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Revision 0

Borehole Summary Report for the Installation of Two Wells in the 100-KR-4 Operable Unit, with an option of Three Wells, FY 2014

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

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



P.O. Box 1600
Richland, Washington 99352



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Borehole Summary Report for the Installation of Two Wells in the 100-KR-4 Operable Unit, with an option of Three Wells, FY 2014

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J. Holland
Freestone Environmental, Inc.

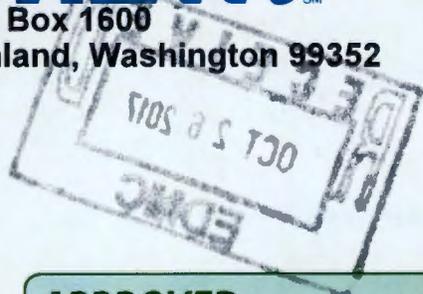
K. Schuyler
Freestone Environmental, Inc.

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ch2mSM
P.O. Box 1600
Richland, Washington 99352



APPROVED
By Ashley R Jenkins at 7:59 am, Jul 14, 2015

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Terms

| | |
|----------------|--|
| bgs | below ground surface |
| CHPRC | CH2M Hill Plateau Remediation Company |
| Cr(VI) | hexavalent chromium |
| ft | feet |
| HCl | hydrochloric acid |
| HEIS | Hanford Environmental Information System |
| KE | 100-K East |
| KW | 100-K West |
| NMLS | Neutron Moisture Logging System |
| OU | operable unit |
| Ringold Unit E | Ringold Formation member of Wooded Island Unit E |
| RUM | Ringold Upper Mud unit |
| SGLS | Spectral Gamma Logging System |
| SN3 | Stoller Newport News Nuclear, Inc |
| TD | total depth |
| WAC | <i>Washington Administrative Code</i> |

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 report presents field-generated records and summarizes field activities performed during the drilling and construction of five monitoring/extraction wells in the 100-K Area of the Hanford Site. Extraction/monitoring wells are being installed to increase mass removal of hexavalent chromium (Cr[VI]) from groundwater and to provide better contaminant plume definition. Efforts to remediate the groundwater contamination began in 1996, pursuant to the 100 Areas inclusion in the Hanford Site's 1989 listing on the CERCLA National Priorities List. The issuance of an interim Record of Decision (ROD/R10-96/134, *Declaration of the Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units*) outlined remediation action goals.

The 100-KR-4 Operable Unit (OU) is located in the northwest portion of the Hanford Site along the southern shoreline of the Columbia River and is located approximately 28 miles north-northwest of Richland, Washington. The 100-KR-4 groundwater OU includes the 100-K East (KE) and 100-K West (KW) Reactor Areas and adjacent portions of the 600 Area.

The primary groundwater contaminant of concern in the 100-KR-4 OU is Cr(VI). Groundwater co-contaminants of concern are strontium-90, carbon-14, nitrate, trichloroethylene, and tritium. Cr(VI) groundwater contamination originated from planned discharges of chromium-treated cooling water in addition to planned and unplanned releases of concentrated sodium dichromate solution used to treat the reactor cooling water. Tritium, nitrate, and carbon-14 were primarily released to the ground in wastewater at the 116-KE-1 and 116-KW-1 Reactor Gas Dryer Condensate Cribs. Strontium-90 in radiologically-contaminated water from the reactor fuel storage basins was discharged to the 116-KE-3 and 116-KW-2 Cribs/Reverse Wells. Radiologically-contaminated reactor cooling water, also containing strontium-90, was released to the ground at the 116-K-2 Trench. A specific source and release point has not been identified for the trichloroethylene observed in groundwater near the 105-W Reactor; it is assumed to have originated from the use of the solvent during maintenance and repair of reactor components. The installation of the three groundwater wells supports Ecology et al., (1989), *Hanford Federal Facility Agreement and Consent Order*, and will be in compliance with requirements of the *Resource Conservation and Recovery Act of 1976* as well as the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA).

