. ang. - sub. rnd.; 60% F/40% m; v. strg. HCl rxn; 2.54 6/2 light brownish gray	<u>Archive @ 235' bgs</u>

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: Julie Johanson

Date: 11-20-14

Signature: Kevin Bergstrom

Date: 3-10-2015

BOREHOLE LOG

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Date: 11-26-14

Well ID: C8922

Well Name: 299-E25-237

Location: S. of WMA A-AX

Project: M-24 Monitoring Wells

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
240	G.S.		[Hand-drawn log showing silty sand texture]	235' - 243': Slightly Silty Sand (mS) @240' bgs: 10% silt, 85% vfn.-v.crs. sand (med.-crs.), 5% vfn.-med. pab; max 9mm, slightly moist-dry; well sorted, sub ang. - sub. rnd; 60% F/40% m; v. strg. HCl rxn, 2.54 6/2 light brownish gray	Cable tool w/ drive barrel Archive @ 240' bgs
245	G.S.			243' - 248': Slightly Silty Gravelly Sand (mgS) @245' bgs: 100% silt, 80% vfn.-v.crs. sand (crs.), 10% vfn.-crs. pab; max 20mm, slightly moist-dry, med. sorted, sub. ang. - sub. rnd; 60% F/40% m; strg.-v. strg. HCl rxn, 2.54 6/2 light brownish gray.	Archive @ 245' bgs @ 248' bgs @ 250' bgs @ 255' bgs @ 260' bgs
250	G.S.		248' - 278': Sand (S) ^{KAB 7-10-2015} 90% sand, 10% silt, med.-coarse sand, color - 2.57 6/2 Lt. grey brown dry, sub ang. - angular, weak rxn to HCl, Quartz rich		
255	G.S.			G.S @ 265	
260	G.S.			11-24-14 I-001 A-D HEIS-B2YPH1, B2YPH2, B2YPH3, B2YPH4 260.4 - 262.9' bgs Blow count 141	
265	G.S.			11-24-14 I-002 A-B HEIS-B2YPH5, B2YPH6, B2YPH7, B2YPH8 Blow count 186 90% recovery	
270	G.S.			@ 270' bgs: med-strg. HCl rxn; 80% F/20% m; dry; slight cementation I-003 A-D, HEIS# B2YPH9, B2YPH10, B2YPH11, B2YPH12; 265.1 - 267.6' bgs (11-25-14) Archive @ 270' bgs	
275	G.S.			@ 275' bgs: strg.-v. strg. HCl rxn; cementation I-004 A-D, HEIS# B2YPH13, B2YPH14, B2YPH15, B2YPH16; 167.45' - 269.95' bgs (11-25-14) I-005 A-D, HEIS# B2YPH17, B2YPH18, B2YPH19, B2YPH20; 272.2' - 274.7' bgs (11-25-14) Archive @ 275' bgs	
	G.S.			278' - 280.7': Sandy silt (sM)	

Reported By: Julie Johanson
 Title: Geologist
 Signature: Julie Johanson
 Date: 11-25-14

Reviewed By: Kevin Bergstrom
 Title: Sr. Geologist
 Signature: K. Bergstrom
 Date: 3-10-2015

BOREHOLE LOG

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Date: 11-25-14

Well ID: C8922

Well Name: 299-E25-237

Location: S. of WMA A-BX

Project: M-24 Monitoring Wells

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
280	G.S.	I-008 100% recovery 43 blows		<p><u>278' - 290' Sandy Silt (SM)</u> 80% silt, 20% vfn. -fn sand; slightly moist; non-plastic w/H₂O present; weak - strg. HCl rxn; 2.54 4/2 light brownish gray, well sorted K₁₀ silt (m) 0.5 (see pg. 7) (11-25-14) See pg. 7</p>	<p>Cable tool w/drive barrel I-006 A-D, HETS# B24PK3, B24PK4, B24PK5, B24PK6, B24PK7, B24PK8, B24PK9, B24PK10, B24PK11, B24PK12, B24PK13, B24PK14, B24PK15, B24PK16, B24PK17, B24PK18, B24PK19, B24PK20, B24PK21, B24PK22, B24PK23, B24PK24, B24PK25, B24PK26, B24PK27, B24PK28, B24PK29, B24PK30, B24PK31, B24PK32, B24PK33, B24PK34, B24PK35, B24PK36, B24PK37, B24PK38, B24PK39, B24PK40, B24PK41, B24PK42, B24PK43, B24PK44, B24PK45, B24PK46, B24PK47, B24PK48, B24PK49, B24PK50, B24PK51, B24PK52, B24PK53, B24PK54, B24PK55, B24PK56, B24PK57, B24PK58, B24PK59, B24PK60, B24PK61, B24PK62, B24PK63, B24PK64, B24PK65, B24PK66, B24PK67, B24PK68, B24PK69, B24PK70, B24PK71, B24PK72, B24PK73, B24PK74, B24PK75, B24PK76, B24PK77, B24PK78, B24PK79, B24PK80, B24PK81, B24PK82, B24PK83, B24PK84, B24PK85, B24PK86, B24PK87, B24PK88, B24PK89, B24PK90, B24PK91, B24PK92, B24PK93, B24PK94, B24PK95, B24PK96, B24PK97, B24PK98, B24PK99, B24PK100</p>
285	G.S.			<p><u>280.7' - 290' Silty Sandy Gravel (MSG)</u> 20% silt, 60% vfn. - v.crs. sand (crs.), 20% vfn. - v.crs. pbh; max 50mm, slightly moist - moist, sub.ang. - sub.rnd.; s: 55%F/45% 45% for sand, g: 65% m/35% f; strg. HCl rxn; 2.54 4/2 dark grayish brown; poorly sorted Archive @ 278' bgs (see pg. 7)</p>	<p>I-007 A-D, HETS# B24PK5, B24PK6, B24PK7, B24PK8, B24PK9, B24PK10, B24PK11, B24PK12, B24PK13, B24PK14, B24PK15, B24PK16, B24PK17, B24PK18, B24PK19, B24PK20, B24PK21, B24PK22, B24PK23, B24PK24, B24PK25, B24PK26, B24PK27, B24PK28, B24PK29, B24PK30, B24PK31, B24PK32, B24PK33, B24PK34, B24PK35, B24PK36, B24PK37, B24PK38, B24PK39, B24PK40, B24PK41, B24PK42, B24PK43, B24PK44, B24PK45, B24PK46, B24PK47, B24PK48, B24PK49, B24PK50, B24PK51, B24PK52, B24PK53, B24PK54, B24PK55, B24PK56, B24PK57, B24PK58, B24PK59, B24PK60, B24PK61, B24PK62, B24PK63, B24PK64, B24PK65, B24PK66, B24PK67, B24PK68, B24PK69, B24PK70, B24PK71, B24PK72, B24PK73, B24PK74, B24PK75, B24PK76, B24PK77, B24PK78, B24PK79, B24PK80, B24PK81, B24PK82, B24PK83, B24PK84, B24PK85, B24PK86, B24PK87, B24PK88, B24PK89, B24PK90, B24PK91, B24PK92, B24PK93, B24PK94, B24PK95, B24PK96, B24PK97, B24PK98, B24PK99, B24PK100</p>
290	G.S.			<p><u>290 - 295' Silty Sandy Gravel (MSG)</u> 20% silt, 55% vfn. - v.crs. sand (vfn.-fn); 20% vfn. - v.crs. pbh; max 45mm; dry - slightly moist; sub.ang. - sub.rnd.; s: 55%F/45% g: 60% m/40% f; strg. HCl rxn; 2.54 4/2 light brownish gray poorly sorted Archive @ 285' bgs Archive @ 290' bgs</p>	<p>I-008 A-D, HETS# B24PK9, B24PK10, B24PK11, B24PK12, B24PK13, B24PK14, B24PK15, B24PK16, B24PK17, B24PK18, B24PK19, B24PK20, B24PK21, B24PK22, B24PK23, B24PK24, B24PK25, B24PK26, B24PK27, B24PK28, B24PK29, B24PK30, B24PK31, B24PK32, B24PK33, B24PK34, B24PK35, B24PK36, B24PK37, B24PK38, B24PK39, B24PK40, B24PK41, B24PK42, B24PK43, B24PK44, B24PK45, B24PK46, B24PK47, B24PK48, B24PK49, B24PK50, B24PK51, B24PK52, B24PK53, B24PK54, B24PK55, B24PK56, B24PK57, B24PK58, B24PK59, B24PK60, B24PK61, B24PK62, B24PK63, B24PK64, B24PK65, B24PK66, B24PK67, B24PK68, B24PK69, B24PK70, B24PK71, B24PK72, B24PK73, B24PK74, B24PK75, B24PK76, B24PK77, B24PK78, B24PK79, B24PK80, B24PK81, B24PK82, B24PK83, B24PK84, B24PK85, B24PK86, B24PK87, B24PK88, B24PK89, B24PK90, B24PK91, B24PK92, B24PK93, B24PK94, B24PK95, B24PK96, B24PK97, B24PK98, B24PK99, B24PK100</p>
295	G.S.			<p><u>@ 295' bgs: 10% silt, 45% vfn. - v.crs. sand (crs.), 45% vfn. pbh.</u> to small cob; max 25mm; dry - moist; med - strg. HCl rxn; 2.54 4/2 light brownish gray for dry, 2.54 4/2 dark grayish brown for moist Archive @ 295' bgs DTW: 295.66' bgs (12-2-14) DTW: 296.31' bgs (12-3-14)</p>	
300	G.S.			<p><u>@ 300' bgs: 15% silt, 20% vfn. - v.crs. sand, 65% vfn. pbh. - lg.</u> cob; max 150mm; wet; s: 50% m/50% f; 45% m/55% f; v. weak. No HCl rxn; 2.54 4/1 dark gray Archive @ 300' bgs</p>	
305	G.S.			<p><u>@ 305 - 306' Sand (S)</u> 3% silt, 90% vfn. - v.crs. sand (crs. - v.crs.), 7% vfn. pbh. - sm. cob; max 72mm; med sorted, wet, sub.ang. - sub.rnd.; s: 50% m/50% f; g: 50% m/50% f; v. weak - no HCl rxn; 2.54 4/2 dark grayish brown. Plug ~ 9' and casing dropped while removing cuttings @ 305' bgs to 310' bgs</p>	
310	G.S.	H ₂ O Sample I-009		<p><u>310 - 315' Silty Sandy Gravel (MSG)</u> @ 310' bgs: 15% silt, 25% vfn. - v.crs. sand (fn - v.crs.), 60% vfn. pbh. sm. cob; max 92mm; poorly sorted; wet; ang. - sub.rnd.; s: 65% m/35% f; 35% f, g: 70% m/30% f; No HCl rxn; 2.54 4/1 dark gray H₂O Sample I-009, HETS# B24PK15, B24PK16, B24PK17, B24PK18, B24PK19, B24PK20, B24PK21, B24PK22, B24PK23, B24PK24, B24PK25, B24PK26, B24PK27, B24PK28, B24PK29, B24PK30, B24PK31, B24PK32, B24PK33, B24PK34, B24PK35, B24PK36, B24PK37, B24PK38, B24PK39, B24PK40, B24PK41, B24PK42, B24PK43, B24PK44, B24PK45, B24PK46, B24PK47, B24PK48, B24PK49, B24PK50, B24PK51, B24PK52, B24PK53, B24PK54, B24PK55, B24PK56, B24PK57, B24PK58, B24PK59, B24PK60, B24PK61, B24PK62, B24PK63, B24PK64, B24PK65, B24PK66, B24PK67, B24PK68, B24PK69, B24PK70, B24PK71, B24PK72, B24PK73, B24PK74, B24PK75, B24PK76, B24PK77, B24PK78, B24PK79, B24PK80, B24PK81, B24PK82, B24PK83, B24PK84, B24PK85, B24PK86, B24PK87, B24PK88, B24PK89, B24PK90, B24PK91, B24PK92, B24PK93, B24PK94, B24PK95, B24PK96, B24PK97, B24PK98, B24PK99, B24PK100</p>	
315	G.S.			<p><u>@ 315' bgs: 15% silt, 15% vfn. - v.crs. sand; 70% vfn.</u> pbh. - sm. cob; wet, sub.ang. - rnd.; 75% m/25% f; No HCl rxn; 2.54 5/1 gray; max 100mm Archive @ 315' bgs</p>	

Reported By: Julie Johanson

Reviewed By: Kevin Berjstrom

Title: Geologist

Title: Sr. Geologist

Signature: Julie Johanson

Date: 12-3-14

Signature: Kevin Berjstrom

Date: 3-10-2015

BOREHOLE LOG

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Date: 12-3-14

Well ID: C8922

Well Name: 299-E25-237

Location: S. of WMA A-AX

Project: M-24 Monitoring Wells

Reference Measuring Point:

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
320	G.S.	Stone Sample 300-301		<u>306-345.78: Silty Sandy Gravel (msG)</u> @ 320' bgs: 15% silt, 25% vfn - v.crs sand (crs), 60% vfn peb - sm. cob; max 102mm, wet, poorly sorted; sub ang. - sub. rnd; s: 60% m/40% f, g: 75% n/25% f; No HCl rxn; 2.54 4/1 dark gray	Cable tool w/drive barrel Archive @ 320' bgs
325	G.S.	H ₂ O Sample I-010		@ 325' bgs: 20% silt, 20% vfn - v.crs sand (vfn + v.crs), 60% vfn - v.crs peb; max 60mm; wet; s: 60% m/40% f, g: 65% n/ 35% f, No mod. HCl rxn.	Archive @ 325' bgs H ₂ O Sample I-010, HETS [®] B24PL6, B24PL7, B24PL8, B24PN2 (Field); 326.08' bgs (12-4-14)
330	G.S.	303-304		@ 330' bgs: 10% silt, 25% vfn - v.crs (crs) sand, 65% vfn peb - sm. cob; max 70mm; wet; v. weak - no HCl rxn.	Archive @ 330' bgs
335	G.S.	Seive Sample 305-310		Increase in silt + cementation @ 332	Reworked Ringold FM. ?
335	G.S.	305-310		@ 334' bgs: 35% silt, 25% vfn - v.crs sand (vfn - med), 30% vfn peb - sm. cob; max 70mm, wet; sub ang. - rnd; s: 70% f/30% m g: 65% f/35% m; (wet - moist) weak - no HCl rxn; No plasticity w/ water content; 10YR 5/4 yellowish brown, 10YR 5/2 grayish brown, 10YR 3/2 very dark grayish brown, 10YR 6/8 brownish yellow, GLEY 2 5/5B bluish gray, 10R 4/3 weak red.	Archive @ 334' bgs
340	G.S.	Seive Sample 310-315		@ 340' bgs: max 67mm; sub ang. - sub rnd; s: 70% f/30% m, g: 75% f/25% m; ^{sub ang. - moist} wet - moist, No - weak HCl rxn; 7.5YR 6/3 light brown, 2.54 6/3 light yellowish brown, 2.54 4/1 dark gray, 2.54 4/2 dark grayish brown.	Archive @ 340' bgs
345	G.S.	315-345		@ 345' bgs: max 67mm, sub ang. - sub rnd. (ang. due to drilling), moist wet; 10YR 6/4 light yellowish brown, 10YR 4/2 dark grayish brown, 2.54 4/2 dark grayish brown, 2.54 6/4 light yellowish brown, 2.54 8/2 pale yellow	Archive @ 345' bgs Switch to hard tool @ 345.78' bgs Water sample I-011 attempted @ 345' bgs, No water re-charge for sample. CASIN WAS AT 344.82 FT. bgs,
350				from 345.78' - 350' 2.54 4/2 dark grayish brown; 65% m/ 35% f bits of sand size formation in slurry	BOREHOLE WAS AT 345.78' bgs + ATTEMPT WAS 12/1-10/14 OVERNIGHT → STILL NO WATER (BWS)
355				from 350' - 355': 10YR 3/2 very dark grayish brown; appears to be ~ 65% m/35% f silty	
				from 355' - 359': 2.54 4/2 3/2 very dark grayish brown; appears to be ~ 60% f/40% m, larger chunks ~ 70% f	

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr Geologist

Signature: Julie Johanson

Date: 12-11-14

Signature: Kevin Bergstrom

Date: 3-10-2015

BOREHOLE LOG

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Date: 12-11-14

Well ID: C9922

Well Name: 299-E25-237

Location: S. of WMA A-AX

Project: M-24 Monitoring Wells

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
360				From 359' - 365' bgs: silty 2.54 5/2 grayish brown 2.54 4/2 dark grayish brown, ~50% m / ~50% f	Cable tool w/ hard tool Possible lithology change @ ~360.5' according to driller.
365					H ₂ O Sample I-012 HETS # B2VPM5, B2VPM6, B2VPM7, B2VPM8 (Feb), I-012 Dup HETS # B2VPM12, B2VPM13, B2VPM14 @ 363.85' bgs (12-15-14)
370	G.S.			366.19 - 374.5 Silty Sandy Gravel (msG) @ 367' bgs: 15% silt, 35% v.f.n. - v.crs. sand (fn), 50% v.f.n. peb 5m. ccb; max 75mm, wet, poorly sorted, ang. - sub. rnd.; s: 20% f / 20% m, g: 20% f / 20% m; v. weak - no HCl rxn; 104R 4/2 dark grayish brown, 104R 4/3 brown, + 104R 4/4 dark yellowish brown	Switch back to drive barrel @ 366.19' bgs Archive @ 367' bgs
375	G.S.			@ 370' bgs: 10% silt, 55% v.f.n. - v.crs. sand (med), 35% v.f.n. - v.crs. peb. max 50mm; moist - dry; s: 75% f / 25% m, g: 20% f / 20% m; weak - no HCl rxn, 104R 7/1 light gray, 104R 4/2 dark grayish brown, 7.5 4R 4/4 brown, 104R 7/2 very pale brown	Archive @ 370' bgs Archive @ 374.5' bgs
390				@ ~371.5' bgs increase in silt (clay) due to weathering 374.5' - 375': Basalt (weathered + fractured) basalt chips + pebbles (angular) mixed with formation above. @ 1E4 3/1 very dark gray; moist - wet, poorly sorted mostly sub ang. - ang.; No HCl rxn on basalt.	TD: 374.78' bgs

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: Julie Johanson

Date: 12-23-14

Signature: Kevin Bergstrom

Date: 3-10-2015

299-E25-237 (C8922)

Log Data Report

Borehole Information:

Log Date:	2014-12-29	Filename:	C8922_HG-NM_2014-12-29	Site:	200E near evaporator
Coordinates (WA St Plane)		DTW¹ (ft):	301.25	DTW Date:	12/29/14
North (m)	East (m)	Drill Date	TOC² Elevation	Total Depth (ft)	Type
N/A	N/A	12/29/14	N/A	374	Cable Tool

Casing Information:

Casing Type	Stickup (ft)	Diameter (in.)		Thickness (in.)	Top (ft)	Bottom (ft)
		Outer	Inside			
Threaded Steel	0.8	12	10 3/4	5/8	0.8	208.75
Welded Steel	1.8	8 5/8	7 3/8	5/8	1.8	374

Borehole Notes:

The onsite geologist provided the total depth and casing depth. The logging engineer measured casing stick-up and casing diameter (rounded to the nearest 1/16-in.). Depth to water inside the casing was derived from moisture measurements. The maximum logging depth achieved was 374 ft.

Zero reference is ground surface.

Logging Equipment Information:

Logging System:	Gamma 4N	Type:	60% HPGe SGLS
Effective Calibration Date:	11/11/14	Serial No.:	45-TP22010A
Calibration Reference:	HGLP-CC-108, Rev. 0	Logging Procedure:	HGLP-MAN-002, Rev. 1

Logging System:	Gamma 4M	Type:	NMLS ³
Effective Calibration Date:	10/13/14	Serial No.:	H340207279
Calibration Reference:	HGLP-CC-109, Rev. 0	Logging Procedure:	HGLP-MAN-002, Rev. 1

SGLS Log Run Information:

Log Run	3	4 Repeat	7	8 Repeat	
HEIS Number	1018597	1018598	1018599	1018600	
Date	11/18/14	11/18/14	12/29/14	12/29/14	
Logging Engineer	Felt/Spatz	Felt/Spatz	Felt/Spatz	Felt/Spatz	
Start Depth (ft)	0.0	50.0	208.0	277.0	
Finish Depth (ft)	209.0	71.0	374.0	293.0	
Count Time (sec)	100	100	100	100	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
Log Speed (ft/min)	N/A	N/A	N/A	N/A	

¹ depth to water inside casing

² top of casing

³ Neutron Moisture Logging System

Log Run	3	4 Repeat	7	8 Repeat	
Pre-Verification	DNK91CAB	DNK91CAB	DNL31CAB	DNL31CAB	
Start File	DNK91000	DNK91210	DNL31000	DNL31167	
Finish File	DNK91209	DNK91231	DNL31166	DNL31183	
Post-Verification	DNK91CAA	DNK91CAA	See logging notes	See logging notes	
Depth Return Error (in.)	N/A	3.0 high	N/A	3.5 low	
Comments	No fine gain adjustments made				

NMLS Log Run Information:

Log Run	1	2 Repeat	5	6 Repeat	
HEIS Number	1018601	1018602	1018603	1018604	
Date	11/18/14	11/18/14	12/29/14	12/29/14	
Logging Engineer	Felt/Spatz	Felt/Spatz	Felt/Spatz	Felt/Spatz	
Start Depth (ft)	0.0	10.0	210.0	277.0	
Finish Depth (ft)	211.25	32.0	301.25	287.0	
Count Time (sec)	15	15	15	15	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	0.25	0.25	0.25	0.25	
Log Speed (ft/min)	N/A	N/A	N/A	N/A	
Pre-Verification	DMY12CAB	DMY12CAB	DMY32CAB	DMY32CAB	
Start File	DMY12000	DMY12846	DMY32000	DMY32366	
Finish File	DMY12845	DMY12934	DMY32365	DMY32406	
Post-Verification	DMY12CAA	DMY12CAA	DMY32CAA	DMY32CAA	
Depth Return Error (in.)	N/A	6.0 high	N/A	0.5 low	
Comments	None	None	None	None	

Logging Operation Notes:

A centralizer was installed on the sondes.

Pre- and post-survey verification measurements met the acceptance criteria for the established systems except for data acquired December 29, 2014 with the SGLS. The post-verification measurement was not acquired due to a data transmission problem. Repeat data collected at the end of the day from 277 to 294 ft indicated the logging system was operating correctly and the data are accepted.

Analysis Notes:

Analyst:	P.D. Henwood	Date:	01/13/15	Reference:	HGLP-MAN-003, Rev. 0
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A casing correction for a 5/8-in. thick casing was applied to the log data.

A correction for water was applied below 301 ft in depth.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as DN20141111, using an efficiency function and corrections for casing and dead time as determined by annual calibration.

NMLS data are represented in counts per second.

The HGU⁴ 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 the borehole. MDLs for Cs-137 are plotted for the entire borehole.

Radon was detected while logging the first casing on November 18, 2014. This was corroborated by the radiation control technician field measurements of cable and sonde wipes.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content. Relatively high moisture is indicated at approximately 279 ft which may indicate perched water. This depth generally coincides with corrosion indicated on casings in nearby groundwater wells.

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

List of Log Plots:

Depth Reference is ground surface.

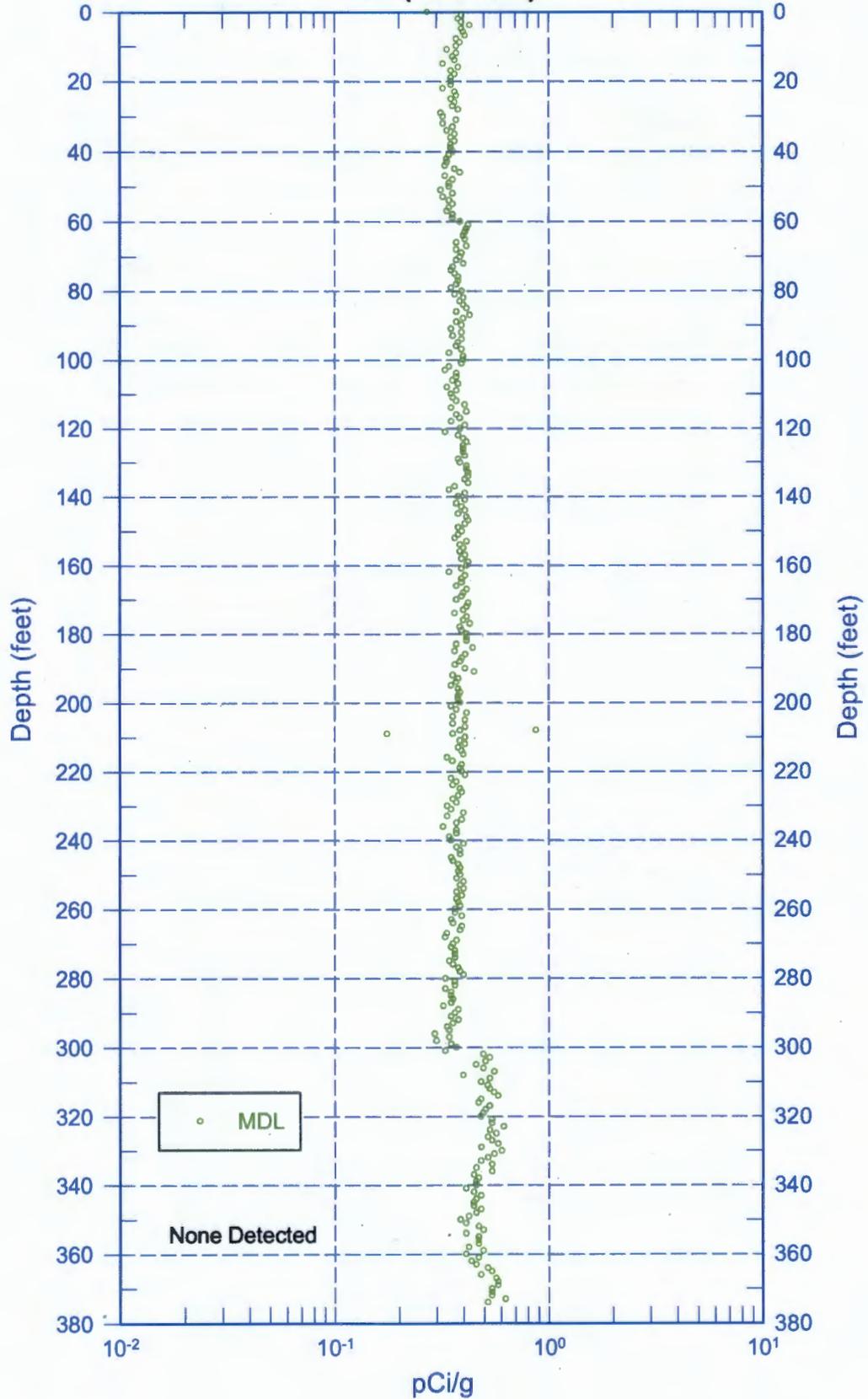
Manmade Radionuclides (0-380 ft)
 Natural Gamma Logs (0-160 ft)
 Natural Gamma Logs (150-310 ft)
 Natural Gamma Logs (300-460 ft)
 Combination Plot (0-120 ft)
 Combination Plot (110-230 ft)
 Combination Plot (220-340 ft)
 Combination Plot (330-450 ft)
 Combination Plot (0-380 ft)
 Total Gamma & Moisture (0-160 ft)
 Total Gamma & Moisture (150-310 ft)
 Total Gamma & Hanford Gamma Unit (0-380 ft)
 Repeat Section of Natural Gamma Logs (50 to 71 ft)
 Repeat Section of Natural Gamma Logs (277 to 294 ft)
 Moisture Repeat Section (10 to 32 ft)
 Moisture Repeat Section (277 to 287 ft)

⁴ Hanford Gamma Unit



299-E25-237 (C8922) Manmade Radionuclides

¹³⁷Cs (662 keV)

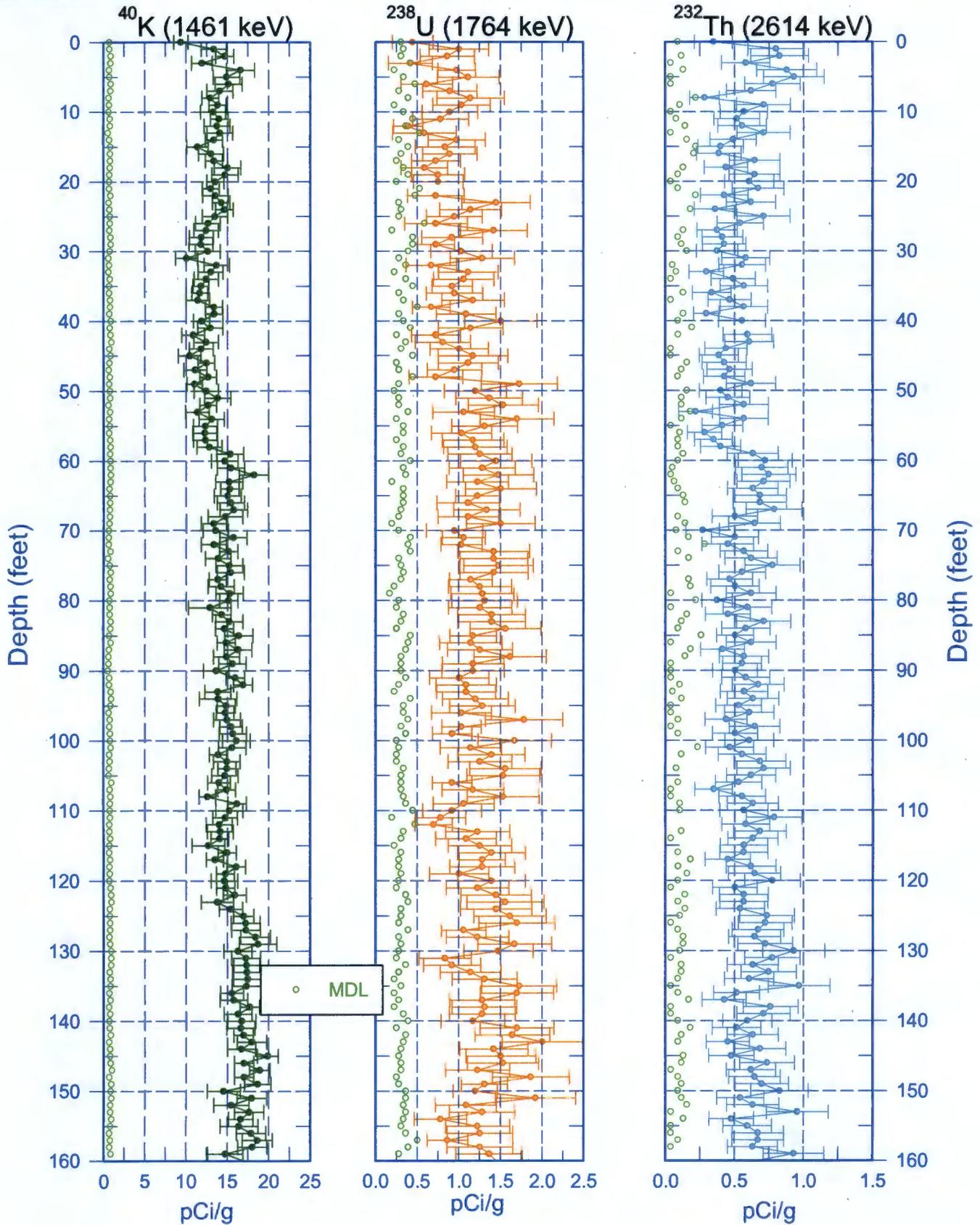


Zero Reference - Ground Surface



Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

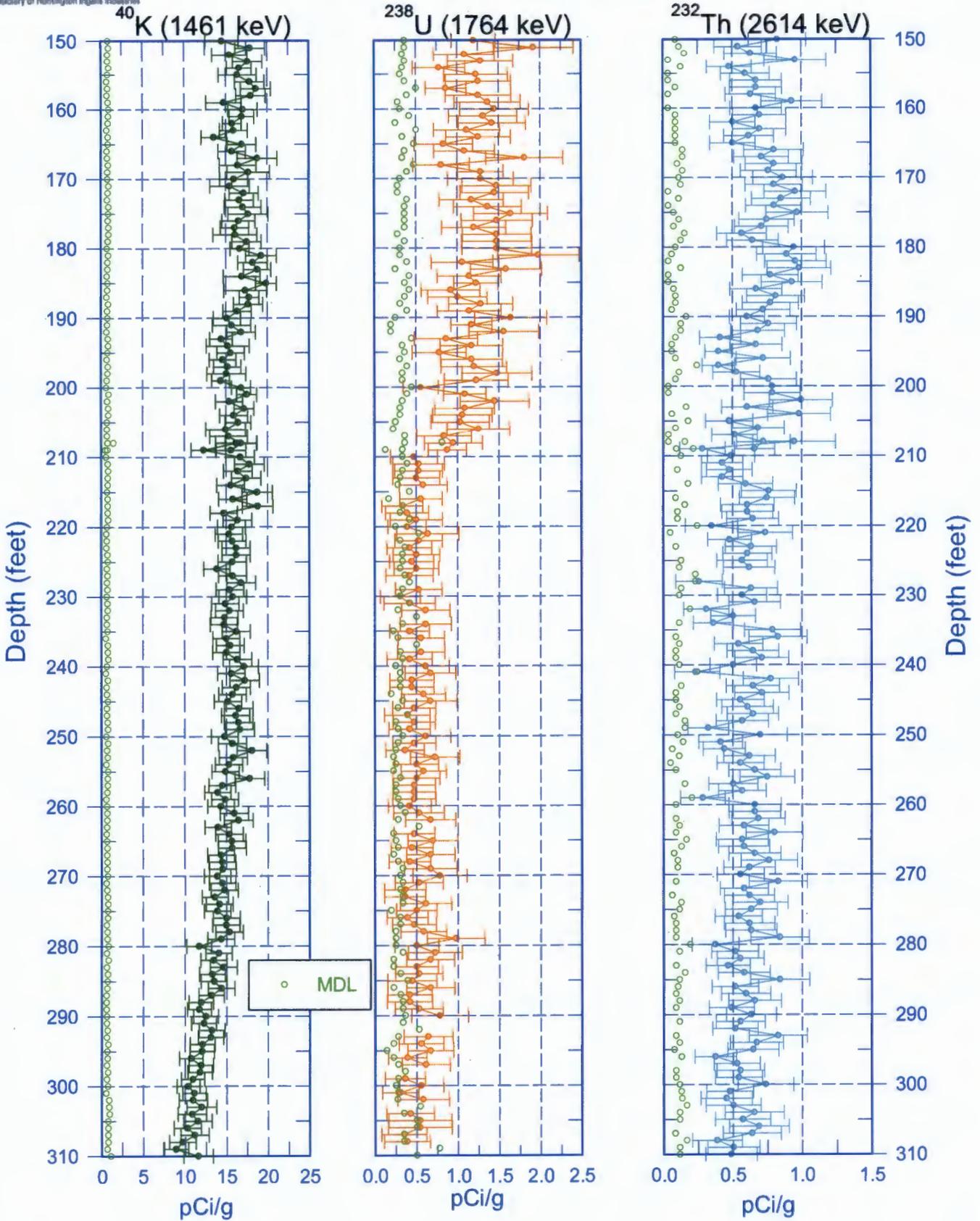
299-E25-237 (C8922) Natural Gamma Logs



Zero Reference - Ground Surface



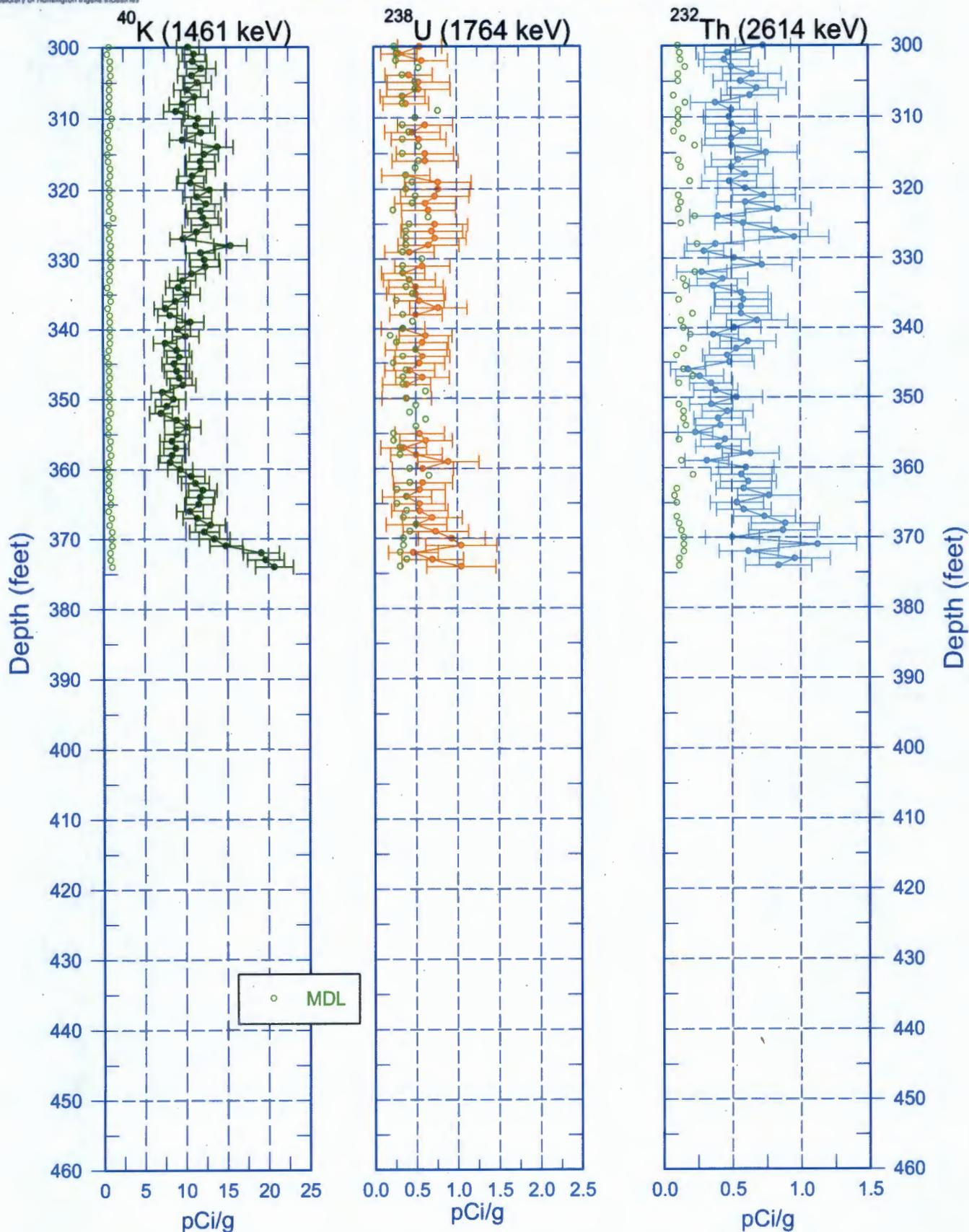
299-E25-237 (C8922) Natural Gamma Logs



Zero Reference - Ground Surface



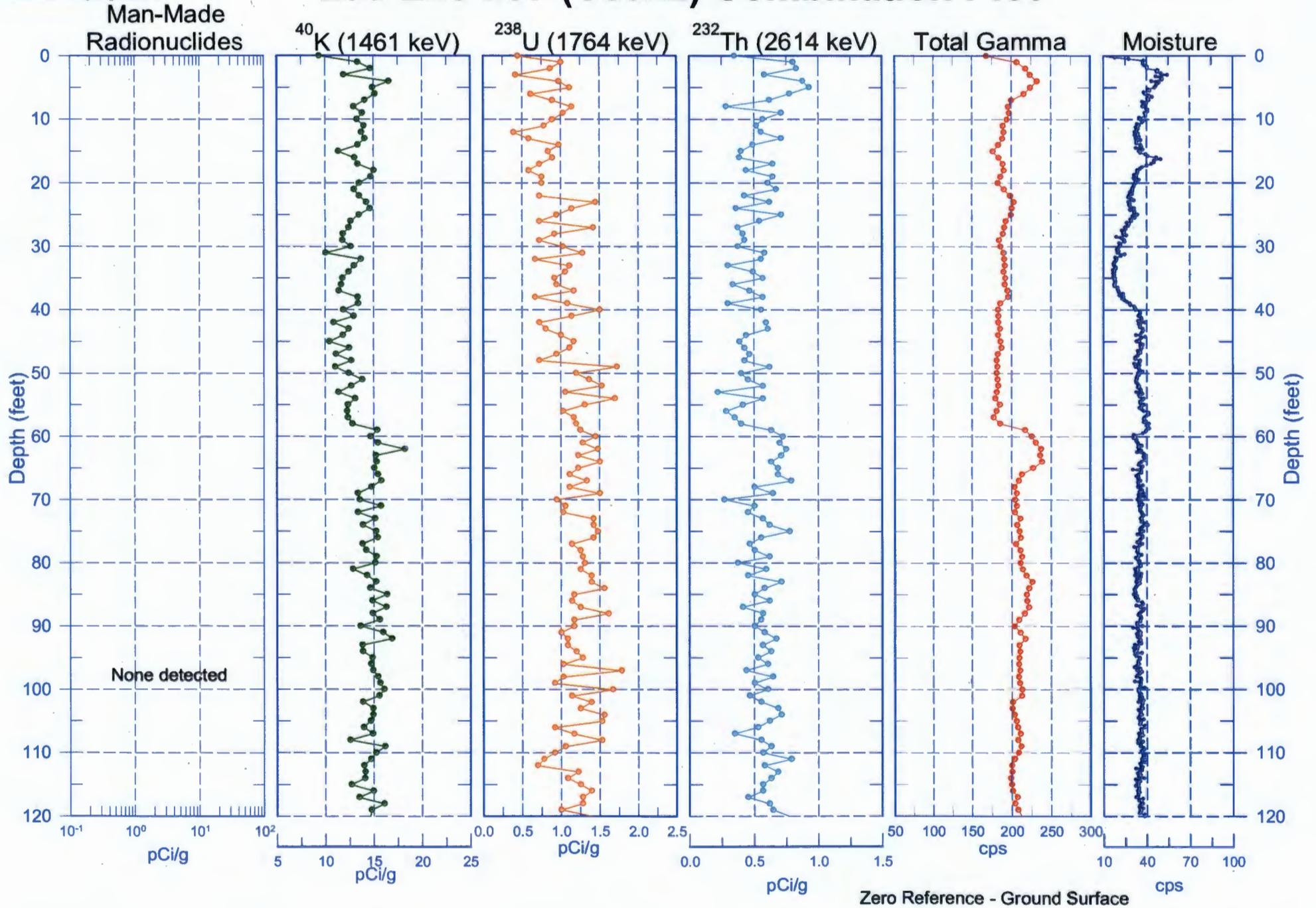
299-E25-237 (C8922) Natural Gamma Logs



Zero Reference - Ground Surface



299-E25-237 (C8922) Combination Plot

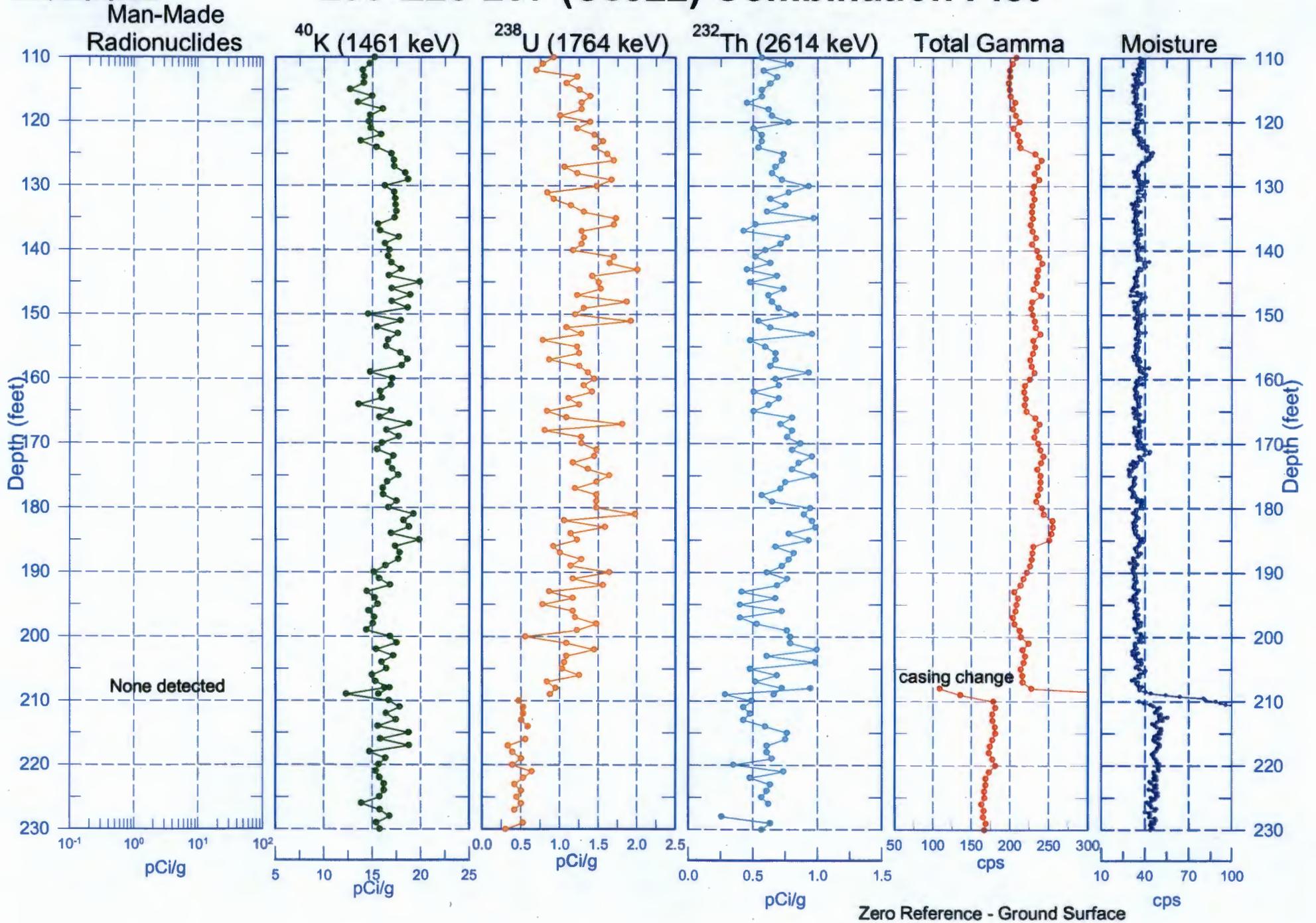




Stellar Newport News Nuclear
A Subsidiary of Westinghouse Inertec Industries

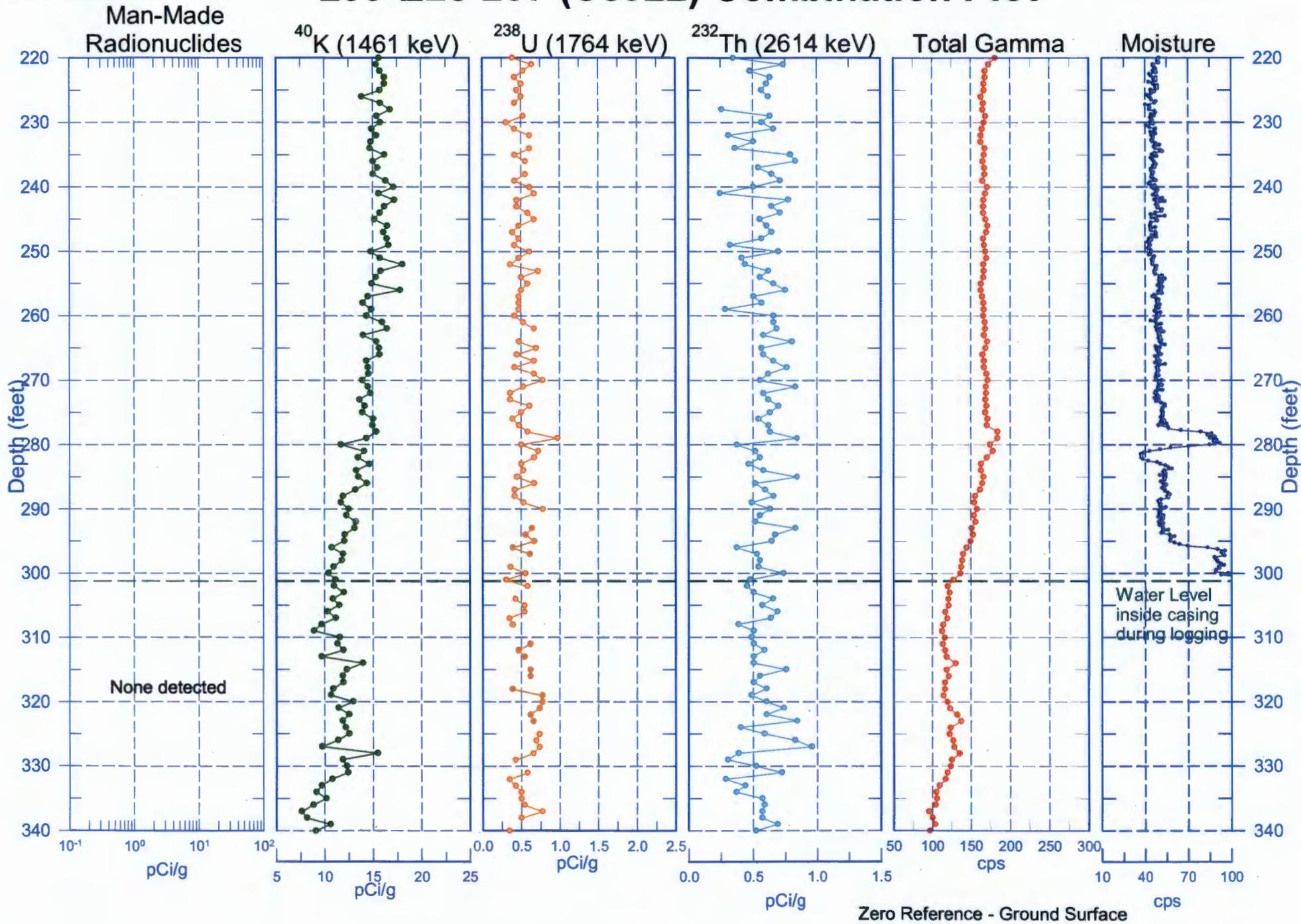
SGW- 58550 REV 0

299-E25-237 (C8922) Combination Plot





299-E25-237 (C8922) Combination Plot

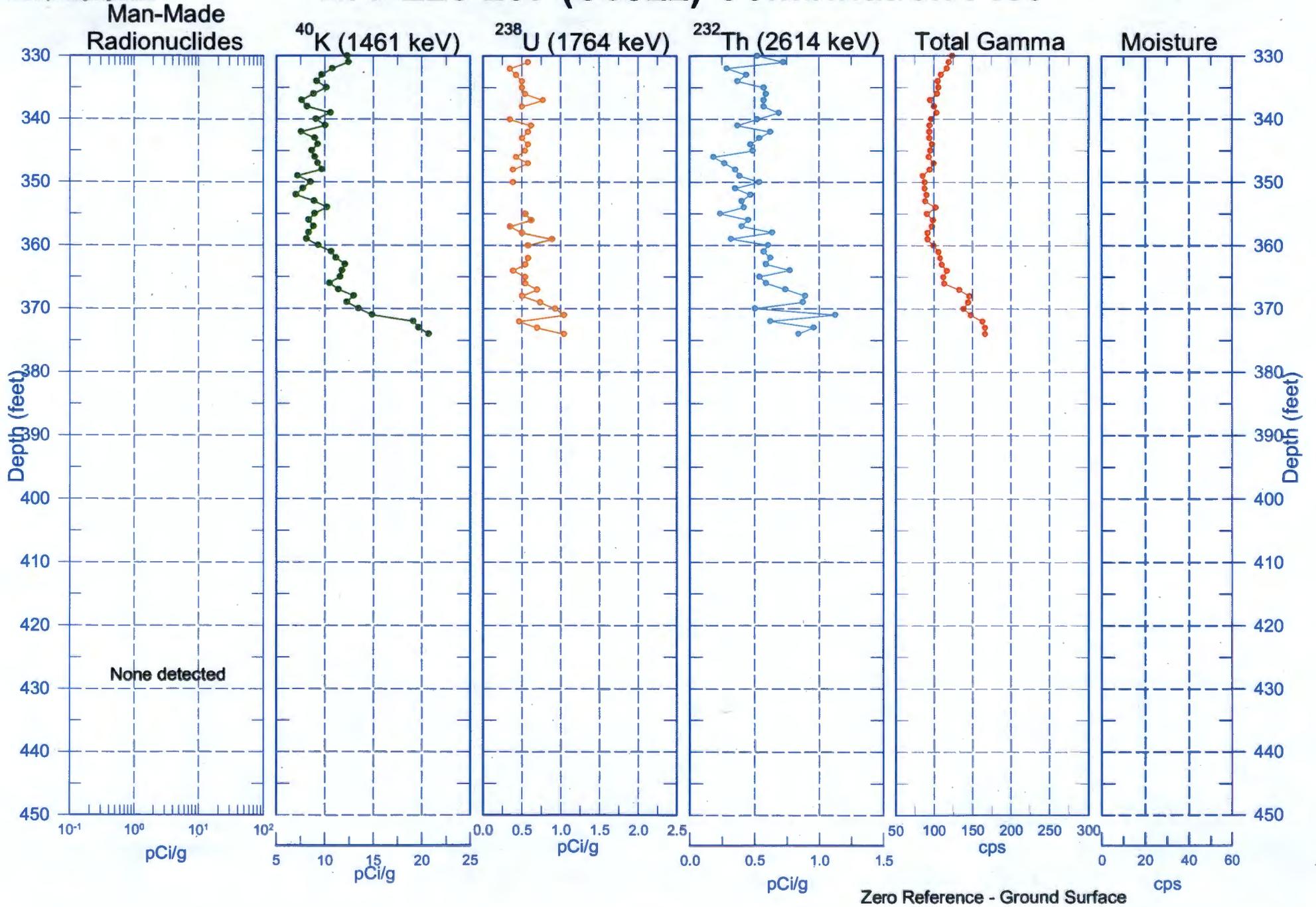




Stellar Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

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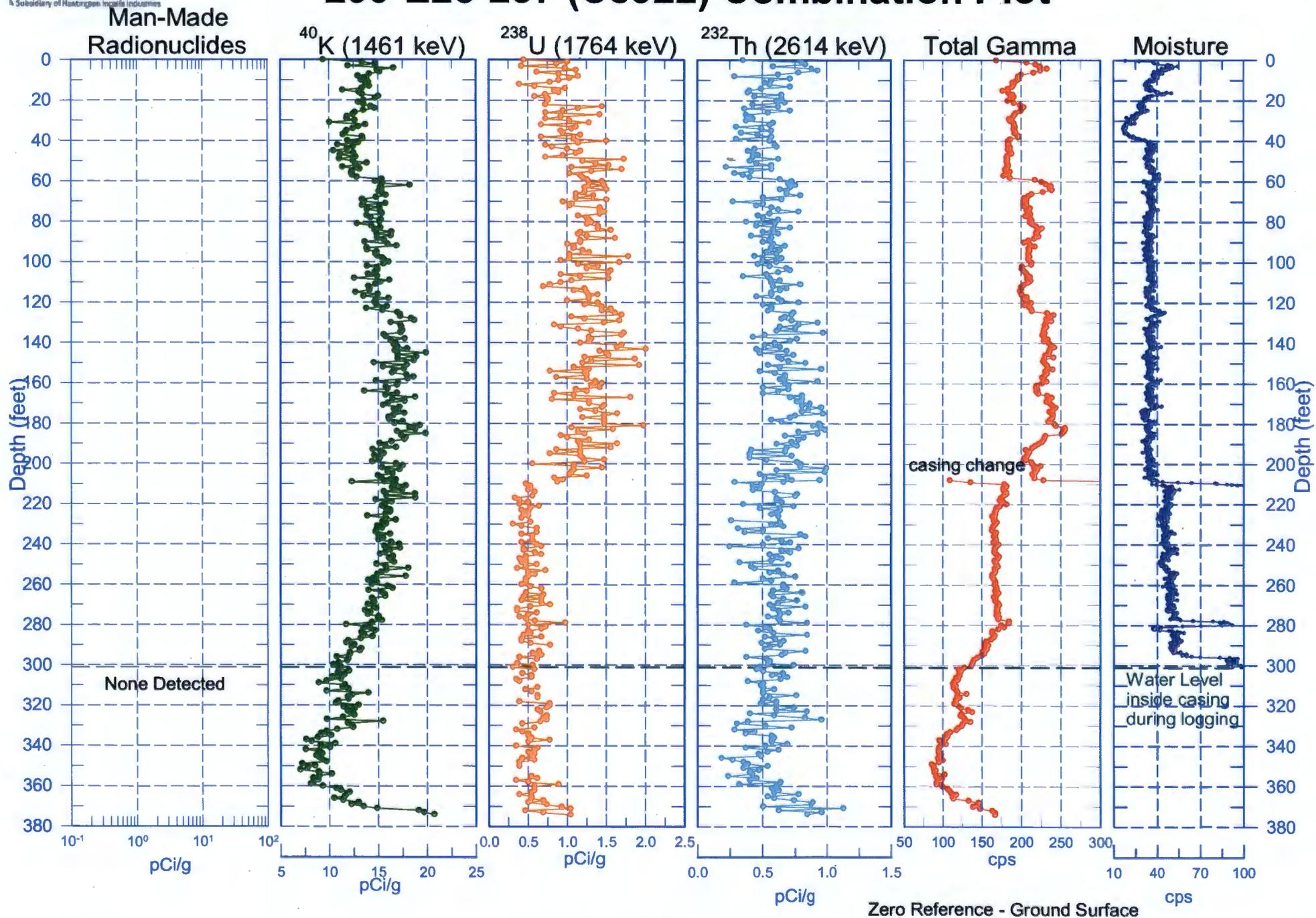
299-E25-237 (C8922) Combination Plot





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A Subsidiary of Huntington Ingalls Industries

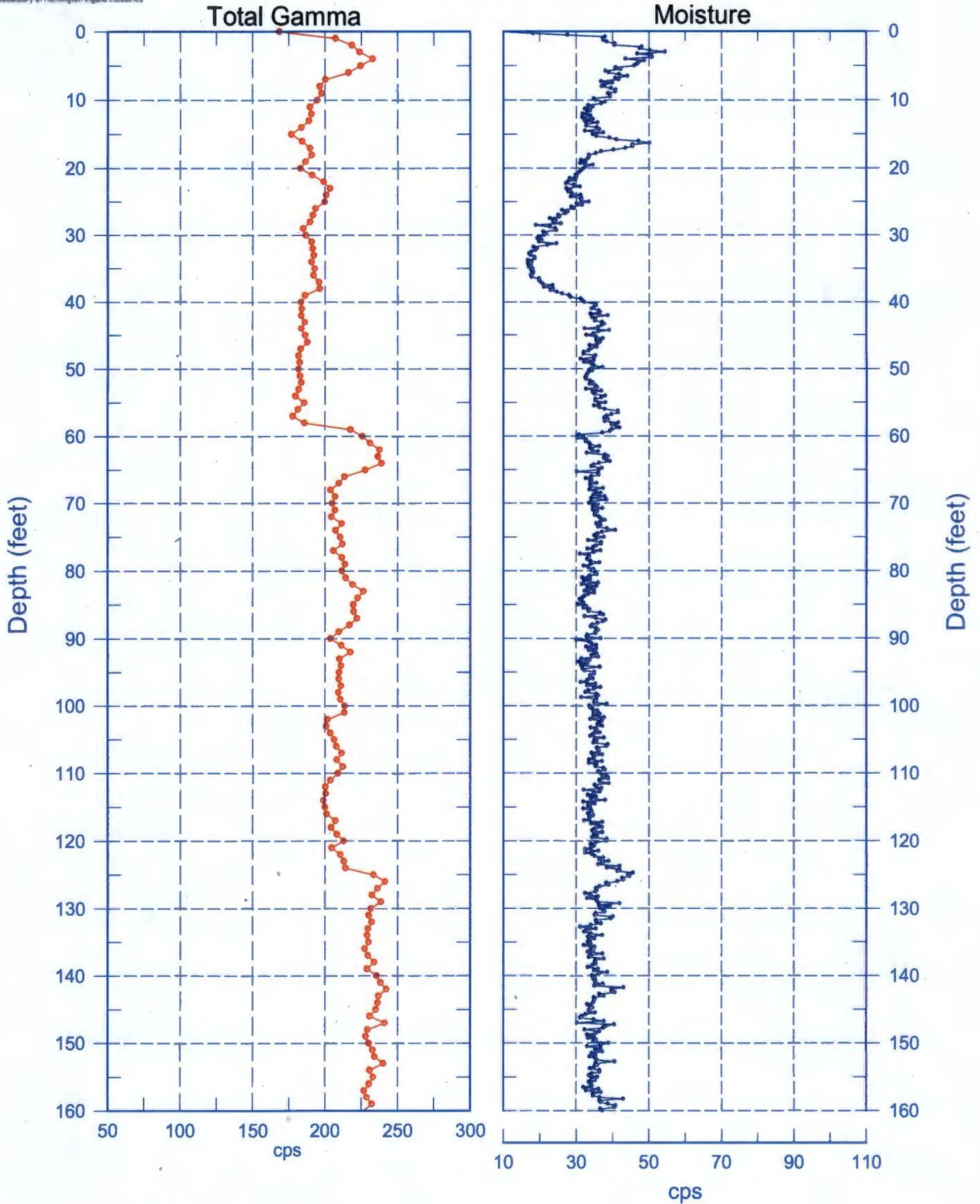
299-E25-237 (C8922) Combination Plot





Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

299-E25-237 (C8922) Total Gamma & Moisture

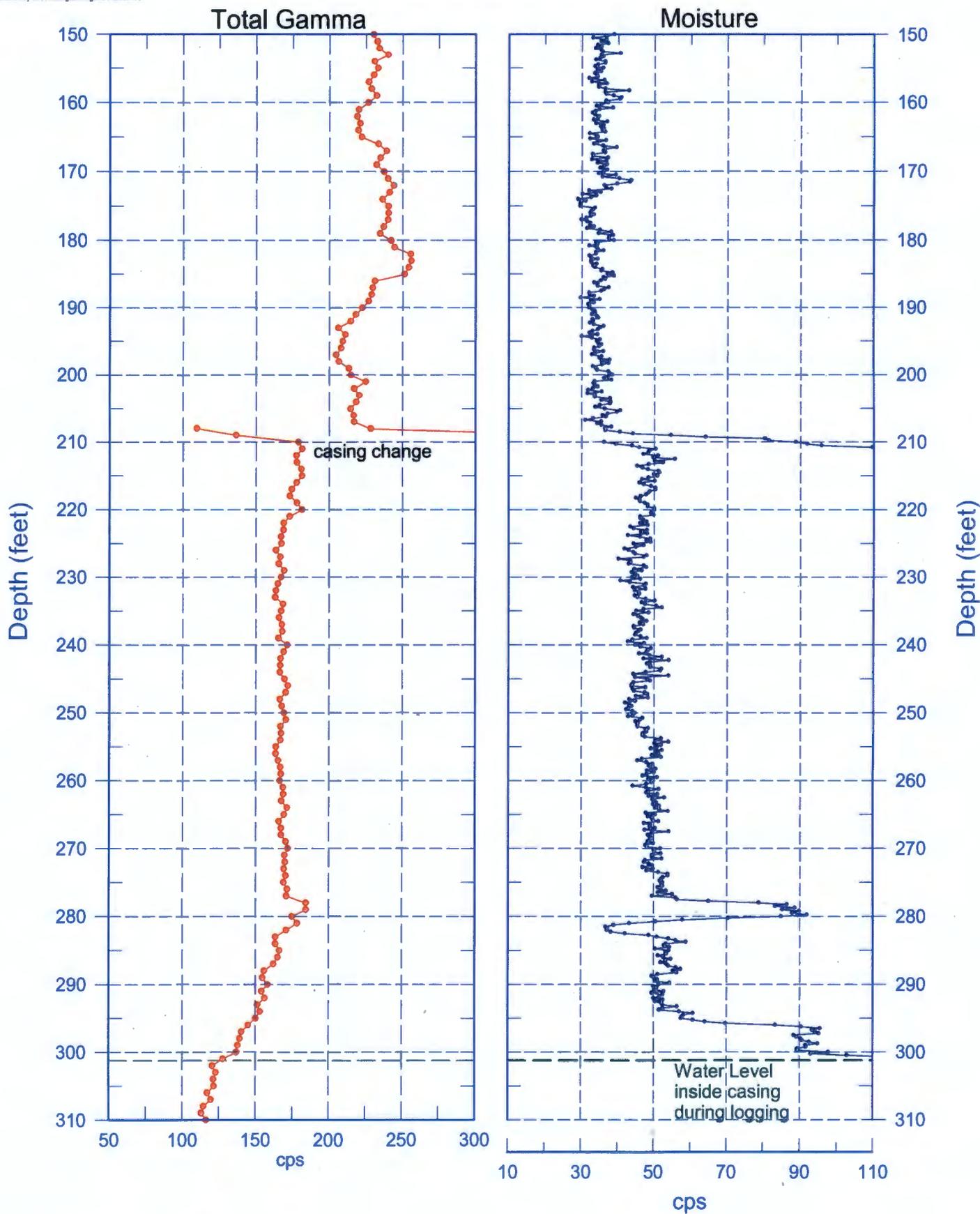


Reference - Ground Surface



299-E25-237 (C8922)

Total Gamma & Moisture

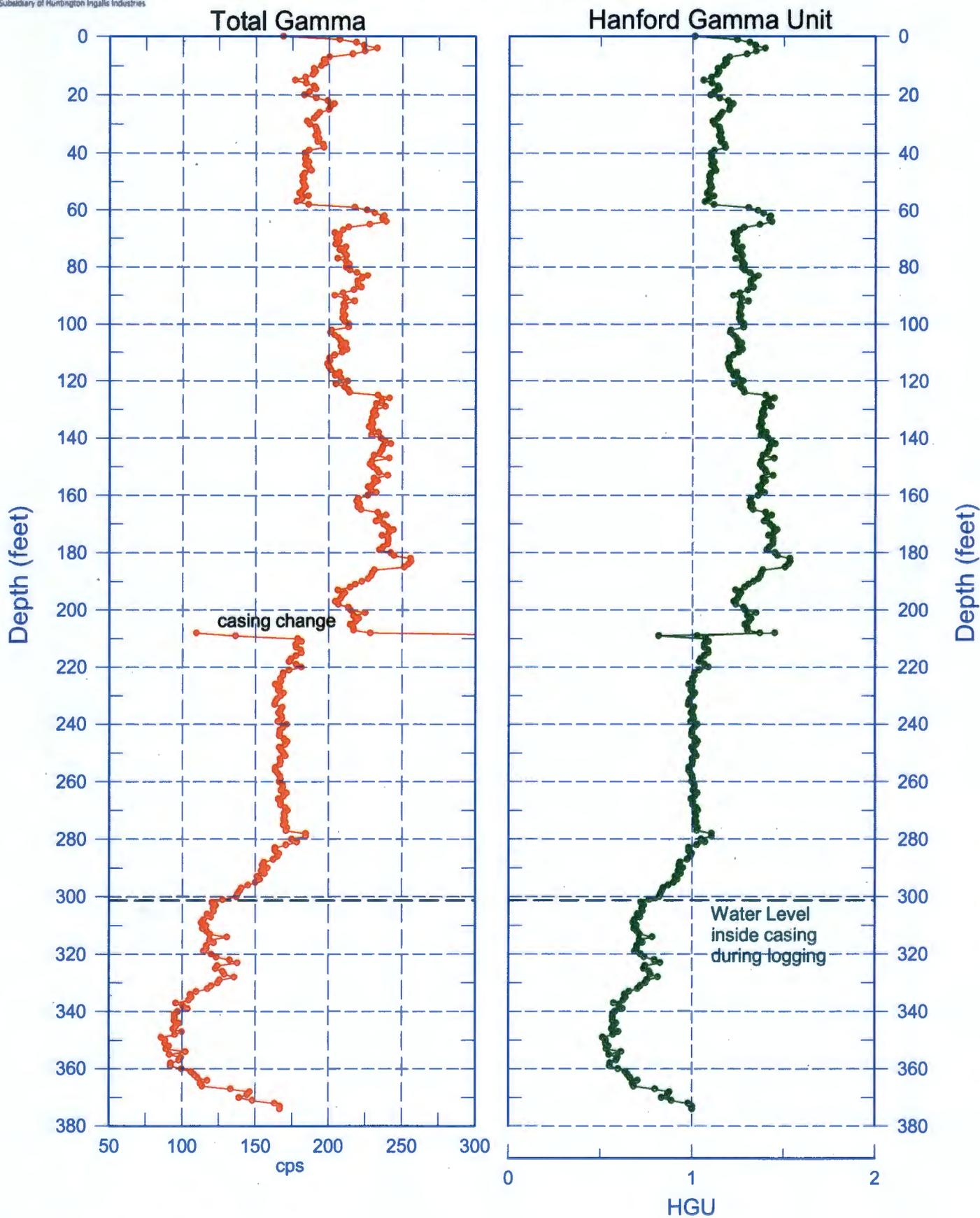


Reference - Ground Surface



299-E25-237 (C8922)

Total Gamma & Hanford Gamma Unit



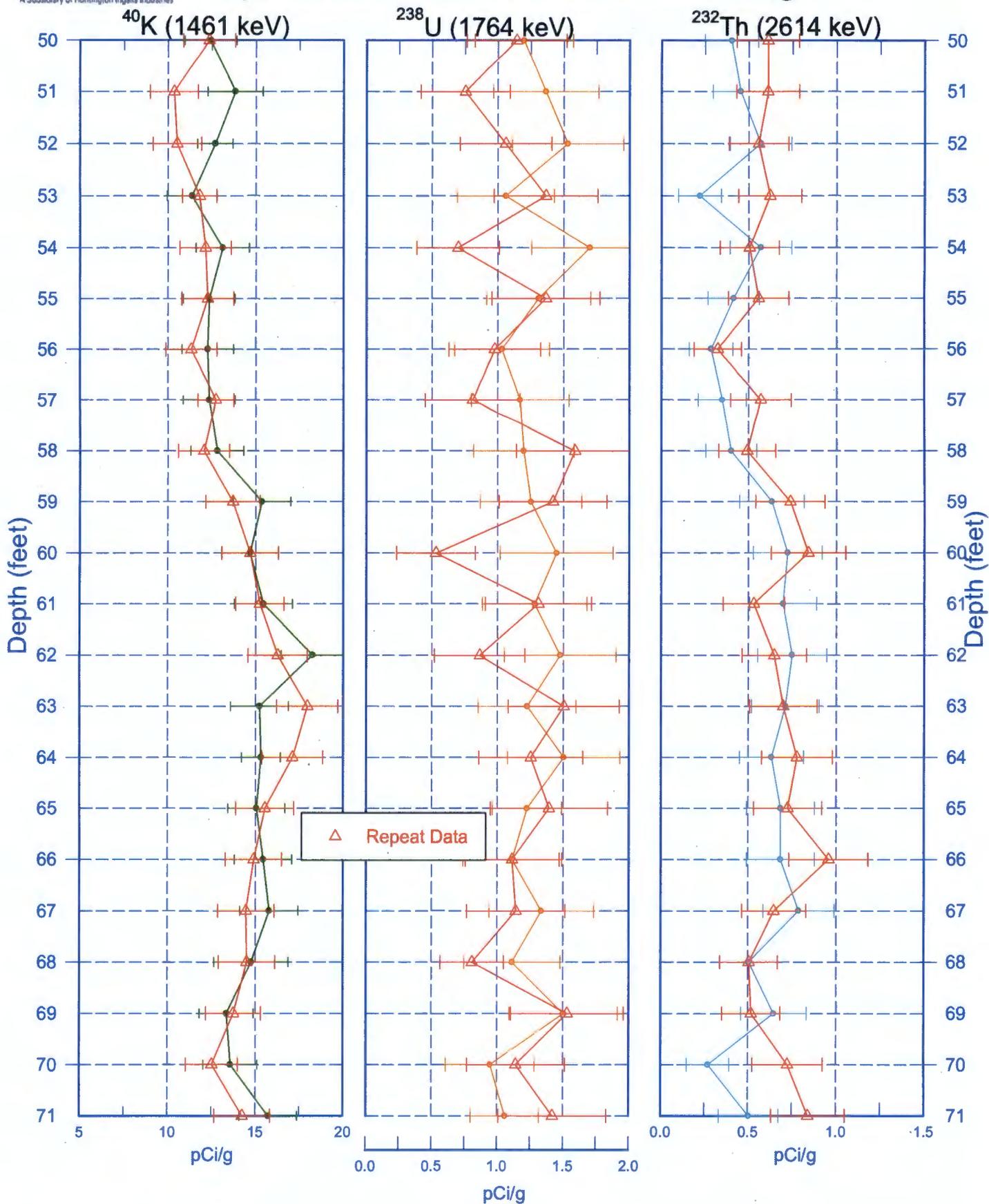
Reference - Ground Surface



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299-E25-237 (C8922)

Repeat Section of Natural Gamma Logs



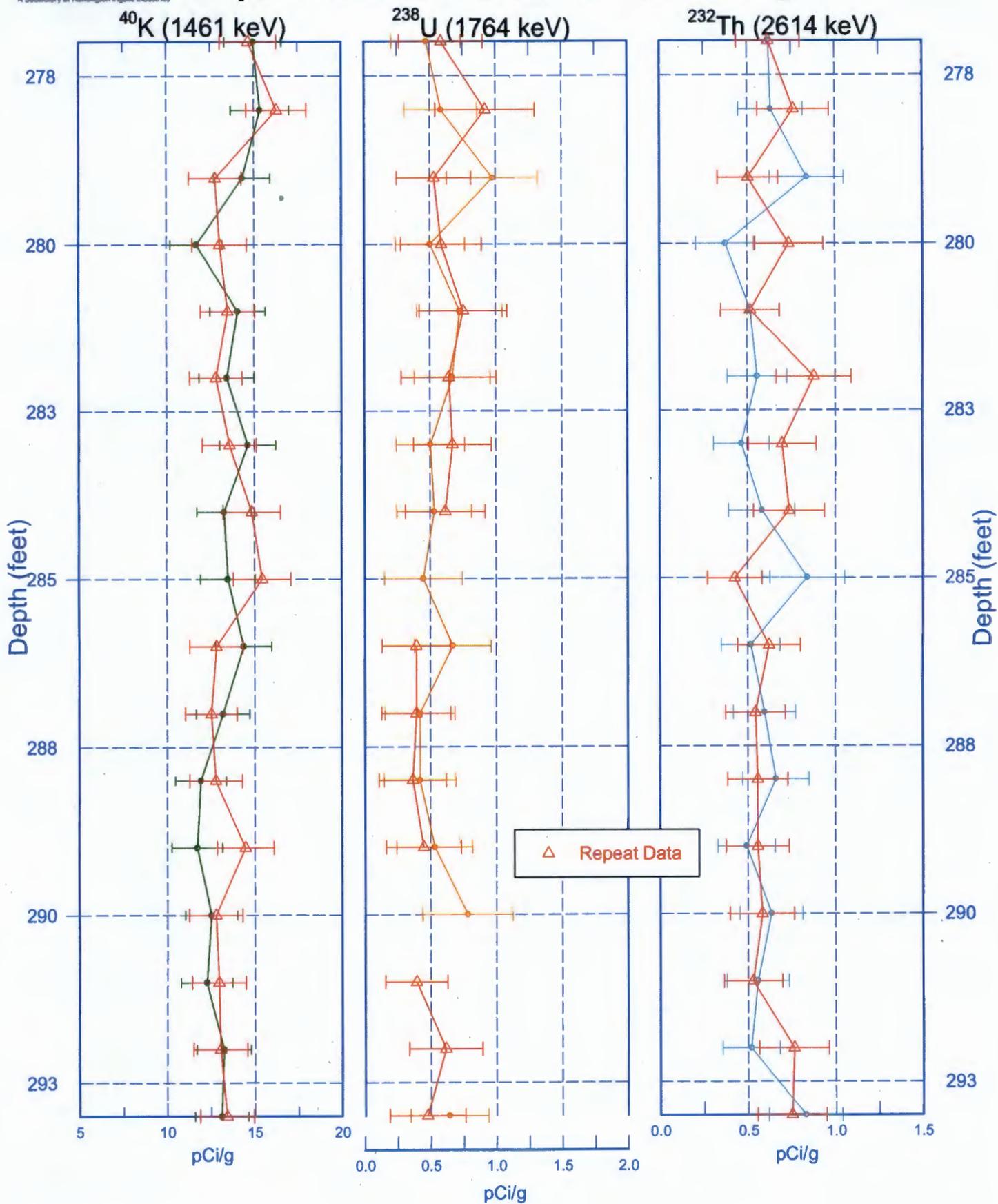
Zero Reference - Ground Surface



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299-E25-237 (C8922)

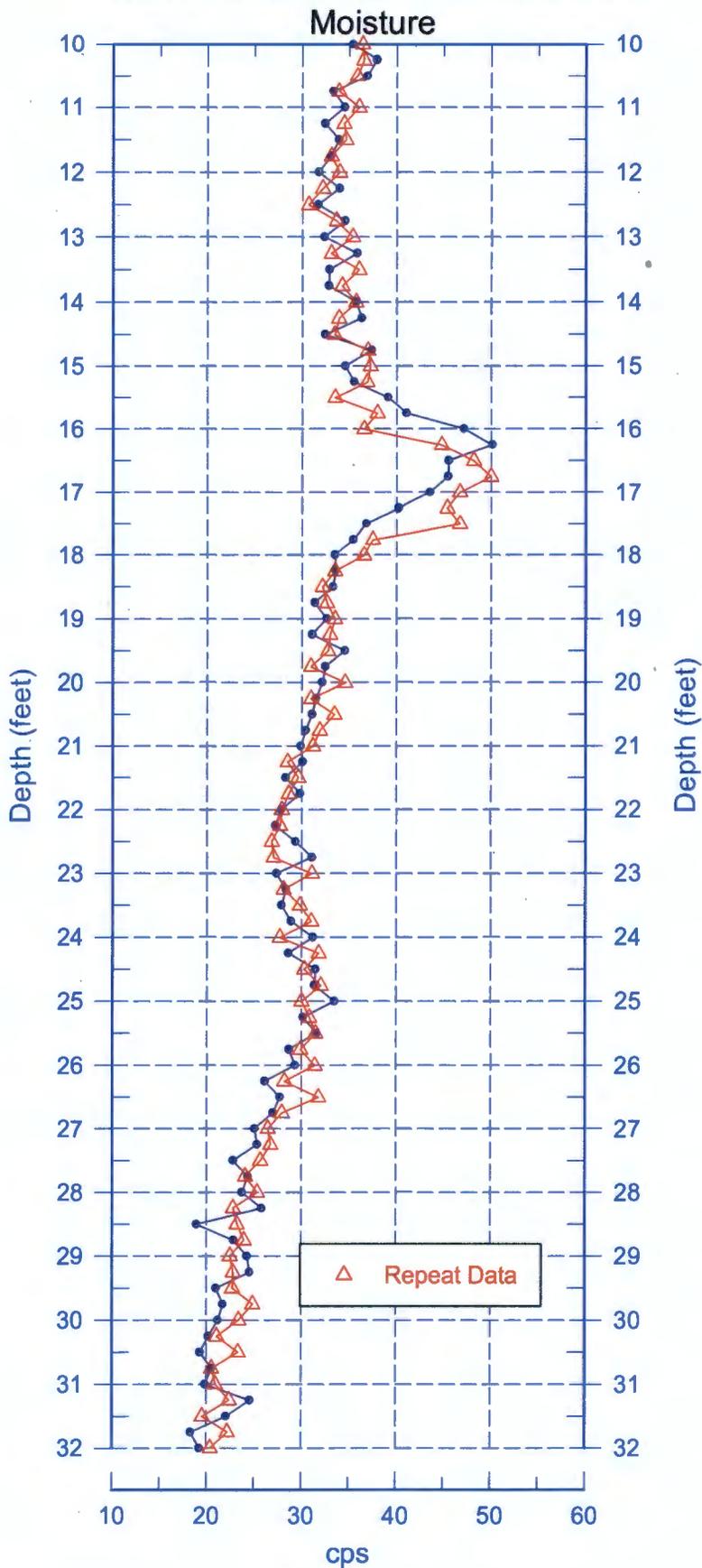
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface



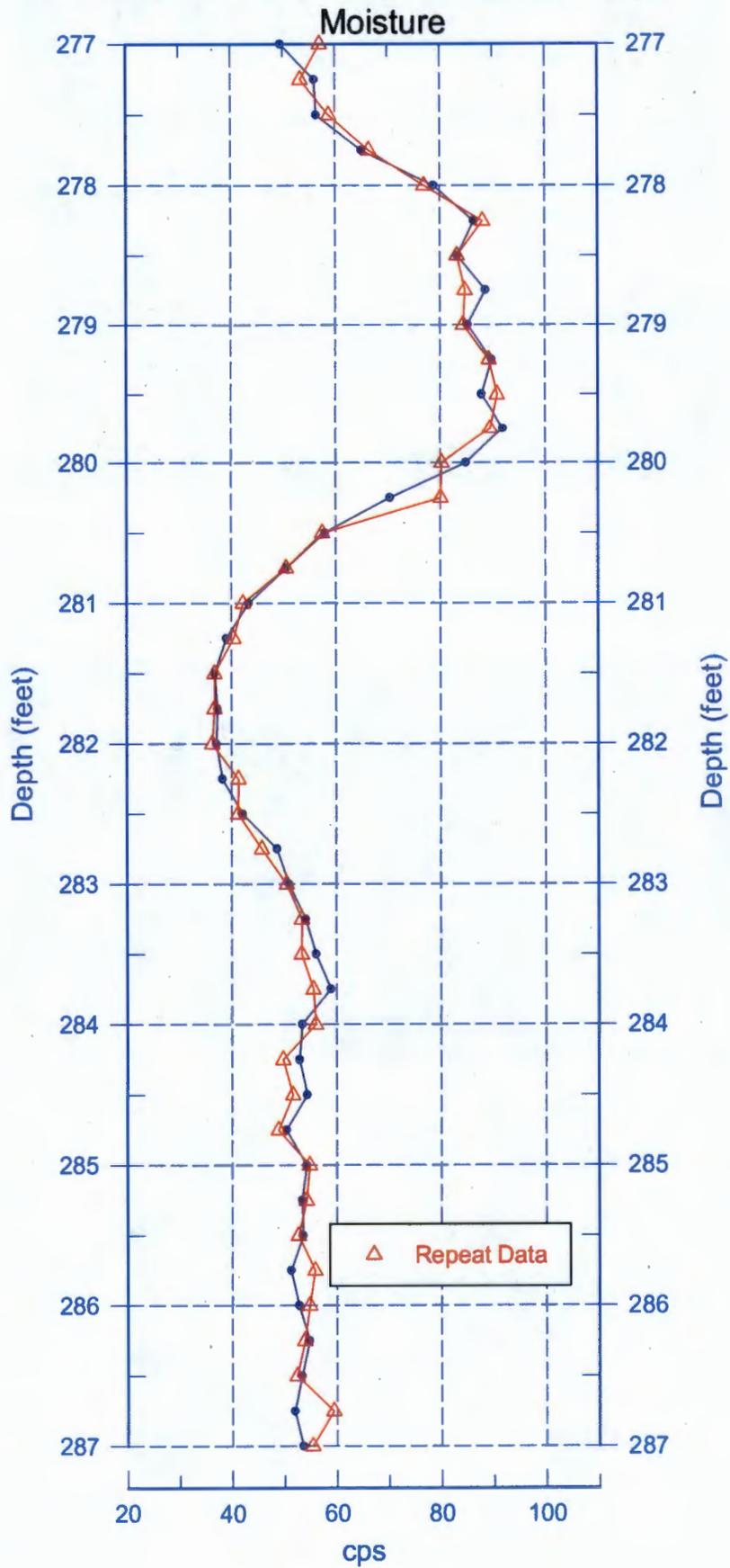
299-E25-237 (C8922) Moisture Repeat Section



Reference - Ground Surface



299-E25-237 (C8922) Moisture Repeat Section



Reference - Ground Surface



Sample: I-001
Sample Depth: 260.4 – 262.4 ft bgs
Recovery: 90%
Sediment Classification: Sand (S)
Formation: Hanford Formation



Top of Liner A: 261.9 – 262.4 ft bgs



Top of Liner B: 261.4 – 261.9 ft bgs



Top of Liner C: 260.9 – 261.4 ft bgs



Sample: I-002
Sample Depth: 262.85 – 264.85 ft bgs
Recovery: 90%
Sediment Classification: Sand (S)
Formation: Hanford Formation



Top Liner A: 264.35 – 264.85 ft bgs



Top Liner B: 263.85 – 264.35 ft bgs



Top Liner C: 263.35 – 263.85 ft bgs



Sample: I-003
Sample Depth: 265.1 – 267.1 ft bgs
Recovery: 100%
Sediment Classification: Sand (S)
Formation: Hanford Formation



Bottom Liner A: 266.6 – 267.1 ft bgs



Bottom Liner B: 266.1 – 266.6 ft bgs



Bottom Liner C: 265.6 – 266.1 ft bgs



Bottom Liner D: 265.1 – 265.6 ft bgs



Sample: I-004
Sample Depth: 267.95 – 269.95 ft bgs
Recovery: 80%
Sediment Classification: Sand (S)
Formation: Hanford Formation



Bottom Liner A: 269.45 – 269.95 ft bgs



Bottom Liner B: 268.95 – 269.45 ft bgs



Bottom Liner C: 268.45 – 268.95 ft bgs



Bottom Liner D: 267.95 – 268.45 ft bgs



Sample: I-005
Sample Depth: 270.2 – 272.2 ft bgs
Recovery: 100%
Sediment Classification: Sand (S)
Formation: Cold Creek Unit



Top Liner A: 271.7 – 272.2 ft bgs



Top Liner B: 271.2 – 271.7 ft bgs



Bottom Liner C: 270.7 – 271.2 ft bgs



Bottom Liner D: 270.2 – 270.7 ft bgs



Sample: I-006
Sample Depth: 272.8 – 274.8 ft bgs
Recovery: 95%
Sediment Classification: Sand (S)
Formation: Cold Creek Unit



Top Liner A: 274.3 – 274.8 ft bgs



Bottom Liner B: 273.8 – 274.3 ft bgs



Bottom Liner C: 273.3 – 273.8 ft bgs



Bottom Liner D: 272.8 – 273.3 ft bgs



Sample: I-007
Sample Depth: 275.6 – 277.6 ft bgs
Recovery: 90%
Sediment Classification: Sand (S)
Formation: Cold Creek Unit



Bottom Liner A: 277.1 – 277.6 ft bgs



Top Liner B: 276.6 – 277.1 ft bgs



Top Liner C: 276.1 – 276.6 ft bgs



Bottom Liner D: 275.6 – 276.1 ft bgs



Sample: I-008
Sample Depth: 278.9 – 280.9 ft bgs
Recovery: 100%
Sediment Classification: Sand Silt (sM)/Gravelly Silty Sand (gmS)
Formation: Cold Creek Unit



Bottom Liner A: 280.4 – 280.9 ft bgs



Bottom Liner B: 279.9 – 280.4 ft bgs



Bottom Liner C: 279.4 – 279.9 ft bgs



Bottom D: 278.9 – 279.4 ft bgs

SURVEY DATA REPORT				Request No. 152-058		
Project No.	Title M-24 Well C8922 (299-E25-237) Final Survey			File No. 2ET12R26		
Job No. CACN: 303345-JPRC	Prepared By N.P. Fastabend	Date 2/11/15	Reviewer <i>LBM</i>			
DESCRIPTION OF WORK			DISTRIBUTION	SDR	PLOT	DWG
Obtained final coordinates (C/L Casing) and elevations of completed M-24 Well C8922 (299-E25-237) in 200E Area. Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)			Survey File	OR		
			J.D. Mehrer	1		
			S.J. Trent	1		
			K.M. Whitley	1		
			J.B. Geiger	1		
			B.J. Howard	1		
			A.J. Green	1		
SURVEY RESULTS AND COMMENTS						
<p>See Attached Well Survey Data Report Sheet</p>						

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 01/21/15	Requestor: Kelly Whitley (CHPRC)
Date of Survey: 02/11/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of M-24 Well C8922 (299-E25-237) located in 200E Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
2E-18 (CHPRC) and 2E-38 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C8922	299-E25-237	575323.84	135965.27		Center of Casing
				212.625	"X" on Rim
				211.872	Brass Survey Marker

Notes:

212.327 Top Inner 4in PVC Casing, North Edge

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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

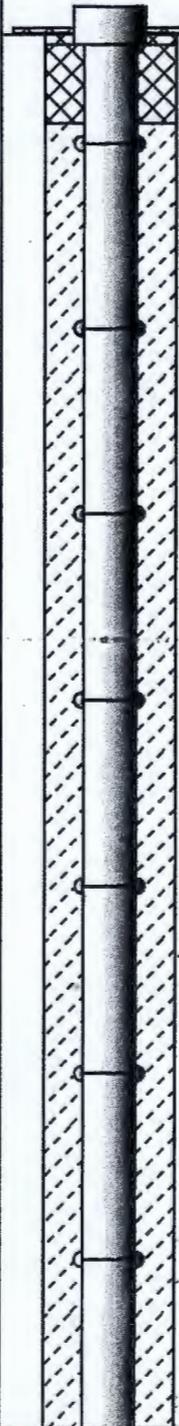


Appendix B

Well Documentation for 299-E33-360 (C8923)

- Well Summary Sheet
- Borehole Log
- Log Data Report
- Photographic Logs
- Final Survey Report

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WELL SUMMARY SHEET		Start Date: 7-23-2014		Page <u>1</u> of <u>2</u>
		Finish Date: 10-29-2014		
Well ID: C8923		Well Name: 299-E33-360		
Location: E. of WMA B-BX-BY, off Baltimore Ave.		Project: <i>M24 Drilling</i>		
Prepared by: Julie Johanson	Date: 11-4-2014	Reviewed by: J.D. MEHRER	Date: <i>1-21-15</i>	
Signature: <i>Julie Johanson</i>		Signature: <i>J.D. Meherer</i>		
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA		
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description
<p>Surface Completion: 4'x4'x6" Concrete Pad with brass survey marker and 10 3/4" protective monument (3.01' ags)</p> <p>Well Completion material: High Strength Concrete 0.0' bgs - 1.40' bgs</p> <p>Type I/II Portland Cement 1.40' bgs - 9.60' bgs</p> <p>Medium Bentonite Chips 9.60' bgs - 224.00' bgs</p> <p>Type I/II Portland Cement 224.00' bgs - 238.84' bgs</p> <p>3/8" Bentonite Pellets 238.84' bgs - 248.05' bgs</p> <p>8x20 Colorado Silica Sand 248.05' bgs - 272.50' bgs</p> <p>Natural Fill 272.50' bgs - 272.8' bgs</p> <p>Permanent Well: 8" ID Stainless Steel Blank 1.97' ags - 251.78' bgs</p> <p>8" ID Stainless Steel 0.065 Slot Screen 251.78' bgs - 271.71' bgs</p> <p>8" ID Stainless Steel Cap 271.71' bgs - 272.18' bgs</p> <p>All temporary casing completely removed from ground on 10/28/14</p> <p>bgs = below ground surface ags = above ground surface</p>		0		<p>0-5: Gravel Pad, Silty Sandy Gravel (msG)</p> <p>5-34: Silty Sandy Gravel (msG)</p> <p>34-37.7: Sandy Gravel (sG)</p> <p>37.7-38: Silty Sand (mS)</p> <p>38-45: Gravelly Sand (gS)</p> <p>45-46: Silty Sandy Gravel (msG)</p> <p>46-120: Slightly Silty Sand ((m)S)</p> <p>120-122: Silty Sand (mS)</p> <p>122-125: Sand (S)</p> <p>125-144: Slightly Silty Sand ((m)S)</p> <p>144-147: Silty Sand (mS)</p> <p>147-165: Slightly Silty Sand ((m)S)</p>

WELL SUMMARY SHEET		Start Date: 7-23-2014	Page <u>2</u> of <u>2</u>
Well ID: C8923		Well Name: 299-E33-360	
Location: E. of WMA B-BX-BY, off Baltimore Ave.		Project: <i>M24 Drilling</i>	
Prepared by: Julie Johanson	Date: 11-4-2014	Reviewed by: J.D. MEHRER	Date: <i>1-21-15</i>
Signature: <i>Julie Johanson</i>		Signature: <i>JDM</i>	
CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA
Description	Diagram	Graphic Log	Lithologic Description
<p>Well Completion material: High Strength Concrete 0.0' bgs - 1.40' bgs</p> <p>Type I/II Portland Cement 1.40' bgs - 9.60' bgs</p> <p>Medium Bentonite Chips 9.60' bgs - 224.00' bgs</p> <p>Type I/II Portland Cement 224.00' bgs - 238.84' bgs</p> <p>3/8" Bentonite Pellets 238.84' bgs - 248.05' bgs</p> <p>8x20 Colorado Silica Sand 248.05' bgs - 272.50' bgs</p> <p>Natural Fill 272.50' bgs - 272.8' bgs</p> <p>Permanent Well: 8" ID Stainless Steel Blank 1.97' ags - 251.78' bgs</p> <p>8" ID Stainless Steel 0.065 Slot Screen 251.78' bgs - 271.71' bgs</p> <p>8" ID Stainless Steel Cap 271.71' bgs - 272.18' bgs</p> <p>All temporary casing completely removed from ground on 10/28/14</p> <p>bgs = below ground surface ags = above ground surface</p>			<p>144-147: Silty Sand (mS) 147-165: Slightly Silty Sand ([m]S)</p> <p>165-166: Silty Sand (mS) 166-170: Gravelly Sand (gS) 170-175: Slightly Silty Sand ([m]S)</p> <p>175-180: Gravelly Sand (gS)</p> <p>180-192: Slightly Silty Gravelly Sand ([m]gS)</p> <p>192-195: Silty Sand (mS) 195-200: Slightly Silty Gravelly Sand ([m]gS) 200-210: Silty Sand (mS)</p> <p>210-214: Gravelly Sand (gS) 214-215: Gravelly Silty Sand (gmS) 215-227: Sandy Silt (sM)</p> <p>DTW: 225.97 ft bgs (Perched water) 227-246: Silty Sand (mS)</p> <p>246-255: Slightly Silty Gravelly Sand ([m]gS) DTW: 252.84 ft bgs</p> <p>255-260.5: Silty Sandy Gravel (msG) 260.5-272.8: Basalt</p> <p>TD: 272.8 ft bgs</p>

BOREHOLE LOG

Page 1 of 7

Date: 7-23-14

Well ID: C8923

Well Name: 299-E33-360

Location: E. of WMA B-BX-B4, off Baltimore Ave.

Project: M-24 Monitoring Wells FY14

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0-5': Gravel Pad and fill: Silty Sandy Gravel (msG)	Cable tool w/drive barrel
5	G.S.			Sandy Gravel sG KB ₁₁₋₁₅ 5-34: Silty Sandy Gravel (msG)	Archive @ 5' bgs
10	G.S.			10% silt, 60% v.f. - v.crs sand (mostly fn-med.); 30% v.f. pebble - sm. cobble; max 15mm; moist, sub-angular to round; sand: 60% f. silic / 40% mafic, gravel: 70% m / 30% f; moderate to poorly sorted; moderate HCl rxn, 10YR 4/2 dark grayish brown.	Archive @ 10' bgs
15	G.S.			@ 10' bgs: Gravel is v.f. - v.crs. pebbles; max 51mm; slightly moist; poorly sorted, sand: 60% m / 40% f; g: 75% m / 25% f; strong HCl rxn.	
15				@ 15' bgs: 10% silt, 50% v.f. - v.crs. sand (med.-crs.); 40% v.f. - v.crs. peb. (med.); max 45mm; slightly damp; g: 80% m / 20% f; mod. HCl rxn, 10YR 5/2 grayish brown.	Archive @ 15' bgs
20	G.S.			@ 20' bgs: 10% silt, 45% v.f. - v.crs. sand (crs. - v.crs.), 45% v.f. peb. - sm. cob; max 120mm; weak - mod. HCl rxn; sand turns a green color due to HCl.	Archive @ 20' bgs
25	G.S.			lg. cob. @ ~ 23' bgs	
25				@ 25' bgs: 10% silt, 40% v.f. - v.crs. sand (med.-crs.); 50% v.f. (med. v.crs. peb.) peb. - sm. cobble; max 72mm; ang. - sub.rnd; s: 65% m / 35% f; g: 85% m / 15% f; strng - v. strng. HCl rxn; 2.5Y 6/2 light brownish gray	Archive @ 25' bgs
30	G.S.			@ 30' bgs: sand (crs. - v.crs.); ang. - rnd.; moist; mod. HCl rxn; 10YR 4/2 dark grayish brown	Archive @ 30' bgs
35	G.S.			34' : Silty Sandy Gravel (msG) 37.7: Sandy Gravel 35' : 5% silt, 30% v.f. - v.crs. sand (crs. - v.crs.), 30% v.f. peb. - sm. cob. (v.f. - fn.); max 15mm; moist; poorly sorted, ang. - sub.rnd; 2.65Y m / 35% f; g: 20% m / 80% f; strong HCl rxn, 10YR 4/2 dark grayish brown.	Archive @ 34' bgs
35					Archive @ 39' bgs

Reported By: Julie Johanson	Reviewed By: Kevin Bergstrom
Title: Geologist	Title: Sr Geologist
Signature:	Signature:
Date: 7-24-14	Date: 3-11-2015

BOREHOLE LOG

Page 2 of 7

Date: 7-24-14

Well ID: C8923

Well Name: 299-E33-340

Location: E. F. WMB B-BX-134; off Baltimore Ave.

Project: M-24 Monitoring Wells F414

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40				<u>37.7 - 38: Silty Sand (mS) (No grab sample)</u> 40% silt, 60% v.f.a. - v.crs. sand; med. sorted; moist; sub-ang. to sub-rnd.; 60% m/40% f; v. strong HCl rxn;	<u>Cable tool w/drive barrel</u>
				<u>38' - 45: Gravelly Sand (gS)</u> 5% silt, 80% v.f.a. - v.crs. sand (v.crs.), 15% v.f.a. - med. pb.	
45	<u>G.S.</u>			max 15mm; med. sorted; moist; ang. - sub-round; 60% m/40% f; med.-strg. HCl rxn; 2.54 4/3 olive brown. (see pg. 1)	<u>Archive @ 45' bgs</u>
				<u>45 - 46: Silty Sandy Gravel (msG) Sandy Gravel gS</u> 10% silt; 45% v.f.a. - v.crs. sand (med.-crs.); 45% v.f.a. - crs. pb.	<u>KAG 3-11-15</u>
50	<u>G.S.</u>			max 23mm; poorly sorted; moist; ang. - sub. rnd.; 5:60% m/40% f; 85% m/15% f; med.-strg. HCl rxn, 2.54 4/3 olive brown	<u>Archive @ 49' bgs</u>
				<u>46 - 120: Slightly Silty Sand (msS) Sandy Gravel gS</u> 10% silt; 85% v.f.a. - v.crs. sand (med.-crs.); 5% v.f.a. - med. pb.;	<u>KAG 3-11-15</u>
55	<u>G.S.</u>			max 10mm; moist, well sorted; ang. - sub. rnd.; 50% m/50% f; weak - strong (silt) HCl rxn; 2.54 4/3 olive brown	
				<u>@ 55' bgs: max 8mm, damp; 55% f/45% m; strong-v. strg. HCl rxn; 10YR 5/2 grayish brown.</u>	<u>Archive @ 55' bgs</u>
60	<u>G.S.</u>				
				<u>60' bgs: 10% silt, 90% v.f.a. - v.crs. sand; max 2mm; 60% f/40% m; weak to No HCl rxn, cemented silt, v. strg. HCl rxn; 2.54 5/3 light olive brown, sand mostly med.</u>	<u>Archive @ 60' bgs</u>
65	<u>G.S.</u>				
				<u>@ 65' bgs: 15% silt, 80% v.f.a. - v.crs. (crs.) sand, 5% v.f.a. - med. pb.; max 12mm; slightly moist, 50% m/50% f; med.-v. strg. (silt) HCl rxn;</u>	<u>Archive @ 65' bgs</u>
70	<u>G.S.</u>				
				<u>@ 70' bgs: max 10mm; moist; strg. - v. strg. HCl rxn,</u>	<u>Archive @ 70' bgs</u>
75	<u>G.S.</u>				
				<u>@ 75' bgs: 10% silt, 85% v.f.a. - v.crs. sand (med.-crs.); 5% v.f.a. - med.; max 9mm; slightly moist; med.-strg. HCl rxn.</u>	<u>Archive @ 75' bgs</u>

Reported By: Julie Johnson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr Geologist

Signature: Julie Johnson

Date: 7-29-14

Signature: Kevin Bergstrom

Date: 3-11-2015

BOREHOLE LOG

Page 3 of 7

Date: 7-28-14

Well ID: C8923 Well Name: 299-E33-360 Location: E. of B-BX-B4; off of Baltimore Ave.

Project: M-24 monitoring wells F414 Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
80	G.S.			<u>46-120; Slightly Silty Sand (med.) @ 80' bgs; Cable tool w/drive barrel</u> <u>10% silt, 85% v.f. - v. crs. sand (med.-crs.); 5% v.f. - fin. med. pb.; max 4mm; well sorted; slightly moist; ang. - sub. rnd;</u> <u>50% m/50% f; strg. - v. strg. HCl rxn; 2.54 5/3 light olive brown</u>	<u>Archive @ 80' bgs</u>
85	G.S.			<u>@ 85' bgs: 10% silt, 85% v.f. - v. crs. sand (med.-crs.); 5% v.f. - med. pb.; max 12mm; strg. - v. strg. HCl rxn; 2.54 4/2 dark grayish brown.</u>	<u>Archive @ 85' bgs</u>
90	G.S.			<u>@ 90' bgs: sand mostly med.; max 8mm, med - strg. HCl rxn; 2.54 5/2 grayish brown</u>	<u>Archive @ 90' bgs</u>
95	G.S.			<u>@ 95' bgs: max 5mm; pb. v.f. - fa.; 55% f/45% m, strg. - v. strg. HCl rxn; 2.54 4/2 dark grayish brown.</u>	<u>Archive @ 95' bgs</u>
100	G.S.			<u>@ 100' bgs: 10% silt, 85% v.f. - v. crs. sand (med.-crs.); 5% v.f. - med. pb.; max 10mm, damp</u>	<u>Archive @ 100' bgs</u>
105	G.S.			<u>@ 105' bgs: max 9mm; 50% m/50% f; 104R 4/2 dark grayish brown</u>	<u>Archive @ 105' bgs</u>
110	G.S.			<u>@ 110' bgs: 15% silt, 80% v.f. - v. crs. sand (med.), 5% v.f. - med. pb.; max 8mm; 2.54 4/2 dark grayish brown.</u>	<u>Archive @ 110' bgs</u>
115	G.S.		<u>@ 115' bgs: pb. v.f. - fa.; max 7mm; sand (med.-crs.);</u>	<u>Archive @ 115' bgs</u>	

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: Julie Johanson

Date: 7-29-14

Signature: Kevin Bergstrom

Date: 3-11-2015

BOREHOLE LOG

Date: 7-29-14

Well ID: C8923

Well Name: 299-E33-360

Location: WMA E. of B-BX-BY, off Baltimore Ave

Project: M-24 monitoring wells FY14

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
120	G.S.			Slightly silty ^{KAB 3-11-15} <u>120-122: Silty Sand (ms) (m) S</u> 30% silt, 60% v.f.n. - v.crs. sand (med-fn.); max 2mm; well sorted; ang. - sub ang.; slightly damp; 60%F/40%M; strg. - v. strg. HCl rxn; 2.54 5/3 light olive brown	Cable tool w/drive barrel Archive @ 120' bgs
	G.S.			<u>122-125: Sand (S)</u> 5% silt; 90% v.f.n. - v.crs. sand (med.-crs.); 5% v.f.n. - fn. peb.; max 7mm; well sorted, ang. - sub ang.; dry to damp; 50%M/50%F; med HCl rxn. 2.54 5/1 gray	Archive @ 122' bgs
125	G.S.			<u>125-144: Slightly Silty Sand (ms) S</u> ^{MMS 3-11-15} 10% silt; 85% v.f.n. - v.crs. sand (fn-med); 5% v.f.n. - fn. peb.; max 6mm; well sorted, dry, subang-ang.; 55%M/45%F; strg. - v. strg. HCl rxn; 2.54-6/2 light brownish gray	Archive @ 125' bgs
130	G.S.	Add ~3 gal H ₂ O		<u>@ 130' bgs: peb. v.f.n.-med. f max 12mm; ang.-sub; med; 50%M/50%F; med.-v. strg. HCl rxn</u>	Archive @ 130' bgs Add ~3 gal H ₂ O @ -130.5' bgs
135	G.S.			<u>@ 131' bgs: a basalt boulder.</u>	
	G.S.			<u>@ 135' bgs: max 14mm, ang. - sub ang.; strg. - v. strg. HCl rxn.</u>	Archive @ 135' bgs
140	G.S.			<u>@ 140' bgs: max 14mm, 55%M/45%F</u>	Archive @ 140' bgs
145	G.S.			<u>144-147: Silty Sand (ms)</u> 35% silt, 65% v.f.n. - v.crs. sand (v.f.n.-fn.); dry well sorted; ang. - sub rnd; 60%F/40%M; v. strg. HCl rxn; 2.54 7/2 light gray	Archive @ 144' bgs
	G.S.			<u>147-149: Slightly Silty Sand (ms) S</u> ^{KAB 3-11-15} 10% silt; 85% v.f.n. - v.crs. sand (fn.-crs.); 5% v.f.n. - fn. peb.; max 6mm; dry, well sorted; ang. - sub ang.; 50%M/50%F; strg. - v. strg. HCl rxn; 2.54 6/2 light brownish gray.	Archive @ 147' bgs.
150	G.S.			<u>@ 150' bgs: 15% silt; 80% v.f.n. - v.crs. sand (v.f.n.-med.); 5% v.f.n.-med. peb. (max 9mm); ang. - sub rnd.; strg. HCl rxn.</u>	Archive @ 150' bgs.
155	G.S.		<u>@ 155' bgs: 10% silt, 85% v.f.n. - v.crs. sand, 5% v.f.n. - crs. peb. max 18mm; 55%M/45%F; med. HCl rxn; 104B 6/2 light brownish gray.</u>	Archive @ 155' bgs	

Reported By: <u>Julie Johanson</u>	Reviewed By: <u>Kevin Bergstrom</u>
Title: <u>Geologist</u>	Title: <u>Sr Geologist</u>
Signature: <u>Julie Johanson</u>	Signature: <u>Kevin Bergstrom</u>
Date: <u>8-4-14</u>	Date: <u>3-11-15</u>

BOREHOLE LOG

Page 5 of 7

Date: 8-4-14

Well ID: C8923

Well Name: 299-E53-360

Location: E. of WMA B-BX-84, off Baltimore Ave.

Project: m-24 monitoring wells F414

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
	Type No.	Blows Recovery			
160	G.S.			<u>147-165: Slightly Silty Sand (mS)</u> @ 160' bgs: 15% silt, 80% v.f.n. - v.crs. sand (med.), 5% v.f.n. med. sorted; max 4mm; dry; well sorted; ang. - sub.ang.; 55%F/45%F; strg. - v. strg. HCl rxn; 10YR 5/2 grayish brown.	<u>Cable tool w/drive barrel</u> <u>Archive @ 160' bgs</u>
165	G.S.			<u>165-166: Silty Sand (mS)</u> 30% silt, 80% v.f.n. - v.crs. sand (Fn); moist; well sorted; ang. - sub.ang.; 55%F/45%F; strg. HCl rxn; 2.5Y 5/3 light olive brown.	<u>Archive @ 165' bgs</u> <u>Archive @ 166' bgs</u>
170	G.S.			<u>166-170: Gravelly Sand (gS)</u> 5% silt, 80% v.f.n. - v.crs. sand (crs.-v.crs.), 15% v.f.n. - crs. peb.; max 20mm; slightly moist; ang. - sub.med.; well sorted; med. - strg. HCl rxn; 2.5Y 5/2 grayish brown; 45%F/35%F.	<u>Archive @ 170' bgs</u>
175	G.S.			<u>170-175: Slightly Silty Gravelly Sand (mgS)</u> 10% silt, 80% v.f.n. - v.crs. sand; 10% v.f.n. - med. peb.; max 13mm; med. sorted; ang. - sub.med.; dry; strg. HCl rxn; 2.5Y 5/2 grayish brown.	<u>Archive @ 175' bgs</u>
180	G.S.			<u>175-180: Gravelly Sand (gS)</u> 5% silt; 80% v.f.n. - v.crs. sand, 15% v.f.n. - med. pebbles; max 11mm; well sorted; dry; ang. - sub.ang.; 45%F/35%F; strg. - v. strg. HCl rxn; 10YR 5/2 grayish brown.	<u>Archive @ 180' bgs</u>
185	G.S.			<u>180-192: Slightly Silty Gravelly Sand (mgS)</u> 10% silt; 80% v.f.n. - v.crs. sand (fa-med.), 10% v.f.n. - med. peb.; 13mm max; well sorted; dry; sub.ang. - ang.; 50%F/50%F; v. strg. HCl rxn; 10YR 5/2 grayish brown.	<u>Archive @ 185' bgs</u>
190	G.S.			<u>@ 185' bgs: sand (med.-crs.); v.f.n. - crs. peb.; max 31mm; med. sorted; slightly moist - dry; ang. - sub.med.; 55%F/45%F; med. - strg. HCl rxn.</u> <u>@ 190' bgs: 10% silt, 70% v.f.n. - v.crs. sand (fa-med.); 20% v.f.n. - crs. pebble; max 20mm; dry; 40%F/40%F; strg. - v. strg. HCl rxn; 2.5Y 5/2 grayish brown</u>	<u>g(S)</u> <u>Archive @ 190' bgs</u>
195	G.S.			<u>31% silt</u> <u>@ 192' bgs: 2</u> <u>192-195: Silty Sand (mS)</u> 30% silt, 65% v.f.n. - v.crs. sand (v.f.n.-crs.); 5% v.f.n. - crs. peb.; max 23mm; dry; med. sorted; ang. - sub.med.; 55%F/45%F; v. strg. HCl rxn; 2.5Y 6/2 light brownish gray	<u>Archive @ 192' bgs</u> <u>Archive @ 195' bgs</u>
				<u>195-200: Slightly Silty Gravelly Sand (mgS)</u> 15% silt, 70% v.f.n. - v.crs. sand, 15% v.f.n. - v.crs. pebbles; (see pg. 6)	

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: Julie Johanson

Date: 8-5-14

Signature: Kevin Bergstrom

Date: 3-11-15

BOREHOLE LOG

Well ID: **C8923**

Well Name: **299-E33-360**

Location: **E. of WMA B-BX-BV, off Baltimore Ave.**

Project: **M-24 Monitoring Wells FY14**

Reference Measuring Point: **Ground Surface**

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
200	G.S.			<p>195-200: Slightly Silty Gravelly Sand (msS) 15% silt, 70% v.f. - v.crs. sand, 15% v.f. - v.crs. pb.; max 6mm; slightly moist-dry; med. sorted; ang. - sub. rd.; 70% m/30% f; strg. - v. strg. HCl rxn; 2.5Y 5/2 grayish brown 200-210: Silty Sand (ms) m(S) ^{KAB 3-1-15} 20% silt; 75% v.f. - v.crs. sand (fn. - crs.); 5% v.f. - fn. pb.; max 5mm; well sorted; slightly moist-dry; ang. - sub. rd.; 50% m/40% f; strg. - v. strg. HCl rxn; 2.5Y grayish brown @ 205' bgs: 30% silt; 65% v.f. - v.crs. sand; 5% v.f. - med. pb.; max 5mm; dry; v. strg. HCl rxn; 5Y 6/1 gray</p>	<p>Cable tool w/drive barrel Archive @ 200' bgs</p>
205	G.S.			<p>210-214: Gravelly Sand (gs) 5% silt, 85% v.f. - v.crs. sand (med. - v.crs.), 10% v.f. - crs. pb.; max 18mm; well sorted, slightly moist-dry; ang. - sub. rd.; 60% m/40% f; med. - strg. HCl rxn; 2.5Y 5/2 grayish brown</p>	<p>Archive @ 205' bgs</p>
210	G.S.			<p>210-214: Gravelly Sand (gs) 5% silt, 85% v.f. - v.crs. sand (med. - v.crs.), 10% v.f. - crs. pb.; max 18mm; well sorted, slightly moist-dry; ang. - sub. rd.; 60% m/40% f; med. - strg. HCl rxn; 2.5Y 5/2 grayish brown</p>	<p>Archive @ 210' bgs</p>
215	G.S.			<p>214-215: Gravelly Silty Sand (msS) 15% silt, 50% v.f. - v.crs. sand (fn.), 25% v.f. - crs. pb.; max 30mm; poorly sorted; slightly moist-dry; ang. - sub. rd.; strg. HCl rxn; 60% m/40% f; 2.5Y 5/2 grayish brown</p>	<p>Archive @ 214' bgs Archive @ 215' bgs</p>
220	G.S.			<p>215-227: Silty Sand (ms) ^{KAB 11-15} 90% silt, 10% v.f. - fn. sand, well sorted, slightly moist, v. strg. HCl rxn, Non plastic w/natural water content; 2.5Y 5/2 grayish brown w splashes of 2.5Y 4/3 olive brown</p>	<p>Archive @ 220' bgs</p>
225				<p>@ 220' bgs: 75% silt, 20% v.f. - v.crs. pb. (med. - fn.); 5% v.f. - fn. pb.; max 3mm; moist, med. sorted; 50% m/50% f; low plasticity w/water content; v. strg. HCl rxn; 2.5Y 5/3 light olive brown.</p>	<p>DTW: 225.97' bgs No archive per RCT.</p>
230				<p>@ 225' bgs: 90% silt/clay, 10% v.f. sand; moist, well sorted, low-med. plasticity w/H₂O present; strong HCl rxn 2.5Y 4/2 dark grayish brown</p>	<p>SS sample C8923 I-001 A-D; HETS# B2XM87, B2XM88, B2XM89, B2XM90; 226.77'-229.4' bgs 8-7-14</p>
235				<p>227-246: Silty Sand (ms) @ 230' bgs: 30% silt, 70% v.f. - fn. sand; very moist, well sorted; Non-plastic; v. strg. HCl rxn; 2.5Y 4/2 dark grayish brown.</p>	<p>SS sample C8923 I-002 A-D; HETS# B2XM91, B2XM92, B2XM93, B2XM94; 229.24'-229.94' bgs 8-7-14</p>
				<p>Confining layer @ ~ 237' bgs @ 235' bgs: very moist - wet; 2.5Y 4/3 olive brown.</p>	<p>H₂O Sample: HETS# B2XM95, B2XM96, B2XM97, B2XM98, B2XM99, B2XM00; 229.24'-229.94' bgs 8-7-14</p>
				<p>@ 237.5' bgs: 40% silt, 60% v.f. sand; moist, non-plastic; 2.5Y 5/3 light olive brown w/stains 10YR 4/4 dark yellowish brown; fine interbeds. of silt.</p>	

Reported By: **Julie Johanson**

Reviewed By: **Kevin Bergstrom**

Title: **Geologist**

Title: **Sr. Geologist**

Signature: *Julie Johanson*

Date: **8-28-14**

Signature: *Kevin Bergstrom*

Date: **3-11-15**

BOREHOLE LOG

Date: 9-28-14

Well ID: C9923

Well Name: 299-E33-340

Location: E. of WMA B-BX-84, off Baltimore Ave.