Drilling and construction activities occurred from August 6, 2014 through March 5, 2015 by Stillwater Drilling Company, Inc. under the direction of CH2M HILL Plateau Remediation Company (CHPRC). Freestone Environmental Services, Inc. provided well site geology and well construction documentation services. Stoller Newport News Nuclear, Inc (SN3) provided geophysical logging services.

1.1 Purpose and Scope

The purpose of this document is to compile field records and summarize observations and measurements made during the drilling and construction of the five new groundwater monitoring/extraction wells. This report includes field notes and forms, well construction details, well development data, and geologic observations. Additional information provided in this report includes civil survey results, management records of investigation-derived waste, and the well acceptance.

The document controlling the well drilling and construction of the five new wells is SGW-57478, *Description of Work for the Installation of Two Wells in the 100-KR-4 Operable Unit, with an Option of Three Wells, FY 2014*. Wells drilled were also controlled by and support SGW-54543, *Recommendations and Technical Justification for New and Replacement Wells and Re-Alignment of Existing Wells Associated with Interim Remedial Actions at 100-k area*. Soil and groundwater sampling activities were

performed in accordance with DOE/RL-2013-36, *100-KR-4 Groundwater Operable Unit Well Installation Sampling and Analysis Plan* (Rev 0, and Addendums 1 and 2). The locations of the five new groundwater wells are shown in Figure 1-1. Well identification and drilling date information are presented in Table 1-1. Appendices A (C8290), B (C8291), C (C8294), D (C8295) and E (C8296) contain the borehole geologic log, well summary sheet, well development and testing data, sample collection summary, photographic log, well survey report, and geophysical logs for the respective well. For convenience, all wells are referred to in the text by their well identification number (e.g., C8290).

Table 1-1. Identification of New Wells in 100-KR-4 OU

| Well ID | Well Name | Well Type | Ecology ID Number | Well Activity Dates | |
|---------|-----------|-----------------------|-------------------|---------------------|----------------------|
| | | | | Drilling Start Date | Well Completion Date |
| C8290 | 199-K-203 | Monitoring/Extraction | BIF383 | 8/6/2014 | 2/9/2015 |
| C8291 | 199-K-204 | Monitoring/Extraction | BIF380 | 8/21/2014 | 10/22/2014 |
| C8294 | 199-K-207 | Monitoring | BIF381 | 12/1/2014 | 2/10/2015 |
| C8295 | 199-K-208 | Monitoring/Extraction | BIN137 | 12/3/2014 | 2/25/2015 |
| C8296 | 199-K-209 | Monitoring/Extraction | BIF359 | 1/27/2015 | 3/5/2015 |