Project: M-24 Monitoring Wells FY14

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
240				<u>227-246: Silty Sand (ms)</u> @ 241' bgs: 40% silt, 60% vfn.-fn sand; moist, well sorted, non-plastic, strg. - v. strg. HCl rxn, 2.54 5/8 light olive brown; stains of 54R 4/6 yellowish red	Cable tool w/drive barrel. 225.77' - 226' bgs 8-11-14
245	G.S.			@ 245' bgs: 35% silt, 65% vfn.-med. sand (v.fn.), moist, well sorted; 2.54 4/8 olive brown.	Archive @ 246' bgs
250	G.S.			<u>246-255: Slightly Silty Gravelly Sand (msgs)</u> 10% silt, 70% vfn.-v.crs. sand (med.), 20% vfn.-v.crs. pb.; max 58mm; poorly sorted; moist; sub ang. - sub rad.; 40% m/60% f; strg. HCl rxn; 2.54 3/8 dark olive brown.	g.s Archive @ 250' bgs
255	G.S.			@ 250' bgs: 15% silt, 85% vfn.-v.crs. sand (crs.), 25% vfn.-v.crs. pb.; max 62mm; strg. somewhat moist; s: 70% m/30% f, g: 95% m/5% f; strg. - v. strg. HCl rxn; 2.54 4/2 dark grayish brown.	DTW: 254.20' bgs (9-2-14) DTW: 253.99' bgs (9-2-14) static
260	G.S.	Sieve Sample 250'-260'		<u>255-260.5: Silty Sandy Gravel (msgs)</u> 10% silt, 55% vfn.-v.crs. sand (crs.-v.crs.), 35% vfn.-v.crs. pb.; max 56mm; slightly wet - moist, poorly sorted; sub ang. - sub rad.; s: 55% m/45% f, g: 60% m/40% f; strg. HCl rxn; 2.54 4/2 dark grayish brown.	Archive @ 255' bgs DTW: 253.23' bgs (9-4-14) static - Sieve Sample Grab 250'-260' bgs
260	G.S.			@ 260' bgs: 10% silt, 40% vfn.-v.crs. sand (crs.-v.crs.); 50% vfn. pb. - sm. cob.; max 112mm; wet; 35% m/65% f, g: 55% s/45% m; weak - mod. HCl rxn	Archive @ 260' bgs Switch to hand tool @ 260.5' bgs Archive @ 260.5' bgs - 265' bgs
265	G.S.			<u>260.5' - 272.8': Basalt</u> color of slurry: 2.54 4/8 olive brown; basalt chips: 2.54 2.5/1 black; wet; chips of non-basalt material included in slurry from formation above basalt; No HCl rxn; all chips angular, some pebbles still sub round from above fm.	265' - 270' bgs Archive @ 265' bgs
270	G.S.			@ 265' : basalt chips are angular, 95% basalt/5% other felsic chips; 104R 2/1 black. @ 270' : 90% basalt / >10% other + felsic chips most likely still from above formation.	Archive @ 270' - 272.8' bgs 90 gal H ₂ O added @ 272.5' bgs TD: 272.8' bgs
275					

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: Julie Johanson

Date: 9-10-14

Signature: Kevin Bergstrom

Date: 3-11-15



299-E33-360 (C8923) Log Data Report

Borehole Information:

Log Date:	2014-09-15	Filename:	C8923_HG-NM_2014-09-15	Site:	North of B Farm
Coordinates (WA St Plane)		DTW¹ (ft):	252.8	DTW Date:	09/11/14
North (m)	East (m)	Drill Date	TOC² Elevation	Total Depth (ft)	Type
N/A	N/A	09/10/14	N/A	273	Cable Tool

Casing Information:

Casing Type	Stickup (ft)	Diameter (in.)		Thickness (in.)	Top (ft)	Bottom (ft)
		Outer	Inside			
Threaded Steel	0.75	13 1/2	12 3/8	9/16	0.75	238
Threaded Steel	0.45	12	10 3/4	5/8	0.45	260

Borehole Notes:

The buyer's technical representative provided the casing depth and total depth is determined from logging measurements. The logging engineer measured casing stick-up and casing diameter (rounded to the nearest 1/16-in.). At the time of logging the first casing August 14, depth to water inside the casing was 236.25 ft according to the moisture log. Even though the borehole had been bailed just after drilling, water from the perched zone accumulated in the bottom of the borehole. Water inside the casing was measured at 252.8 ft on September 11 prior to logging.

Zero reference is ground surface.

Logging Equipment Information:

Logging System:	Gamma 1L	Type:	60% HPGe SGLS ³
Effective Calibration Date:	11/11/13	Serial No.:	45-TP32211A
Calibration Reference:	HGLP-CC-096, Rev. 0	Logging Procedure:	HGLP-MAN-002, Rev. 1

Logging System:	Gamma 1H	Type:	NMLS ⁴
Effective Calibration Date:	11/11/13	Serial No.:	H310700353
Calibration Reference:	HGLP-CC-097, Rev. 0	Logging Procedure:	HGLP-MAN-002, Rev. 1

SGLS Log Run Information:

Log Run	2	5 Repeat	6	7 Repeat	
HEIS Number	1018499	1018500	1018501	1018502	
Date	08/13/14	08/14/14	09/11/14	09/11/14	
Logging Engineer	Pope	Pope	Pope	Pope	
Start Depth (ft)	0.0	214.0	237.0	259.0	
Finish Depth (ft)	238.0	238.0	272.67	262.0	

¹ depth to water inside casing

² top of casing

³ Spectral Gamma Logging System

⁴ Neutron Moisture Logging System



HGLP-LDR-790, Rev. 0

Log Run	2	5 Repeat	6	7 Repeat	
Count Time (sec)	100	200	200	200	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
Log Speed (ft/min)	N/A	N/A	N/A	N/A	
Pre-Verification	AL204CAB	AL205CAB	AL213CAB	AL213CAB	
Start File	AL204000	AL205000	AL213000	AL213037	
Finish File	AL204238	AL205024	AL213036	AL213040	
Post-Verification	AL204CAA	AL205CAA	AL213CAA	AL213CAA	
Depth Return Error (in.)	2.0 low	0.0 low	N/A	1.0 low	
Comments	No fine gain adjustments made				

NMLS Log Run Information:

Log Run	1	3	4 Repeat	8	9 Repeat
HEIS Number	1018503	1018504	1018505	1018506	1018507
Date	08/12/14	08/14/14	08/14/14	09/15/14	09/15/14
Logging Engineer	Pope	Pope	Pope	Pope	Pope
Start Depth (ft)	1.0	89.0	211.0	230.0	240.0
Finish Depth (ft)	91.0	235.25	235.0	253.0	243.0
Count Time (sec)	15	15	15	15	15
Live/Real	R	R	R	R	R
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	0.25	0.25	0.25	0.25	0.25
Log Speed (ft/min)	N/A	N/A	N/A	N/A	N/A
Pre-Verification	AH166CAB	AH167CAB	AH167CAB	AH177CAB	AH177CAB
Start File	AH166000	AH167000	AH167586	AH177000	AH177093
Finish File	AH166360	AH167585	AH167682	AH177092	AH177105
Post-Verification	AH166CAA	AH167CAA	AH167CAA	AH177CAA	AH177CAA
Depth Return Error (in.)	12 low	N/A	2.5 high	N/A	0.5 low
Comments	See logging operation notes below	None	None	None	None

Logging Operation Notes:

A centralizer was installed on the sondes.

The zero reference was marked incorrectly on the sonde before logging was initiated on August 12. This resulted in a depth return error of 12-in. The log data were adjusted one ft down in the table above for log run 1.

SGLS log data for log runs 5, 6, and 7 were acquired at a 200 second counting time rather than the usual 100 seconds to provide improved counting statistics and to lower the MDL for the uranium isotopes and KUT.

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

**Analysis Notes:**

Analyst:	P.D. Henwood	Date:	09/25/14	Reference:	HGLP-MAN-003, Rev. 0
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Casing corrections for a 9/16-in. thick casing from ground surface to 238 ft, a 1.2-in. thick casing for a casing overlap at 237 and 238 ft, and a 5/8-in. thick casing from 239 to 260 ft were applied to the log data. No correction was applied below 260 ft to total depth of 273 ft.

A correction for water inside the casing or within the borehole was applied below 253 ft in depth.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in EXCEL template identified as 1L20131120, using an efficiency function and corrections for casing and dead time as determined by annual calibration.

NMLS data are represented in counts per second because no calibration data exist for either 10 3/4 or 12 3/8-in. inner diameter boreholes.

The HGU⁵ 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:

Cs-137 and manmade uranium (U-238 and U-235) were detected in the borehole.

Cs-137 was detected from 1 to 10 ft with a maximum concentration of approximately 29 pCi/g at 3 ft.

U-238, measured using the 1001 keV Pa-234m daughter, was detected from 230 to 239 ft. The maximum concentration was measured at 148 pCi/g at 238 ft; the average of three measurements acquired at this depth is 123 pCi/g.

U-235 was measured from 229 to 238 ft. The maximum concentration was 30 pCi/g at 238 ft.

Quantification of the uranium concentrations may not be reliable at depths of 237 and 238 ft. Measurements acquired in the first casing are complicated by "end effects" or nonstandard geometry, a correction for water that is thought to have existed inside the casing, and possible mud buildup in the bottom of the borehole. For the second casing, a combined casing thickness of approximately 1.2-in. that can introduce additional error was applied at depths of 237 and 238 ft where an overlap of two casings existed.

The neutron moisture log primarily responds to moisture present in the surrounding formation. In general, an increase in count rate reflects an increase in moisture content. Moisture content may increase in sediments of relatively high silt or clay content. Moisture logging in the first casing indicated water in the bottom of the borehole at approximately 235 ft. Moisture logging in the second event was conducted within two casings from 230 to 238 ft and in a smaller inner diameter casing from 239 to 253 ft where water was encountered. The different casing configurations cause the moisture count rate to appear inconsistent. It is interpreted that relatively uniform high moisture content exists from approximately 215 to 243 ft in depth.

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

⁵ Hanford Gamma Unit



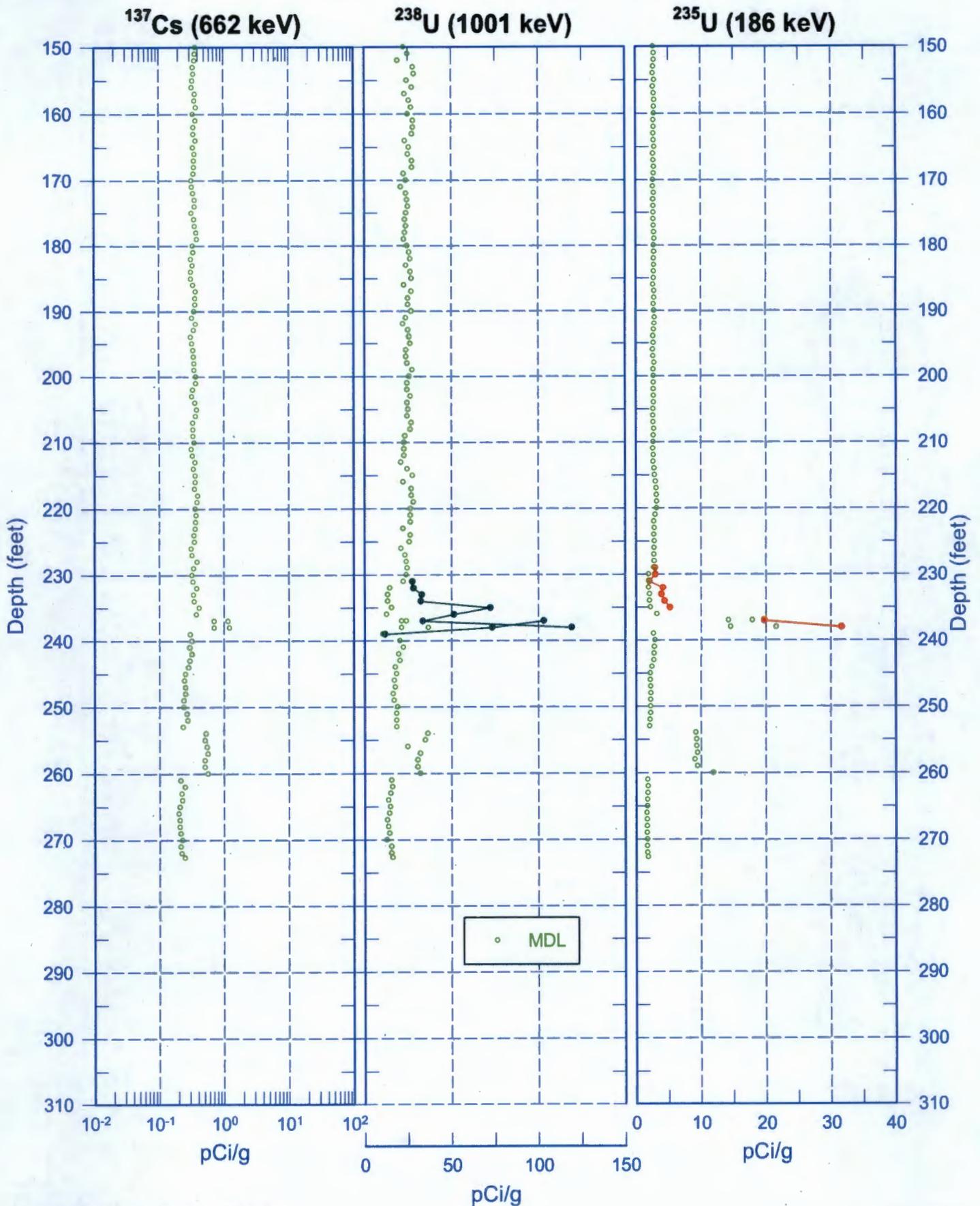
List of Log Plots:

Depth Reference is ground surface.

Manmade Radionuclides (0-160)
Manmade Radionuclides (150-310)
Natural Gamma Logs (0-160)
Natural Gamma Logs (150-310)
Combination Plot (0-120 ft)
Combination Plot (110-230 ft)
Combination Plot (220-340 ft)
Combination Plot (200-240 ft)
Combination Plot (0-280 ft)
Total Gamma & Moisture (0-160)
Total Gamma & Moisture (150-310)
Total Gamma & Hanford Gamma Unit (0-280)
Repeat of Manmade Radionuclides (214-238 ft)
Repeat Section of Natural Gamma Logs (214 to 238 ft)
Repeat Section of Natural Gamma Logs (259 to 262 ft)
Moisture Repeat Section (211 to 235 ft)
Moisture Repeat Section (240 to 243 ft)



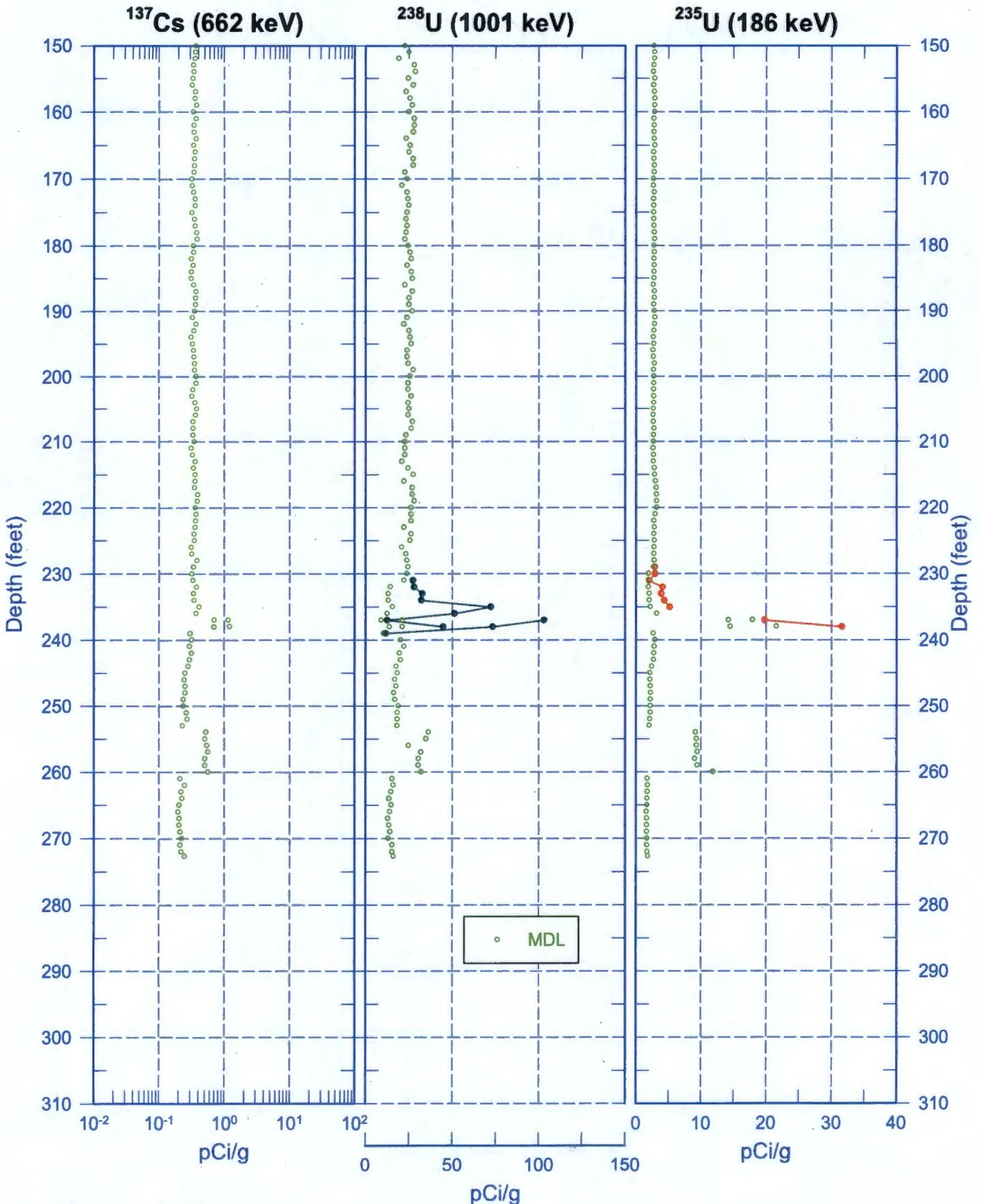
299-E33-360 (C8923) Manmade Radionuclides



Zero Reference - Ground Surface



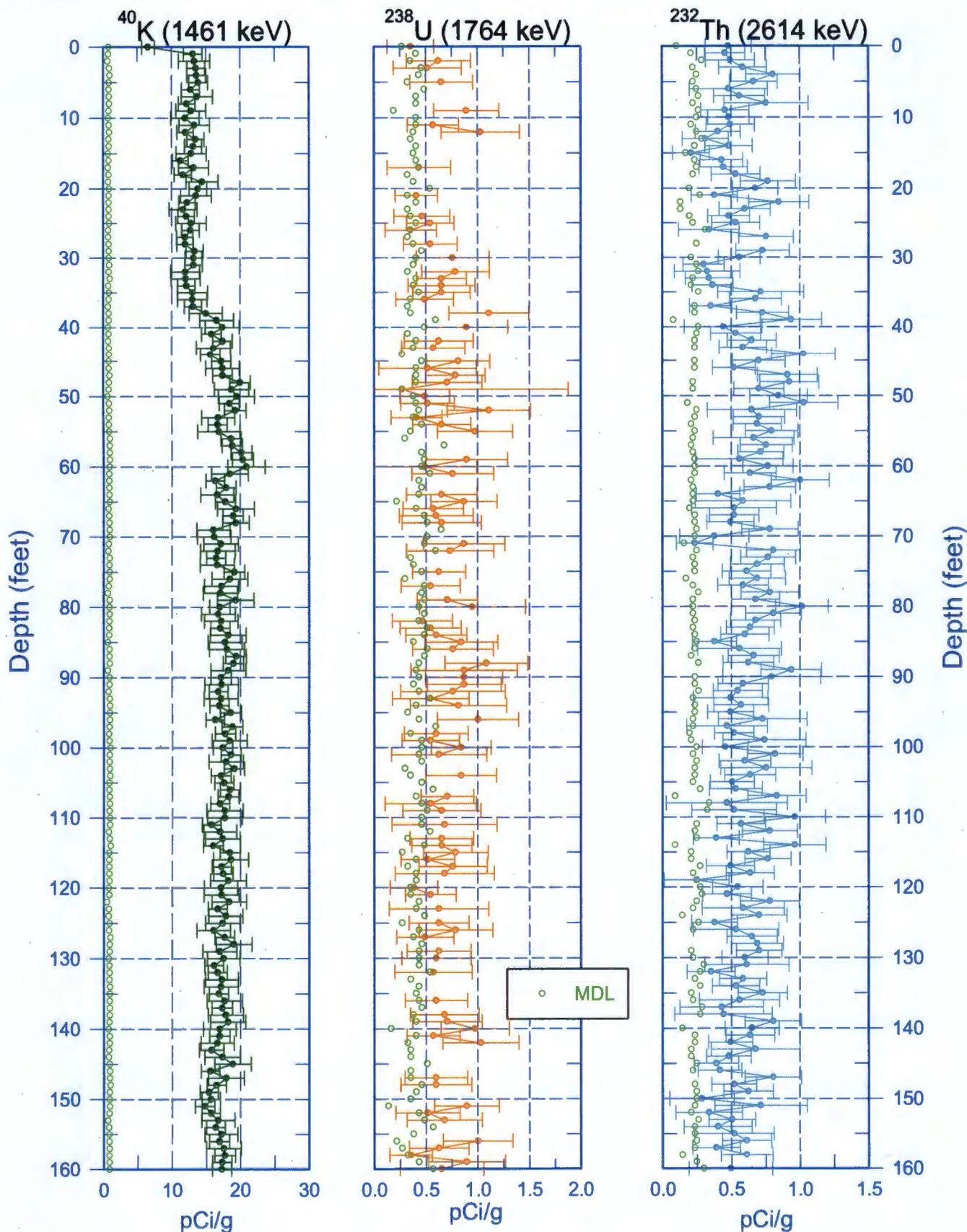
299-E33-360 (C8923) Manmade Radionuclides



Zero Reference - Ground Surface



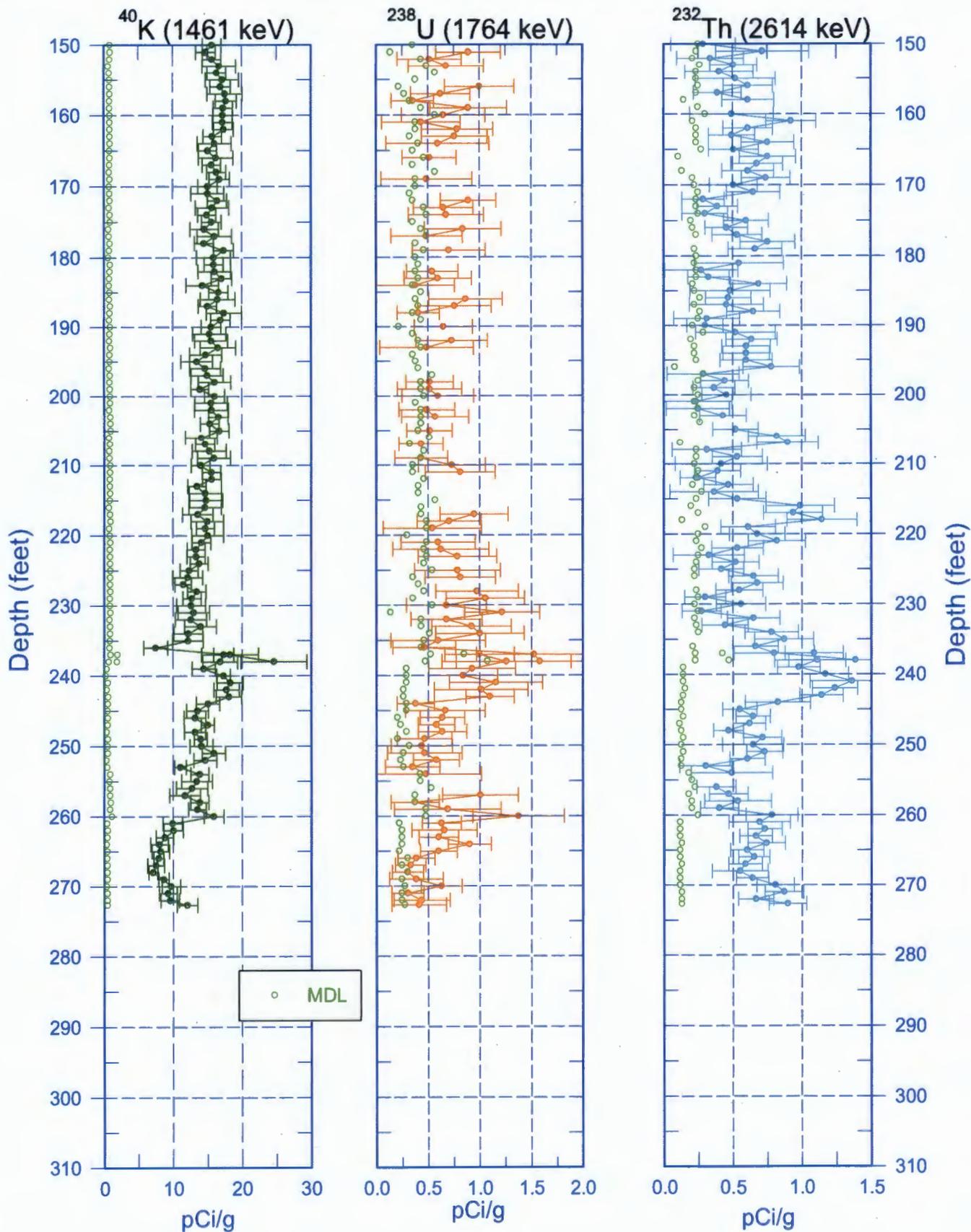
299-E33-360 (C8923) Natural Gamma Logs



Zero Reference - Ground Surface

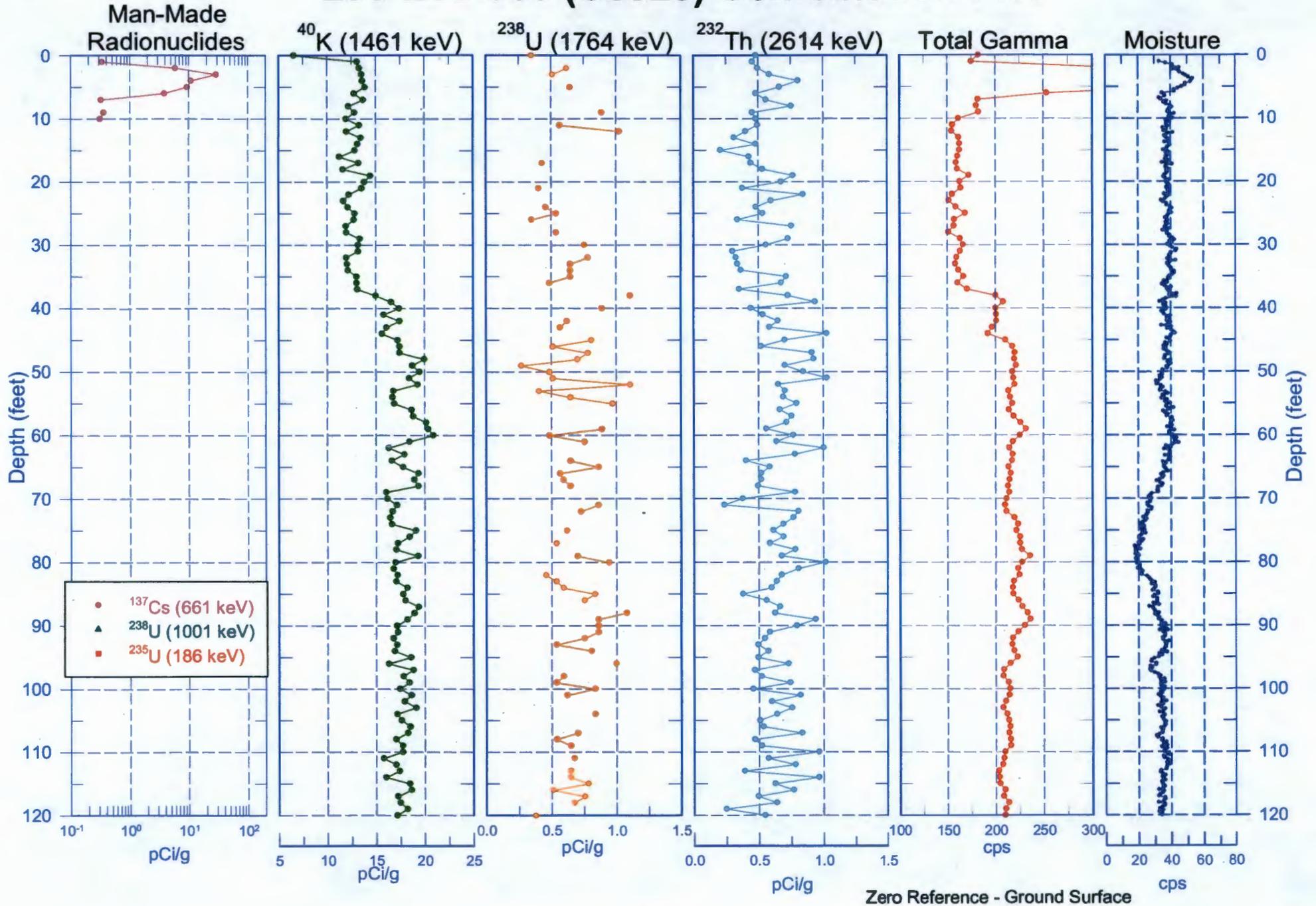


299-E33-360 (C8923) Natural Gamma Logs

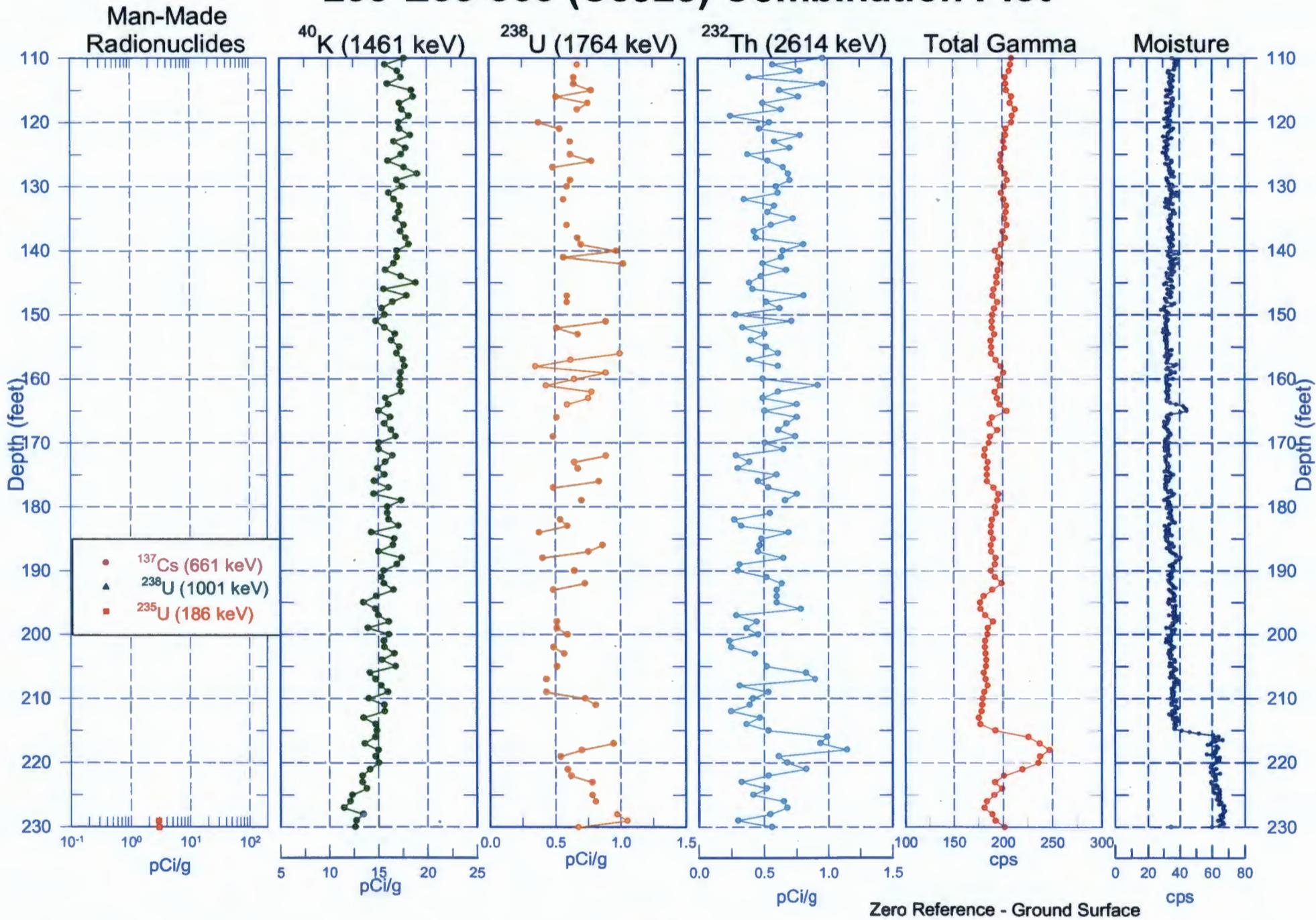


Zero Reference - Ground Surface

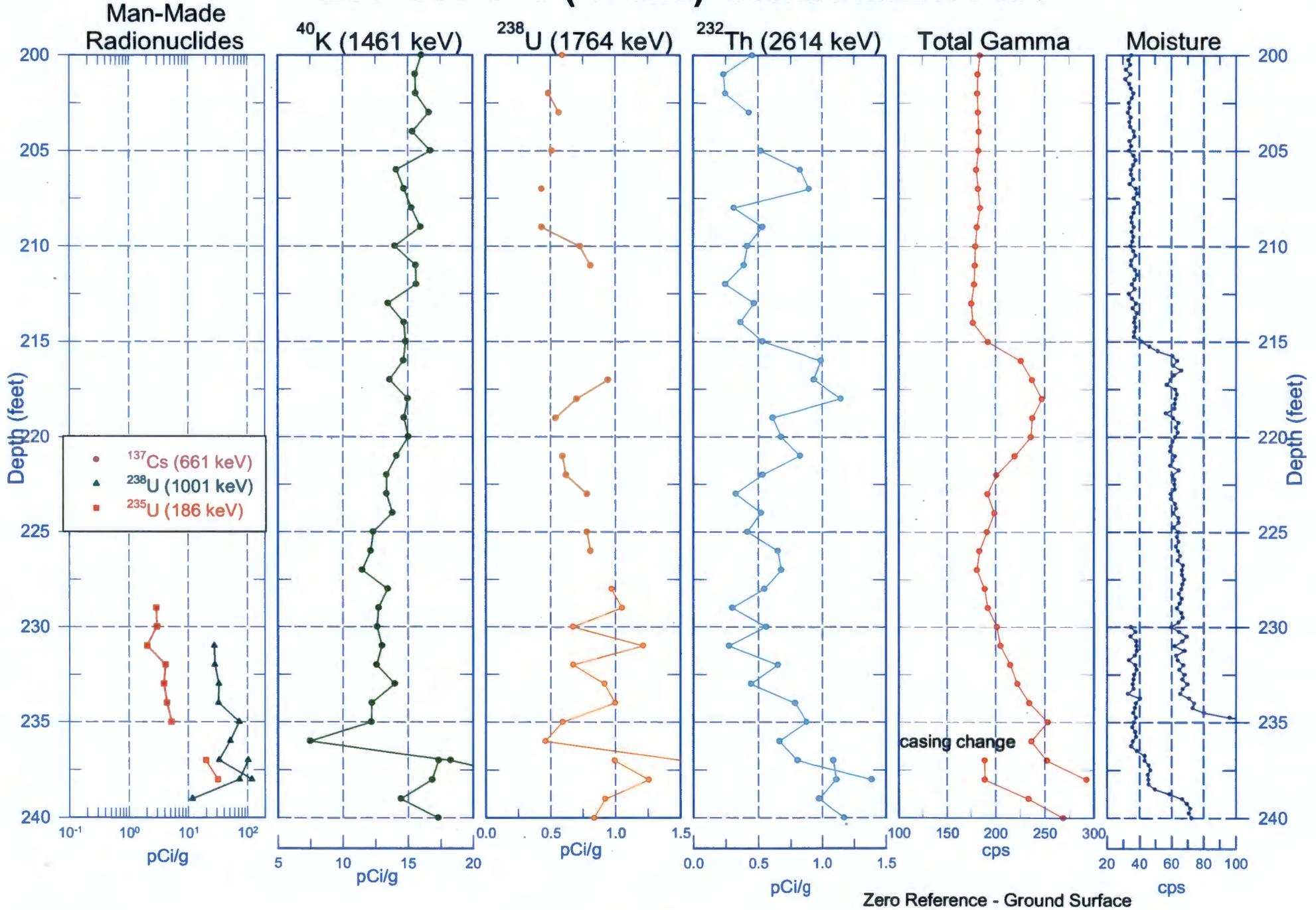
299-E33-360 (C8923) Combination Plot



299-E33-360 (C8923) Combination Plot

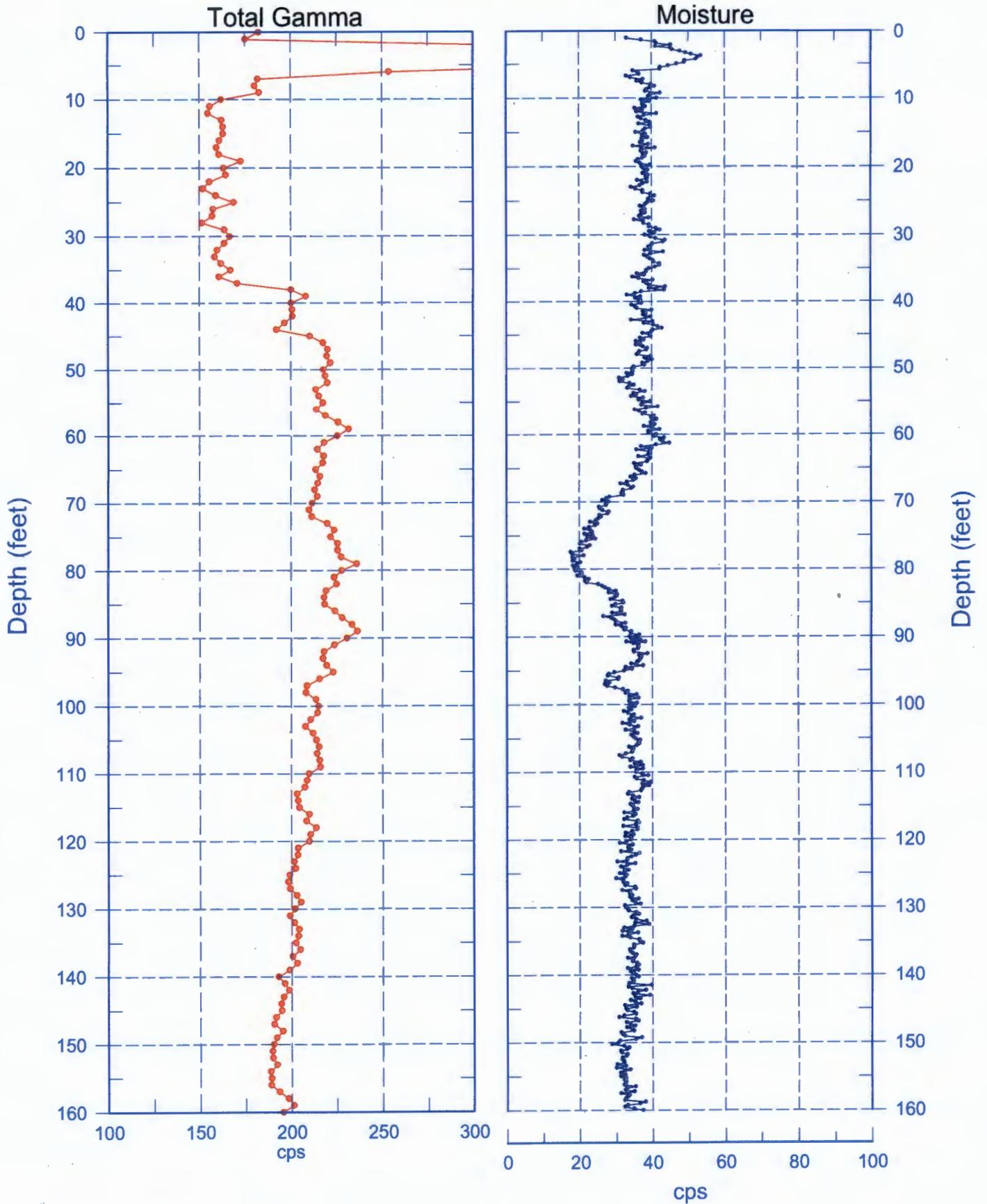


299-E33-360 (C8923) Combination Plot





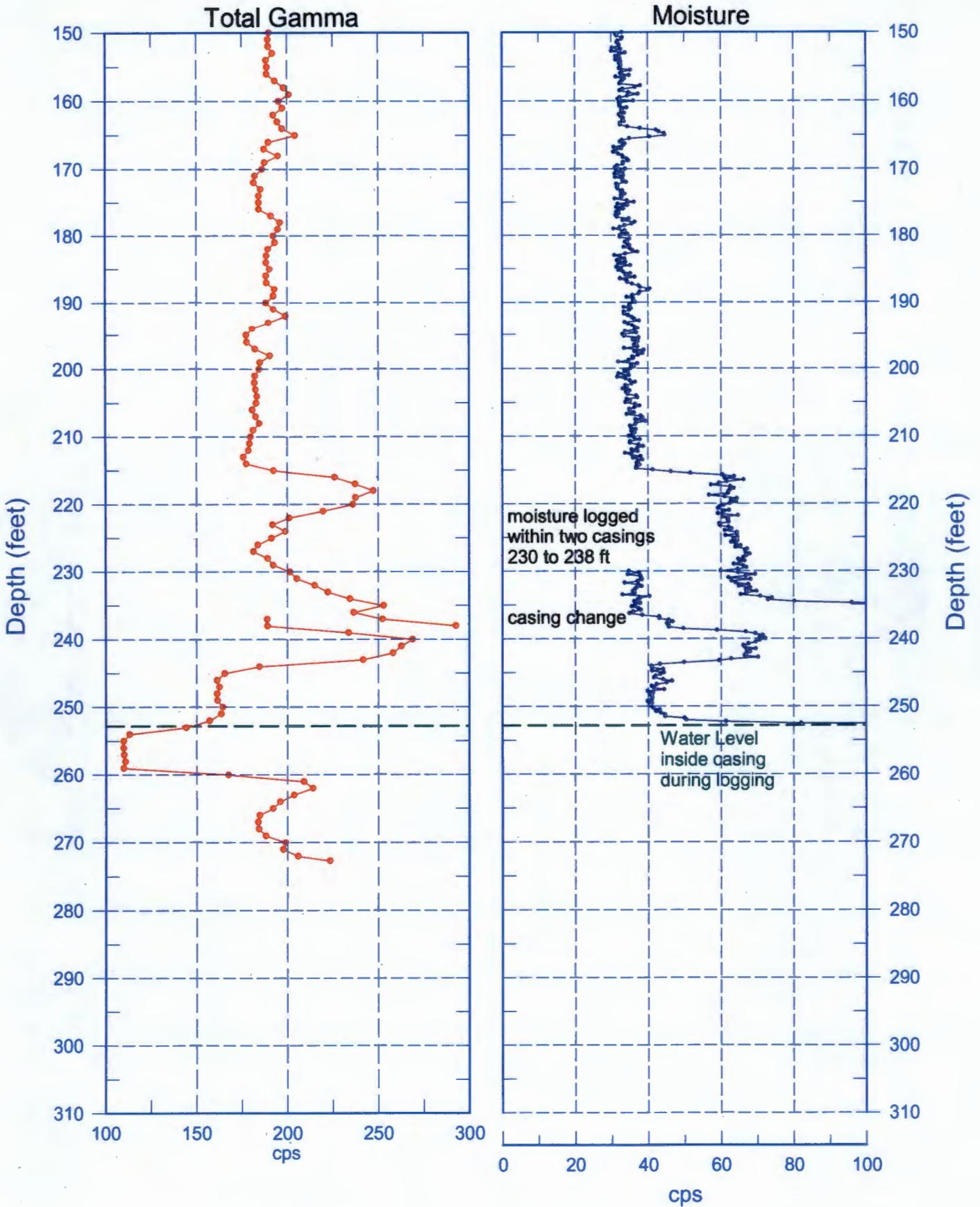
299-E33-360 (C8923) Total Gamma & Moisture



Reference - Ground Surface



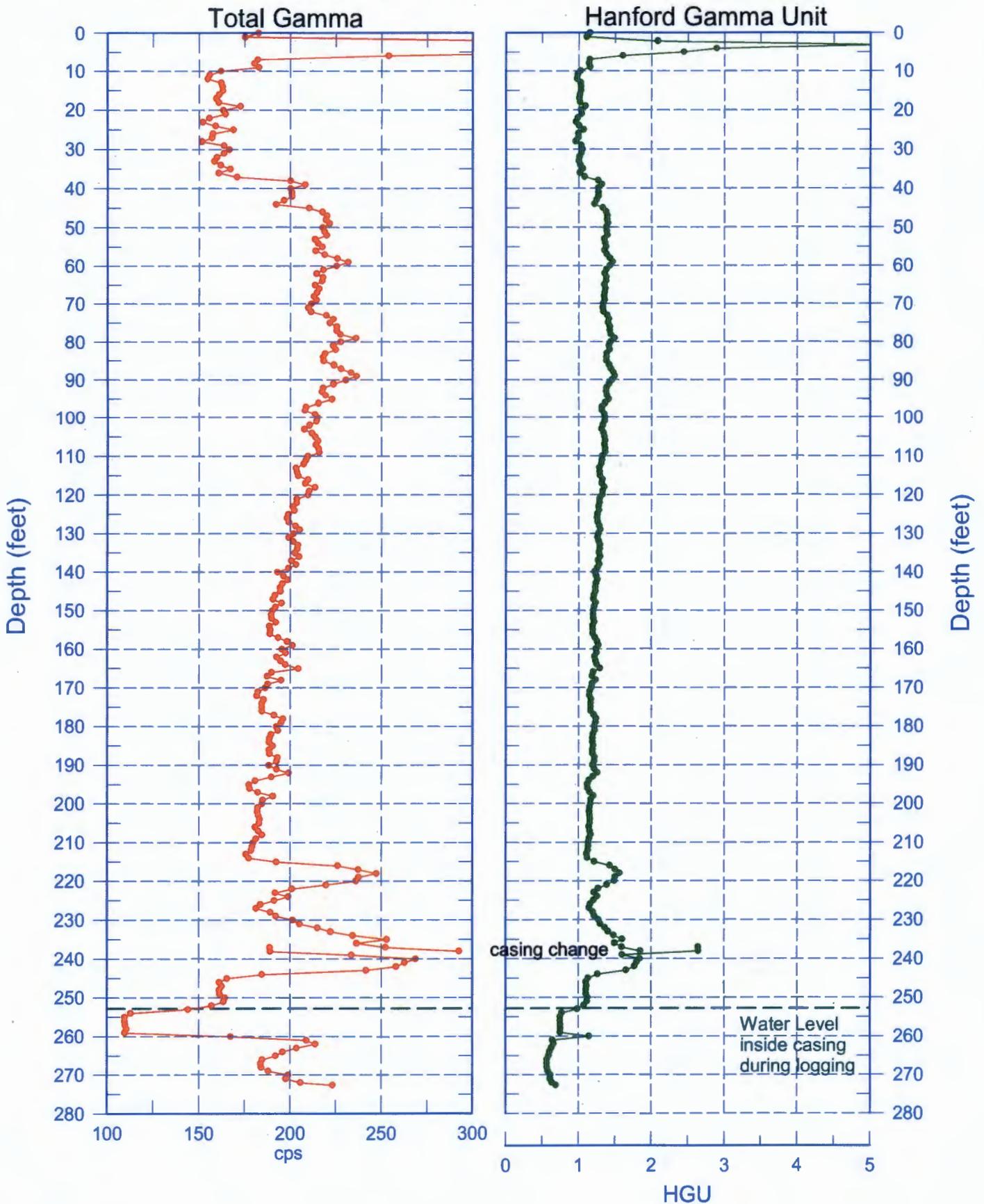
299-E33-360 (C8923) Total Gamma & Moisture



Reference - Ground Surface

299-E33-360 (C8923)

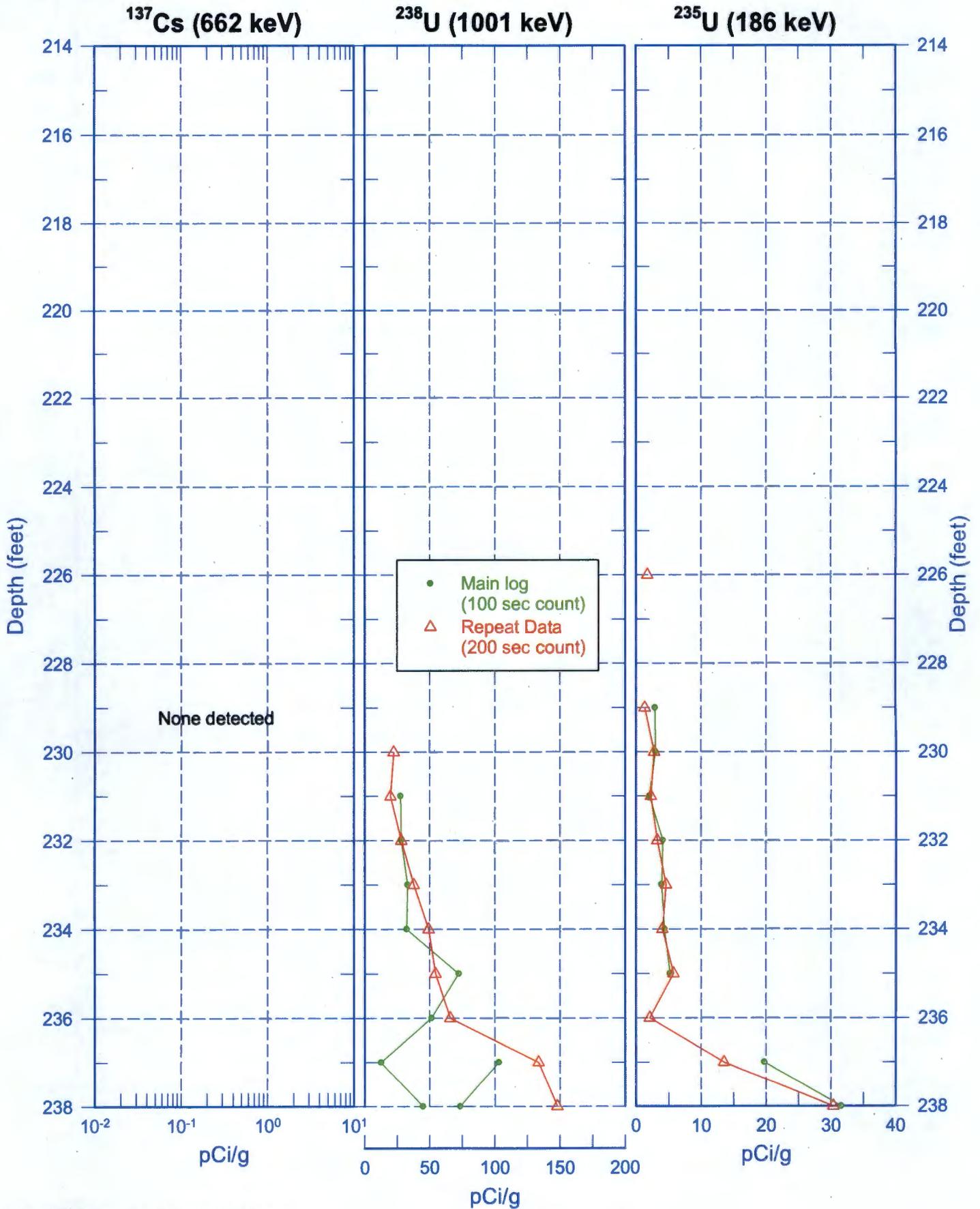
Total Gamma & Hanford Gamma Unit





299-E33-360 (C8923)

Repeat of Manmade Radionuclides

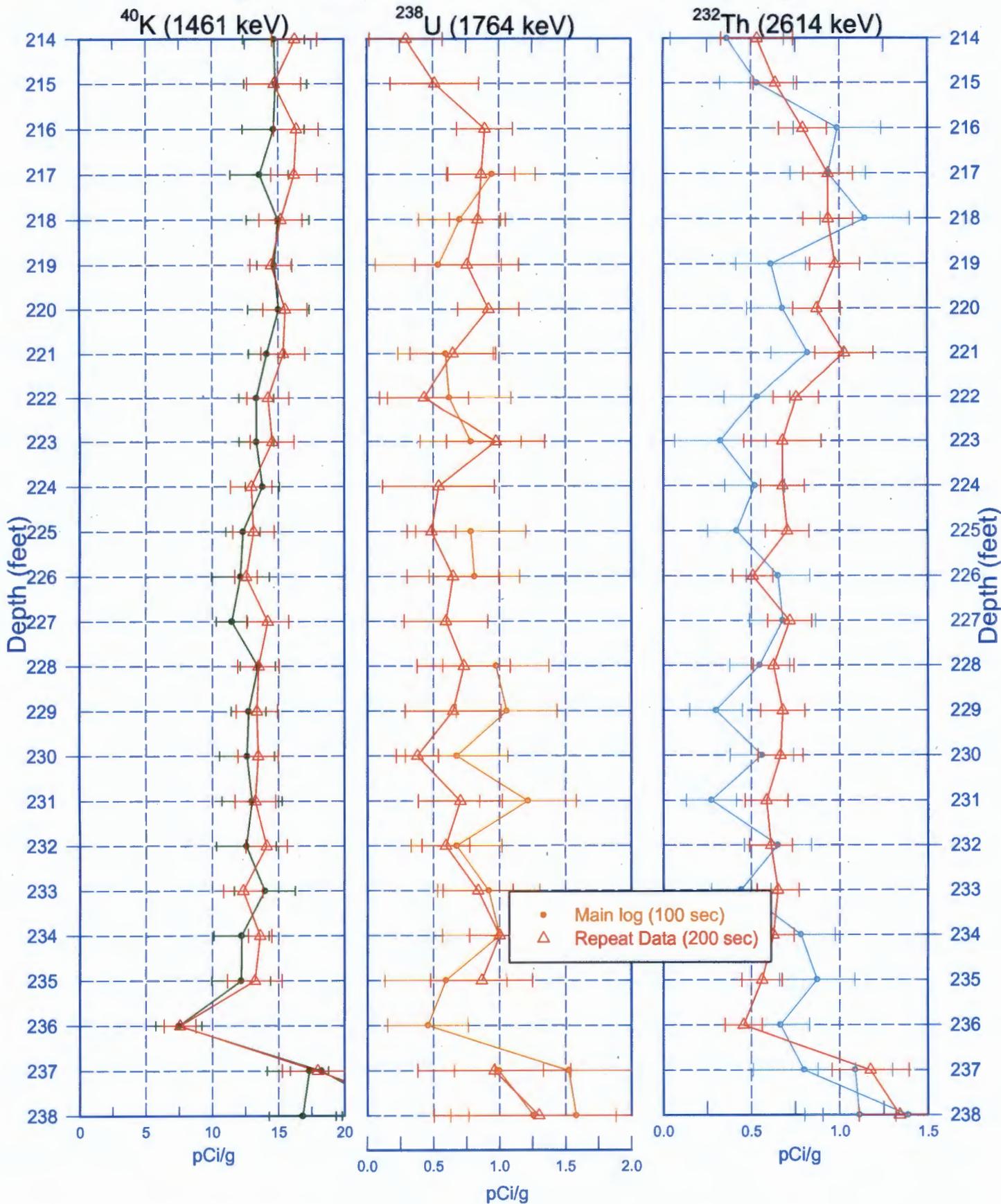


Zero Reference - Ground Surface



299-E33-360 (C8923)

Repeat Section of Natural Gamma Logs

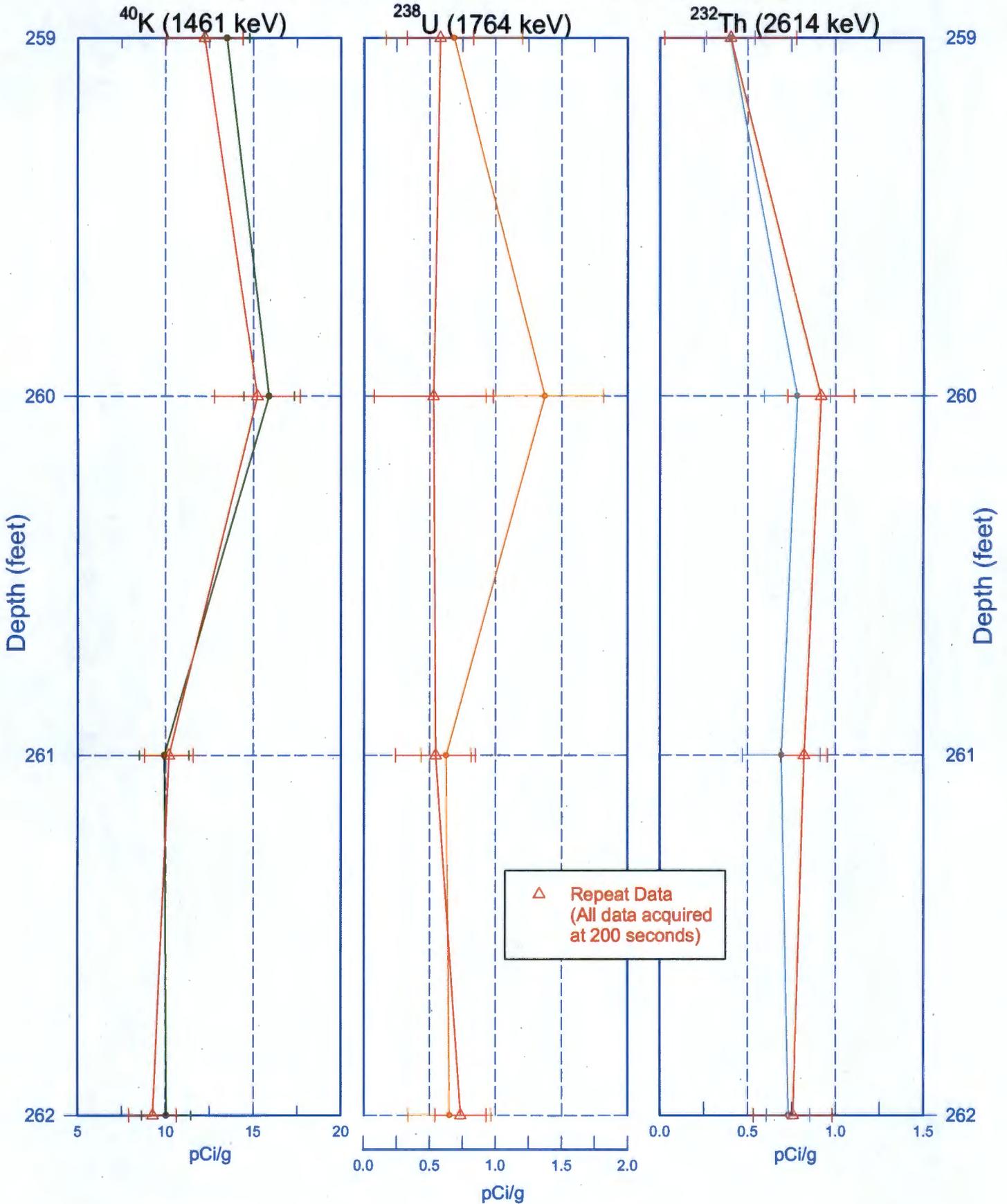


Zero Reference - Ground Surface



299-E33-360 (C8923)

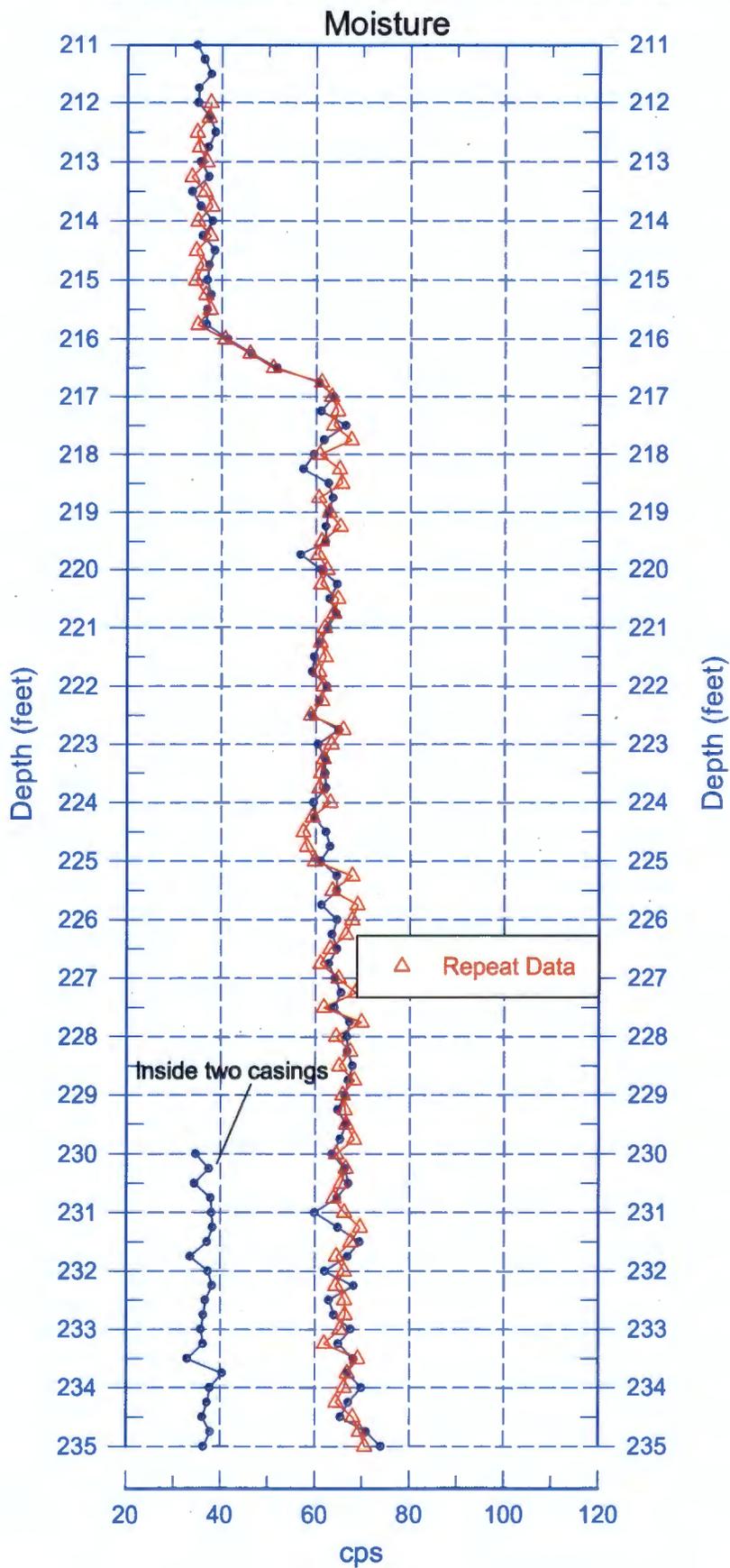
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface



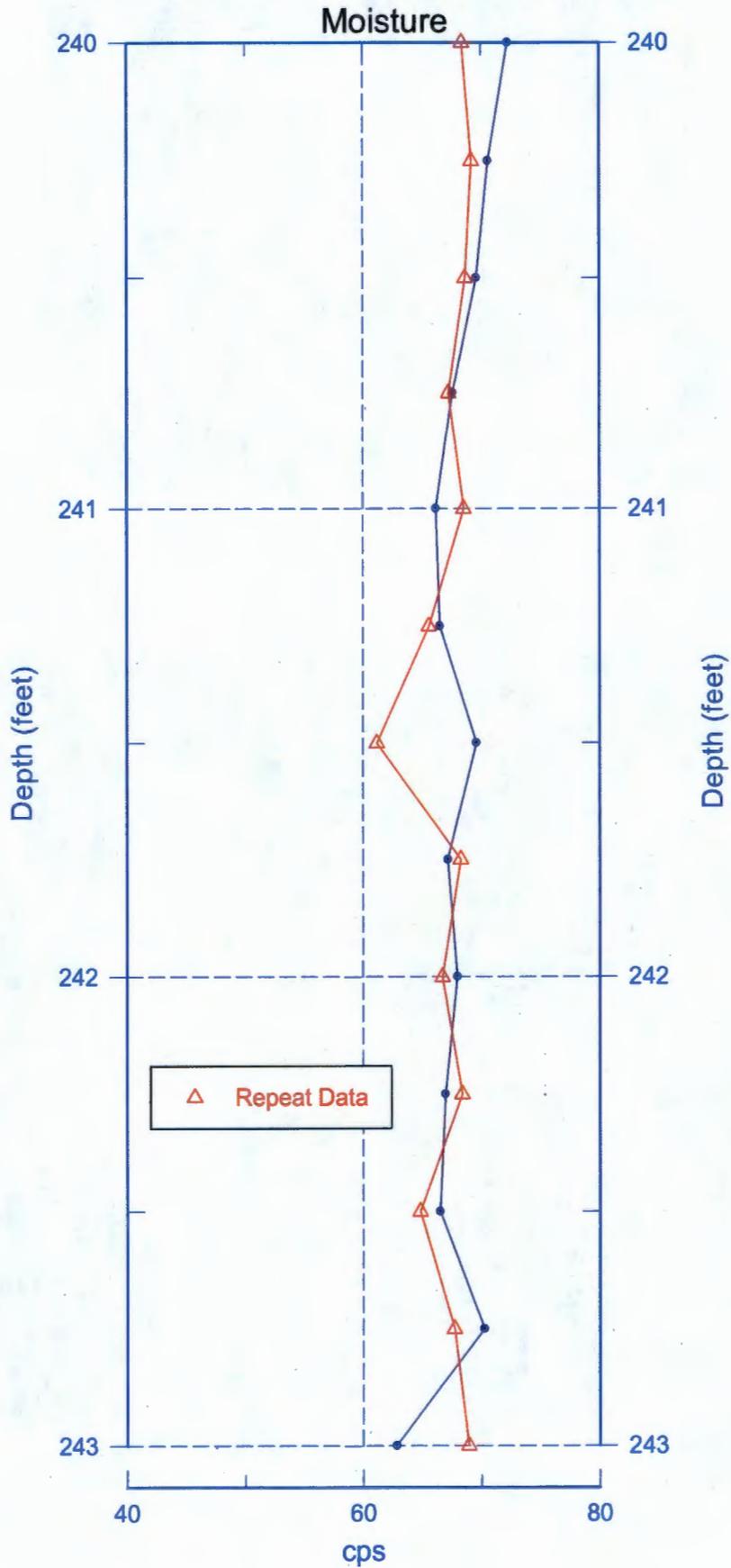
299-E33-360 (C8923) Moisture Repeat Section



Reference - Ground Surface



299-E33-360 (C8923) Moisture Repeat Section



Reference - Ground Surface



Sample: I-001
Sample Depth: 226.77 – 228.77 ft bgs
Recovery: 100%
Sediment Classification: Sand Silt (sM)/Silty Sand (mS)
Formation: Cold Creek Unit



Top of Liner A: 228.33 – 228.77 ft bgs



Top of Liner B: 227.77 – 228.33 ft bgs



Top of Liner C: 227.33 – 227.77 ft bgs



Top of Liner D: 226.77 – 227.33 ft bgs



Sample: I-002
Sample Depth: 233.39 – 235.89 ft bgs
Recovery: 100%
Sediment Classification: Silty Sand (mS)
Formation: Cold Creek Unit



Bottom Liner A: 235.89 – 235.27 ft bgs



Bottom Liner B: 235.27 – 234.64 ft bgs



Bottom Liner C: 234.64 – 234.02 ft bgs



Bottom Liner D: 234.02 – 233.39 ft bgs

SURVEY DATA REPORT				Request No. 152-059		
Project No.	Title M-24 Wells C8923 & C8924 Final Surveys			File No. 2ET13R26		
Job. No. CACN: 303345-JPRC	Prepared By N.P. Fastabend	Date 2/11/15	Reviewer <i>LBM</i>			
DESCRIPTION OF WORK			DISTRIBUTION	SDR	PLOT	DWG
Obtained final coordinates (C/L Casings) and elevations of completed M-24 Wells C8923 (299-E33-360) and C8924 (299-E33-361) in 200E Area. Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)			Survey File	OR		
			J.D. Mehrer	1		
			S.J. Trent	1		
			K.M. Whitley	1		
			J.B. Geiger	1		
			B.J. Howard	1		
			A.J. Green	1		
SURVEY RESULTS AND COMMENTS						
<p>See Attached Well Survey Data Report Sheets</p>						

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 01/21/15	Requestor: Kelly Whitley (CHPRC)
Date of Survey: 02/11/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of M-24 Well C8923 (299-E33-360) located north of 241-B Tank Farm in 200E Area.	Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
HSWB-032 (COE) and 2E-122 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C8923	299-E33-360	573772.05	137386.86		Center of Casing
				199.701	"X" on Rim
				198.949	Brass Survey Marker

Notes:

199.382 Top Inner 8in Casing, North Edge

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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



2-12-2015

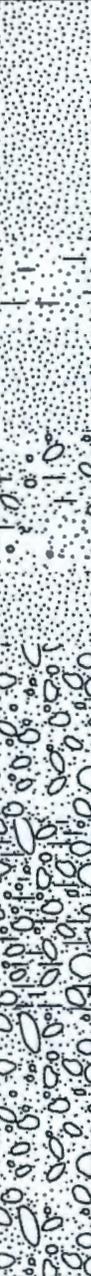
Appendix C

Well Documentation for 299-E33-361 (C8924)

- Well Summary Sheet
- Borehole Log
- Log Data Report
- Variance to Construct
- Final Survey Report

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WELL SUMMARY SHEET		Start Date: 8-13-2014		Page <u>1</u> of <u>2</u>	
		Finish Date: 11-05-2014			
Well ID: C8924			Well Name: 299-E33-361		
Location: N.E. of B-Plant			Project: TPA M-24 Monitoring Wells		
Prepared by: Abby Wicks		Date: 11-11-2014	Reviewed by: MEHRER		Date: 1-28-15
Signature: <i>Abby Wicks</i>			Signature: <i>[Signature]</i>		
CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA		
Description	Diagram		Graphic Log	Lithologic Description	
<u>Temporary Casing Materials</u> 13" Carbon Steel 13 7/16" OD, 12 1/2" ID (0.0 ft- 64.27 ft bgs)		0		0'-1.5' Drill Pad	
		1.5'-7' Silty Sand [mS]			
		7'-31' Silty Sandy Gravel [msG]			
		25			
				31'-55 Sand [S]	
			50		
				55'-60' Gravelly Sand [gS]	
				60'-65' Sand [S]	
				65'-75' Gravelly Sand [gS]	
			75		
				75'-80' Sand [S]	
				80'-90' Gravelly Sand [gS]	
			90'-100' Sand [S]		
		100			
			100'-110' Gravelly Sand [gS]		
			110'-170' Sand [S]		
		125			
<u>Permanent Casing Materials</u> 12" Carbon Steel 11 5/16" OD, 10 11/16" ID (64.27 ft bgs - 275.14 ft bgs)					
8" Type 304 SS sch 10 Riser (+1.40 ft ags - 253.60 ft bgs)					
8" Type 304 SS sch 10 continuous wire wrap 65-slot Screen (253.60 ft bgs - 273.60 ft bgs)					
8" Type 304 SS sch 10 Sump (273.60 ft bgs - 276.60 ft bgs)					
<u>Construction Materials</u> Type I/II Portland Cement (0 ft bgs - 7.40 ft bgs)					
Natural Sluff (7.40 ft bgs - 10.70 ft bgs)					
Med. Bentonite Chips (10.70 ft bgs - 66.0 ft bgs)					
#8/20 Bentonite Crumbles (66.0 ft bgs - 109.3 ft bgs)					
3/8" Bentonite Chips (109.3 ft bgs - 245.6 ft bgs)					
Bentonite Pellets (245.6 ft bgs - 249.0 ft bgs)					
#8/12 Colorado Silica (249.0 ft bgs - 276.0 ft bgs)					

WELL SUMMARY SHEET		Start Date: 8-13-2014	Page <u>2</u> of <u>2</u>
		Finish Date: 11-05-2014	
Well ID: C8924		Well Name: 299-E33-361	
Location: NE of B-Plant		Project: TPA M-24 Monitoring Wells	
Prepared by: Abby Wicks	Date: 11-11-2014	Reviewed by: D. MEHRER	Date: <u>1-21-15</u>
Signature: <i>Abby Wicks</i>		Signature: <i>[Signature]</i>	
CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA
Description	Diagram	Graphic Log	Lithologic Description
			150' - 170' Sand [S] 170' - 180' Slt. Silty Sand [(m)S] 180' - 190' Sand [S] 190' - 195' Gravelly Sand [gS] 195' - 200' Slt. Silty Sand [(m)S] 200' - 205' Gravelly Sand [gS] 205' - 212' Sand [S] 212' - 230' Sandy Gravel [sG] 230' - 250' Silty Sandy Gravel [msG] 250' - 277.8' Sandy Gravel [sG]
Note: All Temporary casing has been removed from the ground. All depths are reported in feet below ground surface (ft bgs) unless otherwise noted.		TD = 277.89 ft bgs DTW = 254.8 ft bgs (11/5/2014)	

BOREHOLE LOG

Page 1 of 7

Date: 8-13-14

Well ID: C8924

Well Name: 299-E33-361

Location: N.E. of B-Plant ~ 1/2 mile

Project: M-24 Monitoring Wells FY14

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0-1.5': <u>Gravel Pad</u>	Cable tool w/drive barrel
5	G.S.	3 gal H ₂ O Added		1.5'-7': <u>Gravelly Silty Sand (S MS)</u> @ 5' bgs: 25% silt, 65% v.f.a. - v.crs. sand (mostly v.f.a.-f.a.), 10% v.f.a. - crs. Peb.; max 28mm; dry; well-med sorted; sub ang. - sub.crd.; 90% m/10% f; v. strg. HCl rxn; 2.5Y 5/2 grayish brown	Archive @ 5' bgs Add 3 gal H ₂ O to aid drilling.
10	G.S.			7-31': <u>Silty Sandy Gravel (MSG) SG</u> @ 8' bgs: 10% silt, 50% v.f.a. - v.crs. sand (crs.), 40% v.f.a. - med. - sm. Peb.; max 45mm; poorly sorted; wet due to added H ₂ O; sub ang. - sub.crd.; 80% m/20% f; strg. HCl rxn; 2.5Y 3/2 very dark grayish brown	Archive @ 8' bgs Archive @ 11' bgs.
15	G.S.			@ 11' bgs: 10% silt, 40% v.f.a. - v.crs. sand, 50% v.f.a. - sm. Peb.; max 108mm; dry; 70% m/30% f; strg. - v. strg. HCl rxn; 2.5Y 5/2 grayish brown	Archive @ 15' bgs
20	G.S.			@ 15' bgs: 10% silt; 60% v.f.a. - v.crs. sand (crs. - v.crs.), 30% v.f.a. - v.crs. Peb. (v.f.a.-f.a.); 52mm max;	
25	G.S.			@ 20' bgs: slightly moist; 60% m/40% f; med. - strg. HCl rxn	Archive @ 20' bgs
30	G.S.			@ 25' bgs: 10% silt; 55% v.f.a. - v.crs. sand (crs. - v.crs.), 35% v.f.a. - (v.f.a.-med.) - v.crs. Peb.; max 45mm; 65% m/35% f; v. strg. HCl rxn.	Archive @ 25' bgs
35	G.S.			@ 30' bgs: 15% silt; 50% v.f.a. - v.crs. sand, 35% v.f.a. - crs. Peb. (v.f.a.-f.a.); max 23mm;	Archive @ 30' bgs Archive @ 31' bgs
				31-55': <u>Sand (S)</u> 5% silt; 95% v.f.a. - med. sand; slightly moist; well sorted; sub. ang. - sub.crd.; 70% f/30% m; v. strg. HCl rxn; 2.5Y 5/3 light olive brown	Archive @ 35' bgs
				@ 35' bgs: sand v.f.a. - v.crs.; 50% m/50% f; med. - strg. HCl rxn; 2.5Y 5/2 grayish brown	

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr Geologist

Signature: Julie Johanson

Date: 8-13-14

Signature: Ken Byles

Date: 3-11-15

BOREHOLE LOG

Page 2 of 7

Date: 9-18-14

Well ID: C8924

Well Name: 119-E32-361

Location: N.E. of B-Plant ~ 1/2 mile

Project: M-24 Monitoring wells FY14

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	G.S.			<u>31-55: Sand (S)</u>	<u>Cable tool w/</u>
				<u>@ 40' bgs: >10% silt, <90% v.f.n. - v.crs. sand (crs.),</u>	<u>Archive @ 40' bgs</u>
				<u>slightly moist; well sorted; sub.ang. - sub.rnd.; strong HCl rxn;</u>	
				<u>2.54 5/2 grayish brown</u>	
45	G.S.			<u>@ 45' bgs: >10% silt, 85% v.f.n. - v.crs. sand (med-crs.), 5%</u>	<u>Archive @ 45' bgs</u>
				<u>v.f.n. - med. Peb.; max 14mm; strg. - v.strg. HCl rxn;</u>	
50	G.S.			<u>@ 50' bgs: max 10mm, ang. - sub.rnd</u>	<u>Archive @ 50' bgs</u>
55	G.S.			<u>55-60: Gravelly Sand (gS)</u>	<u>Archive @ 55' bgs</u>
				<u>>10% silt, 80% v.f.n. - v.crs. sand, 10% v.f.n. - crs. pebbles;</u>	
				<u>max 22mm; slightly moist; med. - well sorted; ang. - sub.rnd.;</u>	
			<u>55% F/45% m; v. strg. HCl rxn; 2.54 5/2 light olive brown</u>		
60	G.S.		<u>60-65: Sand (S)</u>	<u>Archive @ 60' bgs</u>	
			<u>>10% silt, 85% v.f.n. - v.crs. sand (med), 5% v.f.n. - med. Peb.;</u>		
			<u>max 11mm; slightly moist; well sorted; ang. - sub.rnd.; 65% F/</u>		
			<u>45% m; v. strg. HCl rxn; 2.54 5/2 light olive brown</u>		
65	G.S.	<u>1 gal H₂O added</u>	<u>65-75: Gravelly Sand (gS)</u>	<u>Archive @ 65' bgs</u>	
			<u>>10% silt; 80% v.f.n. - v.crs. sand (crs.), 10% v.f.n. - crs. Peb.;</u>		
			<u>max 21mm; slightly moist; med. sorted; ang. - sub.rnd.;</u>		
			<u>65% F/45% m; v. strg. HCl rxn; 2.54 5/2 light olive</u>		
			<u>brown</u>		
70	G.S.		<u>@ 70' bgs: Peb. decrease to medium; max 11mm; dry; ang. -</u>	<u>Archive @ 70' bgs</u>	
			<u>sub.ang.; 65% F/35% m; med-strg. HCl rxn; 2.54 6/2 light</u>		
			<u>brownish gray.</u>		
75	G.S.		<u>75-80: Sand (S)</u>	<u>Archive @ 75' bgs</u>	
			<u>5% silt; 90% v.f.n. - v.crs. sand, >5% v.f.n. - fa. Peb.; max 5mm;</u>		
			<u>dry; well sorted; ang. - sub.rnd.; 60% F/40% m; strg. - v.strg.</u>		
			<u>HCl rxn; 2.54 6/2 light brownish gray</u>		

Reported By: <u>Julie Johanson</u>	Reviewed By: <u>Kevin Bergstrom</u>
Title: <u>Geologist</u>	Title: <u>Sr Geologist</u>
Signature: <u>Julie Johanson</u>	Signature: <u>Kevin Bergstrom</u>
Date: <u>9-11-14</u>	Date: <u>3-11-15</u>

BOREHOLE LOG

Date: 9-11-14

Well ID: C8924

Well Name: 299-E33-361

Location: N.E. of B-Plant ~ 1/2 mile

Project: M-24 Monitoring Wells FY14

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
80	G.S.		[Graphic Log: 80-90' interval]	<u>80-90: Gravelly Sand (GS)</u> 5% silt, 85% v.fn. - v.crs. sand (med.-v.crs.); 10% v.fn. - med. peb; max 9mm; slightly moist-dry; med. sorted; ang. - sub. rd.; 55% F/45% m; med. - strg. HCl rxn; 2.54 5/2 grayish brown.	Cable tool w/drive barrel Archive @ 80' bgs
85	G.S.			@ 85' bgs: max 13mm; 2.54 1/2 light brownish gray	Archive @ 85' bgs
90	G.S.		[Graphic Log: 90-100' interval]	<u>90-100: Sand (S)</u> 5% silt, 90% v.fn. - v.crs. sand (med.-crs.); 5% v.fn. - peb; max 4mm; slightly moist-dry; well sorted; ang. - sub. ang.; 60% F/40% m; strg. - v. strg. HCl rxn; 2.54 5/2 grayish brown	Archive @ 90' bgs
95	G.S.			@ 95' bgs: peb. size increase to medium; max 11mm; ang. - sub. rd.; 65% F/35% m; med. - strg. HCl rxn.	Archive @ 95' bgs
100	G.S.		[Graphic Log: 100-105' interval]	<u>100-110: Gravelly Sand (GS)</u> 5% silt; 85% v.fn. - v.crs. sand (med.), 10% v.fn. - med. peb.; max 15mm; dry; med. sorted; ang. - sub. rd.; 65% F/35% m; strg. - v. strg. HCl rxn; 2.54 5/2 grayish brown	Archive @ 100' bgs
105	G.S.			@ 105' bgs: increase to v.crs. peb.; max 34mm; sand (med.-crs.); slightly moist-dry; 60% F/40% m; med. HCl rxn;	Archive @ 105' bgs
110	G.S.		[Graphic Log: 110-115' interval]	<u>110-115: Sand (S)</u> 5% silt, 90% v.fn. - v.crs. sand (med.-crs.); 5% v.fn. - fn. peb.; max 8mm; slightly moist-dry; 60% F/40% m; med. sorted; ang. - sub. ang.; weak-med. HCl rxn; 2.54 5/2 grayish brown.	Archive @ 110' bgs
115	G.S.			@ 115' bgs: max 7mm; med. - strg. HCl rxn	Archive @ 115' bgs

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr Geologist

Signature: Julie Johanson

Date: 9-15-14

Signature: Kevin Bergstrom

Date: 3-11-15

BOREHOLE LOG

Page 4 of 7

Date: 9-15-14

Well ID: C8924

Well Name: 299-E33-361

Location: N.E. of B-Plant ~ 1/2 mile

Project: M-24 Monitoring Wells F414

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
120	G.S.			<u>110-170: Sand (S) @ 120' bgs</u> <u>5% silt, 94% vfn - v.crs sand (med-crs), 1% vfn-pch; max 8mm; slightly moist - dry; well sorted; ang - sub.crd.; 60%F/40%T; med - strg. HCl rxn; 2.54 5/2 grayish brown</u>	<u>Cable tool w/drive barrel</u> <u>Archive @ 120' bgs</u>
125	G.S.			<u>@ 125' bgs: 5% silt, 94% vfn - v.crs sand (med-crs), 5% vfn - med. pch; max 10mm; med - well sorted; ang - subrang.</u>	<u>Archive @ 125' bgs</u>
130	G.S.			<u>@ 130' bgs: 5% silt, 87% vfn - v.crs (crs - v.crs), 8% vfn - med. pch. max 10mm; ang - sub.crd.; 55%F/45%T; med. HCl rxn; 2.54 4/2 dark grayish brown.</u>	<u>Archive @ 130' bgs</u>
135	G.S.			<u>@ 135' bgs: 5% silt, 94% vfn - v.crs sand (med-crs), 1% vfn - med. pch; max 9mm; well sorted; ang - sub.ang; 50%T/50%F;</u>	<u>Archive @ 135' bgs</u>
140	G.S.			<u>@ 140' bgs: 5% silt, 92% vfn - v.crs sand (med-crs), 3% vfn - fa. pch; max 8mm; ang - sub.crd.; 55%F/45%T; med - strg. HCl rxn; 2.54 5/2 grayish brown</u>	<u>Archive @ 140' bgs</u>
145	G.S.	<u>Add 1gal H₂O</u>		<u>@ 145' bgs: max 6mm;</u>	<u>Archive @ 145' bgs</u> <u>Add 1gal H₂O @ ~145' bgs</u>
150	G.S.			<u>@ 150' bgs: 5% silt, 90% vfn - v.crs sand (med-crs), 5% vfn - med. pch, max 9mm; 50%T/50%F;</u>	<u>Archive @ 150' bgs</u>
155	G.S.		<u>@ 155' bgs: 5% silt, 93% vfn - v.crs sand (med), 2% vfn - fa. pch; max 6mm; strg. HCl rxn.</u>	<u>Archive @ 155' bgs.</u>	

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr Geologist

Signature: Julie Johanson

Date: 9-17-14

Signature: Kevin Bergstrom

Date: 3-11-15

BOREHOLE LOG					Page <u>5</u> of <u>7</u>
Well ID: <u>C8924</u>		Well Name: <u>299-E33-361</u>		Location: <u>N.E. of B-Plant ~ 1/2 mile</u>	
Project: <u>M-24 Monitoring Wells F414</u>			Reference Measuring Point: <u>Ground Surface</u>		
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
160	G.S.			<u>110-170 : Sand (S)</u> @160' bgs: 5% silt; 95% vfn - v.crs sand (med.); max 2mm; slightly moist-dry; well sorted; ang. - sub.rnd.; 55%F/45% m; med.-strg. HCl rxn; 2.5Y 5/2 grayish brown	Cable tool w/drive barrel. Archive @ 160' bgs
165	G.S.	@165' bgs: 5% silt, 94% vfn - v.crs. sand (med.), 1% vfn - fn pb; max 6mm;		Archive @ 165' bgs	
170	G.S.	<u>170-180 : Slightly Silty Sand (mS)</u> 15% silt; 83% vfn - v.crs. sand, 2% vfn - fn pb; max 6mm; slightly moist-dry; med. sorted; ang. - sub.rnd.; 55%F/45% m; med.-strg. HCl rxn; 2.5Y 5/2 grayish brown; ~ 2" layer of v.fn. sand + silt interbed.		Archive @ 170' bgs	
175	G.S.	@-172' sand becomes mostly fine, HCl rxn weak-med. @175' bgs: 15% silt; 85% vfn - v.crs. sand (vfn - fn), 40%F/40% m; med.-strg. HCl rxn; 2.5Y 5/3 light olive brown.		Archive @ 175' bgs	
180	G.S.	<u>180-190 : Sand (S)</u> 7% silt; 90% vfn - v.crs. sand (med.); 3% vfn - med pb; max 11mm; slightly moist-dry; med-well sorted; ang. - sub.rnd.; 40%F/40% m; med.-strg. HCl rxn; 2.5Y 5/2 grayish brown		Archive @ 180' bgs	
185	G.S.	@ 185' bgs: 8% silt, 92% vfn - v.crs. sand (med.); well sorted; strg. HCl rxn		Archive @ 185' bgs	
190	G.S.	<u>190-195 : Gravelly Sand (gS)</u> 8% silt; 78% vfn - v.crs. sand (med.-crs), 15% vfn.pb - sm. pb; max 20mm; slightly moist-dry; poorly sorted, ang. - sub.rnd.; 40%F/40% m; strg. HCl rxn; 2.5Y 5/2 grayish brown		Archive @ 190' bgs	
195	G.S.	<u>195-200 : Slightly Silty Gravelly Sand (mgS)</u> 10% silt; 80% vfn - v.crs. sand (med.-crs.); 10% vfn - med pb; max 15 mm; slightly moist-dry; med. sorted, ang. - sub.rnd.; 55%F/45% m; strg. HCl rxn; 2.5Y 5/2 grayish brown.		Archive @ 195' bgs	

Reported By: <u>Julie Johanson</u>	Reviewed By: <u>Kevin Bergstrom</u>
Title: <u>Geologist</u>	Title: <u>Sr Geologist</u>
Signature: <u>Julie Johanson</u>	Signature: <u>Kevin Bergstrom</u>
Date: <u>9-17-14</u>	Date: <u>3-11-15</u>

BOREHOLE LOG

Page 6 of 7

Date: 9-17-14

Well ID: C8924

Well Name: 299-E33-361

Location: N.E. of B-Plant ~ 1/2 mile

Project: M-24 Monitoring Wells F414

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
200	G.S.				Cable tool w/drive barrel
				<u>200 - 205 : Gravelly Sand (GS)</u>	Archive @ 200' bgs
				77% silt; 83% v.f.a. - v.crs. sand (crs. - v.crs.); 10% v.f.a. - med. peb.; max 13mm; slightly moist-dry; med. sorted; ang. - sub.rnd.; 50% m/50% f; strg. HCl rxn; 2.54 5/1 gray	
205	G.S.			<u>205 - 212 : Sand (S)</u>	Archive @ 205' bgs
				82% silt; 92% v.f.a. - v.crs. sand (med.); slightly moist-dry; ang. - sub.ang.; 55% f/45% m; well sorted; med. - strg. HCl rxn; 2.54 5/2 grayish brown	
210	G.S.			@ 210' bgs: Sand (fa-med.)	Archive @ 210' bgs
	G.S.			<u>212 - 230 : Sandy Gravel (SG)</u>	Archive @ 212' bgs
				82% silt; 52% v.f.a. - v.crs. sand, 40% v.f.a. peb. - sm. cob.; max 28mm; moist; poorly sorted; ang. - sub.rnd.; s: 40% f/40% m, g: 55% m/45% f; strg. HCl rxn; 2.54 5/3 light olive brown	Archive @ 215' bgs
215	G.S.			@ 215' bgs: 5% silt, 60% v.f.a. - v.crs. sand (crs.), 35% v.f.a. - v.crs. peb.; max 45mm; slightly moist-dry; s: 55% f/45% m; g: 50% m/50% f; 2.54 4/2 dark grayish brown	
220	G.S.			@ 220' bgs: 8% silt; 57% v.f.a. - v.crs. sand, 40% v.f.a. - v.crs. peb.; max 52mm; dry; 2.54 5/2 grayish brown	Archive @ 220' bgs
225	G.S.		@ 225' bgs: increase to small cob.; max 46mm; slightly moist-dry; 2.54 5/1 gray	Archive @ 225' bgs	
230	G.S.		<u>230 - 250 : Silty Sandy Gravel (msG)</u>	Archive @ 230' bgs	
			10% silt; 50% v.f.a. - v.crs. sand (v.f.a. - fa), 40% v.f.a. peb. - sm. cob.; max 70mm; slightly moist-dry, mostly dry; ang. - sub.rnd.; s: 50% m/50% f, g: 55% m/45% f; strg. HCl rxn; 2.54 5/2 grayish brown		
235	G.S.		@ 235' bgs: 10% silt, 45% v.f.a. - v.crs. sand (v.f.a. - fa), 45% v.f.a. peb. - sm. cob.; max 63mm; dry; g: 50% m/50% f; 2.54 5/1 gray	Archive @ 235' bgs	

Reported By: Julie Johanson

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr Geologist

Signature: Julie Johanson

Date: 9-23-14

Signature: Kevin Bergstrom

Date: 3-11-15

BOREHOLE LOG

Date: 9-23-14

Well ID: C8924

Well Name: 299-E33-361

Location: N.E. of B-Plant ~ 1/2 mile

Project: M-24 Monitoring Wells FY14

Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
240	G.S.			230 - 250: Silty Sandy Gravel (mG) @ 240' bgs: 10% silt, 50% vfn. - v.crs sand (crs.), 40% vfn. - v.crs. pcb; max 48mm; moist; ang. - sub.rnd (mostly sub.rnd.); s: 55%F/45%M, g: 55%M/45%F; poorly sorted; strg. HCl rxn; 2.54 3/2 very dark grayish brown; slight cementation	Cable tool w/drive barrel Archive @ 240' bgs
245	G.S.			@ 245' bgs: increase to lg. cob; max 148mm; slightly moist - dry; ang. - rnd; s: 50%M/50%F, g: 55%F/45%M; mod. - strg. HCl rxn; 10YR 5/2 grayish brown.	Archive @ 245' bgs
250	G.S.			250 - 273.6: Sandy Gravel (sG) 5% silt; 40% vfn. - v.crs sand (med. - crs.), 55% vfn. - v.crs. pcb; max 62mm; poorly sorted, slightly moist; ang. - sub.rnd; s: 55%F/45%M, g: 65%M/35%F; mod. - strg. HCl rxn; 2.54 4/2 dark grayish brown.	Archive @ 250' bgs
255	G.S.			@ 255' bgs: increased to small cob; max 80mm; moist; ang. - to round; g: 55%M/45%F; weak - mod. HCl rxn; 10YR 4/2 dark grayish brown	Archive @ 255' bgs H ₂ O: 255.24' bgs (9-24-14) DTW: 255.25' bgs (9-29-14)
260	G.S.			@ 260' bgs: 5% silt, 25% vfn. - v.crs sand (v.crs), 70% vfn. - v.crs. pcb; max 55mm, (lg. cob observed); poorly sorted, wet, s: ang. - sub.ang, g: sub.rnd - rnd; s: 60%F/40%M, g: 50%M/50%F; No HCl rxn; 10YR 2/2 very dark brown	Archive @ 260' bgs Waste profil Soil Comp Sample I-502 @ 260' bgs HETS# B2XNP3, B2XNP4, B2XNP5 (9-25-14)
265	G.S.		@ 265' bgs: 25% silt, 30% vfn. - v.crs. sand (crs. - v.crs), 65% vfn. - v.crs. pcb - sm. cob; max 67mm; s: 55%M/45%F, g: 65%M/35%F; 2.54 2.5/1 black	Archive @ 265' bgs B2XNN3, B2XNN4, DUP: B2XNN5, B2XNN6, B2XNN7; 264.44' bgs (9-29-14) I-001 + DUP H ₂ O Sample: HETS# B2XNN8	
270	G.S.		@ 270': 25% silt, 20% vfn. - v.crs. sand (crs. - v.crs.), 75% vfn. pcb - sm. cob; max 86mm; s: 55%M/45%F, g: 60%M/40%F;	Archive @ 270' bgs	
275	G.S.		273.6 - 277.89: Basalt Basalt slurry due to hard tooling; solid basalt; No HCl rxn; 80% basalt/15% felsic + mafic chips from above formation; 2.54 2.5/1 black	I-003 H ₂ O sample: HETS# B2XNN8, B2XNN9, B2XNP0; 272.97' bgs (9-20-14) Archive @ 273.6' bgs TD: 277.89' bgs	

Reported By: Julie Johanson
 Title: Geologist
 Signature: Julie Johanson
 Date: 10-1-14

Reviewed By: Kevin Bergstrom
 Title: Sr. Geologist
 Signature: Kevin Bergstrom
 Date: 3-11-15



299-E33-361 (C8924) Log Data Report

Borehole Information:

Log Date:	2014-10-06	Filename:	C8924_HG-NM_2014-10-06	Site:	M-24 monitoring well, SE of B Farm
Coordinates (WA St Plane)		DTW¹ (ft):	255.05 ft	DTW Date:	10/02/2014
North (m)	East (m)	Drill Date	TOC² Elevation	Total Depth (ft)	Type
N/A	N/A	10/01/2014	N/A	275	Cable Tool

Casing Information:

Casing Type	Stickup (ft)	Diameter (in.)		Thickness (in.)	Top (ft)	Bottom (ft)
		Outer	Inside			
Threaded Steel	0.5	13-7/16	12-3/8	17/32	-0.5	64.3
Threaded Steel	1.7	11-7/8	10-5/8	5/8	-1.7	273

Borehole Notes:

The onsite geologist provided the total depth and casing depth for C8924. The logging engineer measured casing stick-up and casing diameter (rounded to the nearest 1/16-in.). The depth to water was measured by the logging engineer using an e-tape at 255.05 ft on October 2.

Zero reference is ground surface.

Logging Equipment Information:

Logging System:	Gamma 1L	Type:	60% HPGe SGLS
Effective Calibration Date:	11/11/13	Serial No.:	47-TP32211A
Calibration Reference:	HGLP-CC-096, Rev. 0	Logging Procedure:	HGLP-MAN-002, Rev. 1

Logging System:	Gamma 1H	Type:	NMLS
Effective Calibration Date:	11/11/13	Serial No.:	H310700352
Calibration Reference:	HGLP-CC-097, Rev. 0	Logging Procedure:	HGLP-MAN-002, Rev. 1

SGLS Log Run Information:

Log Run	1	2 (Repeat)	7	8	9 (Repeat)
HEIS Number	1018546	1018547	1018548	1018549	1018550
Date	8/15/14	8/15/14	10/3/14	10/6/14	10/6/14
Logging Engineer	Spatz	Spatz	Felt	Felt, Pope	Felt, Pope
Start Depth (ft)	0.0	26.0	63.0	223.0	165.0
Finish Depth (ft)	64.0	32.0	224.0	275.0	185.0
Count Time (sec)	100	100	100	100	100
Live/Real	R	R	R	R	R
Shield (Y/N)	N/A	N/A	N/A	N/A	N

¹ depth to water inside casing

² top of casing



Log Run	1	2 (Repeat)	7	8	9 (Repeat)
MSA Interval (ft)	1.0	1.0	1.0	1.0	1.0
Log Speed (ft/min)	N/A	N/A	N/A	N/A	N/A
Pre-Verification	AL206CAB	AL206CAB	AL219CAB	AL220CAB	AL220CAB
Start File	AL206000	AL206065	AL219000	AL220000	AL220053
Finish File	AL206064	AL206071	AL219161	AL220052	AL220073
Post-Verification	AL206CAA	AL206CAA	AL219CAA	AL220CAA	AL220CAA
Depth Return Error (in.)	N/A	0.0	LOW 1	N/A	0.0
Comments	No fine gain adjustments made	No fine gain adjustments made	Fine gain adjustment made after file AL219053 (116 ft)	No fine gain adjustments made	No fine gain adjustments made

NMLS Log Run Information:

Log Run	3	4 (Repeat)	5	6 (Repeat)	NA – All Below
HEIS Number	1018551	1018552	1018553	1018554	
Date	8/15/14	8/15/14	10/2/14	10/3/14	
Logging Engineer	Spatz	Spatz	Pope	Felt	
Start Depth (ft)	0.0	9.0	63.0	160.0	
Finish Depth (ft)	64.25	15.0	255.25	180.0	
Count Time (sec)	15	15	15	15	
Live/Real	R	R	R	R	
Shield (Y/N)	N/A	N/A	N/A	N/A	
MSA Interval (ft)	0.25	0.25	0.25	0.25	
Log Speed (ft/min)	N/A	N/A	N/A	N/A	
Pre-Verification	AH168CAB	AH168CAB	AH181CAB	AH182CAB	
Start File	AH168000	AH168258	AH181000	AH182000	
Finish File	AH168257	AH168282	AH181769	AH182080	
Post-Verification	AH168CAA	AH168CAA	AH181CAA	AH182CAA	
Depth Return Error (in.)	N/A	HIGH 1	0.0	0.0	
Comments	None	None	None	None	

Logging Operation Notes:

During logging, a centralizer was installed on the sondes.

Maximum logging depth achieved was 275 ft.

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

Analysis Notes:

Analyst:	K.J. Felt	Date:	10/29/14	Reference:	HGLP-MAN-003, Rev. 0
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Casing corrections were applied to the log data from 0-63 ft for a casing thickness of 0.53125 inches, from 63-64.3 ft for a combined casing thickness (caused by casing overlap) of 1.15625 inches, and from 64.3-273 ft for a casing thickness of 0.625 inches. Open hole conditions existed beyond 273 ft, thus no casing correction was applied from 273-275 ft.



A correction for water inside the casing was applied below a depth of 255.05 ft.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in the EXCEL template identified as 1L20131111 using an efficiency function and corrections for casing and dead time as determined by annual calibration.

NMLS data are represented in counts per second because no calibration data exist for 10.625 or 12.375 inch inner diameter casings.

The HGU³ 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:

The manmade radionuclide ¹³⁷Cs was detected near the surface at depths from 0 to 1 ft. The maximum ¹³⁷Cs concentration was found to be 0.27 pCi/g at a depth of 1 ft.

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

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

List of Log Plots:

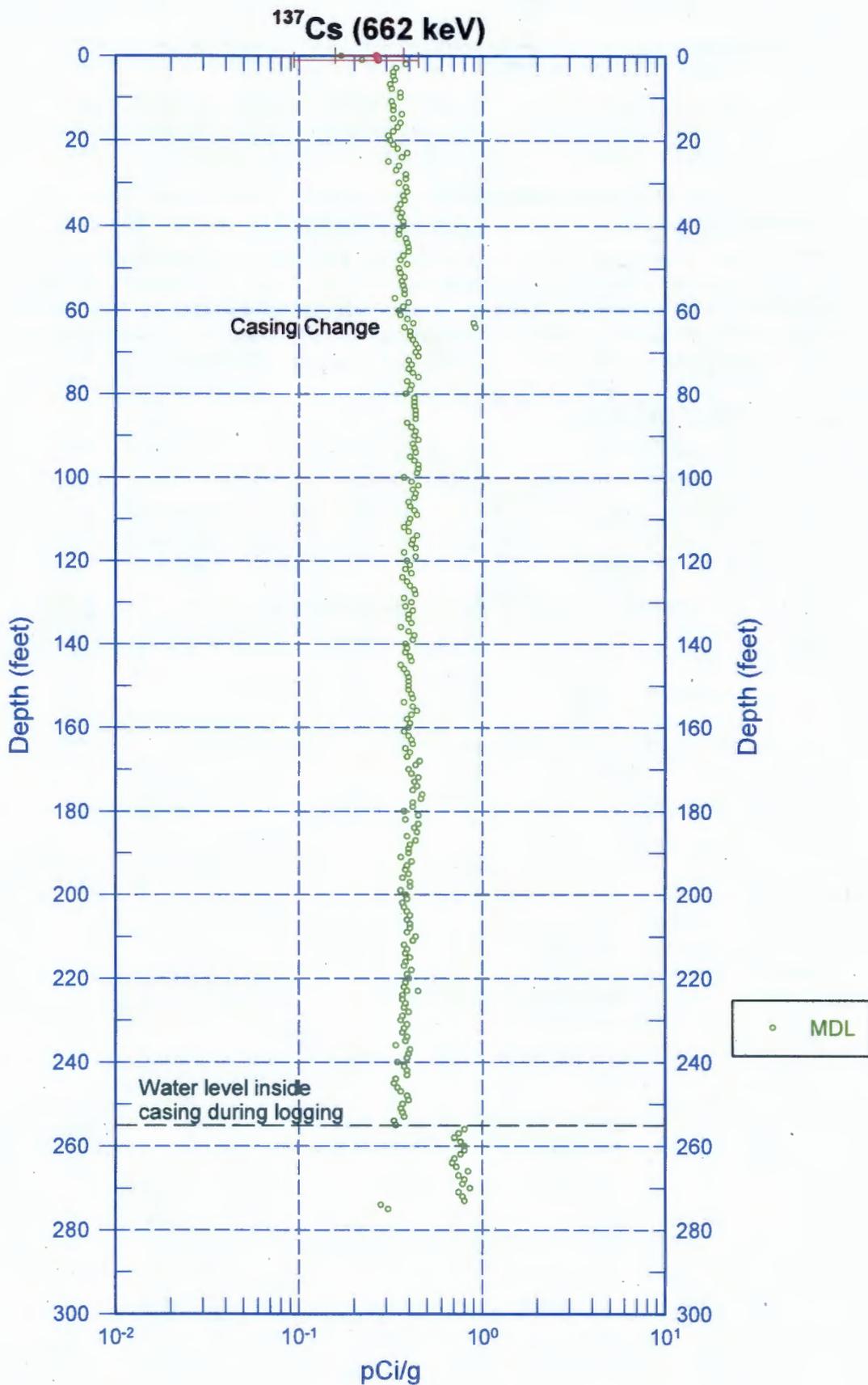
Depth Reference is ground surface.

Manmade Radionuclides (0-300 ft)
 Natural Gamma Logs (0-160 ft)
 Natural Gamma Logs (150-310 ft)
 Combination Plot (0-120 ft)
 Combination Plot (110-230 ft)
 Combination Plot (220-340 ft)
 Combination Plot (0-300 ft)
 Total Gamma & Moisture (0-160 ft)
 Total Gamma & Moisture (150-310 ft)
 Total Gamma & Hanford Gamma Unit (0-300 ft)
 Repeat Section of Natural Gamma Logs (26 to 32 ft)
 Repeat Section of Natural Gamma Logs (165-185 ft)
 Moisture Repeat Section (9 - 15 ft)
 Moisture Repeat Section (160-180 ft)

³ Hanford Gamma Unit



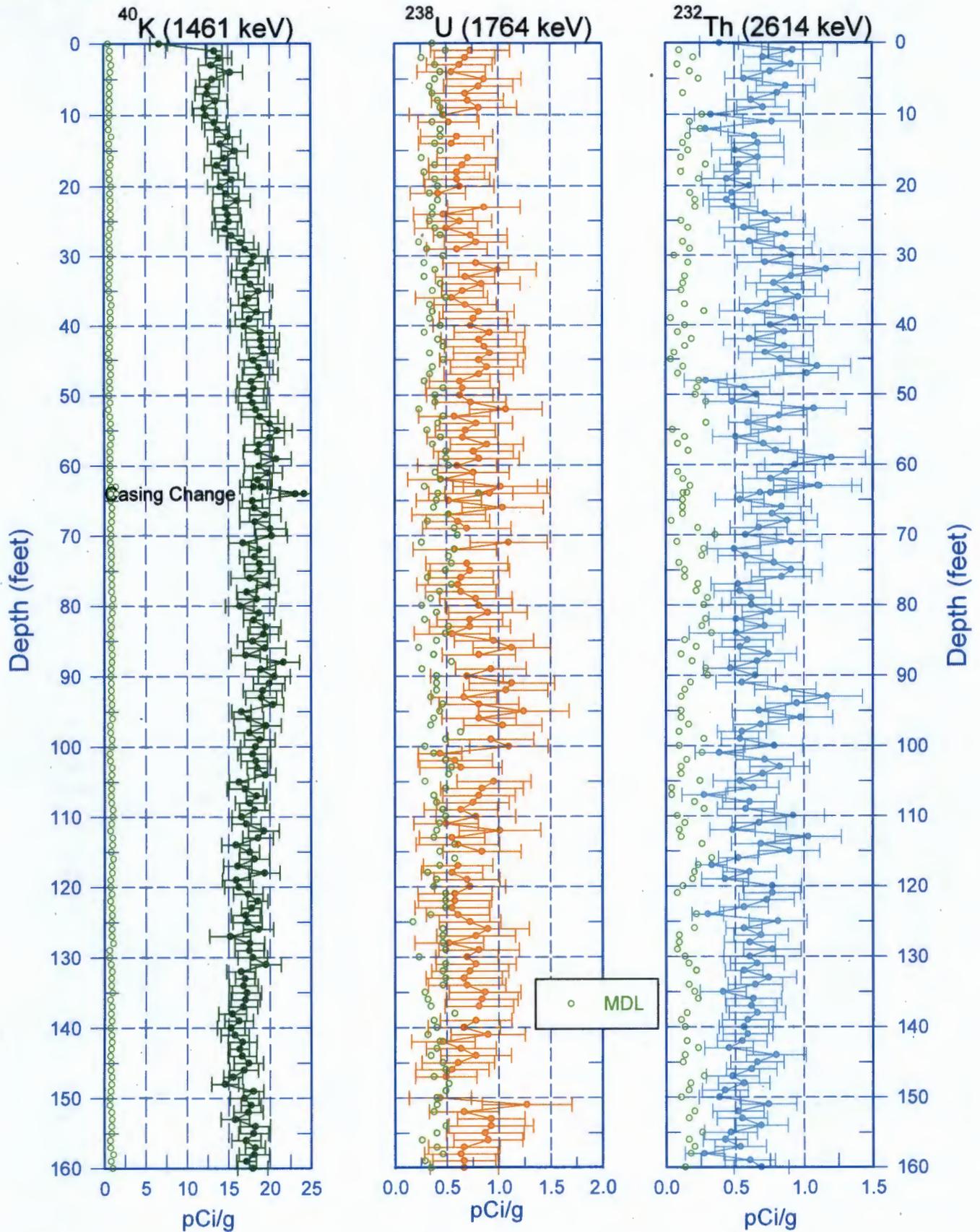
299-E33-361 (C8924) Manmade Radionuclides