Ecology = Washington State Department of Ecology

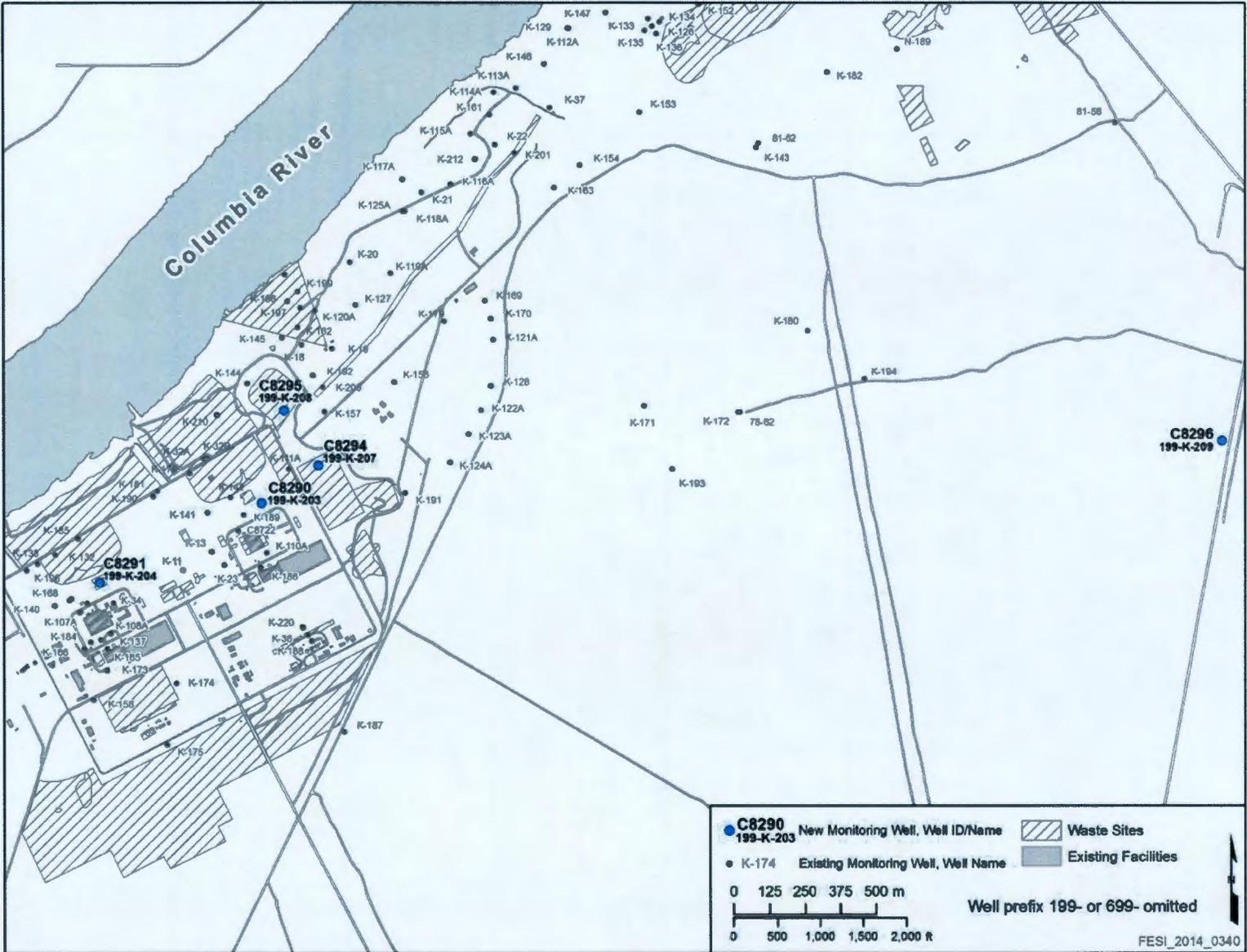


Figure 1-1. New Well Locations in 100-KR-4 OU

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2 Field Activities

This section summarizes the field activities associated with the five groundwater wells. Drilling, sampling, and construction details common to all the wells are summarized in Section 2.1. Well-specific information is presented in Tables 2-1 and 2-2, and Section 2.2. Geologic borehole logs, well summary sheets, geophysical logs, and drill cutting photographs for each borehole are presented in Appendices A through E.

2.1 General Information

Sections 2.1.1 through 2.1.3 summarize activities common to the drilling, sampling, and installation of the five groundwater wells.

2.1.1 Well Drilling and Borehole Logging

The boreholes were drilled and the wells were constructed to Washington State standards detailed in the WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells." Well construction activities were recorded 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*.

2.1.1.1 Borehole Geologic Logging and Photography

Detailed descriptions of all drill cuttings were recorded according to CHPRC procedure SGRP-PRO-EN-50025. Scaled digital photographs were taken in the field to accompany the field description. Geologic logs and drill cutting photographs for each borehole are presented in Appendices A through E.

2.1.1.2 Geophysical Logging

Each borehole was logged using SN3's Spectral Gamma Logging System (SGLS) and Neutron Moisture Logging System (NMLS) to identify natural and man-made gamma-emitting radionuclides and moisture levels in each borehole. Borehole logging was performed through the temporary casing to produce a geophysical log of the entire length of the borehole. All casing strings were logged individually. Log Data Reports of all geophysical logging results, provided by SN3, are presented in Appendices A through E.

2.1.2 Sampling and Health and Safety Screening

2.1.2.1 Archive Lithologic Sampling

Archive samples were collected from the drill cuttings at each borehole at 5-ft intervals and at changes in lithologies. Samples were placed in labeled pint-sized glass jars and sequential chip tray compartments for archive storage.