Zero Reference - Ground Surface



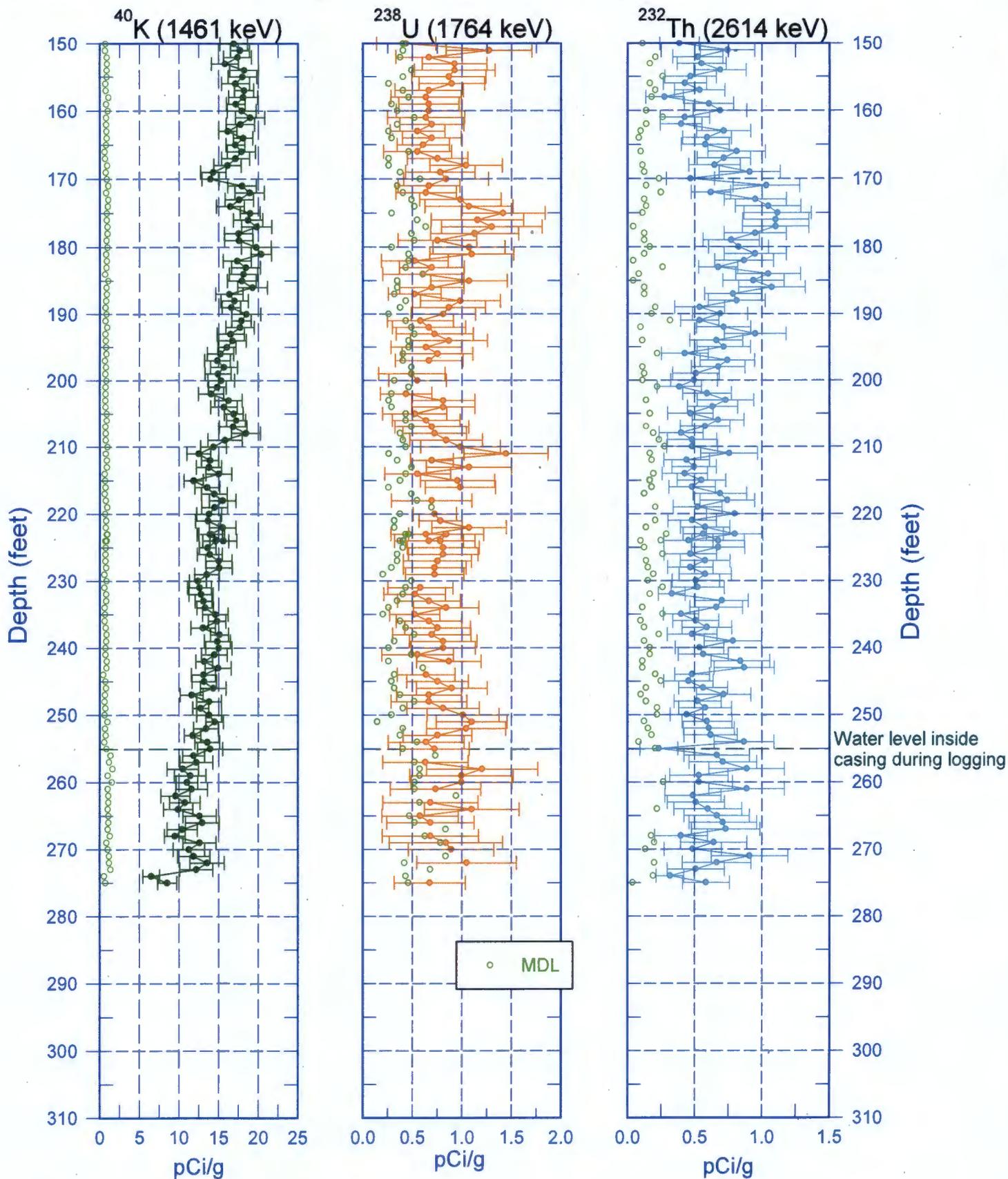
299-E33-361 (C8924) Natural Gamma Logs



Zero Reference - Ground Surface

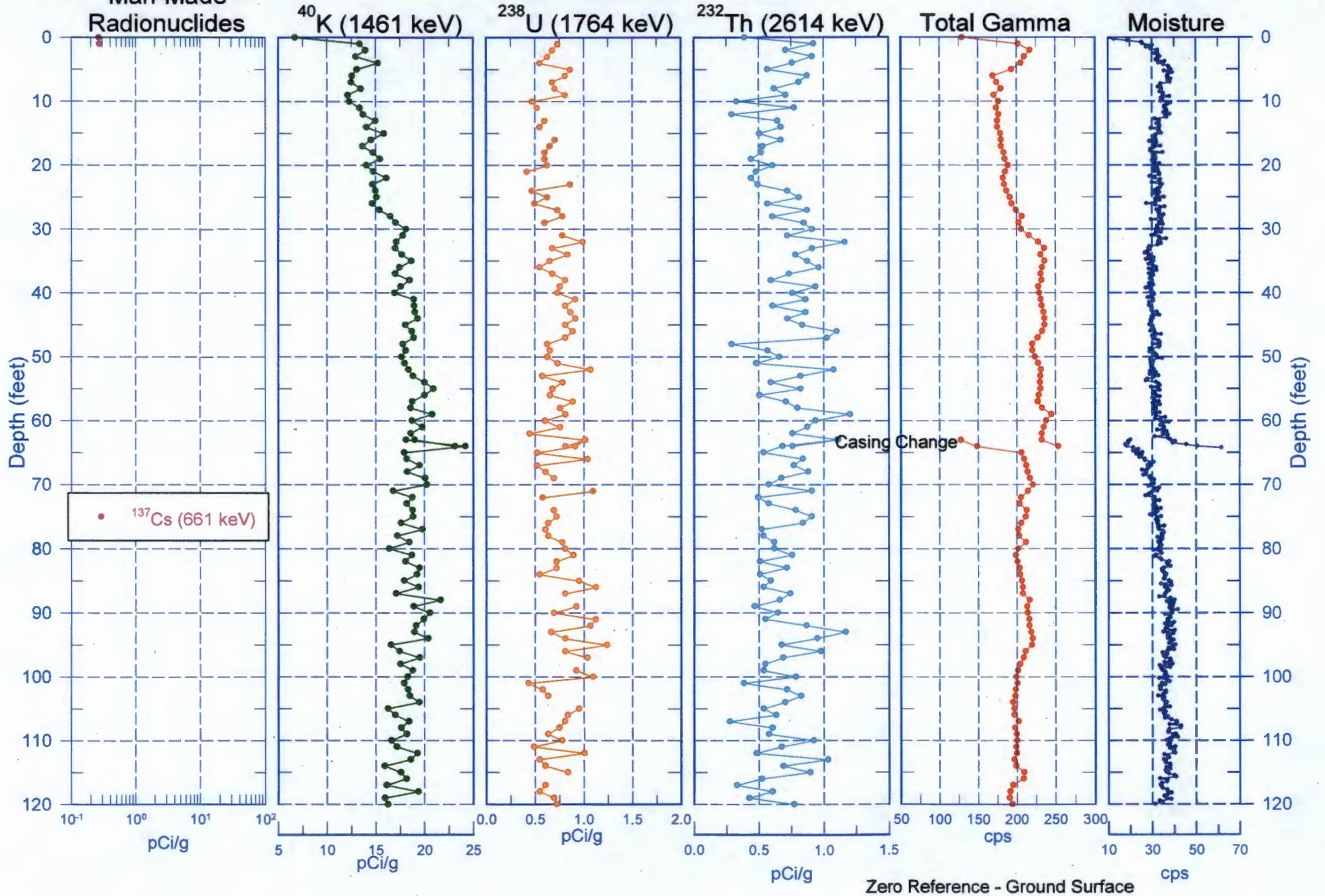


299-E33-361 (C8924) Natural Gamma Logs



Zero Reference - Ground Surface

299-E33-361 (C8924) Combination Plot





299-E33-361 (C8924) Combination Plot

Man-Made
Radionuclides

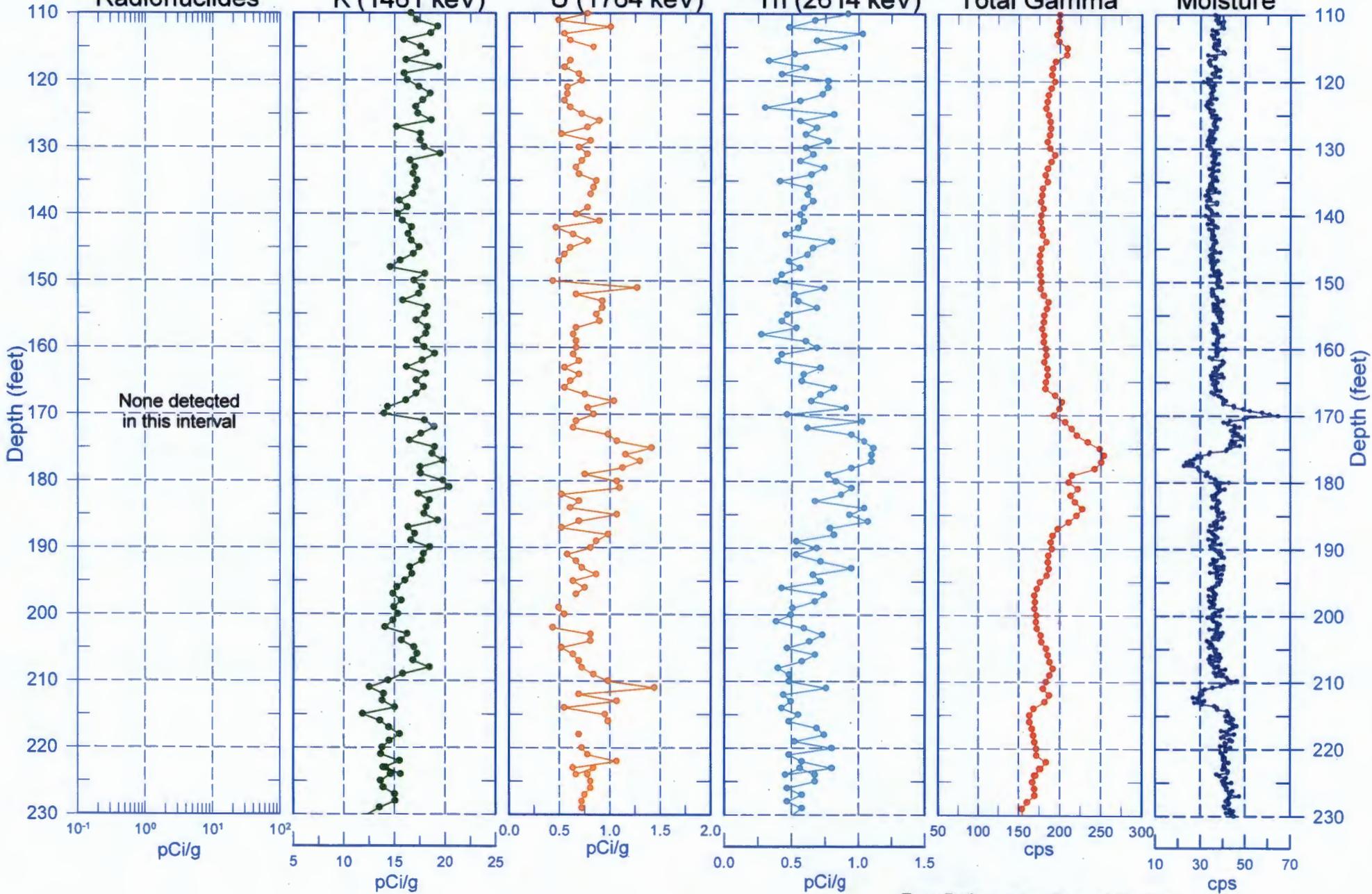
⁴⁰K (1461 keV)

²³⁸U (1764 keV)

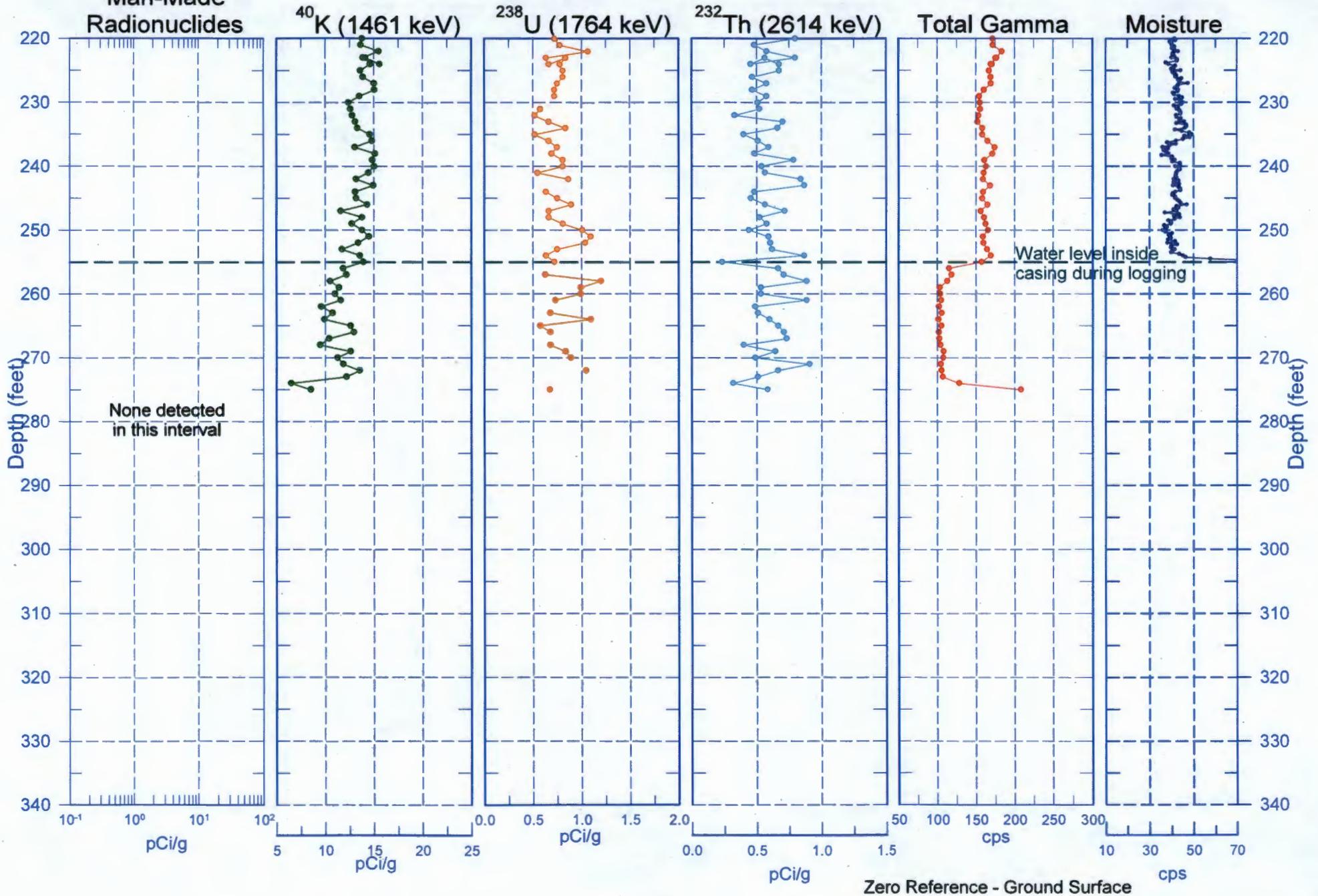
²³²Th (2614 keV)

Total Gamma

Moisture

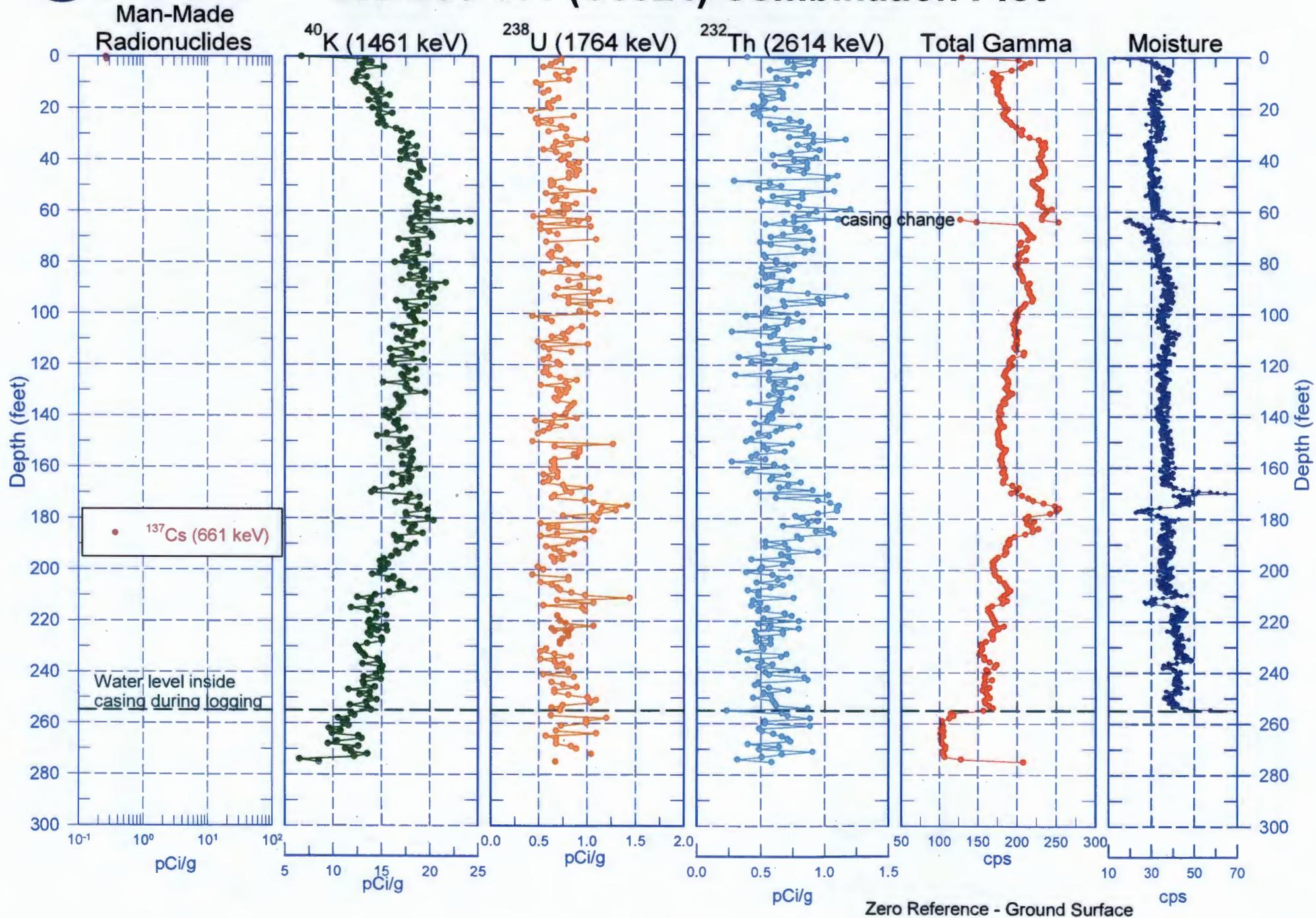


299-E33-361 (C8924) Combination Plot



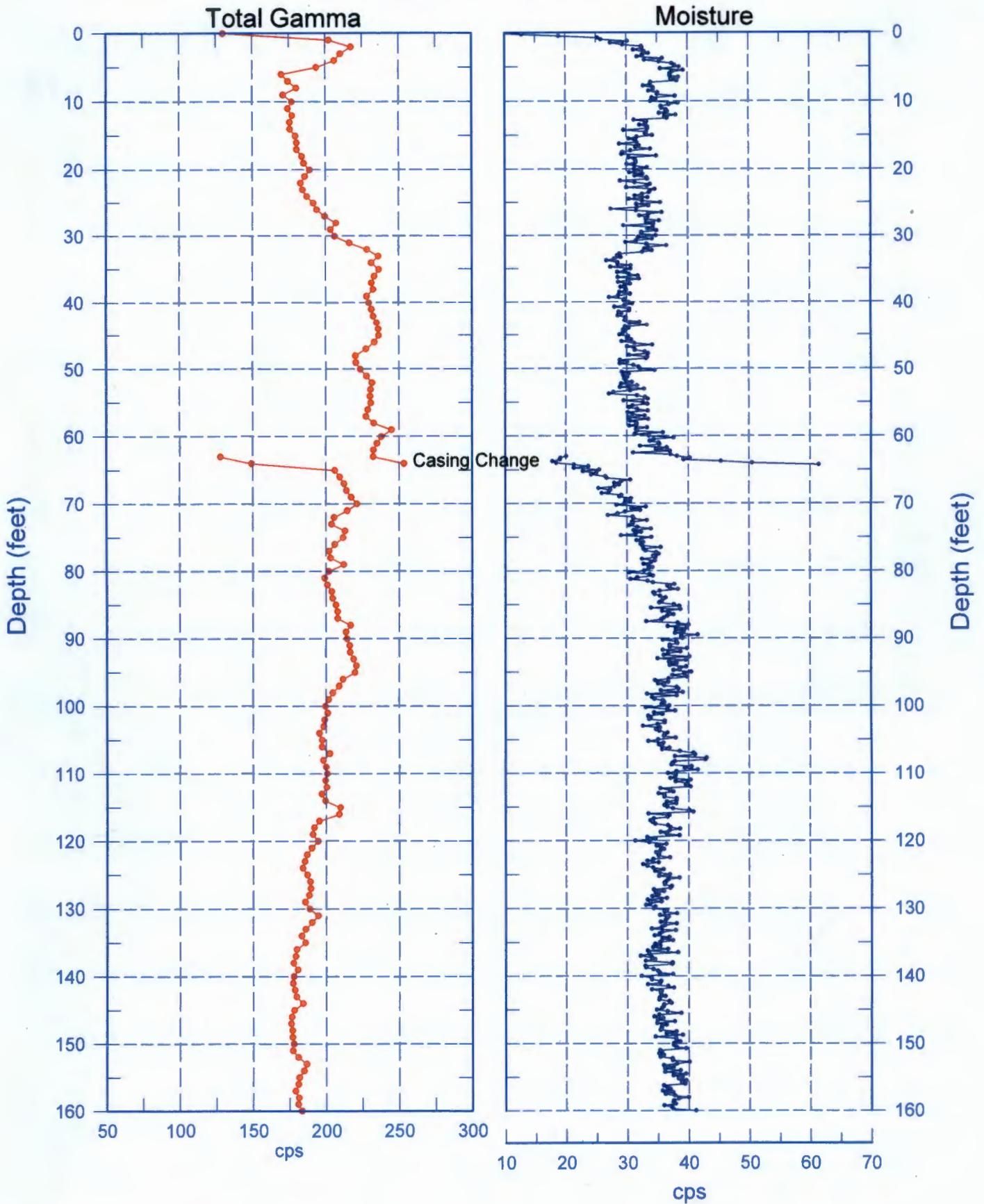


299-E33-361 (C8924) Combination Plot





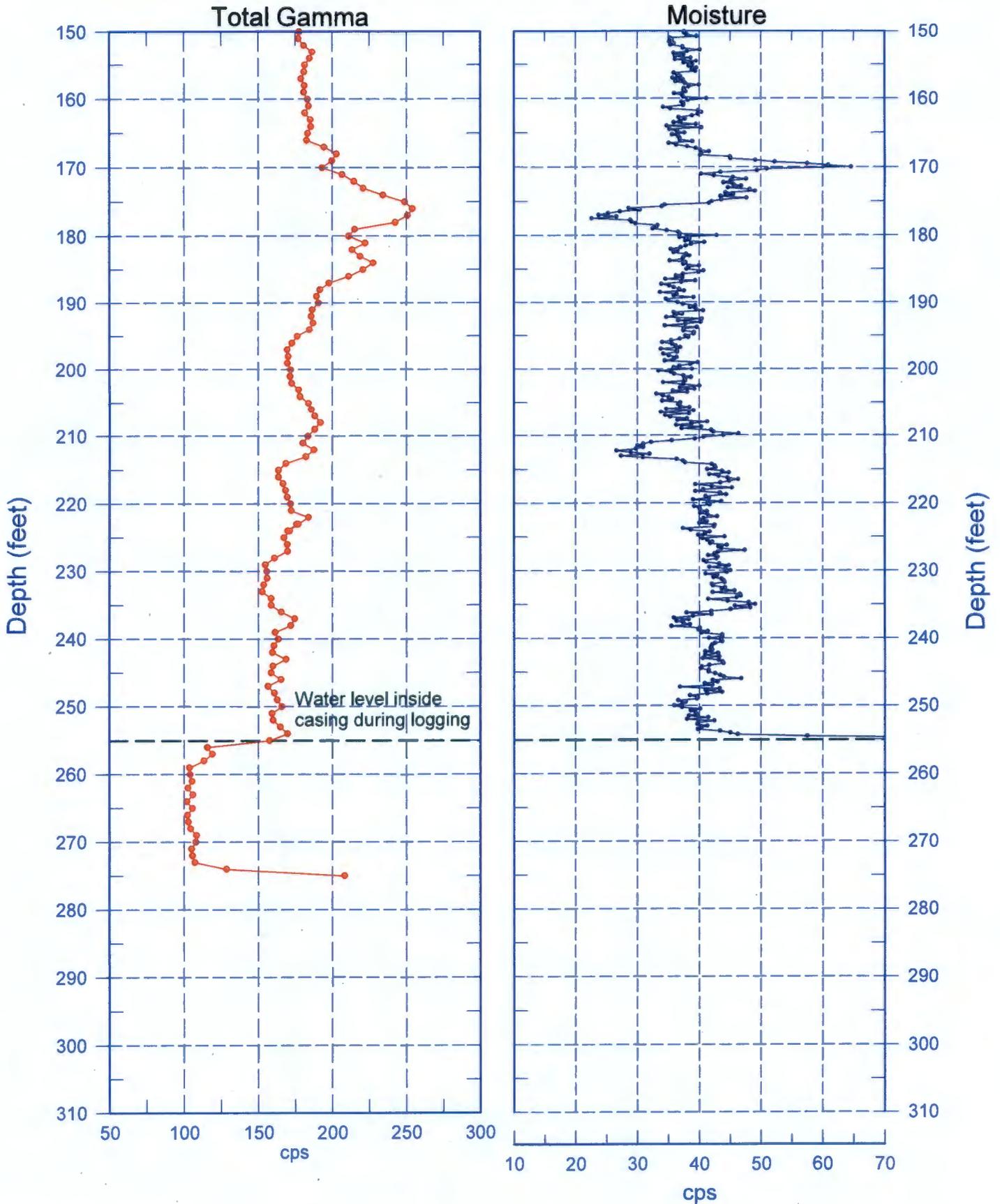
299-E33-361 (C8924) Total Gamma & Moisture



Reference - Ground Surface



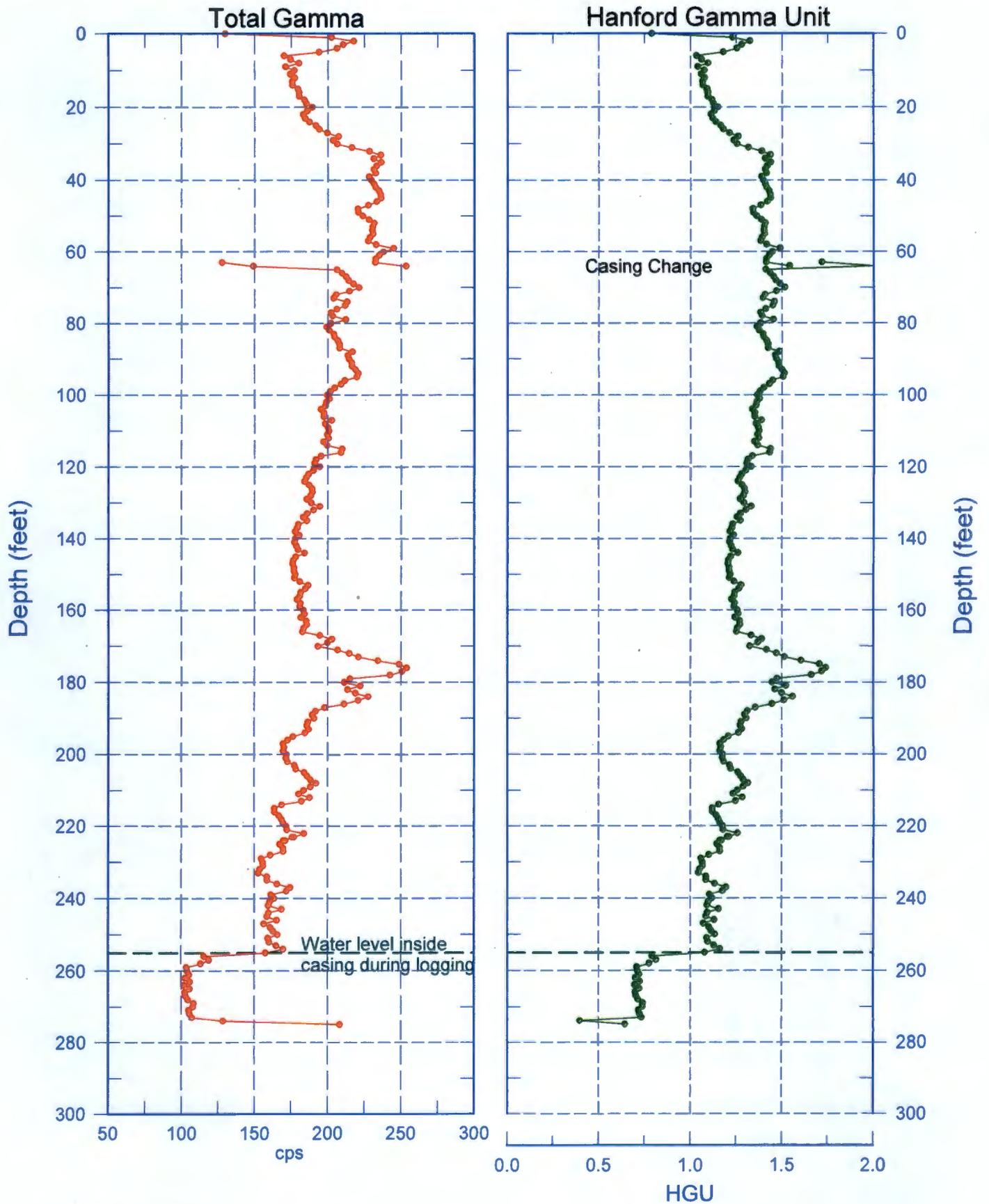
299-E33-361 (C8924) Total Gamma & Moisture



Reference - Ground Surface

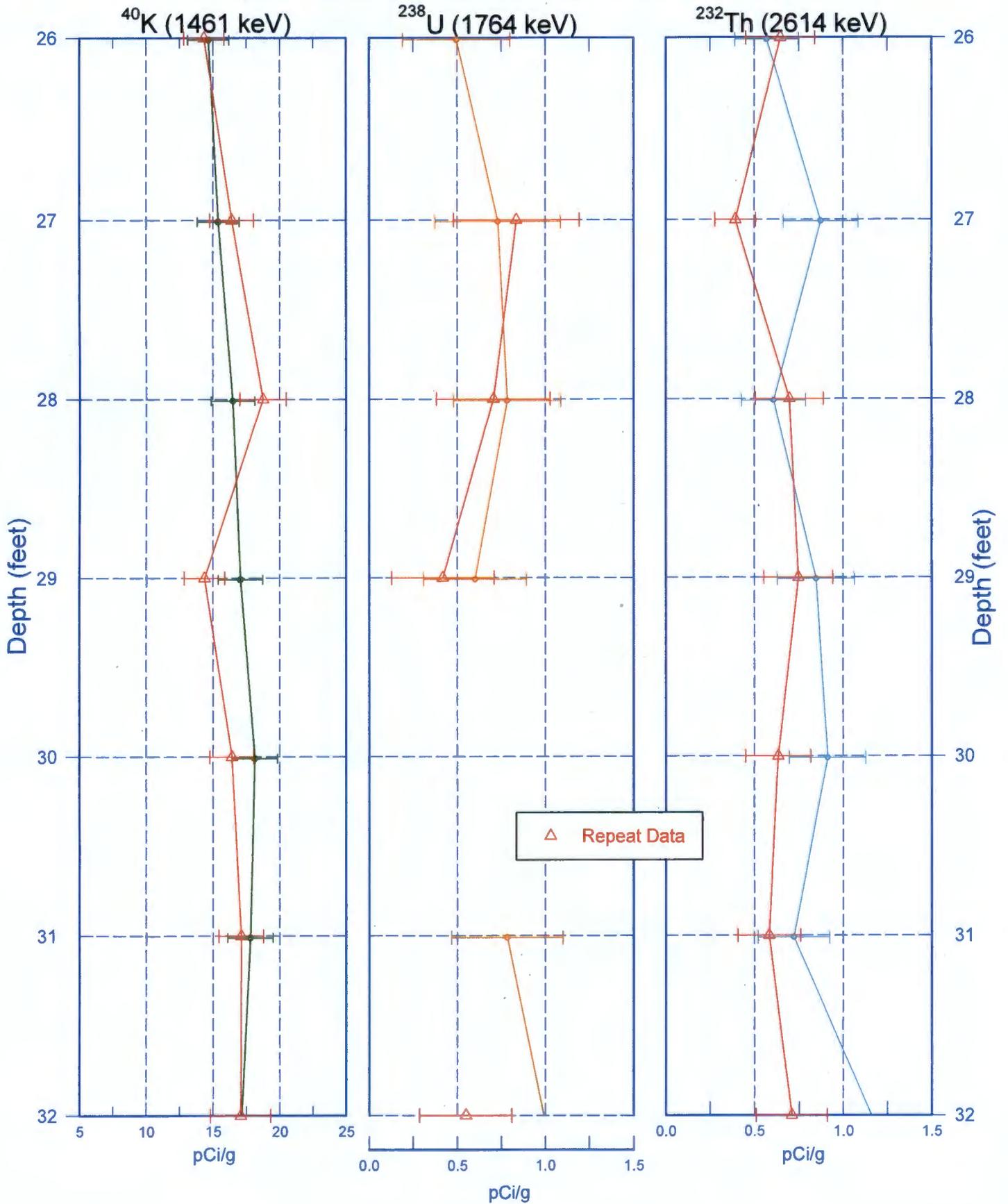
299-E33-361 (C8924)

Total Gamma & Hanford Gamma Unit



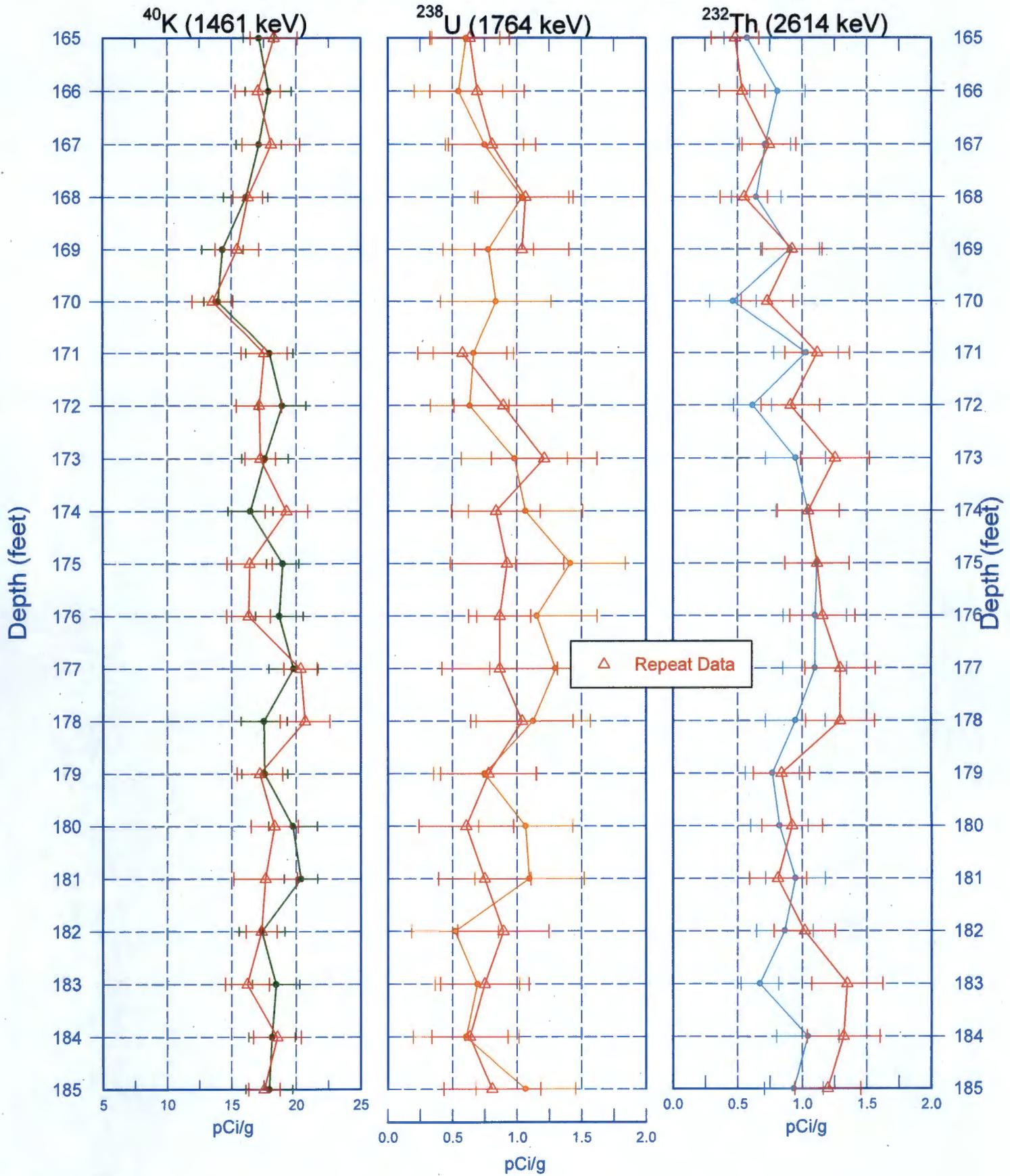
299-E33-361 (C8924)

Repeat Section of Natural Gamma Logs



299-E33-361 (C8924)

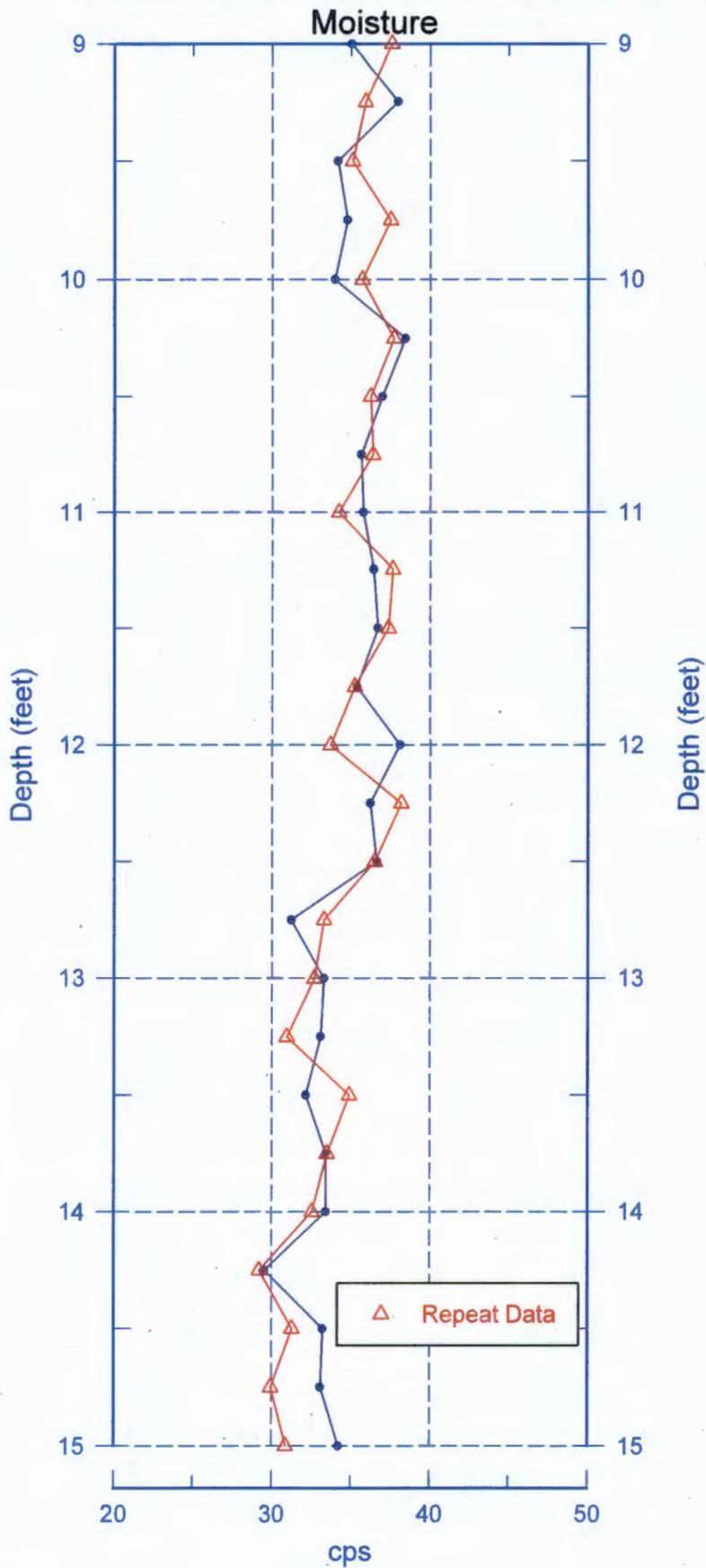
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface



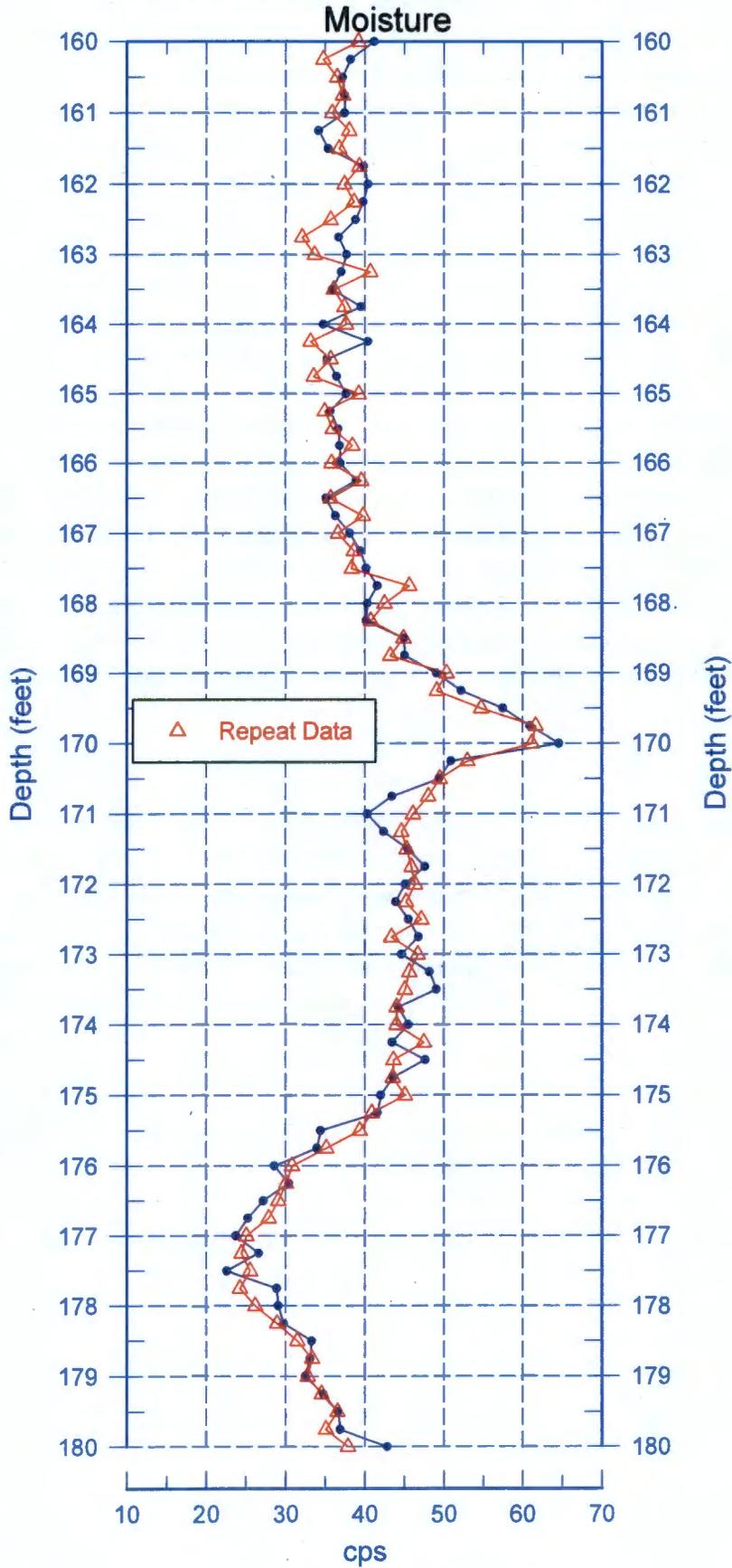
299-E33-361 (C8924) Moisture Repeat Section



Reference - Ground Surface



299-E33-361 (C8924) Moisture Repeat Section



Reference - Ground Surface

**VARIANCE TO CONSTRUCT 200-BP-5 MULTIPURPOSE WELL 299-E33-361 (C8924)
WITH NATURAL FILL IN THE BOREHOLE ANNULAR SPACE
December 10, 2014**

Name, address, and telephone number of the person requesting the variance:

J.G. Morse, Department of Energy-Richland Operations, Federal Building, Richland, WA 99352, (509) 376-0057
[Provided by S.J. Trent, CHPRC, Soil & Groundwater Remediation Project, Well Coordinator, (509) 373-5869]

Address of the well sites:

Hanford Site, Richland, WA 99352

WELL NAME,	WELL ID,	Township, Range, Section, ¼, ¼:
299-E33-361	C8924	T13N, R26E, S35, SW ¼, SW ¼

The specific regulation(s) that cannot be followed; comparable alternative specification; and justification for the request:

A Variance is requested for constructing 200-BP-5 multipurpose well 299-E33-361 (C8924) with natural fill that has collapsed against the permanent casing during well construction activities. WAC 173-160-450 "What are the sealing requirements?" states, "(1) All resource protection wells constructed shall have a continuous seal, which seals the annular space between the bore hole and the permanent casing" and, "(2) After the permanent casing has been set in final position, the filter pack (optional) and sealing material shall be placed in the open bore hole annular space...The remaining annular space shall be filled to land surface in a continuous operation with bentonite, neat cement, or neat cement grout..."

Background:

The listed well will function as a monitoring well but is designed to support future groundwater extraction and treatment actions that may be implemented in the future. Figure 1 shows the location of well 299-E33-361. During construction of the well, problems with completing a continuous annular seal were encountered during emplacement of the surface seal. During back-pulling operations, the drilling contractor lost overlap of temporary casing while emplacing the cement grout surface seal. As a result natural material has in-filled the annular space from 7.4 to 10.7 ft. bgs. The attached well summary sheet graphically illustrates where the natural material has in-filled the borehole annular space for this well.

Construction Variance:

Construction of the well seal was successfully completed with the exclusion of the interval described above. The natural fill is not likely to impact the overall effectiveness of the well seal.

This completed well design does not interconnect separate aquifers, will not impose a hazard to the environment, and is protective of groundwater.

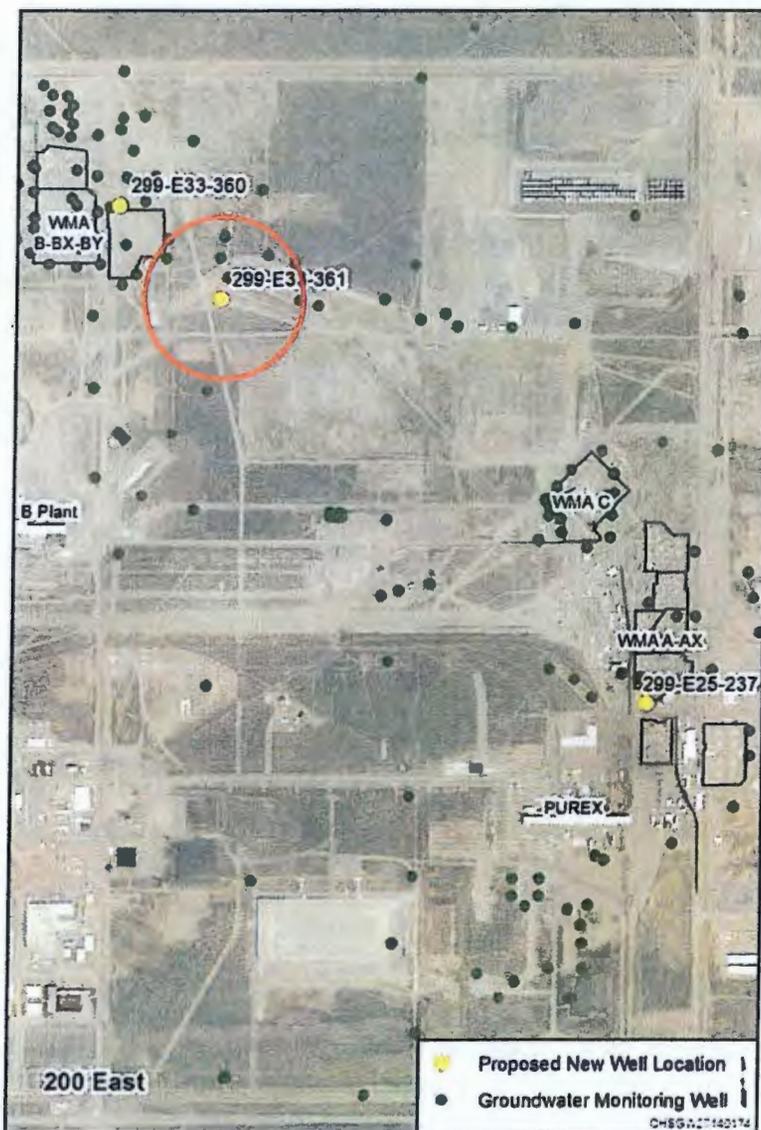
Concurrence & date: *SJ Trent* 12/10/2014 S.J. Trent,
S&GRP Well Coordinator

Concurrence & date: *Jeff Ayres* 12/10/14 Jeff Ayres,
WDOE
Nuclear Waste Program
Richland, WA 99354

Concurrence & date: *Cheryl Whalen* 12/11/14 Cheryl Whalen,
WDOE, Section Manager
Nuclear Waste Program
Richland, WA 99354

Figure 1 - Location of New M-24 Wells in the 200 East Area.

Well 299-E33-361 (C8924) Circled in Red.



Attachment

Construction Summary for Well 299-E33-361 (C8924).

WELL SUMMARY SHEET		Start Date: 8-13-2014		Page <u>1</u> of <u>2</u>		
Finish Date: 11-05-2014						
Well ID: C8924		Well Name: 299-E33-361				
Location: N.E. of B-Plant		Project: TPA M-24 Monitoring Wells				
Prepared by: Abby Wicks		Date: 11-11-2014		Reviewed by:		
Date:		Date:				
Signature: <i>Abby Wicks</i>		Signature:				
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
<u>Temporary Casing Materials</u> 13" Carbon Steel 13 7/16" OD, 12 1/2" ID (0.0 ft - 64.27 ft bgs)		0		0'-1.5' Drill Pad		
				1.5'-7' Silty Sand [mS]		
					7'-31' Silty Sandy Gravel [msG]	
				25	31'-55 Sand [S]	
				50	55'-60' Gravelly Sand [gS]	
					60'-65' Sand [S]	
					65'-75' Gravelly Sand [gS]	
				75	75'-80' Sand [S]	
					80'-90' Gravelly Sand [gS]	
			90'-100' Sand [S]			
		100	100'-110' Gravelly Sand [gS]			
			110'-170' Sand [S]			
		125				
<u>Permanent Casing Materials</u> 8" Type 304 SS sch 10 Riser (+1.40 ft ags - 253.60 ft bgs)						
8" Type 304 SS sch 10 continuous wire wrap 65-slot Screen (253.60 ft bgs - 273.60 ft bgs)						
8" Type 304 SS sch 10 Sump (273.60 ft bgs - 276.60 ft bgs)						
<u>Construction Materials</u> Type I/II Portland Cement (0 ft bgs - 7.40 ft bgs)						
Natural Sluff (7.40 ft bgs - 10.70 ft bgs)						
Med. Bentonite Chips (10.70 ft bgs - 66.0 ft bgs)						
#8/20 Bentonite Crumbles (66.0 ft bgs - 109.3 ft bgs)						
3/8" Bentonite Chips (109.3 ft bgs - 245.6 ft bgs)						
Bentonite Pellets (245.6 ft bgs - 249.0 ft bgs)						
#8/12 Colorado Silica (249.0 ft bgs - 276.0 ft bgs)						

A-8003-843 (05/08)

WELL SUMMARY SHEET

Start Date: 8-13-2014

Page 2 of 2

Finish Date: 11-05-2014

Well ID: C8924

Well Name: 299-E33-361

Location: NE of B-Plant

Project: TPA M-24 Monitoring Wells

Prepared by: Abby Wicks

Date: 11-11-2014

Reviewed by:

Date:

Signature: *Abby Wicks*

Signature:

CONSTRUCTION DATA

GEOLOGIC/HYDROLOGIC DATA

CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA		
Description	Diagram		Graphic Log	Lithologic Description	
		150		110'-170' Sand [S]	
		175		170'-180' Silty Sand [(m)S]	
					180'-190' Sand [S]
					190'-195' Gravelly Sand [gS]
			200		195'-200' Silty Sand [(m)S]
					200'-205' Gravelly Sand [gS]
					205'-212' Sand [S]
					212'-230' Sandy Gravel [sG]
			225		230'-250' Silty Sandy Gravel [msG]
			250		250'-277.8' Sandy Gravel [sG]
			275		
					TD = 277.89 ft bgs
					DTW = 254.8 ft bgs (11/5/2014)

Note:
All Temporary casing has been removed from the ground.

All depths are reported in feet below ground surface (ft bgs) unless otherwise noted.

SURVEY DATA REPORT				Request No. 152-059		
Project No.	Title M-24 Wells C8923 & C8924 Final Surveys			File No. 2ET13R26		
Job No. CACN: 303345-JPRC	Prepared By N.P. Fastabend	Date 2/11/15	Reviewer <i>CBM</i>			
DESCRIPTION OF WORK			DISTRIBUTION	SDR	PLOT	DWG
Obtained final coordinates (C/L Casings) and elevations of completed M-24 Wells C8923 (299-E33-360) and C8924 (299-E33-361) in 200E Area. Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)			Survey File	OR		
			J.D. Mehrer	1		
			S.J. Trent	1		
			K.M. Whitley	1		
			J.B. Geiger	1		
			B.J. Howard	1		
			A.J. Green	1		
SURVEY RESULTS AND COMMENTS						
<p>See Attached Well Survey Data Report Sheets</p>						

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 01/21/15	Requestor: Kelly Whitley (CHPRC)
Date of Survey: 02/11/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend

Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of M-24 Well C8924 (299-E33-361) located southeast of 241-B Tank Farm in 200E Area.	Horizontal Datum: NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
2E-140 (CHPRC) and 2E-49 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C8924	299-E33-361	574069.25	137122.32		Center of Casing
				200.385	"X" on Rim
				199.632	Brass Survey Marker

Notes:

200.076 Top Inner 8in Casing, North Edge

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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



2-12-2015

Appendix D

Well Documentation for 299-W18-260 (C8925)

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

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WELL SUMMARY SHEET		Start Date: 8-20-2014		Page <u>1</u> of <u>3</u>	
Well ID: C8925		Well Name: 299-W18-260			
Location: N of WMA U Tank Farm		Project: TPA M-24 Monitoring Wells			
Prepared by: Abby Wicks		Date: 10-23-2014		Reviewed by: D. MEHRER	
Signature: <i>Abby Wicks</i>		Signature: <i>[Signature]</i>			
CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA		
Description	Diagram		Graphic Log	Lithologic Description	
<u>Temporary Casing Materials</u> 10 3/4" Carbon Steel (9 3/4" OD, 10 3/4" ID) 0.0 ft -129.87' ft bgs 8" Carbon Steel (8 11/16" OD, 8 3/4" ID) 129.87 ft bgs-232.12				0' -4' Drill Pad, Sandy Gravel [sG]	
				4'-15' Sand [S]	
				15'-19' Sandy Gravel [sG]	
				19'-28' Gravel [G]	
				28'-33' Sandy Gravel [sG]	
				33'-45' Sandy Gravel [sG]	
				45'-48' Sandy Gravel [sG]	
				48'-58' Sand [S]	
				58'-60' Silty Sand [mS]	
				60'-78' Sand [S]	
				78'-80' Sandy Silt [sM]	
				80'-85' Slightly Silty Sand [(m)S]	
		85'-90' Sand [S]			
		90'-95' Silty Sand [mS]			
		95'-100' Sand [S]			
		100'-103' Sandy Silt [sM]			
		103'-105' Sand [S]			
		105'-110' Silty Sand [mS]			
		110'-115' Sandy Silt [sM]			
		115'-117' Sand [S]			
		117'-131.4' Silt [M]			
		131.4'-136' Caliche Silt [M]			
		136'-145' Gravelly Silt [gM]			
<u>Permanent Casing Materials</u> 4" Type 304 L sch 10s Riser 2.00 ft ags-239.77 ft bgs 4" Type 304 L sch 10s <u>Continuous wire wrap screen</u> 20 Slot 239.77 ft bgs-269.77 ft bgs 4" Type 304 L sch 10s Sump 269.77 ft bgs-272.77 ft bgs					
<u>Construction Materials</u> <u>Concrete</u> 0 ft bgs-2.5 ft bgs <u>Type I-II Portland Cement Grout</u> 2.5 ft bgs-14.10 ft bgs <u>Granular Bentonite Crumbles</u> 14.10 ft bgs-233.4 ft bgs <u>3/8" Bentonite Pellets</u> 233.4 ft bgs-235.8 ft bgs <u>16-30 Mesh Colorado Silica Sand</u> 235.8 ft bgs- 274.4 ft bgs <u>3/4" Bentonite Hole Plug</u> 274.4 ft bgs- 322.2 ft bgs <u>Natural Fill</u> 322.2 ft bgs-326.3 ft bgs					

Note: All temporary casing has been removed from the ground. All depths are reported in feet below ground surface (ft bgs) unless otherwise noted.

WELL SUMMARY SHEET		Start Date: 8-20-2014		Page <u>2</u> of <u>3</u>	
		Finish Date: <u>11-25-14</u> <i>5/6</i>			
Well ID: C8925		Well Name: 299-W18-260			
Location: N WMA U Tank Farm		Project: TPA M-24 Monitoring Wells			
Prepared by: Abby Wicks	Date: 10-23-2014	Reviewed by: J.D. MEHRER	Date: <u>1-21-15</u>		
Signature: <i>Abby Wicks</i>		Signature: <i>J.D. Mehrer</i>			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA			
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description	
		150		145'-155' Sandy Gravel [sG]	
				155'-185' Gravel [G]	
				175	
					185'-190' Sandy Gravel [sG]
				200	
					190'-326.3' Sandy Gravel [sG]
				225	
		▼		Depth to water 236.6 ft bgs. 9/18/14	
		250			
		275			

BOREHOLE LOG

Well ID: C8925

Well Name: 299-W18-260

Location: N. of WMA 4 tank farm

Project: TPA M-24 Monitoring Wells

Reference Measuring Point: ground surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0-4' Silty sandy gravel, sand is fine to coarse, highly lithic, angular to sub round, very poorly sorted. 10% silt, 50% sand, 40% gravel. Gravel is from 2-70mm 80% mafic 20% felsic. Rounded to angular.	Cable tool Rig, 22W, drive barrel & bars GS = grab sample GS collected at 5' intervals GS 0'-5' collected 8-20-14 GS 5'-10' collected 8-21-14 GS 10'-15' collected 8-21-14 GS 15'-20' collected 8-21-14
5				4'-11' bas 95% Sand (S) Med. to fine grain sand. Sand ~95% silt ~5%. Moisture present, very well sorted. angular to sub angular, quartz rich sand with traces of mica and basalt. Rxn to HCl strong. Color - 2.5Y 4/2 moist.	
10	GS			11'-15' bas Sand (S) Silt 5% Sand 93% coarse gravel 2% med-fine grain sand, moisture present, moderately sorted, angular to sub rounded, quartz rich sand with traces of mica and basalt. basalt cobble to gravel, 5mm-75mm. sub rounded to sub angular.	Drilling slows due to formation change GS @ 14' 3/4 GS @ 20'-25' 1/2 GS @ 28' 1/2
15	GS			15'-19' bas Silty sandy gravel (SG) 40% sand 60% gravel Sand - medium to fine grained, moisture present, sand was very well sorted, angular to sub angular, quartz rich sand with traces of mica and basalt. Strong Rxn to HCl. Color 2.5Y 4/2. Basalt gravel angular to sub rounded.	GS @ 25-30' 1/2 GS @ 30-35' 1/2 GS @ 35' 1/2 GS @ 40-45' 3/4 GS @ 45-50' 1/2
20	GS			19' bas - 28' Silty sandy gravel (SG) 80% gravel 15% silt 5% sand Sand - coarse to fine, moisture present, very well sorted, angular to sub rounded, quartz rich sand, traces of mica and basalt. Gravel - basalt and quartzite, 5mm-50mm, angular to sub rounded, strong Rxn to HCl, color 2.5Y 4/2	Lithology change more silt present in sample.
25	GS				
30	GS				
35	GS				

Reported By: Abby Wice

Reviewed By: BA. WILLIAMS

Title: Geologist

Title: SR GEOLOGIST

Signature: Abby Wice

Date: 8-20-14

Signature: [Signature]

Date: 12/3/14

BOREHOLE LOG

C8925

299 W-260

Well ID: ~~299 W-260~~ ^{AR}

Well Name: ~~C8925~~

Location: N. of WMA 4 Januform

Project: TPA m-24 monitoring wells

Reference Measuring Point: ground surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	95			10'-28' bgs Silty sandy gravel with a possible slight calcareous cement. moist, poorly sorted, angular to sub rounded, basalt, quartz Strong rxn to HCl	Cable tool rig
45	95			28' bgs Gravely silty sand and SANDY GRAVEL 50% sand 40% gravel 10% silt. Slightly moist. Sand is med-fine grained, angular to sub angular, slightly moist, well sorted, basalt and mainly quartz sand. Strong rxn to HCl, Gravel, 5-30mm, angular to sub rounded, mostly basalt, some quartz, color 2.5Y 5/6.	Change with less silt more sand. poorly sorted.
50	95	8-25-14		28'-38' bgs Gravely silty sand SANDY GRAVEL (Sg) 60% sand 30% gravel 10% silt. Sand is med-fine grained, angular to sub angular, slightly moist, well sorted sand, overall poorly sorted, mainly quartz sand with traces of basalt and mica, strong rxn to HCl, gravel is 5-20mm, angular to sub rounded mostly basalt, some quartz, color 2.5Y 5/6 slightly damp.	
55	95	8-25-14		33' bgs Slightly silty sandy gravel (Sg) gravel 70% sand 25% silt 5% Gravel - sub angular to sub rounded, mostly basalt, some quartz, very poorly sorted, slightly moist, 5-50mm, strong rxn to HCl. Sand - coarse to med. grained, angular to sub angular, well sorted, mainly quartz, some basalt and mica color - 2.5Y 4/1 moist.	
60	95	8-26-14		33-45'-48' bgs Sandy gravel (Sg) gravel 70% sand 30% 5-50mm gravel, sub angular to sub rounded, mostly basalt some quartz. Poorly sorted, slightly moist. Sand very coarse to fine, mostly quartz, traces of basalt and mica angular to sub angular strong rxn to HCl, color 2.5Y 5/2 moist.	some calcareous cemented chunks.
65	95	8-26-14			
70	95	8-26-14			
75	95	8-26-14			

Reported By: Abby Wicks

Reviewed By: BA WILLIAMS

Title: Geologist

Title: Sr. Geologist

Signature: Abby Wicks

Date: 8-21-14

Signature: BA WILLIAMS

Date: 12/3/14

BOREHOLE LOG

Date: 8-26-14

C892S

299-W18-260

Well ID: 299-W18-260

Well Name: C892S

Location: W WMA 4. Tank farms

Project: TPA-M24 monitoring wells

Reference Measuring Point:

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
80	95	8-26-14		48' bgs SS Sand (S) 95% Sand 5% silt. Coarse to fine grained sand, moisture present, very well sorted, angular to sub angular. Quartz rich sand with traces of basalt and mica. medium rxn to HCl. color - 2.5Y 4/2	Some small black chunks of possible silt compacted.
85	95	8-26-14		55' bgs SS Sand (S) 90% Sand 5% gravel 5% silt Coarse to fine grained sand, moisture present moderately sorted, angular to sub angular. Quartz rich sand with basalt and mica. moderate rxn to HCl. color - 2.5Y 4/2	lense of silt @ 57' bgs
90	95	8-26-14		58'-60' bgs Sandy silt (SM) (MS) 50% Sand 50% silt Sand - coarse to fine sand, moisture present Well sorted, angular to sub angular quartz rich sand, with traces of basalt and mica. Color - 2.5Y 4/2 Slight rxn to HCl.	
95	95	8-26-14		60'-76' bgs Sand (S) 95% Sand 5% silt. Coarse sand, some moisture present, moderately sorted, angular to sub angular, Quartz rich sand, traces of basalt, mica. Color - 2.5Y 4/2 Dark greyish brown, slight rxn to HCl.	lense of silt @ 107' bgs
100	95	8-27-14		78' bgs - 80' bgs Sandy silt. (SM) 60% silt 40% sand. Sand coarse to fine sand, moisture present well sorted, angular to sub angular, quartz rich, with mica and traces of basalt. color - 2.5Y 5/1 light olive brown - moist, weak rxn to HCl	
105	95	8-27-14		80' bgs - 85' bgs Silty Sand (SM) 80% Sand 20% silt. Sand - coarse grained moisture present, well sorted, angular to sub angular, Quartz rich sand, traces of basalt and mica. Very weak rxn to HCl. dark greyish brown.	
110	95	8-27-14		80' bgs - 85' bgs Silty Sand (SM) 80% Sand 20% silt. Sand - coarse grained moisture present, well sorted, angular to sub angular, Quartz rich sand, traces of basalt and mica. Very weak rxn to HCl. dark greyish brown.	
115	95	8-27-14			

Reported By: Abby Lucas Title: Geologist Signature: Abby Lucas Date: 8-27-14

Reviewed By: Bob Williams Title: SP. Geologist Signature: Bob Williams Date: 12/3/14

BOREHOLE LOG

Page 4 of 9

Date: 8-26-14

Well ID: C8925

Well Name: 299-W18-260

Location: N. WMA tank farms

Project: M-24 monitoring wells

Reference Measuring Point: ground surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
120	95 8-27-14			85' bgs - 90' bgs Sand (S) 95% sand 5% silt. coarse sand, moisture present, well sorted, angular to sub angular. Quartz rich sand, traces of basalt. color 2.5Y 4/2 dark greyish brown. No rxn to HCl.	
125	95 8-27-14			90' - 95' bgs Silty sand (MS) 70% sand 30% silt medium to fine grained sand, moisture present well sorted, angular to sub angular. More mica in this sample. some pieces of basalt, mostly quartz rich. color 2.5Y 4/2 greyish brown. No rxn to HCl.	lense of silt @ 88' bgs
130	95 8-28-14			95' - 100' bgs Sand (S) 95% sand 5% silt coarse sand, moisture present, well sorted, angular to sub angular, quartz rich sand, with some basalt, color - 2.5Y 4/2 dark greyish brown. Weak rxn to HCl.	
135	95 9-2-14			100' - 103' bgs Sandy silt. (SM) 70% silt 30% sand Medium to fine sand, moisture present, well sorted, angular to sub angular. Traces of basalt, mostly quartz rich sand. color 2.5Y 7/2 light olive brown. Weak rxn to HCl.	
140	95 9-2-14			103' - 105' bgs Sand 95% sand 5% silt (S) coarse to fine grained sand, moisture present angular to sub angular, mostly quartz rich sand with 2.5% basalt, 3% mica, color - 2.5Y 4/2 dark greyish brown, weak rxn to 10% HCl.	more coarse sand than previous sample @ 103' bgs
145	95 9-3-14			105' - 110' bgs Silty sand (MS) 70% sand 30% silt, medium to fine grained sand moisture present, angular to sub angular, quartz rich sand, 30% basalt, 10% mica, color - 2.5Y 7/2 light olive brown, dry. Weak rxn to HCl.	

Reported By: Ryan Wick

Reviewed By: BA. WILLIAMS

Title: Geologist

Title: SP. GEOLOGIST

Signature: Ryan Wick

Date: 8-27-14

Signature: [Signature]

Date: 12/3/14

BOREHOLE LOG					Page <u>5</u> of <u>9</u>
Well ID: <u>C8925</u>			Well Name: <u>299-418-260</u>		Date: <u>9-11-14</u>
Project: <u>TPA - m24 monitoring wells</u>			Location: <u>W. WMA Luma Farms</u>		
Reference Measuring Point: <u>ground surface</u>					
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
160	95			110'-115' ^{bas} Sandy silt. (SM) 70% silt, 30% sand med-fine sand, moisture present well sorted angular to sub angular traces of basalt and mica, mostly quartz rich sand color 2.5Y 5/6 light olive brown. weak rxn to moderate rxn to HCl.	Samples @ Grab Samples 160' - 9/4 165' - 9/4 170' - 9/4 175' - 9/4 185' - 9/4 190' - 9/4 195' - 9/11
165	95			115'-117' ^{bas} Sand. (S) coarse to fine sand, moisture present well sorted, angular to sub angular, 20% basalt, quartz rich sand. traces of mica, color - 2.5Y 4/6 dark greyish brown.	116'-118' more basalt present in sand. about 45% basalt.
170	95			117'-131.4' ^{bas} Silt. (M) 4' per cold creek unit somewhat moist, color, 2.5Y 5/6 light olive brown - moist, low plasticity, dense, moderate rxn to HCl.	Thick silt layer, moist layer of silt continues to 131.4' ^{bas}
175	95			131.4'-136.0' ^{bas} Caliche Silt (M) Violent rxn to HCl, poorly sorted, color - 5Y 8/6 pale yellow - light pink, some white.	Caliche layer @ 131.4' 8-28-14
180	95			136.0'-145' ^{bas} Gravely silt. 70% silt 25% gravel 5% sand. Gravel, mostly basalt some quartz. 5-70mm very poorly sorted, angular to sub rounded strong rxn to HCl, color 2.5Y 5/6 light brownish grey. slightly moist.	Still some caliche, possibly fallen in from above. @ 136.0'
185	95			145'-155' ^{bas} Silty Sandy gravel (SG) 20% sand 70% gravel 10% silt. Sand - coarse, slight moisture, 40% basalt, 40% quartz, well sorted, gravel mostly basalt but increasing quartz, angular to sub rounded. poorly sorted, no rxn to HCl color - 10YR 4/1 - gray	Showing signs of cementation. more basalt in these samples larger gravel and cobble are present 145'-155' ^{bas} 9/3/14
190	95			155'-185' ^{bas} Silty Sandy Gravel (G) 80% gravel 20% sand	Some silt present, maybe 5%
195	95				

Reported By: <u>Abby Wickes</u>	Reviewed By: <u>RA - WILLIAMS</u>
Title: <u>geologist</u>	Title: <u>SP. OF LOGS</u>
Signature: <u>Abby Wickes</u>	Signature: <u>[Signature]</u>
Date: <u>9-11-14</u>	Date: <u>12/3/14</u>

BOREHOLE LOG					Page <u>6</u> of <u>9</u>	
Well ID: <u>299-W18-260</u>		Well Name: <u>299-W18-260</u>		Location: <u>N. Wm 9 tank farm</u>		
Project: <u>TPA - M-24 Monitoring Wells</u>			Reference Measuring Point: <u>ground Surface</u>			
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments	
	Type No.	Blows Recovery				
200	25 9-15-14	5-14		155'-185' ^{gravel} sandy gravel (g) 80% sand, 20% gravel Sand - medium to fine grained, dry, well sorted, angular to sub angular, quartz rich with basalt and traces of mica 70% quartz 30% basalt. Gravel - 80% basalt 20% quartz, round to sub round 5mm-100mm, Sample color - 2.5Y 7/2 light brownish gray. NO Rxn to HCl.	Sand seems to be increasing Still lots of larger gravels Drilling has slowed due to increased gravel and cobble. 9/9	
205	95 9-16-14			185'-190' ^(Sg) gravelly sand / sandy gravel 60% sand 40% gravel Sand - med - fine grained, well sorted, dry, angular to sub angular, mostly quartz rich sand with traces of basalt and mica. 40% quartz, 20% basalt. Gravel - 60% basalt 40% quartz. 10mm - 70mm color 2.5Y 7/2 light gray. NO Rxn to HCl.	Sample at 185' bgs had 9/9 more sand in it but the next drive barrel was still the same sandy gravel. 9/9 mostly gravelly sand but changes back to sandy gravel every few drive barrel loads. 9/9	
210	95 9-16-14			190'-245' ^(Sg) silty sandy gravel (Sg) Silt - 10% Sand 20% gravel 70% Sand - med - fine grained, well sorted, quartz rich, dry, angular to sub angular, traces of basalt & mica, Gravel - mostly basalt and quartz, size - 5mm - 100mm. NO Rxn to HCl color - 2.5Y 7/2 light gray.	Drilling has slowed at 200' bgs, due to compacted gravels, and larger cobbles 9/11/14 H2O contact @ 236.06' bgs 9/12/14 ✓	
215	95 9-16-14			245'-254' ^(MSH) silty sandy gravel (Wet) (MSH) Silt - 20% Sand - 20% gravel = 60% sand - medium to fine grained, well sorted, quartz rich, wet, angular to sub angular, traces of basalt & mica, Gravel - mostly basalt, some quartz, size 5mm - 100mm NO Rxn to HCl color - 2.5Y 5/3 olive brown	Sieve grab sample @ 240' bgs, 9-22-14 NEW Soil Samples 9-22-14 HEISB 2x PL9 0A50 HEISB 2x PMØ HEISB 2x PM1 NEW Water Samples 9-22-14 B2x PM2 1420 B2x PM3 B2x PM4	
220	25 9-16-14					
225	25 9-17-14					
230	25 9-17-14					
235	55 9-18-14					
						Water contact

Reported By: <u>Abby Wilcus</u>	Reviewed By: <u>BA. WILLIAMS</u>
Title: <u>geologist</u>	Title: <u>SP. GEOLOGIST</u>
Signature: <u>Abby Wilcus</u>	Signature: <u>[Signature]</u>
Date: <u>9-18-14</u>	Date: <u>12/3/14</u>

BOREHOLE LOG

Page 7 of 9

Date: 10-6-14

Well ID: C 8925

Well Name: 299-WB-260

Location: N of WMA R. farm

Project: TPA M-24 monitoring wells.

Reference Measuring Point: Ground surface

Depth (Fl.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
240	gs & sieve 9-18-14			245-254.80' <u>silty sandy Gravel (msg)</u>	Drilling is being conducted with 22 cable tool rig.
				Silt ~20% Sand ~20% Gravel ~60%	Drive barrel and 8" temporary casing.
				Sand medium to fine grain, well sorted	
				qtz rich angular to sub angular	
245	9-22-14			Accessory minerals include mica and basalt	
				Gravel highly mafic (basalt) some qtz	GS Grab Sample
				Size range from 5mm to 100mm	
				No reaction to HCL. 2.5Y 5/3 olive brown	Drive of temp casing improves.
				Sample is wet.	
250	250 gs				754.80-256.00' <u>silty sandy Gravel (msg)</u>
				~30% Silt ~30% Sand and 40% Gravel	255 + 260'
				Some plasticity noted in the mud less than 1% of overall sample	260 + 265'
255	255 gs			Sand is fine to medium grain sub ang to sub Round silica rich.	265 + 270'
				Gravels are 7mm to 100mm Round to sub round 80% mafic, 20% felsic	AA Sample material added to 1 sieve sample for the water table
260	260 gs			No reaction to HCL	
				256.00 to 256.50' <u>Sand lens</u>	
				fine to medium grain sand.	Water sample (1210) 10-2-14
				sub round to sub ang.	B2XPM5, B2XPM6 B2XPM7, B2XPM9
265	265 gs			256.50-266.0' <u>silty sandy Gravel (msg)</u>	Intake = 259.2 RH 264.9
				silt ~20% Sand ~20% Gravel ~60%	
				sand is med to fine grain well sorted	GS collected
				qtz rich angular to sub angular	770'-275' 10-6-14
				some mica and basalt	275'-280' 10-6-14
270	270 gs			Gravel is highly mafic ~80%	
				~5mm to 100mm well rounded to sub round. No reaction to HCL	
				2.5Y 5/3 olive brown wet sample	
275	275			Sand lens @ 267.8 to 269.1' ft hgs	
				Some silica cement noted on some of the gravels.	

Reported By: Abby Wicks / Candice Burnett

Reviewed By: BA WILLIAMS

Title: Geologist

Title: SA GEOLOGIST

Signature: Abby Wicks / Candice Burnett

Date: 10-6-14

Signature: [Signature]

Date: 12/3/14

BOREHOLE LOG

Page ¹⁰⁻⁶⁻¹⁴ 8 of 9
Date: 10-06-14

Well ID: C8925 Well Name: 299-W18-260 Location: N of WMA on tank farms
Project: EPA M29 monitoring wells Reference Measuring Point: ground level

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
280	GS 10-06-14			286' to 288' silty sandy gravel (MSG) silt ~15% sand ~35% Gravel 50% silt - compact dump no plasticity sand fine to very coarse L ~30% F ~10% QTZ ~60% sub rounded to sub ang poorly sorted Gravel ranges from 2mm to ~100mm larger gravels tend to be better rounded. Over all the sample is sub angular to sub rounder ~80% mafic 20% felsic No reaction to HCL some silica cement noted on the larger gravels less than 2% of overall sample 286' to 288' silty sandy gravel (MSG) silt ~15% sand - 40% Gravel - 45% silt - fine, no plasticity, color 5YR 3/3 DK reddish brown, sand - 70% quartz 30% basalt, 10% mica, angular to sub angular, coarse sand, gravel - micaceous subarkose sandstone, with calcite and hematite cementation, subangular to angular, very violent rxn to HCl, color - 5YR 4/2 - 5YR 5/2, reddish brown to reddish gray to grey. sample was wet, size 30mm - 15mm 290' to 325' silty sandy gravel (MSG) silt - non plastic, sand - 50% Gravel - 40% sand - med - coarse sand, wet, well sorted, angular to sub angular, mostly quartz rich sand, some basalt some mica, gravel, mostly basalt and quartz, No rxn to HCl. color - 2.5Y 5/3 olive brown wet sample.	Drilling is being conducted with a 22-w cable tool rig. Drive barrel . 8" Temporary casing. gs = grab sample gs between 280 + 285' H2O samples - HEIS: B2XPM8, B2XPM9, B2XPN0, B2XPP8 taken on 10-9-14 @ 285' 286', dark reddish brown sand/silt. formation change. Gravel is sandstone chunks, very violent rxn with HCl when broke in half. Very hard sandstone, had to break with a sledge hammer when not saturated with water. 10/8/14 HEIS - B2XPN1, B2XPN2, B2XPN5 *10-9-14 - hard tooling starting @ 290' bgs samples may not fully represent formation 10-13-14 - hard tooling will continue until TD. samples may not fully represent formation.
285	GS 10-07-14				
290	GS 10-08-14				
295	GS 10-09-14				
300	GS 10-14-14				
305	GS 10-14-14	Water Sample			
310	GS 10-15-14				
315	GS 10-15-14				

Reported By: Candie Burnette / Abby Lucas Reviewed By: RA. WILLIAMS
Title: Geologist Title: Sr. Geologist
Signature: [Signatures] Date: 10-6-14 Signature: [Signature] Date: 12/3/14

BOREHOLE LOG					Page <u>9</u> of <u>9</u>
Well ID: <u>C8925</u>			Well Name: <u>200-WB-260</u>		Date: <u>10-16-14</u>
Project: <u>T&A m-24 monitoring wells</u>			Location: <u>N. Lima U. tank farms</u>		
Reference Measuring Point: <u>ground surface</u>					
Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
320	<u>SS</u> <u>10-16-14</u>			<u>290'-325'± Silty Sandy Gravel (MSG)</u> <u>Silt - 30%, Sand 30%, gravel 40%</u> <u>Sand: med- to coarse, wet, well sorted angular- to</u> <u>angular, quartz rich, with basaltic gravel mostly</u> <u>basalt and quartz. also seen to Hcl. color - 2.57</u> <u>5/3 olive brown wet sample.</u>	<u>Drilling with a 22W cable</u> <u>tool rig.</u> <u>Hard tooling / bails,</u> <u>8" temporary casing - 10-16-14</u>
325	<u>SS</u> <u>10-16-14</u> <u>Waters</u> <u>sample</u>			<u>TD @ 326.3' bgs</u>	<u>HEES B2xPN4, B2xPN5,</u> <u>B2xPN6</u>
<div style="position: absolute; top: 50%; left: 50%; transform: translate(-50%, -50%); opacity: 0.5; font-size: 2em;"> NOT USED </div>					

Reported By: <u>Abby Wines</u>		Reviewed By: <u>RL Williams</u>	
Title: <u>geologist</u>		Title: <u>SR GEONIST</u>	
Signature: <u>Abby a. Wines</u>	Date: <u>10-16-14</u>	Signature: <u>[Signature]</u>	Date: <u>12/3/14</u>



299-W18-260 (C8925) Log Data Report

Borehole Information:

Log Date:	2014-10-21	Filename:	C8925_HG-NM_2014-10-21	Site:	North of U Farm
Coordinates (WA St Plane)		DTW¹ (ft):	236.1	DTW Date:	10/21/14
North (m)	East (m)	Drill Date	TOC² Elevation	Total Depth (ft)	Type
N/A	N/A	10/20/14	N/A	325	Cable Tool

Casing Information:

Casing Type	Stickup (ft)	Diameter (in.)		Thickness (in.)	Top (ft)	Bottom (ft)
		Outer	Inside			
Threaded Steel	0.65	10 3/4	9 1/2	5/8	0.65	130
Threaded Steel	1.2	8 5/8	7 3/8	5/8	1.2	325

Borehole Notes:

The total depth and casing depth are provided by the onsite geologist. The logging engineer measured casing stick-up and casing diameter (rounded to the nearest 1/16-in.). Depth to water was measured with an e-tape at 238.6 ft by the geologist on October 20. At the time of logging on October 21, depth to water inside the casing was 236.1 ft according to gamma and moisture logs. The maximum logging depth achieved was 324 ft, approximately 1 ft above the reported casing depth.

Zero reference is ground surface.

Logging Equipment Information:

Logging System:	Gamma 1L	Type:	60% HPGe SGLS
Effective Calibration Date:	11/11/13	Serial No.:	47-TP32211A
Calibration Reference:	HGLP-CC-096, Rev. 0	Logging Procedure:	HGLP-MAN-002, Rev. 1

Logging System:	Gamma 1H	Type:	NMLS ³
Effective Calibration Date:	11/11/13	Serial No.:	H310700352
Calibration Reference:	HGLP-CC-097, Rev. 0	Logging Procedure:	HGLP-MAN-002, Rev. 1

SGLS Log Run Information:

Log Run	4	5 Repeat	8	9	
HEIS Number	1018555	1018556	1018557	1018558	
Date	08/29/14	08/29/14	10/21/14	10/21/14	
Logging Engineer	McClellan/Felt	McClellan/Felt	McClellan/Felt	McClellan/Felt	
Start Depth (ft)	0.0	45.0	130.0	180.0	
Finish Depth (ft)	131.0	58.0	324.0	200.0	

¹ depth to water inside casing

² top of casing

³ Neutron Moisture Logging System



HGLP-LDR-802, Rev. 0

Log Run	4	5 Repeat	8	9	
Count Time (sec)	100	100	100	100	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
Log Speed (ft/min)	N/A	N/A	N/A	N/A	
Pre-Verification	AL211CAB	AL211CAB	AL225CAB	AL225CAB	
Start File	AL211000	AL211133	AL225000	AL225195	
Finish File	AL211131	AL211146	AL225194	AL225215	
Post-Verification	AL211CAA	AL211CAA	AL225CAA	AL225CAA	
Depth Return Error (in.)	N/A	0.0	N/A	0.5 high	
Comments	No fine gain adjustments made				

NMLS Log Run Information:

Log Run	1	2	3 Repeat	6	7 Repeat
HEIS Number	1018559	1018560	1018561	1018562	1018563
Date	08/28/14	08/29/14	08/29/14	10/20/14	10/20/14
Logging Engineer	McClellan/Felt	McClellan/Felt	McClellan/Felt	McClellan/Felt	McClellan/Felt
Start Depth (ft)	0.0	58.0	20.0	130.0	215.0
Finish Depth (ft)	59.0	131.5	33.0	237.75	226.0
Count Time (sec)	15	15	15	15	15
Live/Real	R	R	R	R	R
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	0.25	0.25	0.25	0.25	0.25
Log Speed (ft/min)	N/A	N/A	N/A	N/A	N/A
Pre-Verification	AH174CAB	AH175CAB	AH175CAB	AH187CAB	AH187CAB
Start File	AH174000	AH175000	AH175295	AH187000	AH187432
Finish File	AH174236	AH175294	AH175347	AH187431	AH187476
Post-Verification	AH174CAA	AH175CAA	AH175CAA	AH187CAA	AH187CAA
Depth Return Error (in.)	0.0	N/A	0.5 high	N/A	0.0
Comments	None	None	None	None	None

Logging Operation Notes:

A centralizer was installed on the sondes.

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

Analysis Notes:

Analyst:	P.D. Henwood	Date:	11/06/14	Reference:	HGLP-MAN-003, Rev. 0
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Casing corrections for a 5/8-in. thick casing was applied to the log data throughout the borehole.

A correction for water inside the casing was applied below 236 ft in depth.



· SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as AL20131120.xls, using an efficiency function and corrections for casing and dead time as determined by annual calibration.

NMLS data are represented in counts per second because no calibration data exist for a 9 1/2-in. inner diameter casing.

The HGU⁴ 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:

Cs-137 was detected from 1 to 4 ft with a maximum concentration of approximately 4 pCi/g measured at 2 ft in depth. Although there were no other detections, the MDLs for Cs-137 are plotted for the entire borehole on the Manmade Radionuclide plot.

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

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

List of Log Plots:

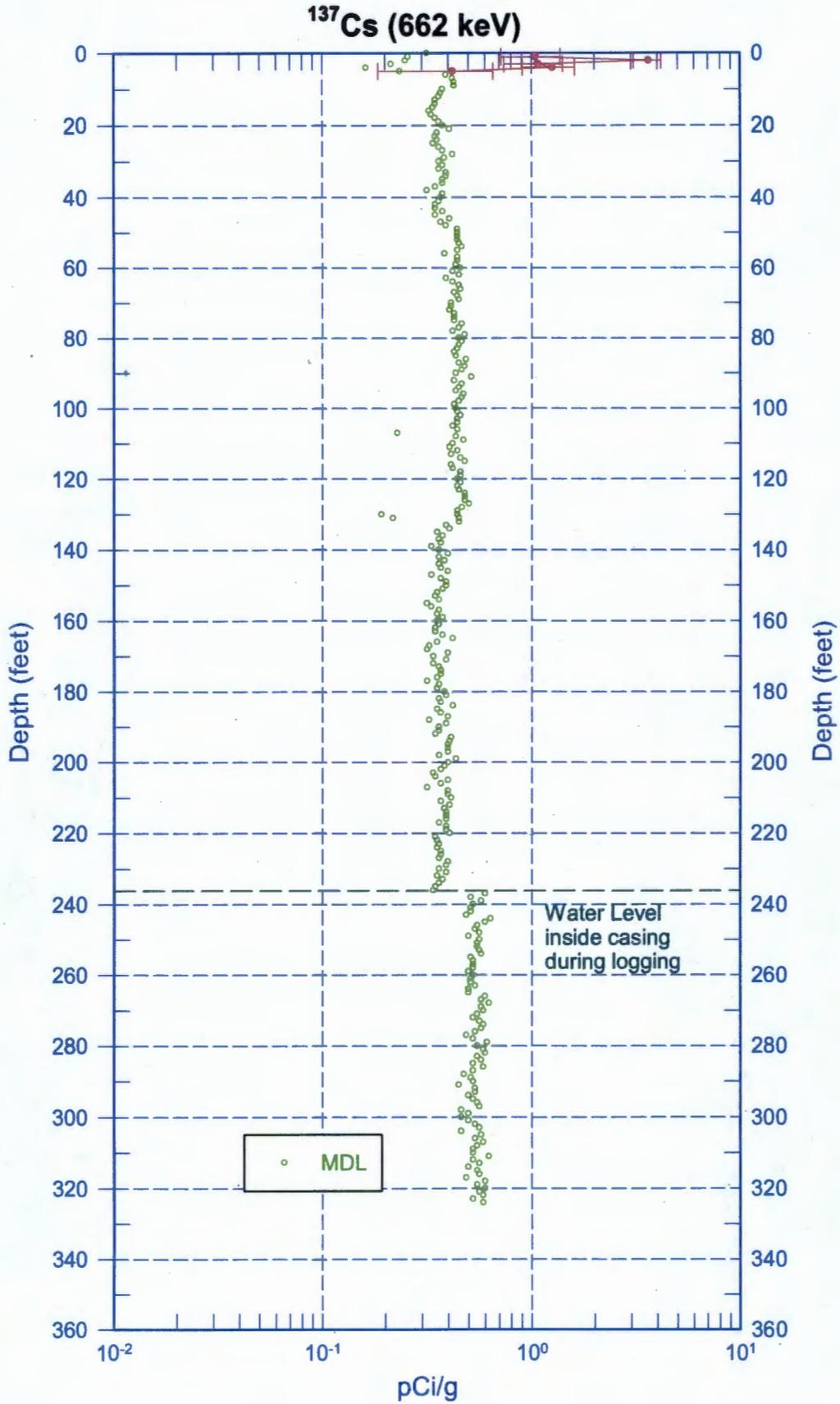
Depth Reference is ground surface.

Manmade Radionuclides (0-360 ft)
 Natural Gamma Logs (0-170 ft)
 Natural Gamma Logs (170-340 ft)
 Combination Plot (0-120 ft)
 Combination Plot (110-230 ft)
 Combination Plot (220-340 ft)
 Combination Plot (0-360 ft)
 Total Gamma & Moisture (0-160 ft)
 Total Gamma & Moisture (150-310 ft)
 Total Gamma & Hanford Gamma Unit (0-340 ft)
 Repeat Section of Natural Gamma Logs (45 to 60 ft)
 Repeat Section of Natural Gamma Logs (180 to 200 ft)
 Moisture Repeat Section (20 to 33 ft)
 Moisture Repeat Section (215 to 226 ft)

⁴ Hanford Gamma Unit

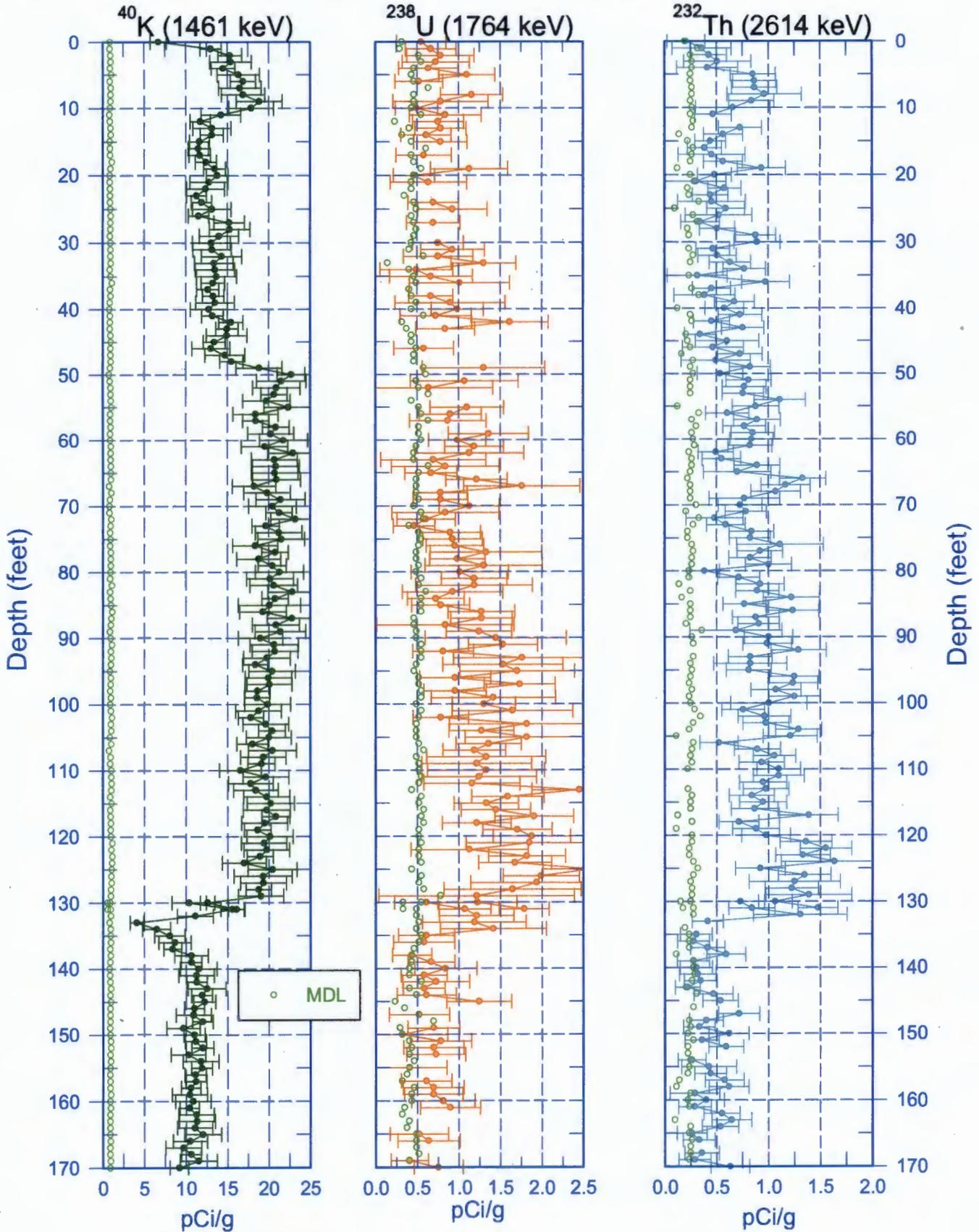


299-W18-260 (C8925) Manmade Radionuclides





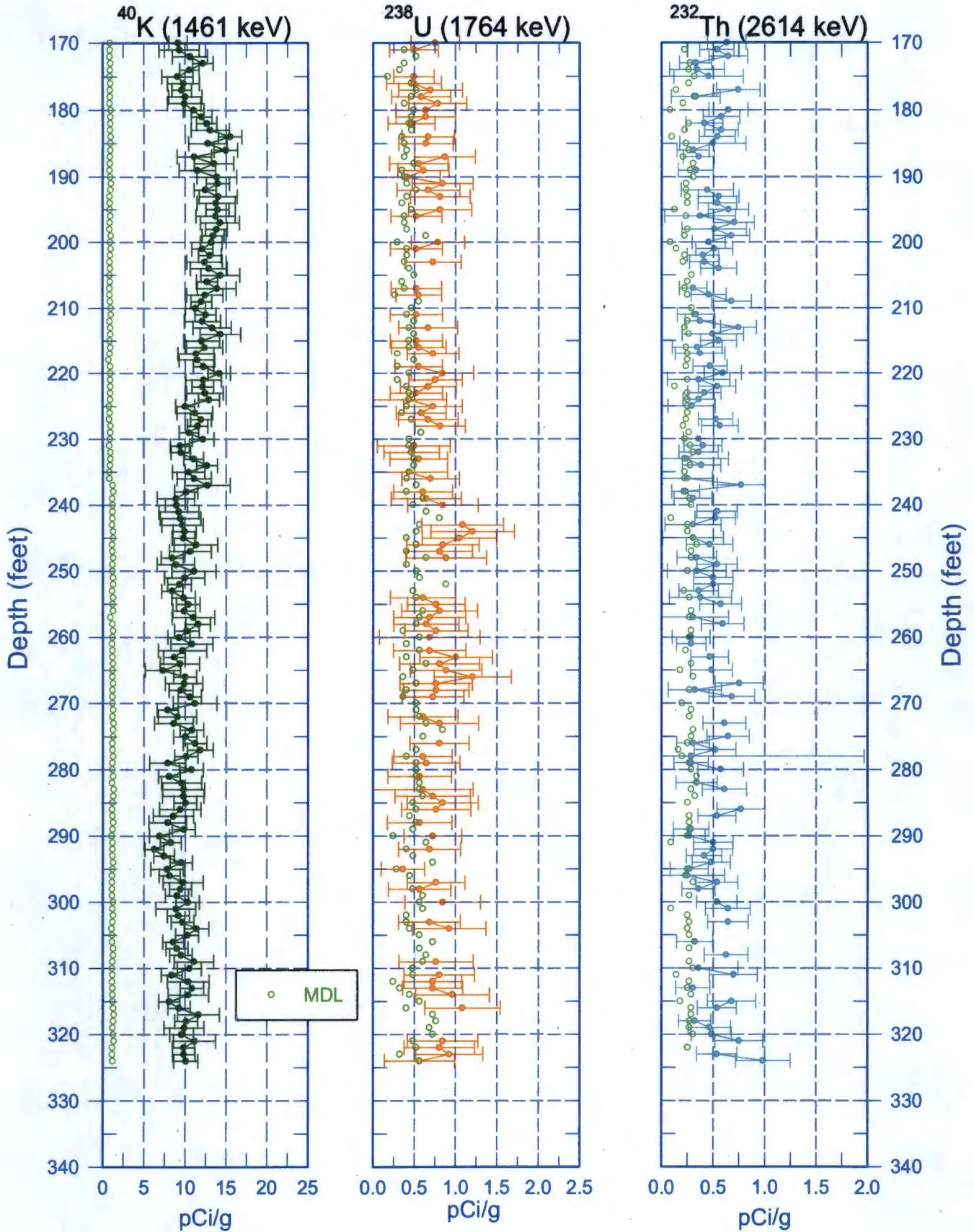
299-W18-260 (C8925) Natural Gamma Logs



Zero Reference - Ground Surface

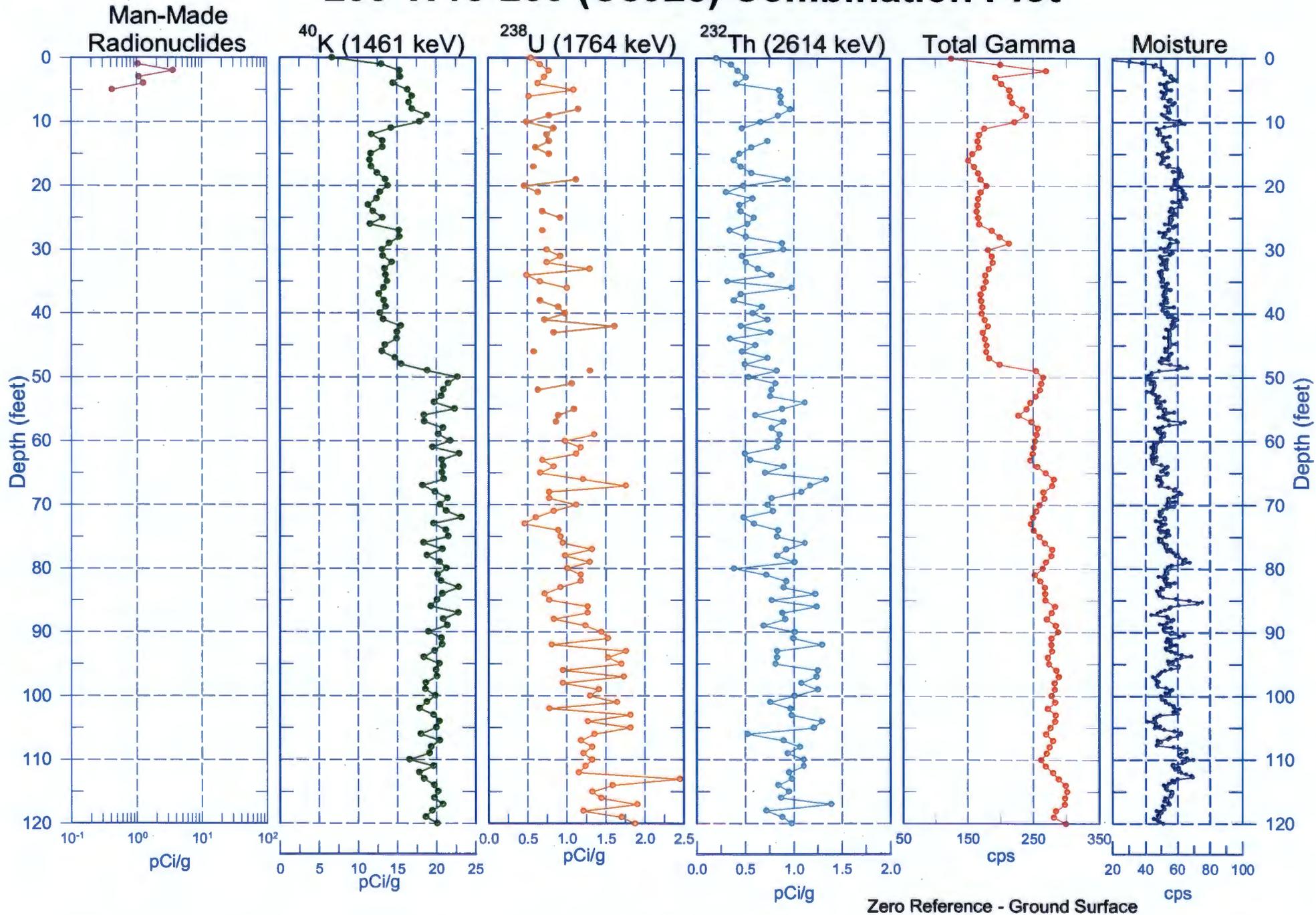


299-W18-260 (C8925) Natural Gamma Logs

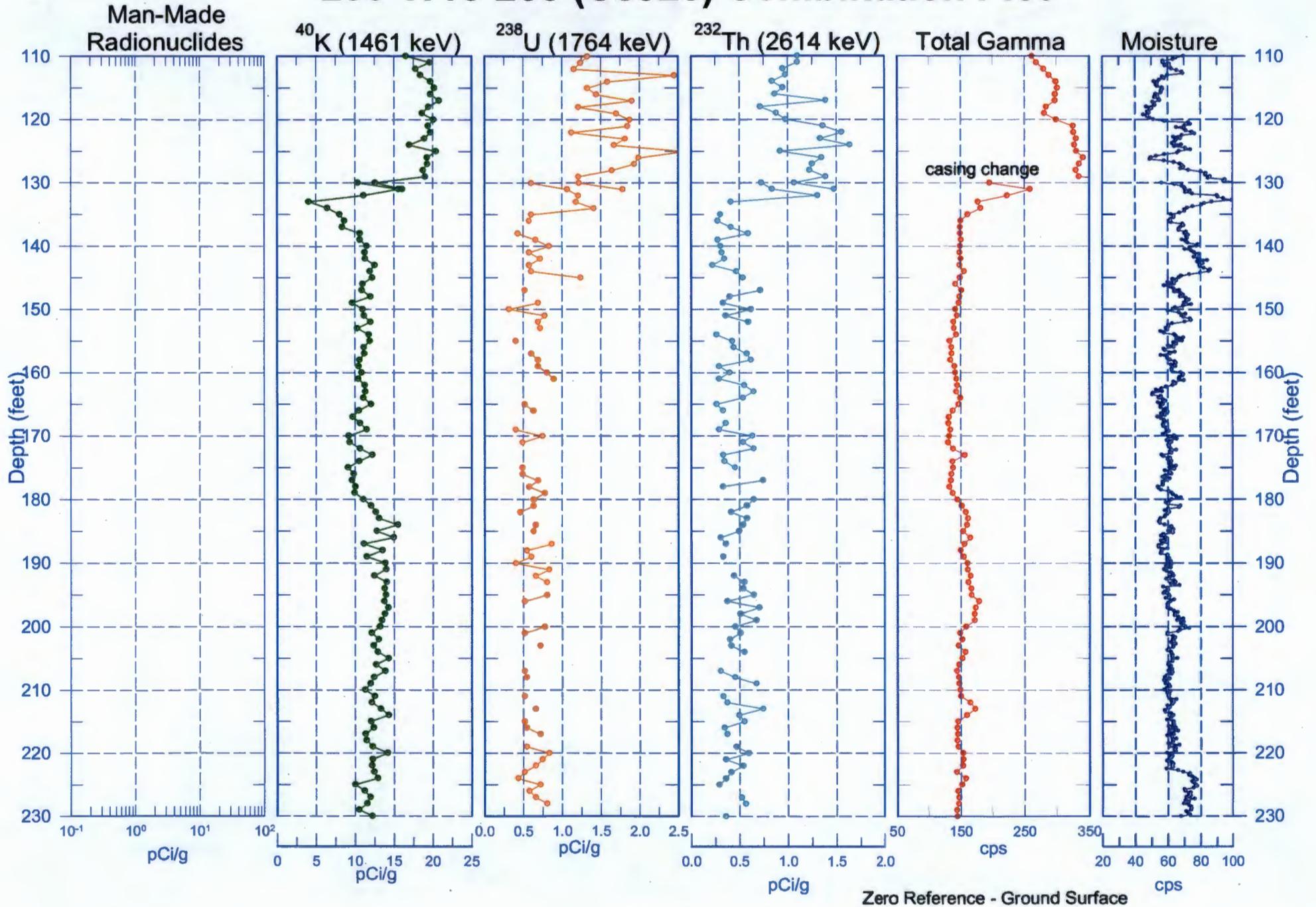


Zero Reference - Ground Surface

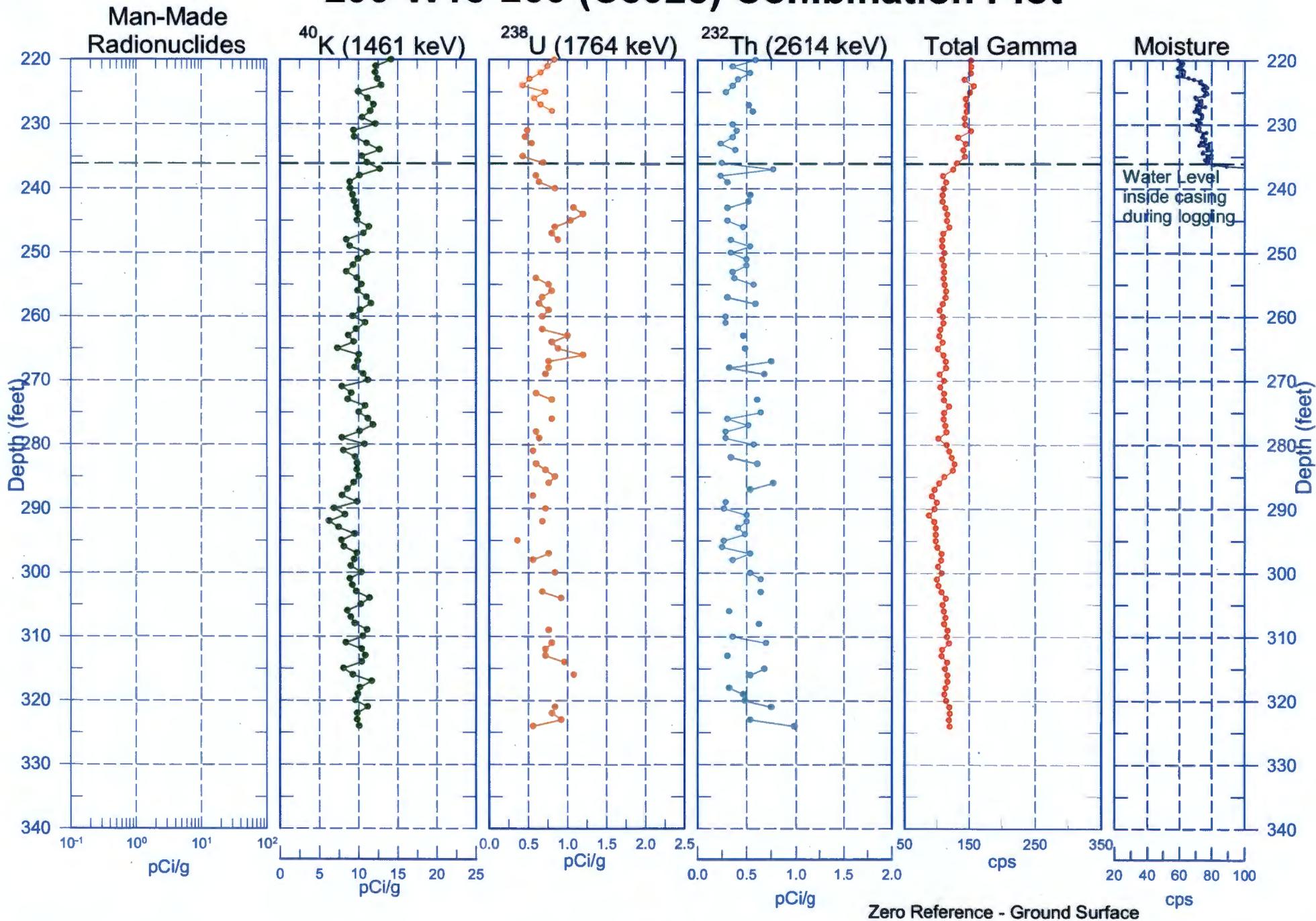
299-W18-260 (C8925) Combination Plot



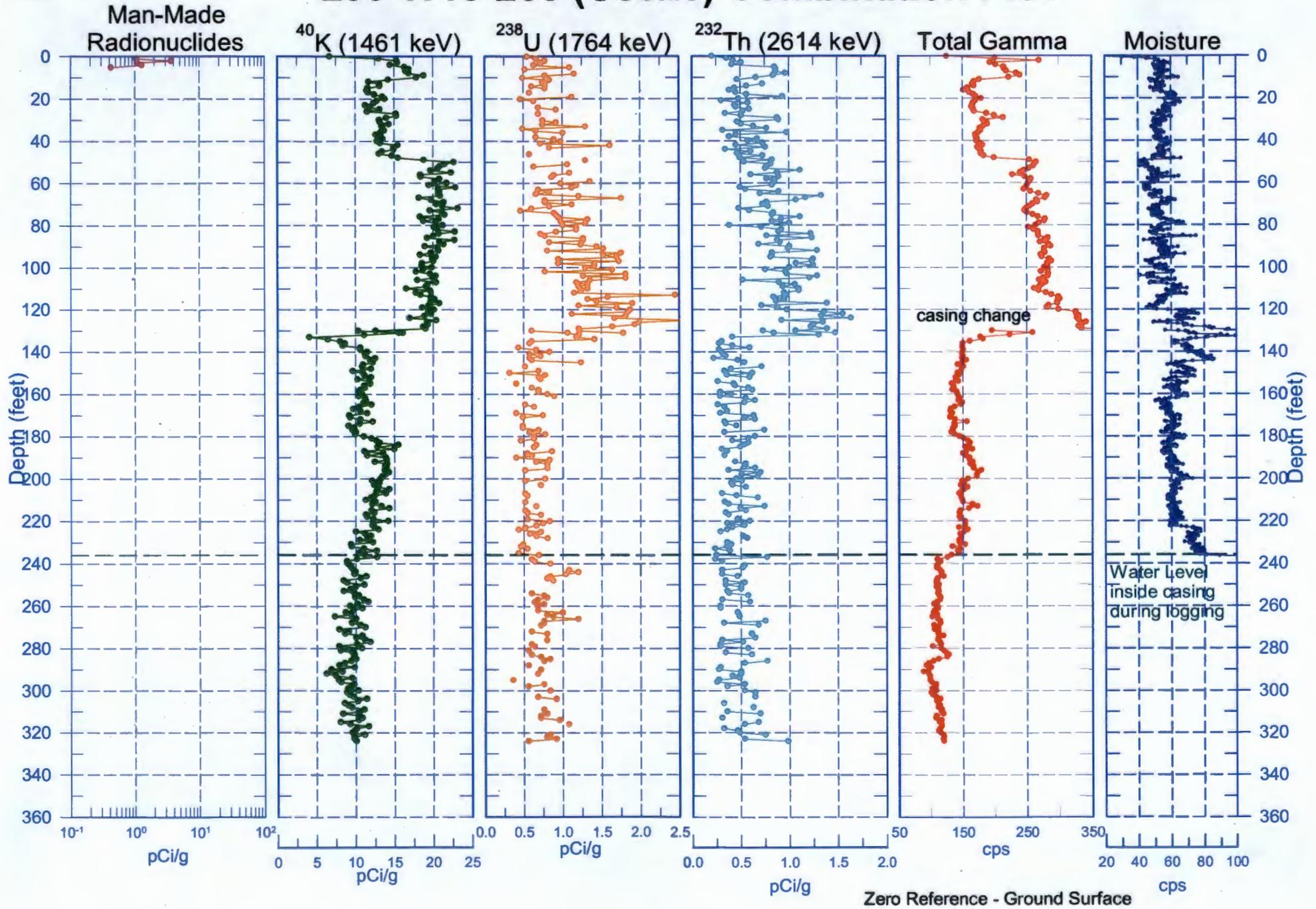
299-W18-260 (C8925) Combination Plot



299-W18-260 (C8925) Combination Plot

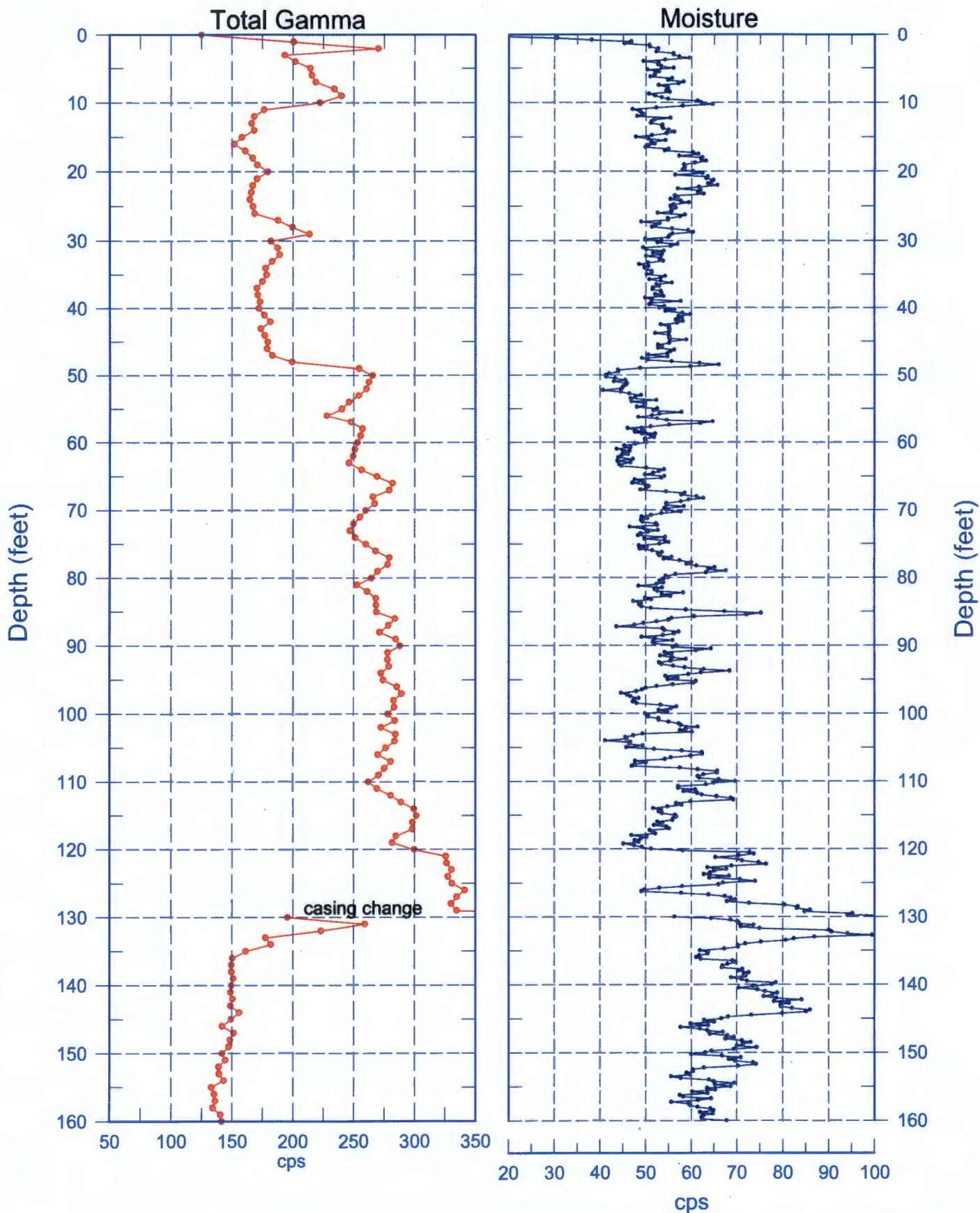


299-W18-260 (C8925) Combination Plot





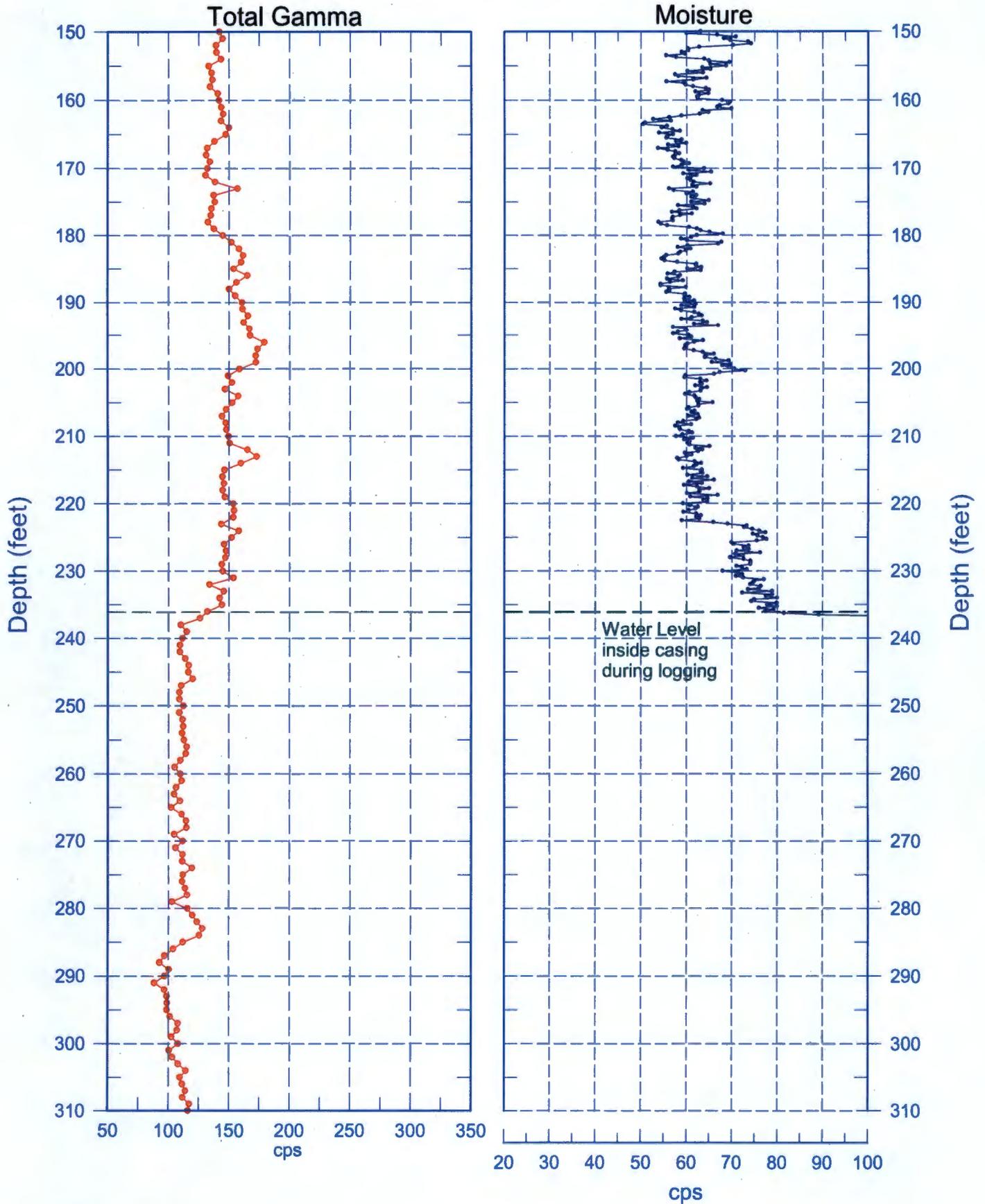
299-W18-260 (C8925) Total Gamma & Moisture