2.1.2.2 Sieve Sampling and Analysis

Sediment samples were collected for sieve analysis every 5 ft, then composited over 10-ft intervals through the saturated zone. A sieve analysis was performed in accordance with SGRP-PRO-OP-50037 (GRP-EE-05-1.21), *Particle Size Distribution of Soil-Wet Sieve Analysis*, on each composite sample. Sieve analyses were used to determine the appropriate screen slot size for the completed well. Sieve analysis results are presented in Appendices A through E.

2.1.2.3 Split-Spoon Sampling

Split-spoon samples were collected at the top and bottom of the unconfined aquifer and at the midpoint of the planned screen interval for physical and chemical analyses of the sediment in each borehole. In addition, at C8294, three additional split-spoons were collected for further chemical analysis: below the

bottom of the backfill, midway between the bottom of the backfill and the water table, and at the base of the vadose zone. The samples were collected by driving a decontaminated 4-in diameter split-spoon 2.5 ft through the sampling interval or until refusal. Split-spoon sample depths and associated *Hanford Environmental Information System* (HEIS) numbers are included in Appendices A through E.

2.1.2.4 Groundwater Sampling

Groundwater samples were collected at the top and bottom of the unconfined aquifer and at the midpoint of the planned screen interval using a temporary submersible pump. When conditions prevented sample collection at the planned depth due to insufficient yield or heaving sands, the borehole was advanced 5 to 10 ft for sample collection. Boreholes were purged for a minimum of three borehole volumes and until the dissolved oxygen level stabilized at or above 7 mg/L to ensure that groundwater samples are representative of undisturbed groundwater conditions. When sampling conditions did not permit the three borehole purge volume or dissolved oxygen stabilization, the buyers' technical representative was contacted and sampling occurred following approval. Drilling has been shown to create reducing conditions proximate to the borehole which may result in inaccurate Cr(VI) chemical analysis results. Groundwater samples were collected by a nuclear chemical operator once field parameters (temperature, pH, conductivity, dissolved oxygen, turbidity, and oxidation-reduction potential) were allowed to stabilize within 10 percent of variance over three consecutive measurements prior to sample collection according to CHPRC procedure SGRP-PRO-SMP-50047 (GRP-FS-04-G-012), *Sample Packaging, Transporting and Shipping*. Each completed well also had one groundwater sample collected at the end of well development for laboratory analysis. All groundwater sample depths and associated HEIS numbers are included in Appendices A through E.

2.1.2.5 Radiological Field Screening

A radiological control technician performed radiological surveys of the drill cuttings, geologic samples, temporary drive casing, and drillers' control station every morning and afternoon at wells C8294, C8295 and C8296 using standard field screening instruments. Continuous radiological support was required at C8290 and C8291 due to low-level radiological contamination in the surrounding soil. Field measurements detected radiation readings slightly above background levels on equipment and cuttings during drilling at well C8290, but were not significant enough to suspend drilling. The pump used during well development had low level radiological contamination and was used only under supervision and direction of a radiological control technician. The pump was kept in a radioactive material area when not in use. No other measurements above background were observed.

2.1.2.6 Air Quality Monitoring

Air quality monitoring was performed by an industrial hygienist technician twice daily to check for volatile organic compound vapors. The drillers' breathing zone near the wellhead, the fresh drill cuttings, and geologic samples were surveyed for volatile organic compounds using a photoionization detector. Air quality was also monitored during both split-spoon and groundwater sampling. No field measurements above background levels were reported during drilling activities.

2.1.3 Well Construction and Development

2.1.3.1 Well Screen and Casing

Each well was constructed using 6-in nominal diameter, schedule 10, 304/304L stainless steel casing, continuous wire wrap stainless steel well screen and a sump with end cap. Centralizers were installed above and below the screen and at 40-ft intervals to ground surface. The well summary sheets included in the appendices provide visual representations of each well design as-built.