Reference - Ground Surface



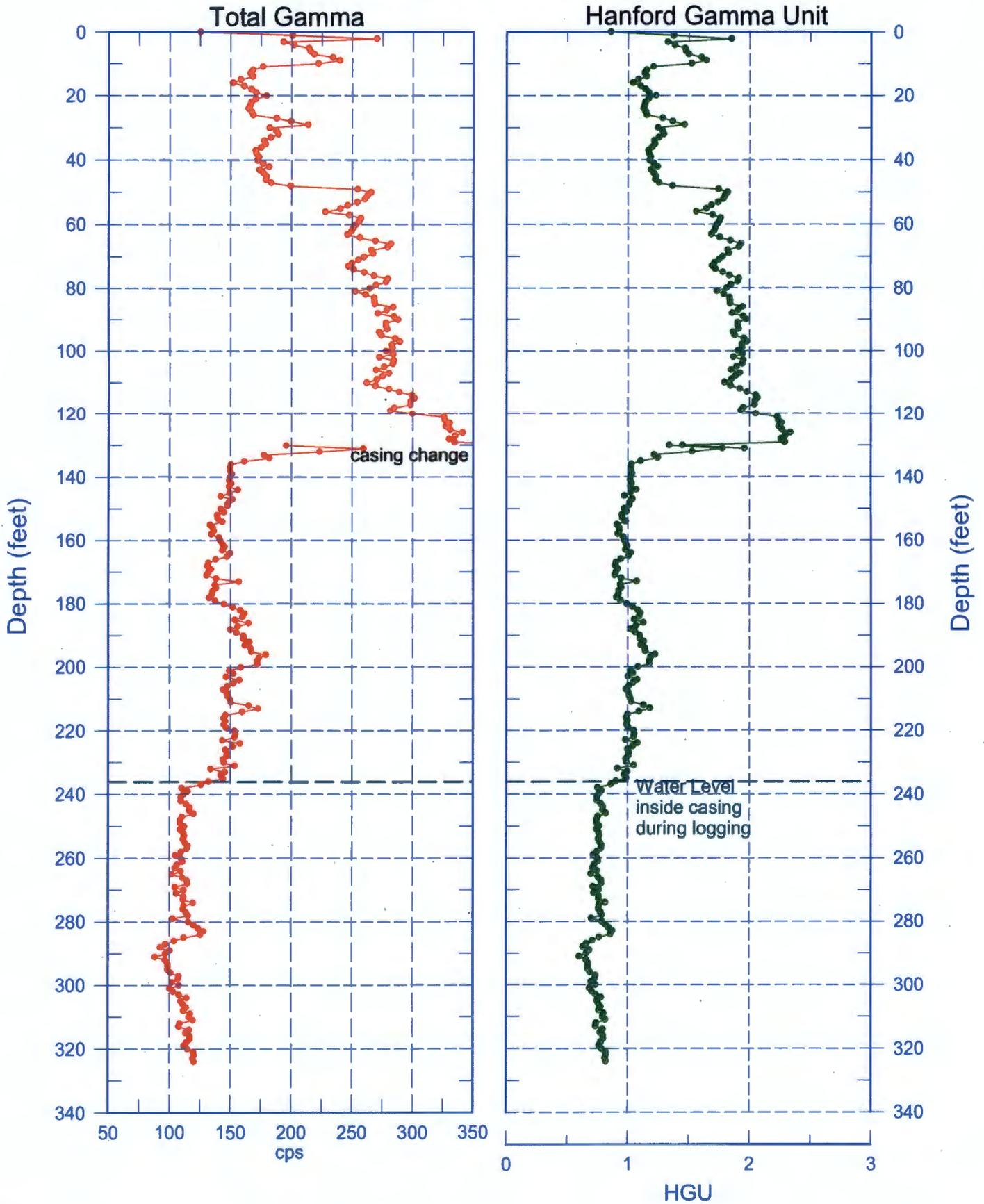
299-W18-260 (C8925) Total Gamma & Moisture



Reference - Ground Surface

299-W18-260 (C8925)

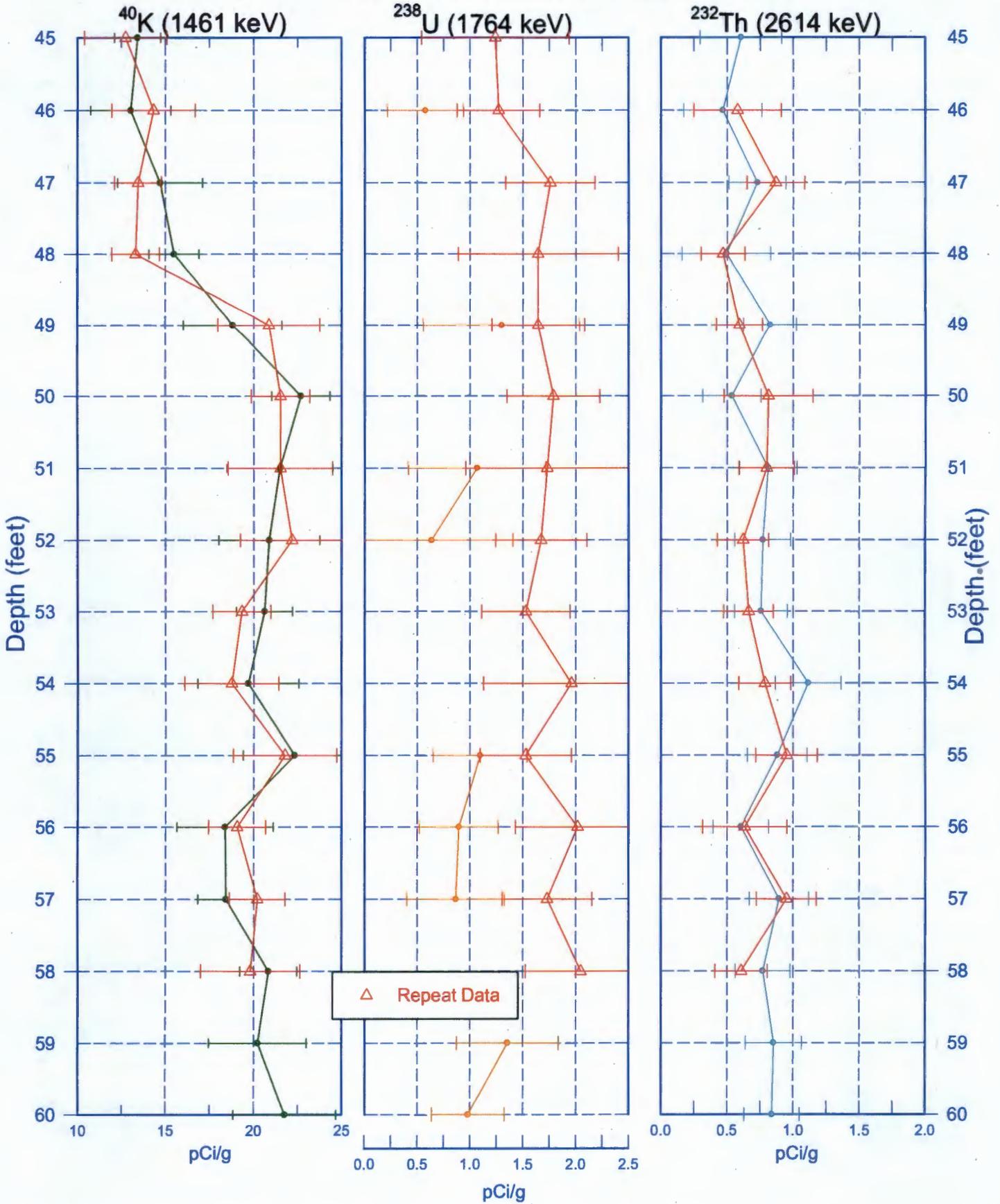
Total Gamma & Hanford Gamma Unit





299-W18-260 (C8925)

Repeat Section of Natural Gamma Logs

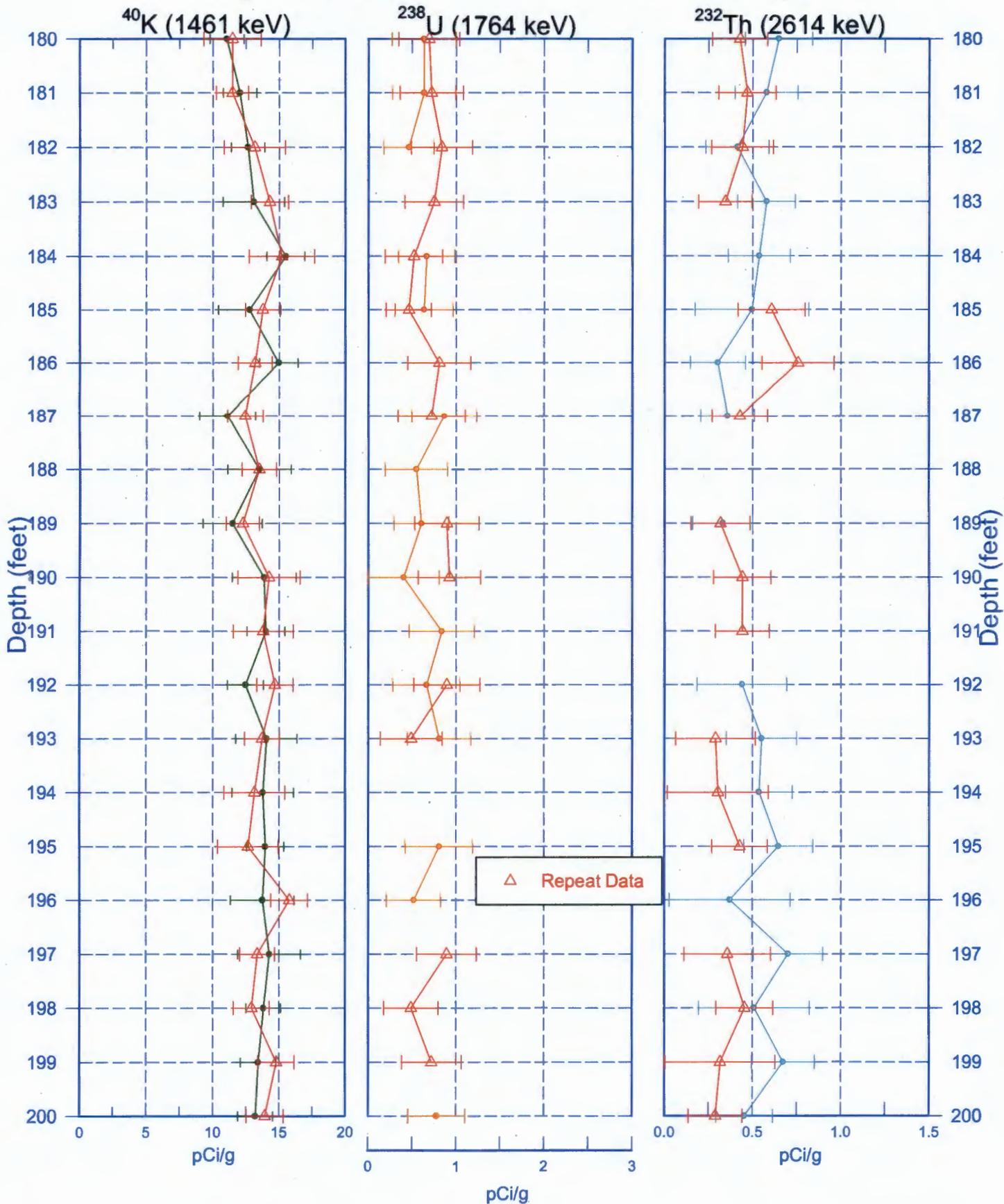


Zero Reference - Ground Surface



299-W18-260 (C8925)

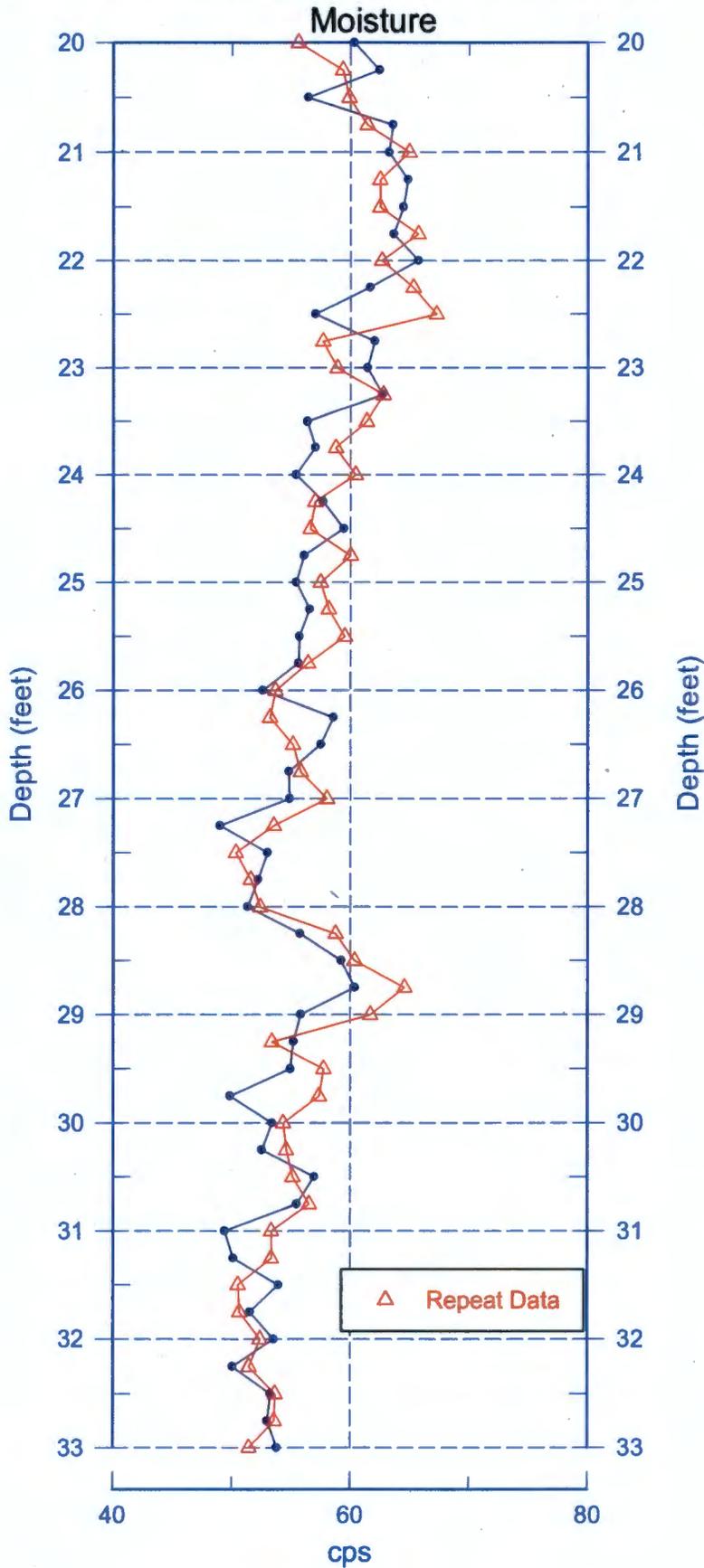
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface



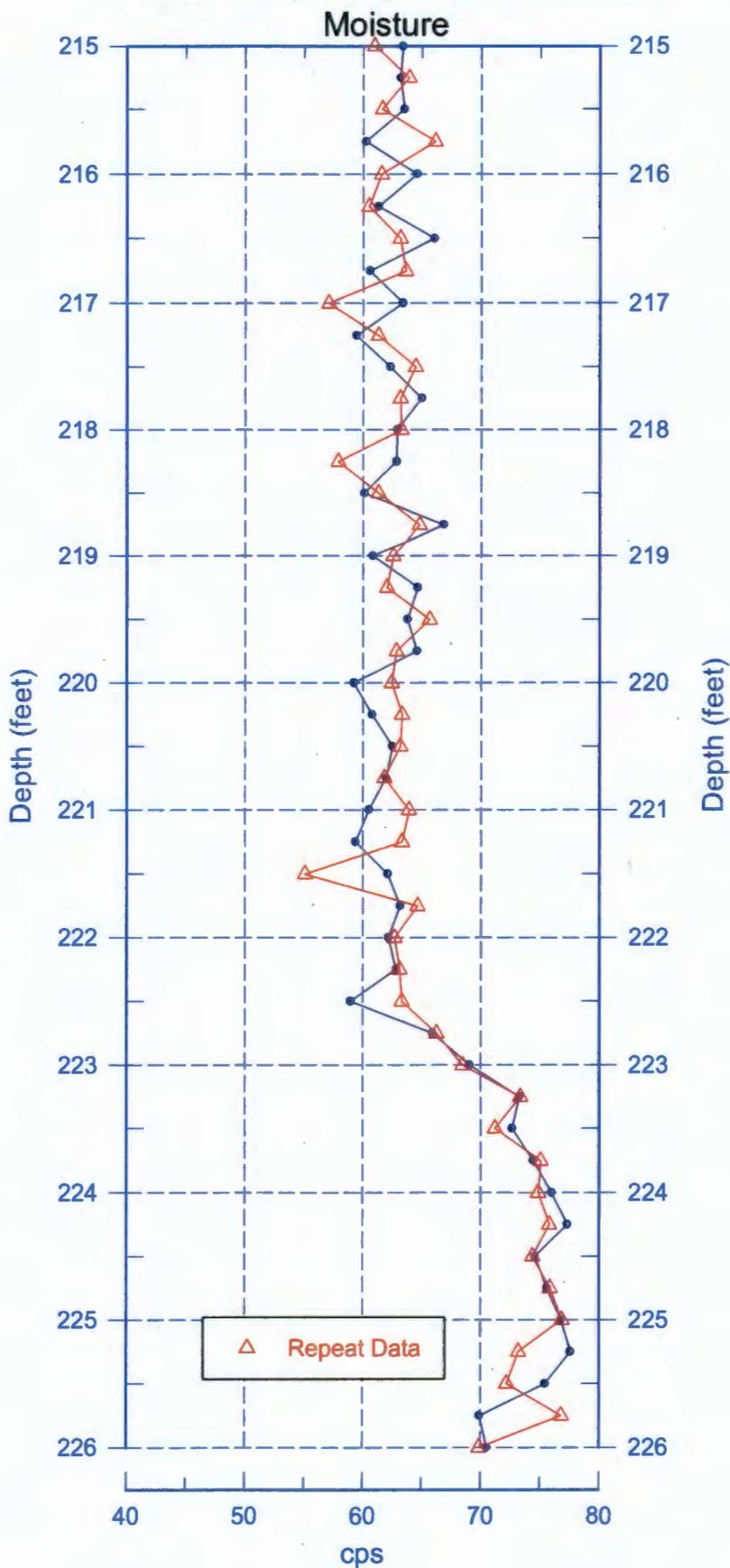
299-W18-260 (C8925) Moisture Repeat Section



Reference - Ground Surface



299-W18-260 (C8925) Moisture Repeat Section



Reference - Ground Surface

SURVEY DATA REPORT				Request No.		
				152-060		
Project No.	Title			File No.		
	M-24 Wells C8925 & C8943 Final Surveys			2WT12R25		
Job. No.	Prepared By		Date	Reviewer		
CACN: 303345-JPRC	N.P. Fastabend		2/11/15	CBM		
DESCRIPTION OF WORK			DISTRIBUTION	SDR	PLOT	DWG
Obtained final coordinates (C/L Casings) and elevations of completed M-24 Wells C8925 (299-W18-260) and C8943 (299-W22-113) in 200W Area. Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)			Survey File	OR		
			J.D. Mehrer	1		
			S.J. Trent	1		
			K.M. Whitley	1		
			J.B. Geiger	1		
			B.J. Howard	1		
			A.J. Green	1		
SURVEY RESULTS AND COMMENTS						
<p>See Attached Well Survey Data Report Sheets</p>						

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 01/21/15	Requestor: Kelly Whitley (CHPRC)
Date of Survey: 02/11/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend
Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of M-24 Well C8925 (299-W18-260) located north of 241-U Tank Farm in 200W Area.	Horizontal Datum: NAD83 (91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 200W

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
2W-170 (CHPRC) and 2W-49 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C8925	299-W18-260	566862.54	135196.89		Center of Casing
				205.777	"X" on Rim
				205.052	Brass Survey Marker

Notes:

205.487 Top Inner 4in Casing, North Edge

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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



2-12-2015

Appendix E

Well Documentation for 299-W22-113 (C8943)

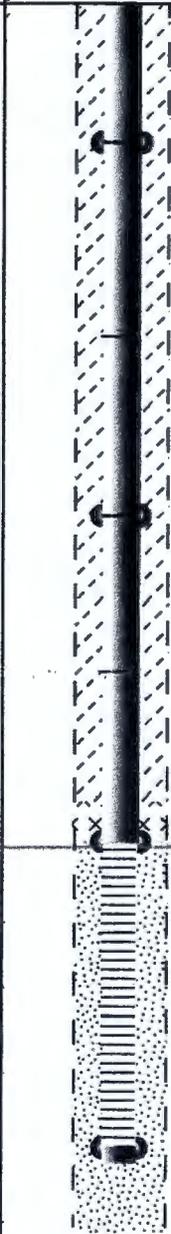
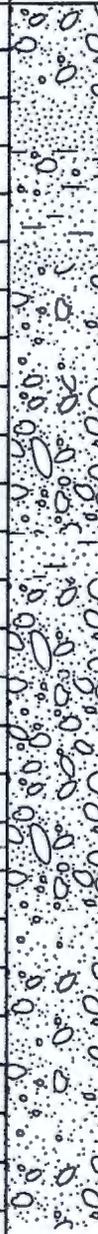
- Well Summary Sheet
- Borehole Log
- Log Data Report
- Final Survey Report

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WELL SUMMARY SHEET		Start Date: 7-23-2014		Page <u>1</u> of <u>2</u>		
Well ID: C8943		Well Name: 299-W22-113				
Location: SE corner of WMA SX		Project: TPA M-24 Monitoring Wells				
Prepared by: Abby Wicks		Date: 10-22-14		Reviewed by: J.D. MEHRER Date: <u>1-26-15</u>		
Signature: <i>Abby Wicks</i>		Signature: <i>J.D. Mehrer</i>				
CONSTRUCTION DATA		Depth in Feet	GEOLOGIC/HYDROLOGIC DATA			
Description	Diagram		Graphic Log	Lithologic Description		
<p><u>Temporary Casing Materials</u></p> <p>12" Carbon Steel (11 3/4" OD, 11 5/16" ID) 0.0 ft -105 ft bgs</p> <p>8" Carbon Steel (8 11/16" OD, 8 3/4" ID) 105 ft- 271ft bgs</p> <p><u>Permanent Casing Materials</u></p> <p>4" Type 316 L sch 10s Riser 2.00 ft ags- 233.9 ft bgs</p> <p>4" Type 316 L sch 10s Continuous wire wrap screen 40-slot. 233.9 ft bgs- 264.0 ft bgs</p> <p>4" Type 316 L sch 10s sump 264.0 ft-267.0 ft bgs</p> <p><u>Construction Materials</u></p> <p>Type I/II Portland Cement 0.0 ft bgs - 11.1ft bgs</p> <p>Medium Bentonite Chips 11.1 ft bgs- 104.2 ft bgs</p> <p>#8 Granular Bentonite 104.2 ft bgs- 227 ft bgs</p> <p>3/8" Bentonite Pellets 227.1 ft bgs- 230.0 ft bgs</p> <p>Colorado Silica Sand 230.0 ft bgs -269.1 ft bgs</p>						<p>0-1": Gravel Pad</p> <p>1"-50': Sand [S]</p> <p>50'-55': Silty Sandy Gravel [msG]</p> <p>55'-60': Sandy Gravel [sG]</p> <p>60'-65': Slt. Silty Sandy Gravel [(m)S]</p> <p>65'-80': Sand [S]</p> <p>80'-85': Slt. Silty Sand [(m)S]</p> <p>85'-90' Sand [S]</p> <p>90'-95' Silt [M]</p> <p>95'-115' Sand [S]</p> <p>115'-130' Silty Sand [mS]</p> <p>130'-140' Sandy Silt [sM]</p> <p>140'-145' Silt [M]</p> <p>145'-155' Gravelly Sand [gS]</p>

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

All depths are reported in feet below ground surface (ft bgs) unless otherwise noted.

WELL SUMMARY SHEET		Start Date: 7-23-2014		Page <u>2</u> of <u>2</u>		
Finish Date: 10-8-2014						
Well ID: C8943			Well Name: 299-W22-113			
Location: SE corner of WMA SX			Project: TPA M-24 Monitoring Wells			
Prepared by: Abby Wicks		Date: 10-22-14	Reviewed by: J.D. MEHRER		Date: 1-21-15	
Signature: <i>Abby Wicks</i>			Signature: <i>J.D. Mehrer</i>			
CONSTRUCTION DATA		GEOLOGIC/HYDROLOGIC DATA				
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description		
		150		145'-155' Gravelly Sand [gS]		
				155'-160' Sand [S]		
					160'-165' Slt. Silty Grvly Sand [(m)gS]	
					165'-170' Slt. Silty Sand [(m)S]	
				175	170'-172' Sand [S]	
					172'-177' Gravelly Sand [gS]	
					177'-200 Sandy Gravel [sG]	
				200	200'-205' Slt. Silty Sand [(m)S]	
					205'-238' Sandy Gravel [sG]	
				225		
					238'-240' Gravelly Sand [gS]	
					240'-271' Sandy Gravel [sG]	
		250				
		275				
			TD= 271.3 ft bgs			
			DTW=232.5 ft bgs 10/8/2014			

BOREHOLE LOG

Well ID: C8943 Well Name: 299-W22-113 Location: E. of WMA S-SX

Project: TPA M-24 Monitoring Wells Reference Measuring Point: GROUND SURFACE

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
0				0-0.08' (~1") "PAD" - Misc. gravel	Cable Tool: 22-W
5	G.S.	+32 oz. H ₂ O		0.08' - 10' Sand (95% S, 5% G); Sand: damp, v. fine-fine grn., ang.-sub ang., 70% f/m% moisture clumps, v. well sort; Gravel: 20mm pebbles, basalt & quartzite, sub. rnd-rnd, v. poor sort; silt. rxn to HCl; color = 10 YR 4/3 "BROWN"; OVERBURDEN	Drive barrel: 2.75' x 8 3/8" od. Archive @ 5' bgs. ~ 32 oz H ₂ O added @ 5' bgs.
10	G.S.			10'-15' Sand (90% S, 5% M, 5% G); Sand: damp, moisture clumping, v. fine-fine grn., ang.-sub. ang., 80/20 m/f%, v. well sort; GRAVEL: 10mm pebbles, sub rnd-rnd, basalt & quartzite, v. poor sort; silt% increase, non-plastic, damp; violent rxn to HCl; color = 10 YR 3/2 "v. drk. grayish brown"	Archive @ 10' bgs.
15	G.S.			Hanford formation	Archive @ 15' bgs.
20	G.S.			15'-20' Sand (100%); Sand: damp, no clumps, v. fine-fine grn., ang.-sub ang., 80% m/f%, v. well sort, silt rxn to HCl; color = 10 YR 3/2 "v. drk grayish brown"; Hanford formation. @ 16' one ~ 200mm cobble of basalt, rnd.	Archive @ 20' bgs
25	G.S.			20-27' Sand (95% S, 5% M); Sand: silt. damp, no clumps, v. fine-fine grn., ang.-sub ang., 80/20 m/f%, v. well sort; Silt: non-plastic, % picks up; violent rxn to HCl; color = 10 YR 4/1 "dk. gray"; Hanford formation	Archive @ 25' bgs
30	G.S.			@ 25' color = 10 YR 4/2 "dk. grayish brown" violent rxn to HCl; damp w/ clumps.	Archive @ 30' bgs.
35	G.S.			27'-30' Sand (100%); Sand: fine-med grn., dry, "salt & pepper" 50/50 m/f%, ang.-sub ang.; v. well sort; silt drops off; color = 10 YR 4/1 "gray"; no rxn to HCl; Hanford formation	Archive @ 35' bgs

Reported By: Jess Hoeking Reviewed By: Kerwin Bergstrom
 Title: Sr. Geologist Title: Sr. Geologist
 Signature: [Signature] Date: 7/24/14 Signature: [Signature] Date: 3-13-2015

BOREHOLE LOG

Page 2 of 10
Date: 7-23-2014

Well ID: C8943 Well Name: 299-W22-113 Location: E. of WMA S-SX

Project: TPA M-24 Monitoring Wells Reference Measuring Point: GROUND SURFACE

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
40	G.S.			30'-40' Sand (95% S, 5% M); Sand: v.fine-med. gm., damp w/clumps, 80/20 mlf %, well sort, mod. rxn to HCl, color: 10YR 5/3 "brown"; ang-sub. ang; silt % increase, non-plastic, clumps; Hanford formation.	Cable Tool: 22-W Drive barrel: 2.75' x 8 5/8" OD Archive @ 40' bgs (Elevated bkgnd.)
45	G.S.			40'-50' Sand (90% S, 10% M); Sand: v.fine-fine gm., ang-sub. ang, clumping, 10YR 5/2 "grayish brown", v. well sort, silt damp-dry, silt rxn to HCl, 70/30 mlf %; Silt: % increase, non-plastic, silt damp-dry, clumping; Hanford formation.	Archive @ 45' bgs (Elevated)
50	G.S.			@ 45' more clumping present, violent rxn to HCl, 70/30 mlf %	Archive @ 50' bgs (Elevated)
55	G.S.			50'-55' Silty Sandy Gravel (55% S, 30% G, 15% M); Sand: v.fine-crse gm., ang-sub. ang., mod. sort, dry-silt. damp, no clumping; Gravel: conglomerates w/silt matrix, 2mm-70mm, basalt, sub. ang-sub. end, v. poor sort; Silt: % increase, clumping, staining, semi-plastic, damp; 90/10 mlf %; Hanford formation; 10YR 4/2 "dk. grayish brown", violent rxn to HCl.	Archive @ 55' bgs (Elevated)
60	G.S.			55'-60' Silty Sandy Gravel (60% S, 35% G, 5 % M); Sand: dry, fine-crse gm., 60/40 mlf %, ang-sub. ang., mod. sort, 10YR 5/2 "grayish brown", mod rxn to HCl; Gravel: 2mm- 50mm, ang-rad, basalt/quartzite (mostly basalt) v. poor sort; Silt: % drops, dry, non-plastic, loose; Hanford formation.	Archive @ 60' bgs (Elevated)
65	G.S.			60'-65' Silt. Silty Sand (80% S, 20% M); Sand: dry-silt damp, v.fine-fine gm., 60/40 mlf %, ang-sub. ang., well sort, 10YR 4/2 "lt. brownish gray", silt-no rxn to HCl; Silt: % increase, silt damp-dry	Archive @ 65' bgs (Elevated)
70	G.S.				Archive @ 70' bgs. (Elevated)
75	G.S.				Archive @ 75' bgs. (Elevated)

Reported By: Jess Hocking Reviewed By: Kevin Bergstrom
Title: Sr. Geologist Title: Sr. Geologist
Signature: [Signature] Date: 7/24/14 Signature: [Signature] Date: 3-10-2015

BOREHOLE LOG

Page 3 of 10

Date: 7-24-2014

Well ID: C2943 Well Name: 299-W22-113 Location: E. of WMA S-SX

Project: TPA M-24 Monitoring Wells Reference Measuring Point: GROUND SURFACE

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
80	G.S.			60'-65' Silt. Silty Sand (cont'd): clumping, non-plastic; Hanford formation.	Cable Tool: 22-W Drive barrel: 2.75' x 8 5/8" OD; CASING = 12"
85	G.S.			65'-80' Sand (100% S); Sand: dry - silt. damp, v. fine - v. coarse grn., ang. - sub ang. v. well sort, 10YR 6/2 Lt. brownish gray, silt. - no rxn to HCl, 60/40 mlt%; Hanford formation.	Archive @ 80' bgs (Elevated Backgrnd.) Archive @ 85' bgs (Elevated)
90	G.S.			@ 70' Sand (100% S); sand: no rxn to HCl, micaceous sands, v. fine - med. grn. "Beach sand"; Hanford formation.	Archive @ 70' bgs (Elevated)
95	G.S.			@ 75' Sand (100% S); sand: v. fine grn., silt. damp w/clumping, v. well sort, ang. - sub. ang. 20/80 mlt%, 10YR 5/3 "brown", no rxn. to HCl	Archive @ 75' bgs (bkgrnd.)
100	G.S.			80'-85' Silt. Silty Sand (85% S, 15% M); Sand: v. fine - fine, silt. damp - dry, v. well sort, ang. - sub. ang. 40/60 mlt%, 10YR 5/3 "brown", silt. - no rxn to HCl; Silt: % increase, compaction clumps, non-plastic, silt. damp;	Archive @ 100' bgs (bkgrnd)
105	G.S.			85'-90' Sand (90% S, 10% M); Sand: v. fine - fine grn., silt. damp - dry, v. well sort, ang. - sub. ang. 20/80 mlt%, 10YR 6/2 Lt. brownish gray; mod. - violent rxn to HCl. Silt: % decrease, dry, non-plastic, small moisture/compaction clumps.	Archive @ 105' (bkgrnd) CABLE TOOL: 22-W DRIVE BARREL: 2.5' x 7" OD; CASING = 8"
110	G.S.			90'-95' Silt (95% M, 5% S); Silt: % increase, dense & compact, massive, semi-plastic, silt. damp - dry, 2.5 YR 5/3 Lt. olive brown, 100 mlt%, violent rxn to HCl; Sand: fine grn., poor sort, ang. - sub. ang. dry;	Archive @ 110'

Reported By: Jess Hocking Reviewed By: Kevin Bergstrom
 Title: Sr. Geologist Title: Sr. Geologist
 Signature: [Signature] Date: 7/28/14 Signature: [Signature] Date: 3-10-2015

BOREHOLE LOG

Well ID: C8943 Well Name: 299-W22-113 Location: E. of WMA S-SX
 Project: TPA M-24 Monitoring Wells. Reference Measuring Point: GROUND SURFACE

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
120	G.S.			95' - 115' Sand (90% S, 10% M); Sand: v.fine - fine grn., dry - silt damp, 10YR 4/2 "lt. brownish gray", 40/60 m/f%, violent rxn to HCl, v. well sort; Silt: % drops, clumping, damp-dry, non-plastic; @ 105' Sand (90% S, 10% M); Sand: v.fine - med. grn., silt damp-dry, ang. - sub. ang., 40/60 m/f%, 10YR 4/2 "lt. brownish gray", sand does not react to HCl - silt does (mod.), well sort, silt remains the same, @ 110' Sand (95% S, 5% M); Sand: fine - coarse grn., silt damp-dry, ang. - sub. ang., silt - no rxn to HCl, 10YR 4/2 "lt. brownish gray", mod. sort; Silt: % decrease, semi-plastic, clumping, damp-dry; 50/50 m/f %;	CABLE TOOL: 22-W DRIVE BARREL: 2.5' x 7" OD Archive @ 120' bgs Archive @ 125' bgs Archive @ 130' bgs Archive @ 135' bgs
125	G.S.				
130	G.S.				
135	G.S.				
140	G.S.				
145	G.S.			115' - 130' Silty Sand (70% S, 30% M); Sand: v.fine grn., silt damp, ang. - sub. ang., mod. rxn to HCl, 2.5YR 4/3 "olive brown", v. well sort; Silt: % increase, damp, semi-plastic, clumping; 10/90 m/f %	Archive @ 140' bgs Archive @ 145' bgs
150	G.S.			@ 120' Silty Sand (70% S, 30% M); Sand: v.fine - med. grn., ang. - sub. ang., v. well sort, mod. rxn to HCl, 2.5YR 4/3 "olive brown"; Silt: remains the same, 20/80 m/f %;	Archive @ 150' bgs
155	G.S.			@ 125' Silty Sand (70% S, 30% M); Sand: 2.5YR 5/3 "lt. olive brown", violent rxn. to HCl; Silt: same as before; 10/90 m/f %;	Archive @ 155' bgs

Reported By: Jess Hocking Reviewed By: Kevin Bergstrom
 Title: Sr. Geologist Title: Sr. Geologist
 Signature: [Signature] Date: 7/31/14 Signature: [Signature] Date: 3-10-2015

BOREHOLE LOG

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Date: 7-31-2014

Well ID: C8943

Well Name: 299-WZZ-113

Location: E. of WMA S-SX

Project: TPA M-24 Monitoring Wells

Reference Measuring Point: GROUND SURFACE

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
160	G.S.			130'-140' Sandy Silt (60% M, 40% S) Silt: % increase, dry, non-compact, semi-plastic, mod. rxn to HCl, 2.5 yk 1/3 "lt. yellowish brown", v. well sort; Sand: v. fine gm, dry, v. well sort, sub ang; 100% felsic	CABLE TOOL: 22-W DRIVE BARREL: 2.5' x 7" OD Archive @ 160' bgs
165	G.S.			@ 135' Sandy Silt (65% M, 35% S); Silt: % increase, dry, non-compact, non-plastic, violent rxn to HCl, 2.5 yk 5/8 "lt. olive brown", v. well sort; Sand: % decrease, v. fine gm, dry, v. well sort, sub. ang - sub. rad; 100% felsic	Archive @ 165' bgs
170	G.S.			140'-145' Silt (95% M, 5% S); Silt: % increase, dry - slt damp, compact & dense in spots, loose in others, semi-plastic, violent rxn to HCl, 2.5 yk 1/3 "olive brown", v. well sort; Sand: v. fine gm, v. well sort, % decrease, dry - slt damp, sub. rad; 100% felsic, staining visible.	Archive @ 175' bgs
175	G.S.				
180	G.S.			145-155' gravelly Sand (80% S, 15% G, 5% M); Sand: v. fine - v. crse gm, ang - sub. ang, mod. sort, dry, 100 mlf %; mod. - violent rxn. to HCl, 2.5 yk 5/8 "gray"; Silt: % decrease, loose, dry, non-plastic, v. well sort; Gravel: 2mm - 4.5" ang - rnd., v. poor sort, basalt, quartzite, feldspar mix (mostly quartzite & feldspars); Caliche present: less than 6", violent rxn to HCl, 2.5 yk 8/16 "white"	Archive @ 180' bgs
185	G.S.	+2 gal H2O			Add 2 gallons H2O @ 182' bgs to aid in drilling.
190	G.S.	+1 gal H2O		@ 185' gravelly Sand (80% S, 15% G, 5% M); Sand med. - v. crse gm, ang - sub. ang, mod. sort, dry, 100 mlf %; no - slt. rxn to HCl, 2.5 yk 1/2 "lt. brownish gray"; Silt & GRAVEL the same.	DRIVE BARREL: 2.5' x 6.5" OD w/whiskers. Archive @ 185' bgs
195	G.S.	+1 gal H2O			Add 1 gallon H2O @ 186' bgs to aid in drilling. Archive @ 190' bgs Add 1 gallon H2O @ 170' bgs to aid in drilling Archive @ 195' bgs.

Reported By: Jess Hocking

Reviewed By: Kevin Bergstrom

Title: Sr. Geologist

Title: Sr. Geologist

Signature: [Handwritten Signature]

Date: 8/4/14

Signature: [Handwritten Signature]

Date: 3-10-2015

BOREHOLE LOG

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Date: 8-4-2014

Well ID: C8943 Well Name: 299-W22-113 Location: E. of WMA S-SX
Project: TPA M-24 Monitoring Wells Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
200	G.S.	+ 1 gal. H ₂ O		155-160' Sand (90% S, 5% G, 5% M) Sand: fine - coarse grn., well sort, dry, 2.5 Y ₁₀ 1/2" lt. brownish gray, no rxn to HCl, ang-sub. ang. 10% mlt %; Gravel: % decrease, rnd.-sub. ang., mostly basalt, 10-30 mm pebbles, v. poor sort; Silt: % same, dry, loose, non-plastic.	CABLE TOOL: 22-W DRIVE BARREL: Add 1 gallon H ₂ O @ 192' bgs to aid in drilling.
205	G.S.	+ 1 gal. H ₂ O		160-165' Silt. Silty Gravelly Sand (75% S, 15% M, 10% G); Sand: v. fine - med. grn., mod. sort, dry, 10% mlt; 2.5 Y ₁₀ 1/2" lt. brownish gray, no rxn to HCl; Gravel: % increase, rnd. - sub. ang., v. poor sort, 10-50mm pebbles, quartzite & basalt mix (mostly quartzite); Silt: % increase, clumping, but mostly dry, loose & non-plastic.	Add 1 gallon H ₂ O @ 199' bgs to aid in drilling.
210	G.S.	+ 1 gal. H ₂ O		165-170' Silt. Silty Sand (75% S, 20% M, 5% G); Sand: v. fine - fine grn, well sort, dry, 10% mlt, 2.5 Y ₁₀ 1/2" brownish gray, no rxn to HCl; Silt: % increase, clumping, but mostly dry, loose & non-plastic; Gravel: % decrease, rnd. - sub. ang., v. poor sort, 5mm - 20mm pebbles, quartzite & basalt mix (mostly quartzite).	Archive @ 200' bgs. Add 1 gallon H ₂ O @ 201' bgs to aid in drilling.
215	G.S.	+ 1 gal. H ₂ O		170-172' Sand (95% S, 5% M): Sand: fine - med. grn, dry - sth. damp, v. well sort, 20% mlt, 2.5 Y ₁₀ 1/2" lt. yellowish brn., no rxn to HCl; Silt: % decrease clumping, loose in spots, non-plastic, non-compact/dense, NO GRAVELS	Add 1 gallon H ₂ O @ 211' bgs to aid in drilling DTW: 235.9' bgs Archive @ 215' bgs.
220	G.S.	+ 1 gal. H ₂ O		172-177' gravelly Sand (75% S, 20% G, 5% M); Sand: fine - med. grn., dry - sth. damp, v. well sort, 20% mlt, 2.5 Y ₁₀ 1/2" lt. brownish gray, no rxn to HCl; Gravel: 5mm - 65mm rng., rnd-ang.	Archive @ 205' bgs. Archive @ 210' bgs. Add 1 gallon H ₂ O @ 226.5' to aid drilling Archive @ 230' bgs (see pg. 9) Archive @ 235' bgs Increase in water 7%
225	G.S.	+ 1 gal. H ₂ O		177-182' Sand (95% S, 5% M): Sand: fine - med. grn, dry - sth. damp, v. well sort, 20% mlt, 2.5 Y ₁₀ 1/2" lt. yellowish brn., no rxn to HCl; Silt: % decrease clumping, loose in spots, non-plastic, non-compact/dense, NO GRAVELS	Archive @ 220' bgs.
230	G.S.	+ 1 gal. H ₂ O		182-187' Sand (95% S, 5% M): Sand: fine - med. grn, dry - sth. damp, v. well sort, 20% mlt, 2.5 Y ₁₀ 1/2" lt. yellowish brn., no rxn to HCl; Silt: % decrease clumping, loose in spots, non-plastic, non-compact/dense, NO GRAVELS	Archive @ 225' bgs (see pg. 9) Add 1 gal H ₂ O @ 226.5' to aid drilling Archive @ 230' bgs (see pg. 9) Archive @ 235' bgs Increase in water 7%
235	G.S.	+ 1 gal. H ₂ O		187-192' Sand (95% S, 5% M): Sand: fine - med. grn, dry - sth. damp, v. well sort, 20% mlt, 2.5 Y ₁₀ 1/2" lt. yellowish brn., no rxn to HCl; Silt: % decrease clumping, loose in spots, non-plastic, non-compact/dense, NO GRAVELS	Archive @ 230' bgs (see pg. 9) Archive @ 235' bgs Increase in water 7%

Reported By: Jess Hocking/Julie Johnson Reviewed By: Kevin Bergstrom
Title: Sr. Geologist/Geologist Title: Sr. Geologist
Signature: [Signature] Date: 8/5/14 Signature: [Signature] Date: 3-10-2015

BOREHOLE LOG

Well ID: **C8943** Well Name: **299-W22-113** Location: **E. of WMA S-SX**

Project: **TPA M-24 Monitoring Wells** Reference Measuring Point: **GROUND SURFACE**

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
240	G.S.			172- 177' Gravelly Sand (cont'd): Gravels: 5mm-65mm rng. rnd.-ang. v. poor sort, basalt/quartzite mix (mostly basalt); % increase; Silt: same as before, clumps, mostly dry; loose, non-plastic, non-dense.	CABLE TOOL: 22-W DRIVE BARREL: 6 5/8" x 4' Archive @ 240' bgs
245	G.S.				Archive @ 245' bgs
250	G.S.			177- 200' Sandy Gravel (60% S, 30% G, 10% M); Sand: fine-med grn. dry, med. sort, 5/80 mlt%, 2.5Y 1/2 lt. brownish gray, no rxn to HCl; Gravel: % increase, 2mm-65mm rng. rnd.-ang., v. poor sort basalt/quartzite mix (mostly basalt); Silt: % increase, dry, loose, non-plastic, non-dense - could possibly be rock flour (hard to tell).	Archive @ 250' bgs DRIVE BARREL: 5 5/8" x 3.54'
255	G.S.				Archive @ 255' bgs
260	G.S.			@ 185' cemented gravels are observed; "CEMENT" does not react to HCl	Archive @ 260' bgs
265	G.S.			@ 188' Sandy Gravel (60% S, 35% G, 5% M); description same as above, % is changed.	
270	G.S.			@ 190' Sandy Gravel (55% S, 40% G, 5% M); Sand: v. fine-med grn., dry, med. sort, 5/95 mlt%, 2.5Y 1/2 lt. gray, no rxn to HCl; Gravel: % increase, 2mm-70mm rng. rnd.-ang., v. poor sort, basalt/quartzite; misc. feldspars (mostly quartzite); Silt: % same, dry, loose, non-dense, non-plastic.	Archive @ 270' bgs TD: 271.30' bgs Current DTW: 232.5' bgs
275				200- 205' Silt. Silty Sand (85% S, 15% M); Sand: med. grn., dry, no rxn to HCl, 5/95 mlt%, ang-sub ang, v. well sort, 10YR 1/2 lt. gray; Silt: % increase, clumps, mostly dry, non-dense, non-plastic	

Reported By: **Jess Hacking / JAMES PATTERSON** Reviewed By: **Kevin Bergstrom**
 Title: **Sr. Geologist** Title: **Sr. Geologist**
 Signature: *[Signature]* Date: **8/7/2014** Signature: *[Signature]* Date: **3-10-2015**

BOREHOLE LOG

Well ID: C8943

Well Name: 299-W22-113

Location: E. of WMA S-SX

Project: TPA M-24 Monitoring Wells.

Reference Measuring Point: GROUND SURFACE

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
				<p>@ 202' <u>slt. silty Sand (80% S, 15% M, 5% G)</u>; Sand: silt description the same; Gravel: <u>rnd. - sub. rnd., 5mm - 40mm rng., v. poor sort, basalt/quartzite mix (mostly quartzite).</u></p>	
				<p>205- <u>Sandy Gravel (60% G, 35% S, 5% M)</u>; Gravel: % increase, v. poor sort, <u>ang - sub. rnd., 5mm - 200mm rng. (broken), basalt/quartzite mix (mostly quartzite)</u>; Sand: <u>fine - v. coarse grn., poor sort, dry, 2.5Y 5/2 "lt. grayish brown", no rxn to HCl, ang - sub. ang, 5/95 m/f %</u>; Silt: % same, <u>dry, non-dense, non-plastic.</u></p>	
				<p>@ 210' <u>Sandy Gravel (75% G, 25% S)</u>; Gravel: % increase, v. poor sort, <u>ang - sub. rnd., 2mm - 70mm rng., basalt/quartzite mix (mostly basalt), dry, cemented gravels seen, HCl does not react with cement</u>; Sand: % decrease, <u>med - v. coarse grn, dry - slt. damp, no rxn to HCl, 2.5Y 4/1 "dk. gray", v. poor sort, ang - sub. ang, 60/40 m/f %, Silt = 0%.</u></p>	
				<p>@ 215' <u>Sandy Gravel (70% G, 25% S, 5% M)</u>; Gravel: % decrease, v. poor sort, <u>ang - sub. rnd., 2mm - 70mm rng., basalt/quartzite mix (~50%)</u>; Sand: % same, <u>fine - med grn., dry, 2.5Y 4/2 "lt. brownish gray", no rxn to HCl, poor sort, 20/70 m/f %</u>; Silt: % increase, <u>dry, loose, non-dense, non-plastic.</u></p>	
				<p>@ 220' <u>Sandy Gravel (50% G, 40% S, 10% M)</u>; Gravel % drops; Sand % increases; Silt % increases; otherwise same as above description; <u>20/80 m/f %; 2.5Y 4/2 "lt. brownish gray"; no rxn to HCl.</u></p>	

Max Used JST 11-5-14

Max Used JST 11-5-14

Reported By: Jess Hocking

Reviewed By: Kevin Bergstrom

Title: Sr. Geologist

Title: Sr. Geologist

Signature: [Signature]

Date: 8/11/14

Signature: [Signature]

Date: 3-10-2015

BOREHOLE LOG

Page 10 of 10

Date: 8-12-14

Well ID: C8948 Well Name: 299-W22-113 Location: E of WMA 5-5A
 Project: TPA M-24 MONITORING WELLS Reference Measuring Point: GROUND SURFACE

Depth (Ft.)	Sample		Graphic Log	Sample Description	Comments
	Type No.	Blows Recovery			
				<p>@ 260' hgt INCREASE IN SILT CONC. 60% GRAVEL, 20% SAND, 20% SILT GRAVEL: 5mm to 150mm, well rounded, sub angular to sub rounded; SAND: 1/2 to 1/4 well sorted, mostly feldic w/ some mafic (15%); SILT: 35% med, 65% fine SILT: 2.5YR 4/4 (olive brown) SANDY GRAVEL: 10YR 4/2 (Dk Gray Brown) SOIL SATURATED; MAX SIZE: 150mm Silty Sandy Gravel mg G K⁸ 3-10-2015</p>	CABLE TOOL W/ DRIVE BARREL
				<p>@ 265' hgt SANDY GRAVEL (SG) 60% GRAVEL, 20% SAND, 20% SILT GRAVEL: 3-140mm, well rounded, discoidal to spherical, feldic, some I.T. white SAND: FINE TO COARSE, but mostly MED. 80% feldic, 10% intermediate, 10% mafic sub angular to sub rounded w/ some very angular due to drilling. SILT: 2.5YR 4/4 (olive brown), mostly feldic w/ some mafic SANDY GRAVEL: 10YR 4/2 (Dk Gray Brown) Saturated, max size: 140mm</p>	
				<p>@ 270' hgt SANDY GRAVEL (SG) 60% GRAVEL, 40% SAND, little to no silt. GRAVEL: 5-160mm, well rounded, spherical to discoidal, mostly feldic (quartzite) SAND: Mostly med w/ some fine to coarse, well sorted, light brown (7.5YR 6/3), moist but not saturated; Max ~160mm</p>	

Max Used STAT 11-5-14

Max Used STAT 11-5-14

Reported By: JAMES PATTERSON Reviewed By: Kevin Bergstrom
 Title: GEOLOGIST Title: Sr. Geologist
 Signature: [Signature] Date: 11-5-14 Signature: [Signature] Date: 3-10-2015



299-W22-113 (C8943) Log Data Report

Borehole Information:

Log Date:	2014-08-22	Filename:	C8943_HG-NM_2014-08-22	Site:	M-24 Well East of S Farm
Coordinates (WA St Plane)		DTW¹ (ft):	234.45	DTW Date:	08/25/14
North (m)	East (m)	Drill Date	TOC² Elevation	Total Depth (ft)	Type
N/A	N/A	08/12/14	N/A	271.3	Cable Tool

Casing Information:

Casing Type	Stickup (ft)	Diameter (in.)		Thickness (in.)	Top (ft)	Bottom (ft)
		Outer	Inside			
Threaded Steel	0.5	11 7/8	10 7/8	0.5	0.5	105.33
Threaded Steel	2.0	8 5/8	7 5/8	0.5	2.0	270.5

Borehole Notes:

The total depth and casing depth are provided by the onsite geologist. The logging engineer measured casing stick-up and casing diameter (rounded to the nearest 1/16-in.). Depth to water was measured at 234.45 ft by the geologist on August 25. At the time of logging August 21, depth to water inside the casing was 237.25 ft according to the moisture log. August 22, the depth to water inside the casing was 235 ft as determined by the gamma logs. The maximum logging depth achieved was 273 ft, approximately 2.5 ft below the reported casing depth.

During SGLS logging on July 29, the logging system experienced winch problems and logging was terminated at 62 ft; moisture data had been acquired to 105 ft prior to the SGLS logging. A decision was made by the BTR to restart drilling rather than wait for the necessary repairs to complete logging to 105 ft. Therefore, no SGLS log data were acquired from 62 to 100 ft. The next logging occurred on August 20 starting at 100 ft after the equipment was repaired.

Zero reference is ground surface.

Logging Equipment Information:

Logging System:	Gamma 4N	Type:	60% HPGe SGLS ³
Effective Calibration Date:	08/23/13	Serial No.:	45-TP22010A
Calibration Reference:	HGLP-CC-091, Rev. 0	Logging Procedure:	HGLP-MAN-002, Rev. 1

Logging System:	Gamma 1L	Type:	60% HPGe SGLS
Effective Calibration Date:	11/11/13	Serial No.:	47-TP32211A
Calibration Reference:	HGLP-CC-096, Rev. 0	Logging Procedure:	HGLP-MAN-002, Rev. 1

Logging System:	Gamma 1H	Type:	NMLS ⁴
Effective Calibration Date:	11/11/13	Serial No.:	H310700352
Calibration Reference:	HGLP-CC-097, Rev. 0	Logging Procedure:	HGLP-MAN-002, Rev. 1

¹ depth to water inside casing

² top of casing

³ Spectral Gamma Logging System

⁴ Neutron Moisture Logging System



Logging System:	Gamma 4M	Type:	NMLS
Effective Calibration Date:	08/21/13	Serial No.:	H340207279
Calibration Reference:	HGLP-CC-097, Rev. 0	Logging Procedure:	HGLP-MAN-002, Rev. 1

SGLS Log Run Information:

Log Run	3	7	8	9 Repeat	
HEIS Number	1018459	1018460	1018461	1018462	
Date	07/29/14	08/21/14	08/22/14	08/22/14	
Logging Engineer	Pope	Felt	Felt	Felt	
Start Depth (ft)	0.0	100.0	160.0	170.0	
Finish Depth (ft)	62.0	161.0	273.0	187.0	
Count Time (sec)	100	100	100	100	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
Log Speed (ft/min)	N/A	N/A	N/A	N/A	
Pre-Verification	DNK21CAB	AL207CAB	AL208CAB	AL208CAB	
Start File	DNK21000	AL207000	AL208000	AL208114	
Finish File	DNK21062	AL207061	AL208113	AL208131	
Post-Verification	Not acquired	AL207CAA	AL208CAA	AL208CAA	
Depth Return Error (in.)	0.0	0.0	N/A	0.5 low	
Comments	No fine gain adjustments made				

NMLS Log Run Information:

Log Run	1	2 Repeat	4	5	6 Repeat
HEIS Number	1018463	1018464	1018465	1018466	1018467
Date	07/29/14	07/29/14	08/20/14	08/20/14	08/21/14
Logging Engineer	Pope	Pope	Felt	Felt	Felt
Start Depth (ft)	0.0	20.0	100.0	194.25	140.0
Finish Depth (ft)	105.0	22.0	194.0	237.25	154.0
Count Time (sec)	15	15	15	15	15
Live/Real	R	R	R	R	R
Shield (Y/N)	N	N	N	N	N
MSA Interval (ft)	0.25	0.25	0.25	0.25	0.25
Log Speed (ft/min)	N/A	N/A	N/A	N/A	N/A
Pre-Verification	DMX72CAB	DMX72CAB	AH169CAB	AH170CAB	AH171CAB
Start File	DMX72000	DMX72421	AH169000	AH170000	AH171000
Finish File	DMX72420	DMX72429	AH169376	AH170172	AH171056
Post-Verification	DMX72CAA	DMX72CAA	AH170CAA	AH170CAA	AH171CAA
Depth Return Error (in.)	N/A	0.0	N/A	1.0 high	0.5 high
Comments	None	None	None	None	None



Logging Operation Notes:

A centralizer was installed on the sondes.

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

Analysis Notes:

Analyst:	P.D. Henwood	Date:	08/28/14	Reference:	HGLP-MAN-003, Rev. 0
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A casing correction for a 1/2-in. thick casing was applied to the log data for the entire borehole except for the depth interval from 100 to 105 ft where two casings existed. A combined casing correction for a 1-in. thick casing was applied for this interval. No correction was applied to the bottom three ft of the borehole.

A correction for water inside the casing was applied below 235 ft in depth.

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in EXCEL templates identified as 1L20131111 and 4N20130823, using an efficiency function and corrections for casing and dead time as determined by annual calibration.

NMLS data are represented in counts per second.

The HGU⁵ 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:

Cs-137 was detected at the ground surface at less than 1 pCi/g. The MDLs for Cs-137 are plotted on the Manmade Radionuclide plot for the entire borehole.

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

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

List of Log Plots:

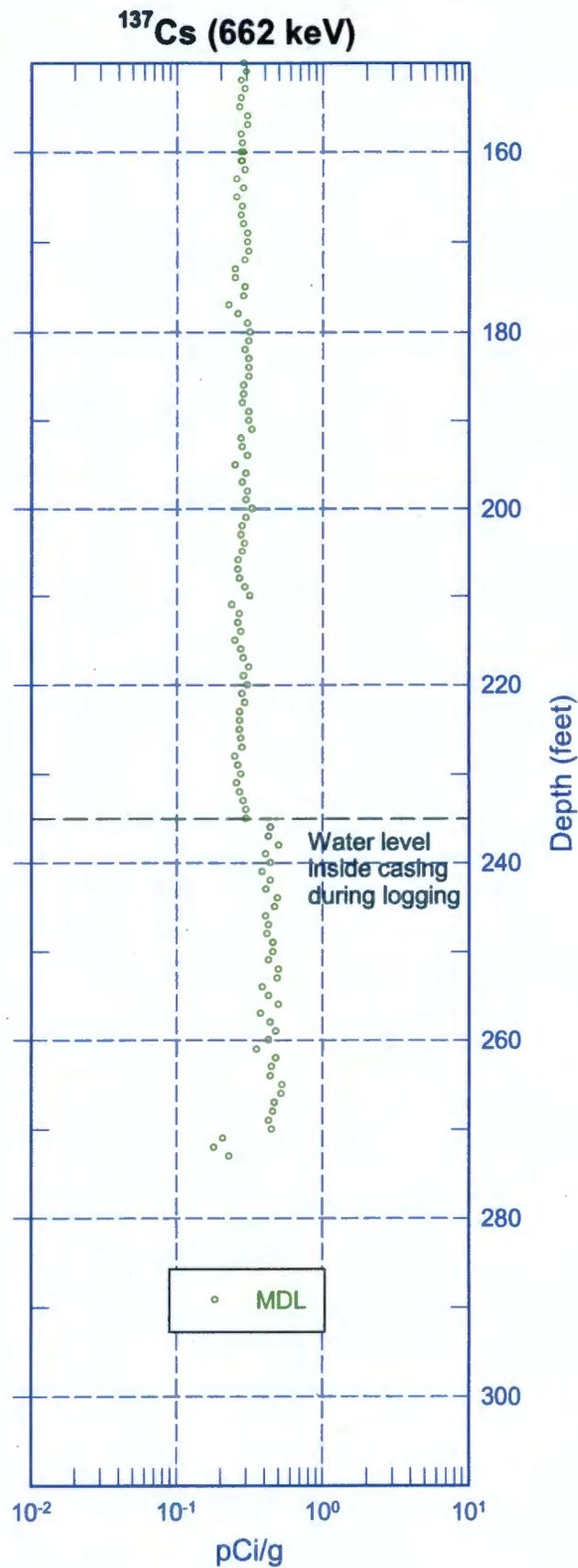
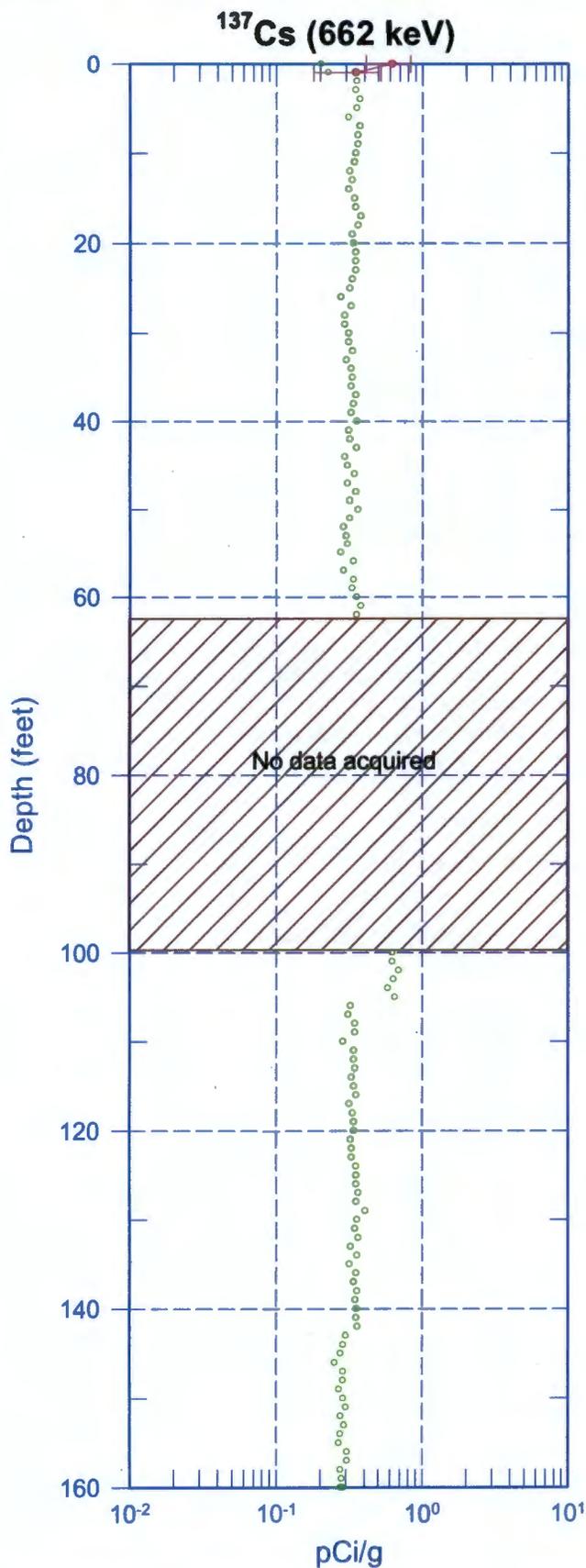
Depth Reference is ground surface.

Manmade Radionuclides (0-310)
 Natural Gamma Logs (0-160)
 Natural Gamma Logs (150-310)
 Combination Plot (0-120 ft)
 Combination Plot (110-230 ft)
 Combination Plot (220-340 ft)
 Combination Plot (0-280 ft)
 Total Gamma & Moisture (0-160)
 Total Gamma & Moisture (150-310)
 Total Gamma & Hanford Gamma Unit (0-280)
 Repeat Section of Natural Gamma Logs (170 to 187 ft)
 Moisture Repeat Section (140 to 154 ft)

⁵ Hanford Gamma Unit

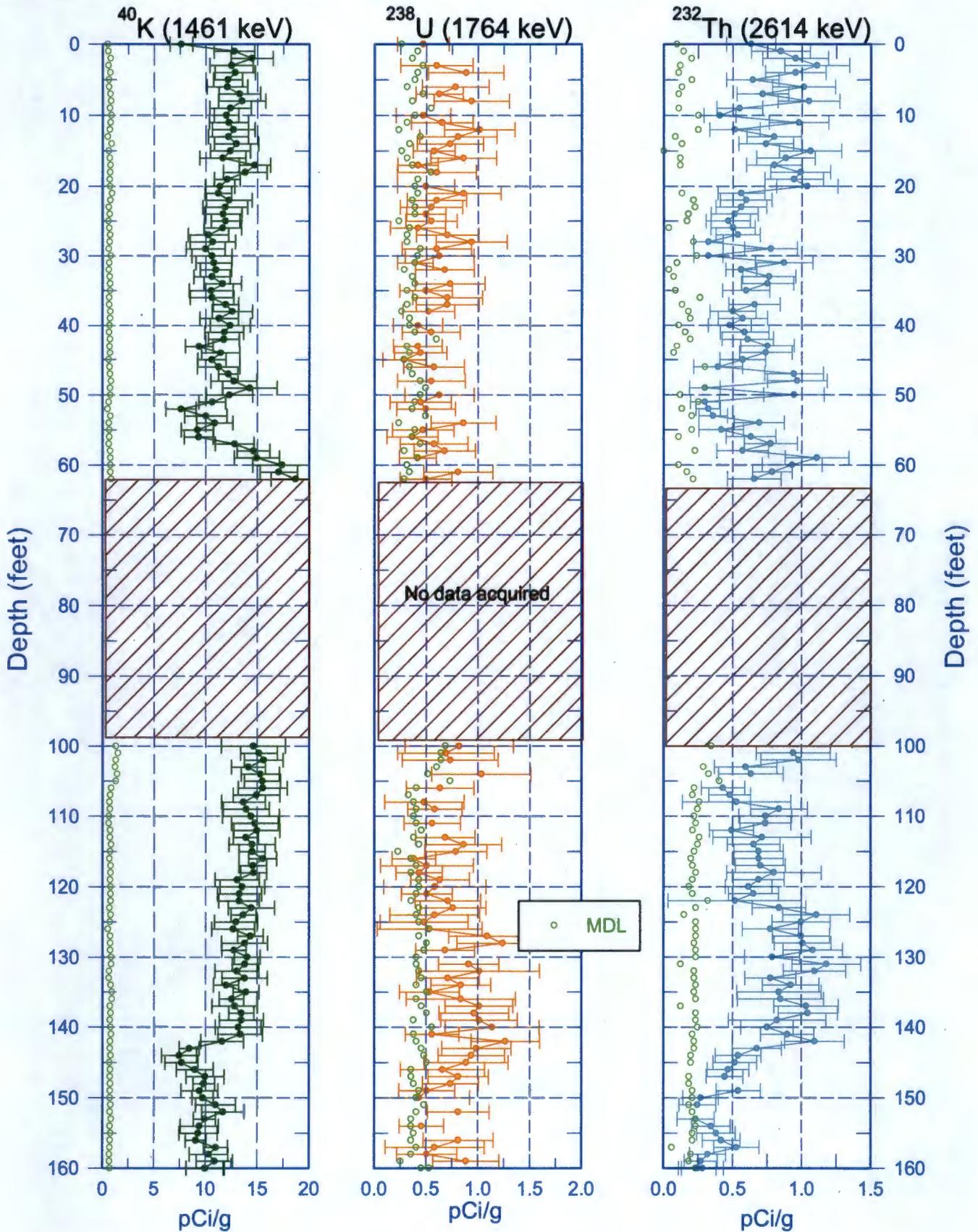


299-W22-113 (C8943) Manmade Radionuclides





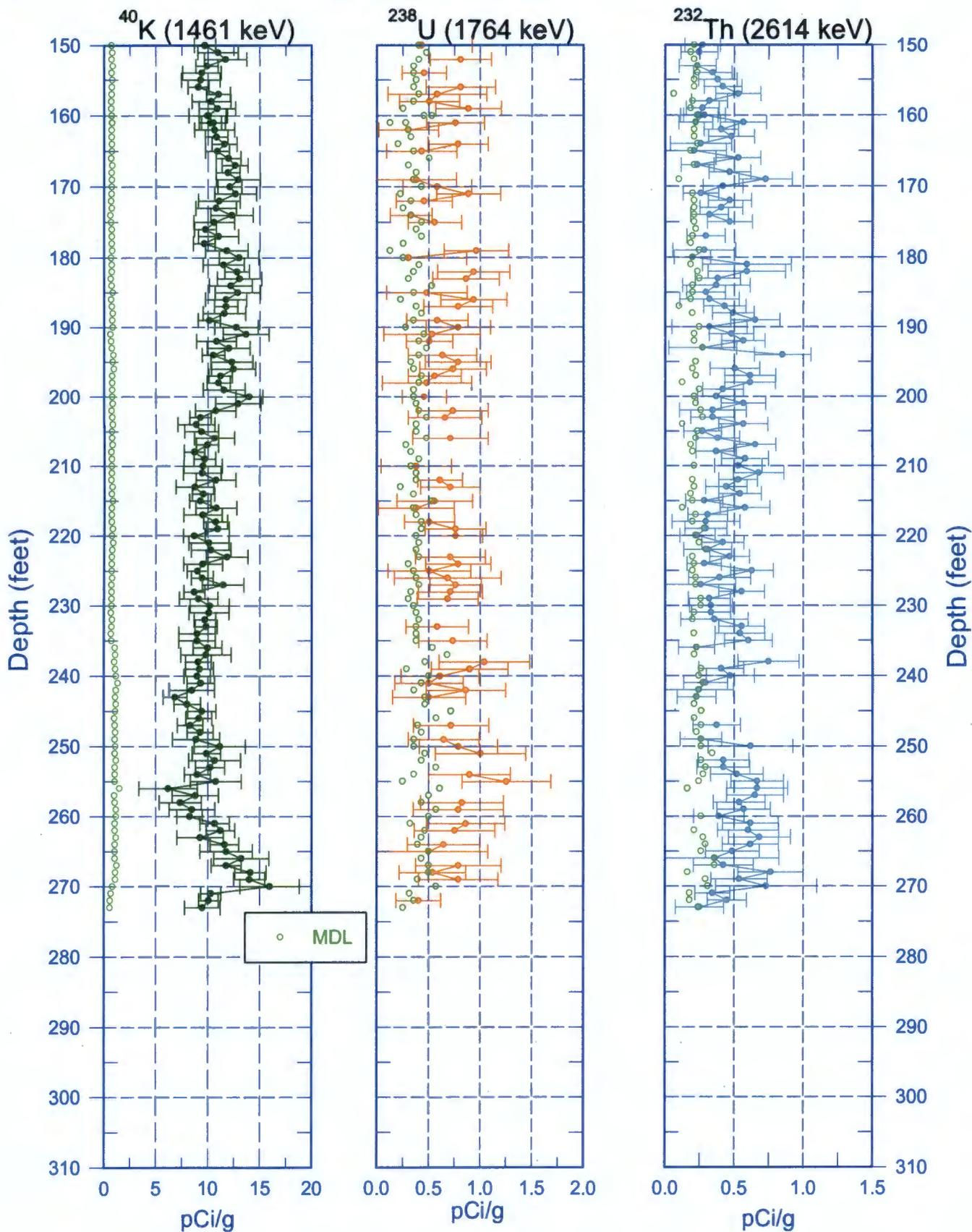
299-W22-113 (C8943) Natural Gamma Logs



Zero Reference - Ground Surface

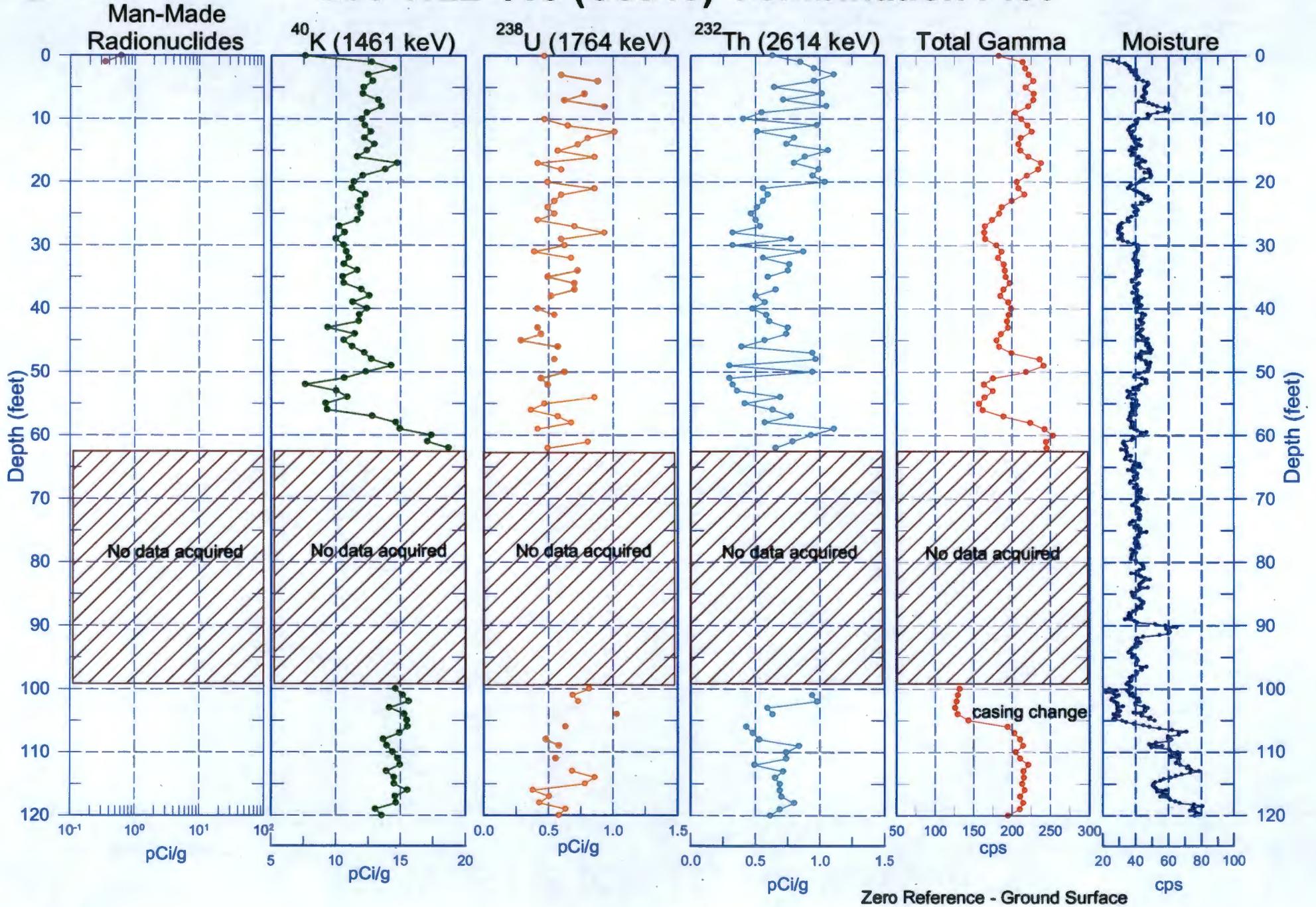


299-W22-113 (C8943) Natural Gamma Logs

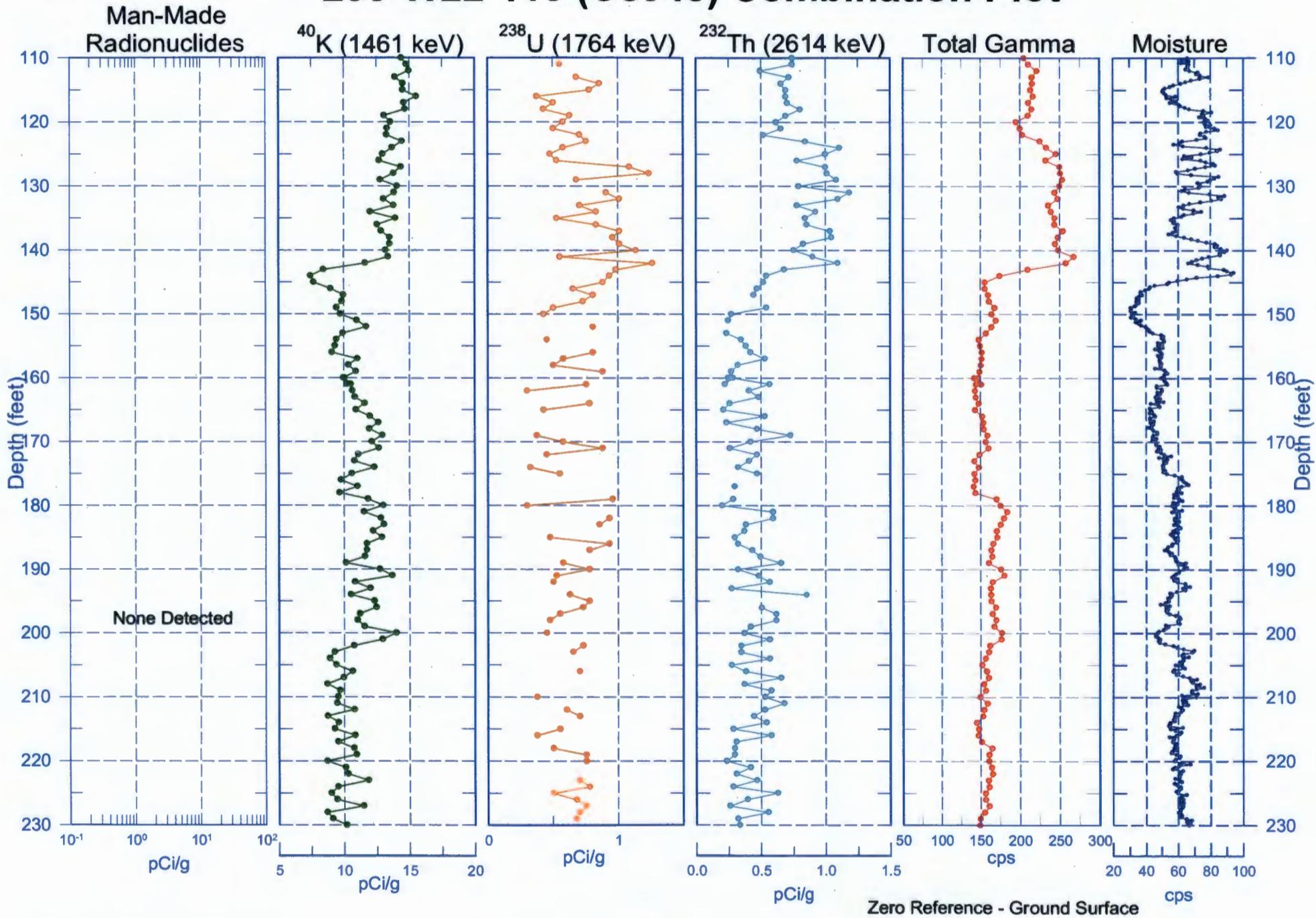


Zero Reference - Ground Surface

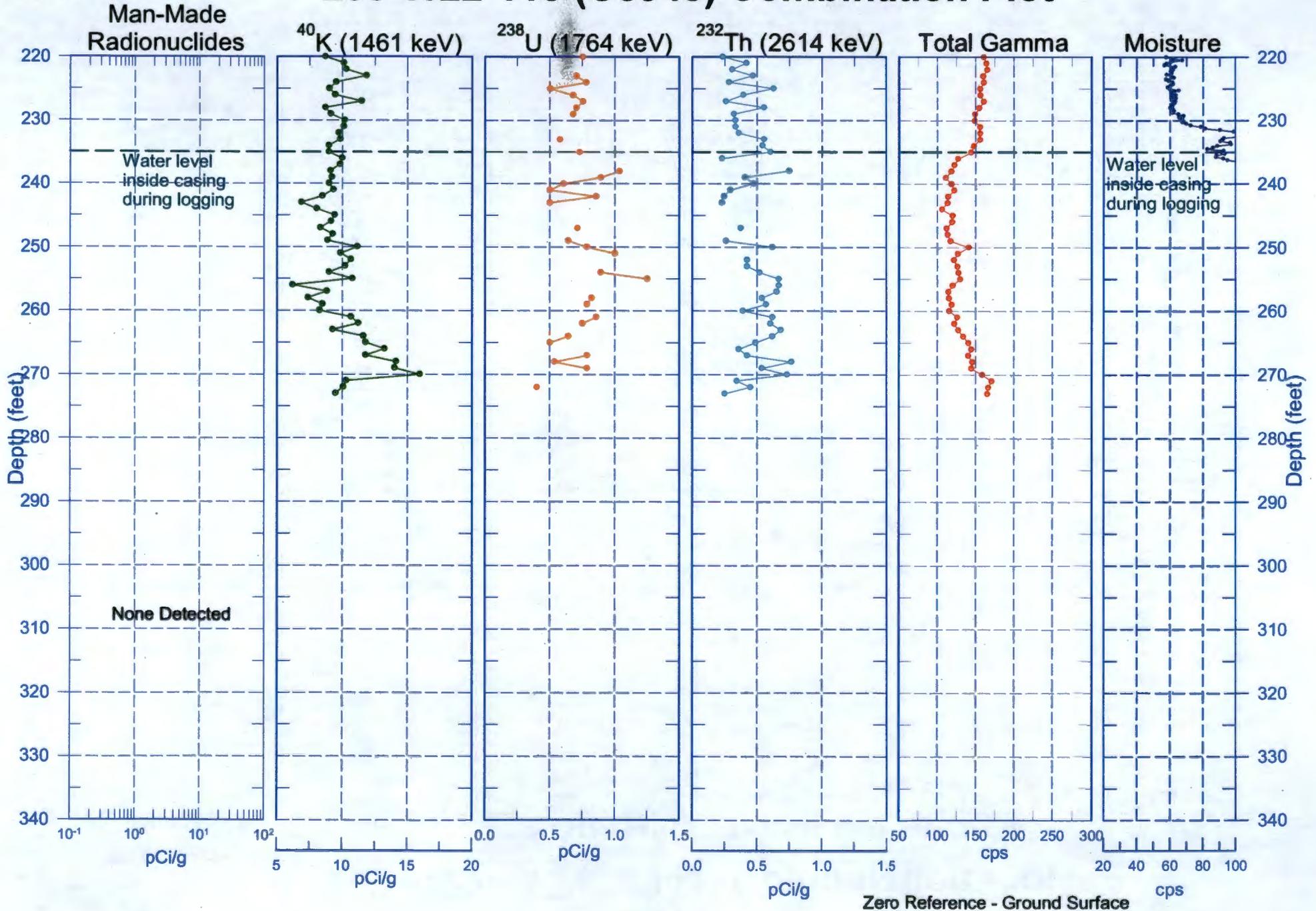
299-W22-113 (C8943) Combination Plot



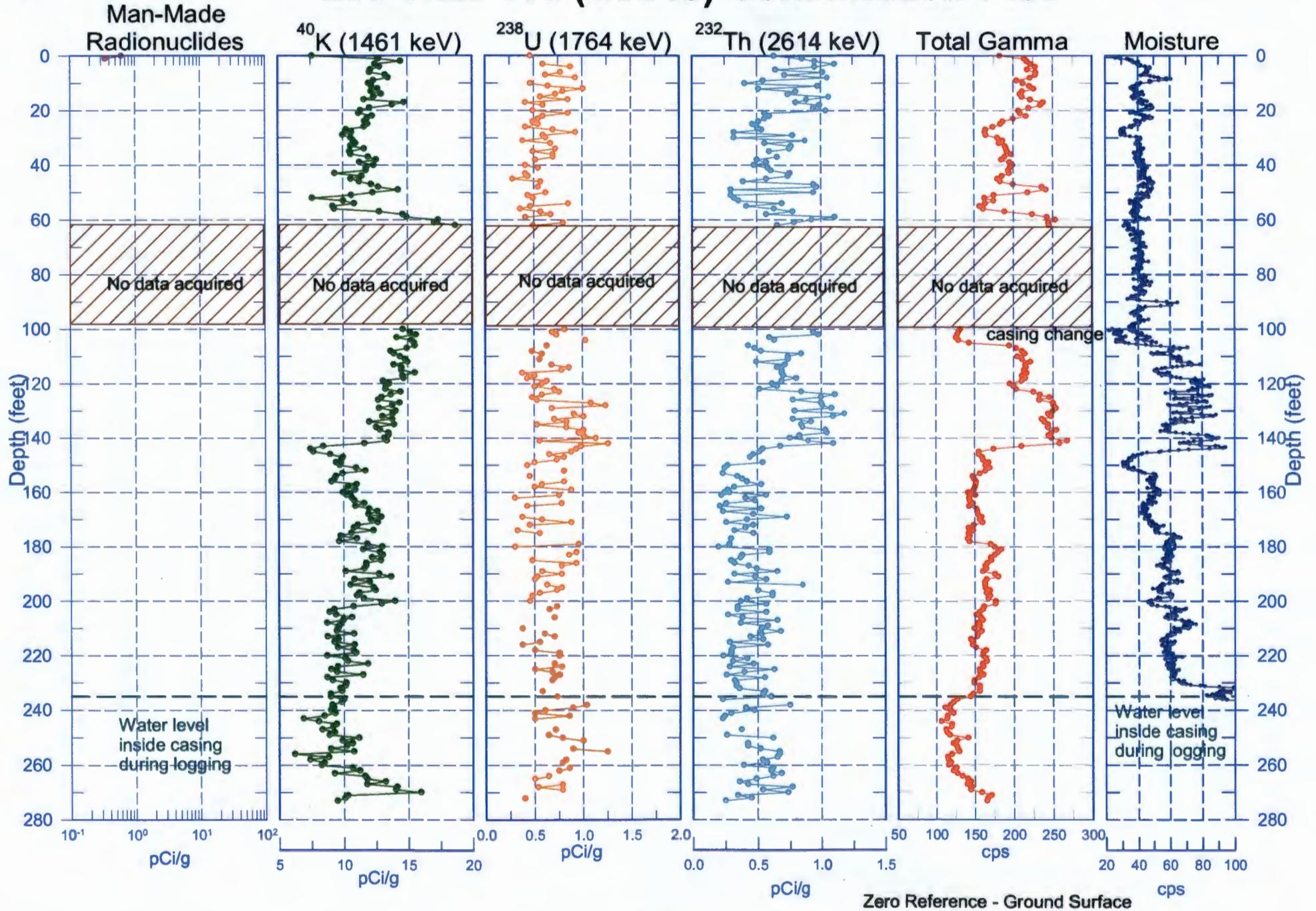
299-W22-113 (C8943) Combination Plot



299-W22-113 (C8943) Combination Plot

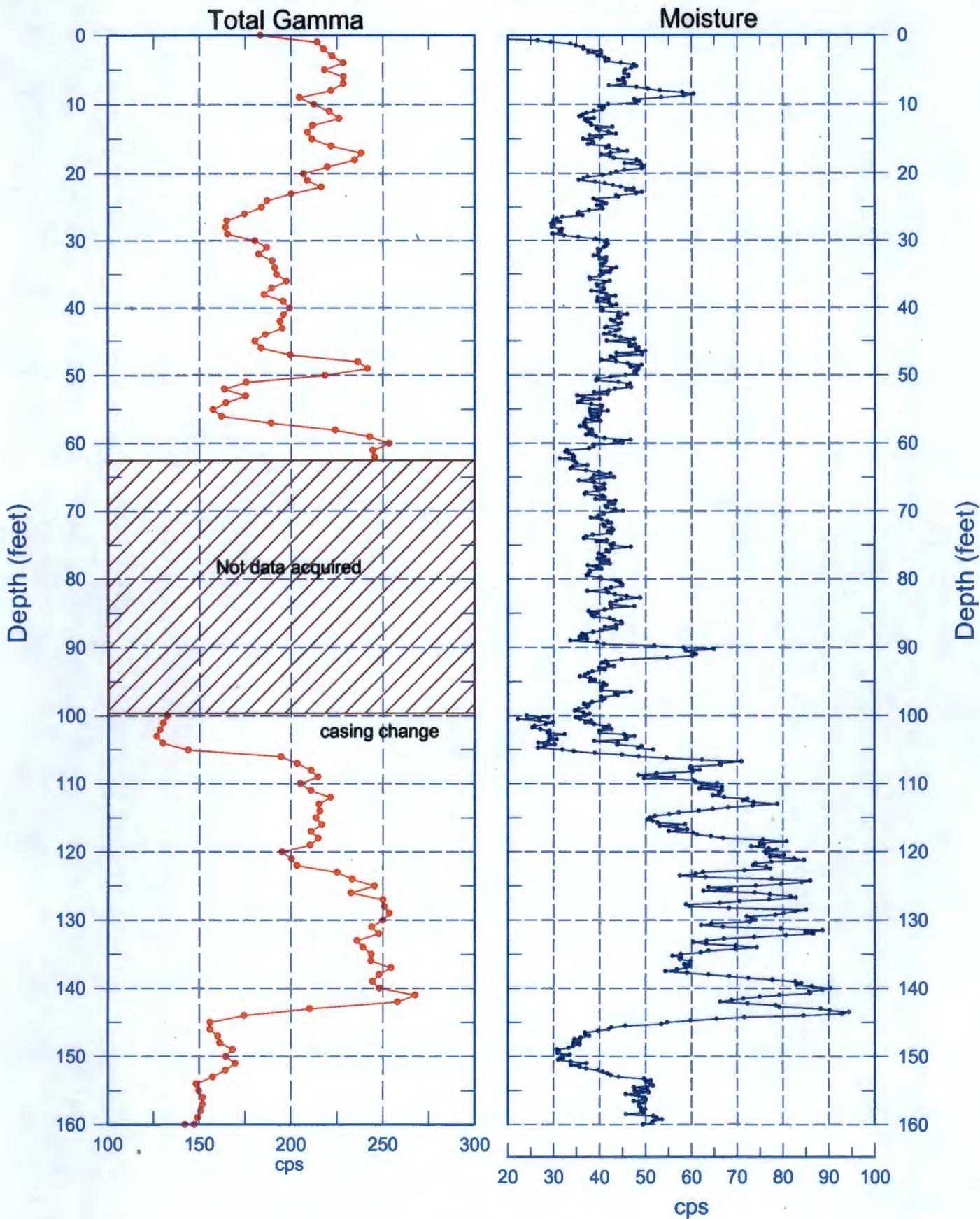


299-W22-113 (C8943) Combination Plot





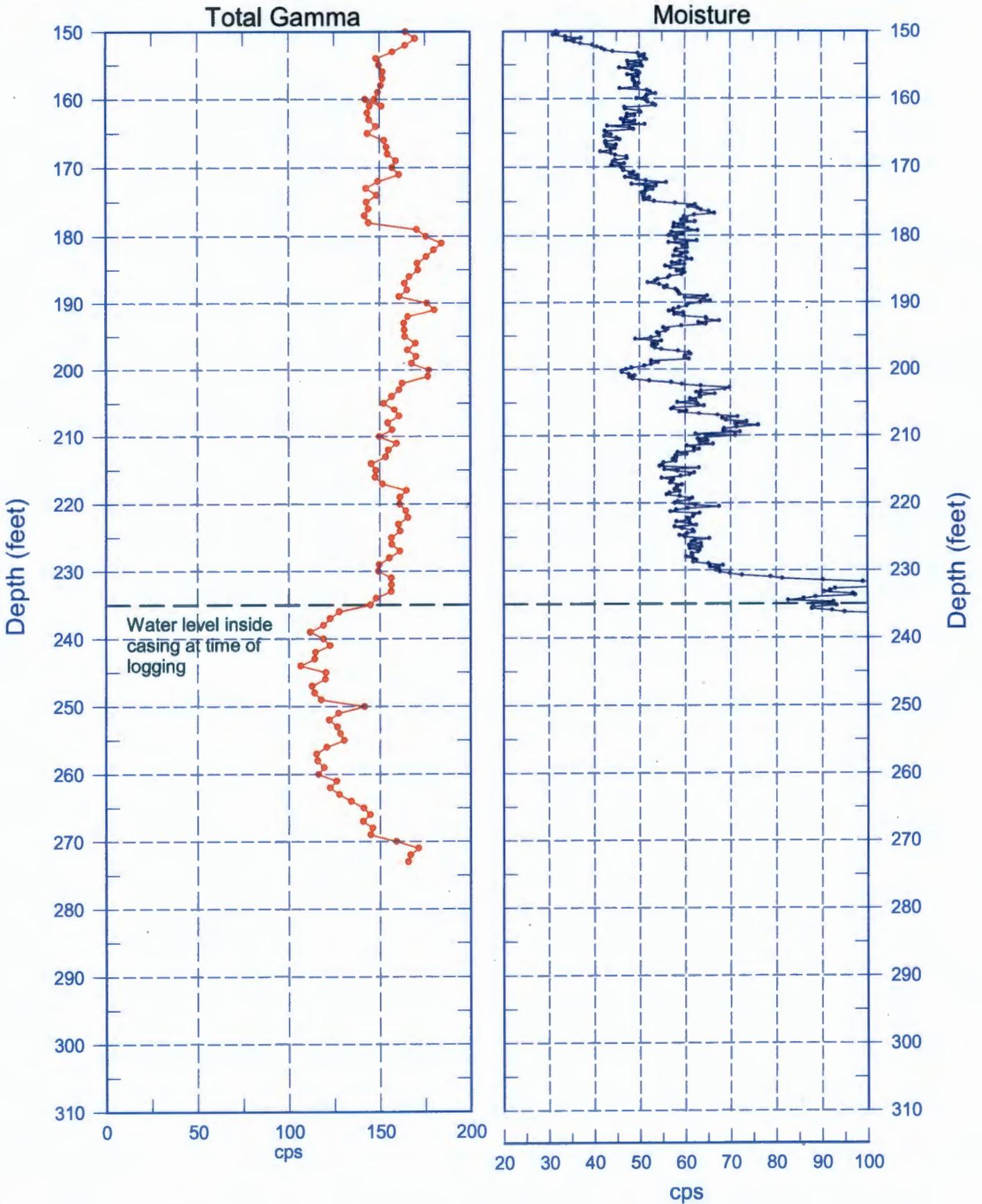
299-W22-113 (C8943) Total Gamma & Moisture



Reference - Ground Surface



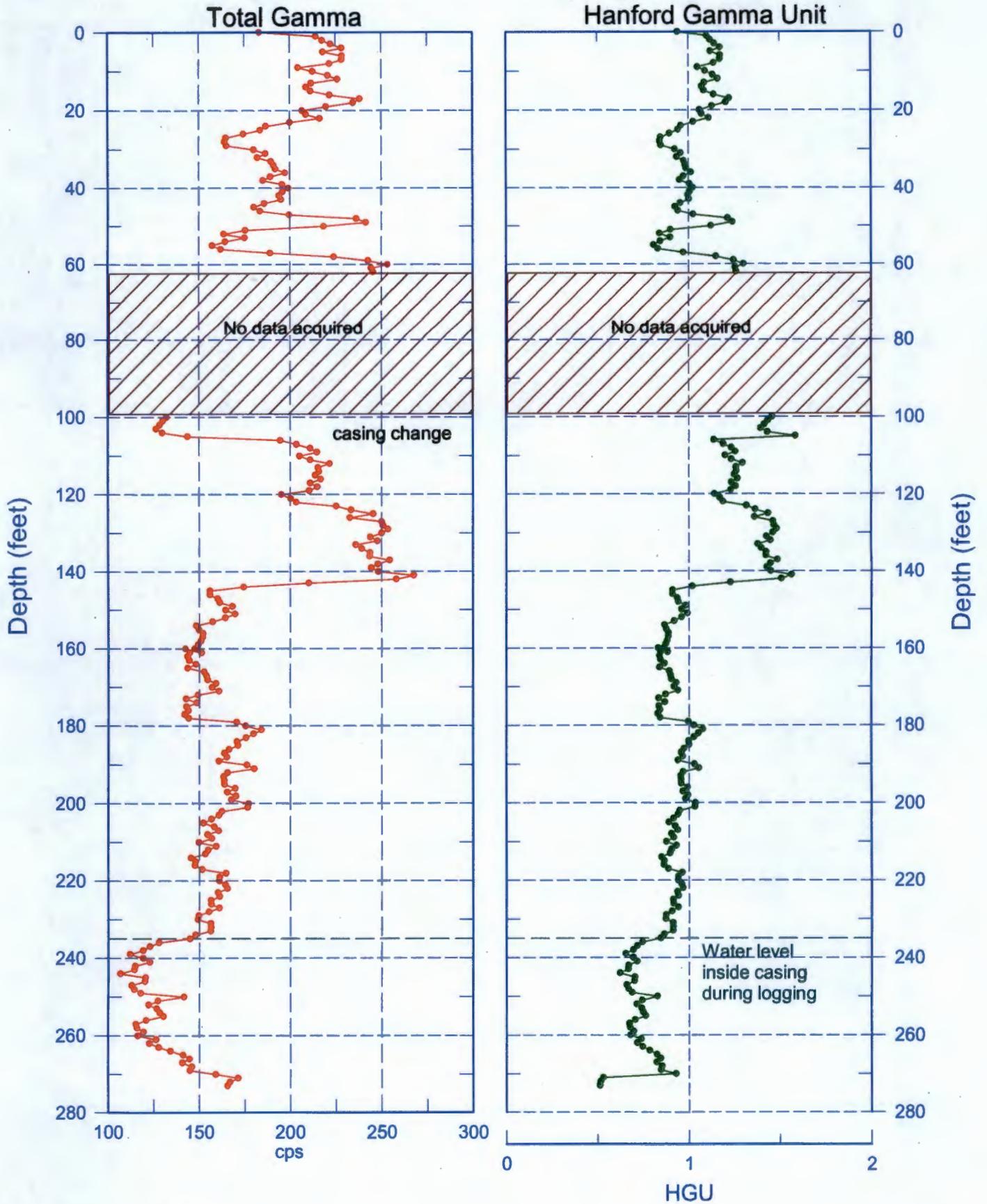
299-W22-113 (C8943) Total Gamma & Moisture





299-W22-113 (C8943)

Total Gamma & Hanford Gamma Unit

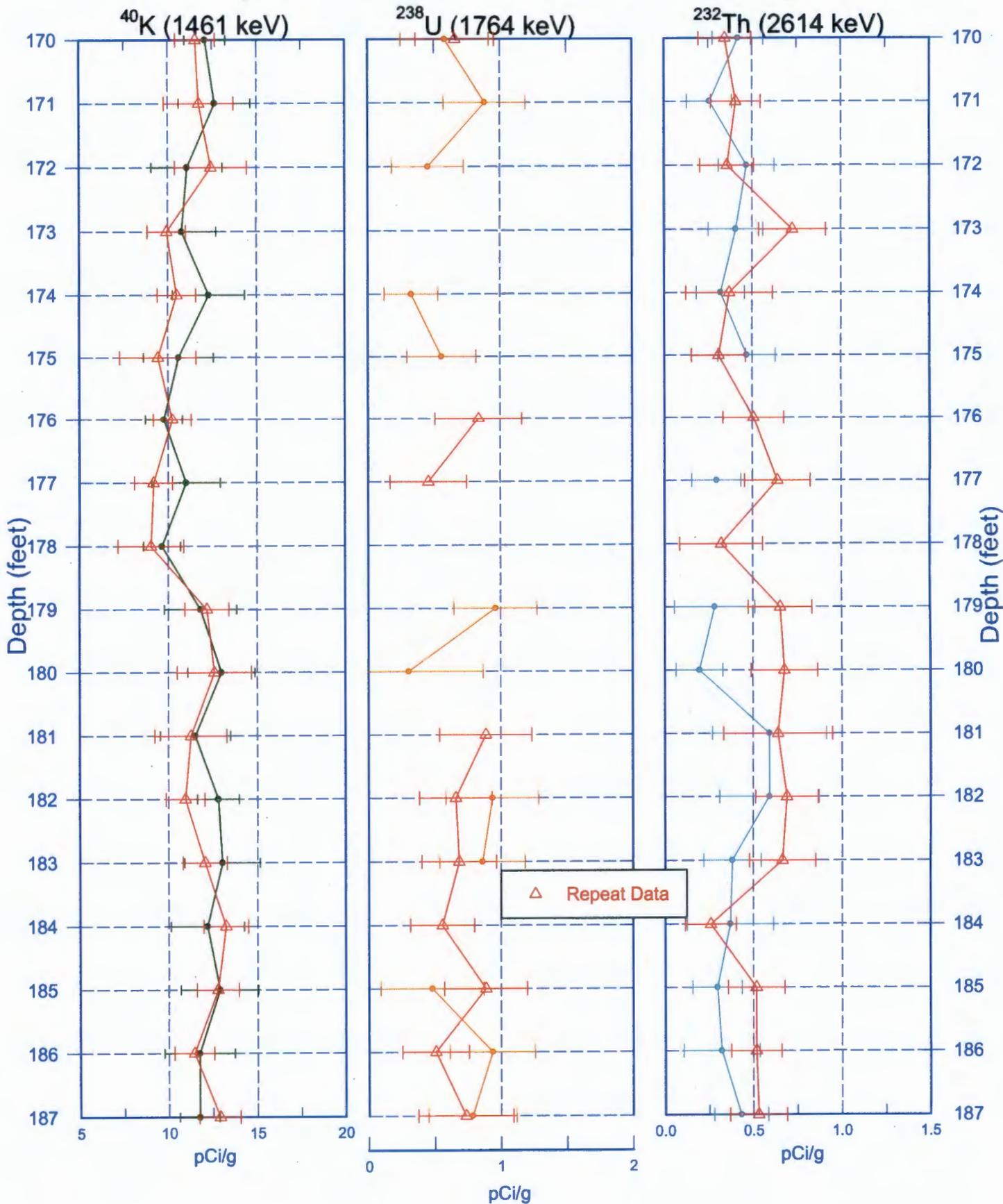


Reference - Ground Surface



299-W22-113 (C8943)

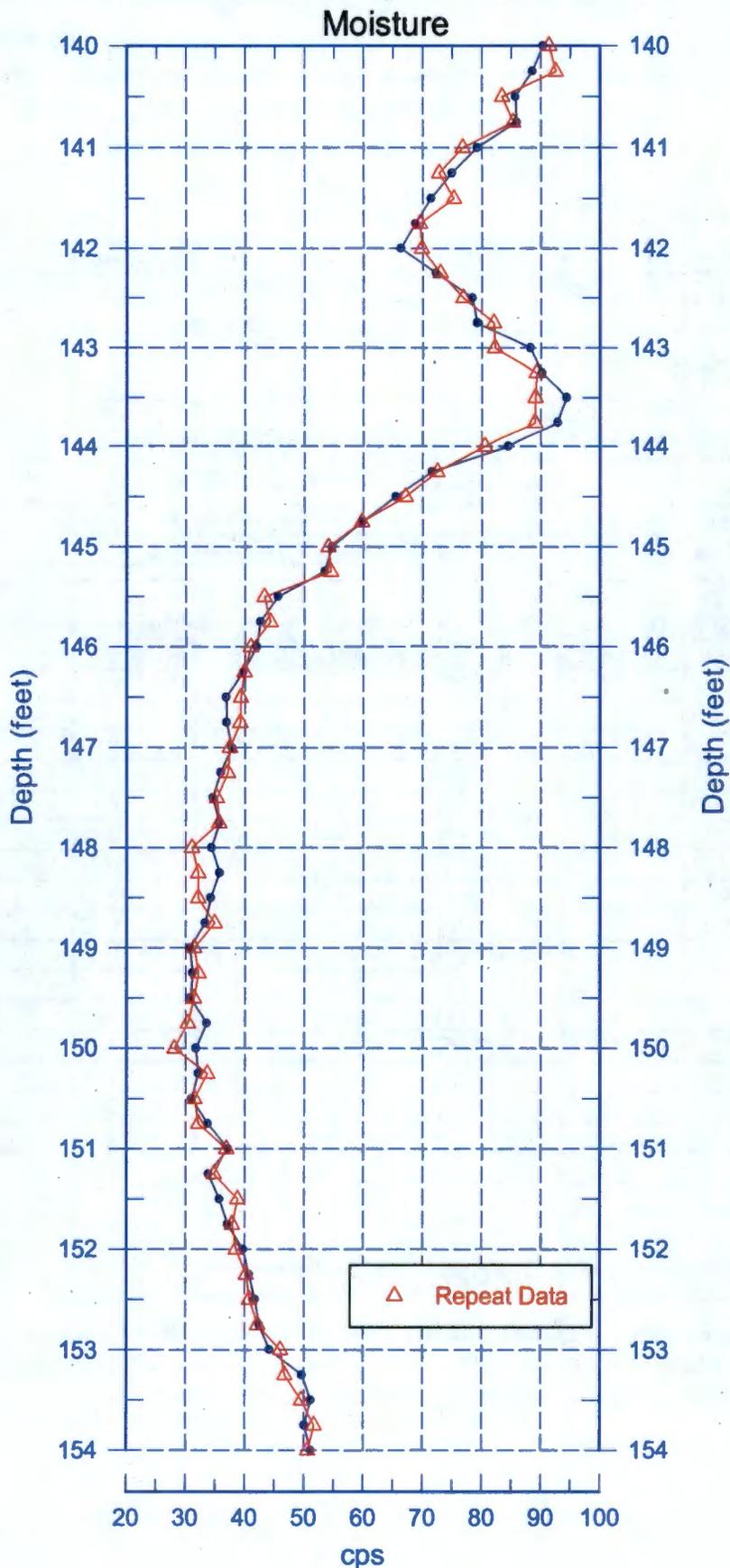
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface



299-W23-113 (C8943) Moisture Repeat Section



Reference - Ground Surface



HGLP-LDR-815, Rev. 0

299-W22-113 Log Data Report

Borehole Information:

Borehole:	299-W22-113	Well ID:	C8943	Client:	CHPRC
Log Date		Engineer		Depth Reference	Site
12/16/2014		Felt		Top of Casing	East of SX farm

Log Run Information:

Logging System:	Borehole Deviation	Model:	DG69-0901-4 #4654
Calibration Date:	10/27/2014	Calibration Reference:	HGLP-CC-110, Rev. 0
		Logging Procedure:	HGLP-PRO-005, Rev. 2

Log File:	299-W22-113.raw	Report File:	299-W22-113.rpt
Sight Line:	083	Magnetic Declination:	-15.25

Measured Depth (feet)	Course Incl. from Vert.	Course Direction (deg)	Closure Direction (deg)	True Vert. Depth (feet)	Rectangular Coordinates		Dogleg Severity %/100 f	Closure Distance (feet)
					+N/-S	+E/-W		
1	0.19	355.6	155.37	1	-0.01	0.01	183.7	0.01
20	0.4	184.8	183.01	20	-0.05	0	3	0.05
40	0.3	141.2	171.1	40	-0.16	0.02	1.4	0.16
60	0.3	160.2	163.07	60	-0.24	0.07	0.5	0.26
80	0.3	160.5	162.29	80	-0.34	0.11	0	0.36
100	0.3	143.7	159.99	100	-0.43	0.16	0.4	0.46
120	0.31	147.8	157.32	120	-0.52	0.22	0.1	0.57
140	0.28	155.3	156.4	140	-0.61	0.27	0.3	0.67
160	0.31	143.1	155.42	160	-0.7	0.32	0.3	0.77
180	0.47	139.7	153.29	180	-0.81	0.41	0.8	0.9
200	1.13	133.8	149.12	200	-1.01	0.6	3.3	1.17
220	1.58	117.7	142.14	219.99	-1.27	0.99	2.9	1.61
240	2.25	101.6	132.46	239.98	-1.48	1.62	4.3	2.19
260	3.23	90.6	121.39	259.96	-1.56	2.56	5.5	3
267.6	3.27	90.7	117.66	267.54	-1.57	2.99	0.6	3.38

Analysis Notes:

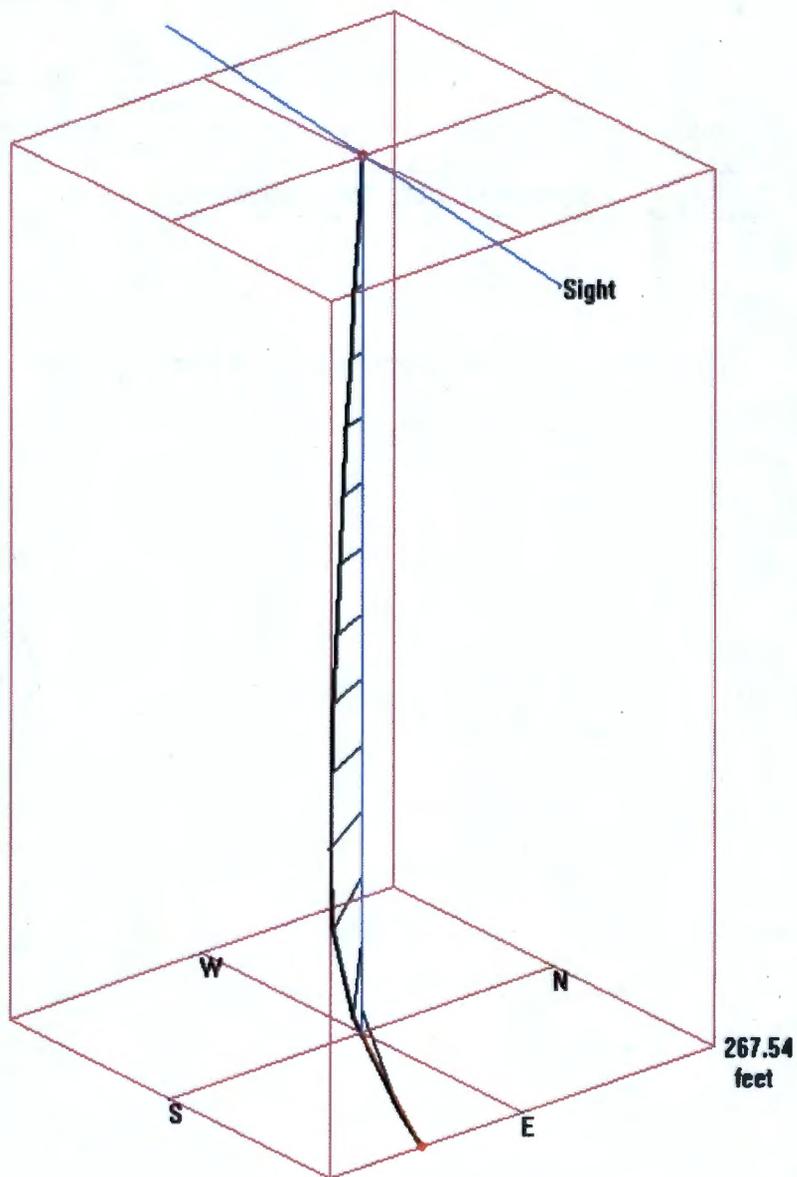
Analyst:	Felt	Date:	12/17/2014
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Plots are for illustrative purposes. Sight line is initial orientation of tool. Borehole trajectory determined by minimum curvature method. Refer to table for true vertical depth and N/S and E/W deviation in feet. Due to a restriction associated with the logging truck boom, this log run started at 1.0 ft.

List of Log Plots:

Borehole Deviation

299-W22-113
Borehole Deviation



SURVEY DATA REPORT				Request No. 152-060		
Project No.	Title M-24 Wells C8925 & C8943 Final Surveys			File No. 2WT12R25		
Job. No. CACN: 303345-JPRC	Prepared By N.P. Fastabend	Date 2/11/15	Reviewer <i>CBM</i>			
DESCRIPTION OF WORK			DISTRIBUTION	SDR	PLOT	DWG
Obtained final coordinates (C/L Casings) and elevations of completed M-24 Wells C8925 (299-W18-260) and C8943 (299-W22-113) in 200W Area. Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)			Survey File	OR		
			J.D. Mehrer	1		
			S.J. Trent	1		
			K.M. Whitley	1		
			J.B. Geiger	1		
			B.J. Howard	1		
			A.J. Green	1		
SURVEY RESULTS AND COMMENTS						
<p>See Attached Well Survey Data Report Sheets</p>						

WELL SURVEY DATA REPORT

Project:	Prepared By: Neil P. Fastabend Company: CHPRC
Date Requested: 01/21/15	Requestor: Kelly Whitley (CHPRC)
Date of Survey: 02/11/15	Surveyor: Lawrence B. Munnell (CHPRC)
Fluor Hanford Point of Contact:	Survey Co. Point of Contact: Neil P. Fastabend

Description of Work: Obtain final survey coordinates (C/L Casing) and elevations of M-24 Well C8943 (299-W22-113) located east of 241-SX Tank Farm in 200W Area.	Horizontal Datum: NAD83(91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 200W

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
2W-73 (CHPRC) and 2W-157 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C8943	299-W22-113	566904.52	134192.75		Center of Casing
					"X" on Rim
				204.041	Brass Survey Marker

Notes:

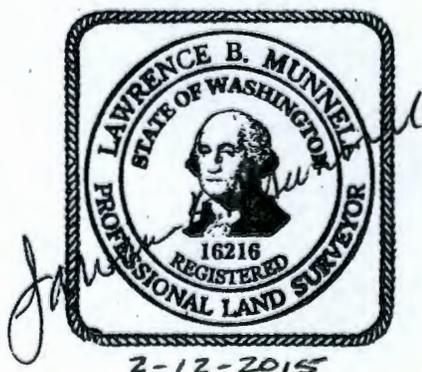
204.756 Top Pump Base-plate, North Edge

204.750 Top Outer 6in Casing, North Edge

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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



2-12-2015

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