2.1.3.2 Primary Filter Pack

The filter pack surrounding the screen at wells C8290, C8291, C8295 and C8296 consist of 8-16 mesh Colorado Silica Sand. The filter pack at well C8294 consists of 10-20 mesh Colorado Silica Sand. Following placement of each 10-ft interval, the filter pack was surged using a dual surge block until measured settling met CHPRC well development specifications (i.e., less than 0.1 ft of settling in 15 minutes of surging).

2.1.3.3 Annular Seal

Directly above the primary filter pack, 1 to 3 ft of 3/8-in coated bentonite pellets were placed to form an impermeable seal. Medium bentonite chips or crumbles were placed above the pellets to approximately 10 to 15 ft below ground surface (bgs). The annular surface seal consists of Portland Type I/II cement grout placed from the bentonite to approximately 1 ft bgs. The remaining 1 ft was filled using Sakrete¹.

2.1.3.4 Surface Completion

The surface completion consists of an 8-in nominal diameter stainless steel protective casing, a 4-ft by 4-ft concrete pad, and a protective cap with locking hasp. The Sakrete at the top of the annular seal was used to secure the protective casing. Four painted 3-in diameter steel posts were installed at each corner of the cement pad and extend to 3 ft above the ground surface.

2.1.3.5 Well Development

Well development occurred at each well following completion. Development was performed with a 15 horsepower submersible pump at all of the wells. The wells were developed at one or more intervals depending on the length of the screen. Each interval was pumped until turbidity was less than 5 nephelometric turbidity units and additional water quality parameters (conductivity, pH, and temperature) stabilized. The water level was monitored using an In-Situ Inc., Level TROLL² 700 pressure transducer and Rugged Reader³ datalogger. Final development data is summarized in Table 2-2. Well development was performed in accordance with CHPRC procedure SGRP-PRO-OP-50024 (GRP-EE-01-6.3), *Well Development and Testing*.

2.1.3.6 Washington State Department of Ecology Identification

The unique well identification tags were affixed to the protective casing of each well. The identification numbers are found in Table 1-1.

2.2 Site Specific Information for Groundwater Wells

This section summarizes the borehole drilling and sampling, split-spoon and groundwater sampling, and well construction and development activities specific to each well. Well construction information for each well is summarized in Table 2-1. Well development information for each well is summarized in Table 2-2

¹ Sakrete is a registered trademark of SAKRETE of North America LLC, Charlotte, NC 28273

² Level Troll is a registered trademark of In-Situ, Inc., Fort Collins, Colorado.

³ Rugged Reader is a registered trademark of In-Situ, Inc., Fort Collins, Colorado.

Table 2-1. Well Construction Information

| Well ID | Total Depth Drilled (ft bgs) | Permanent Screen and Casing ^a | | | | | Surface Seal ^b (ft bgs) | Annular Seal ^c (ft bgs) | Bentonite Seal ^d (ft bgs) | Primary Filter Pack ^e (ft bgs) |
|---------|------------------------------|--|-----------------------|-----------------|------------------|-----------------------|------------------------------------|------------------------------------|--------------------------------------|---|
| | | Casing Size | Blank Casing (ft bgs) | Screen (ft bgs) | Screen Slot Size | Sump/End Cap (ft bgs) | | | | |
| C8290 | 161.8 | 6-in | +2.12 – 64.92 | 64.92 – 155.01 | 50 | 155.01 – 160.02 | 0 – 15.0 | 15.0 – 58.5 | 58.5 – 61.2 | 61.2 – 161.80 (8-16) |
| C8291* | 163.0 | 6-in | +2.00 – 62.22 | 62.22 – 157.21 | 50 | 157.21 – 162.21 | 0 – 10.2 | 10.2 – 55.0 | 55.0 – 57.7 | 57.7 – 162.8 (8-16) |
| C8294 | 155.5 | 6-in | +2.00 – 63.80 | 63.80 – 148.80 | 40 | 148.80 – 153.80 | 0 – 14.1 | 14.1 – 59.4 | 59.4 – 60.4 | 60.4 – 155.5 (10-20) |
| C8295 | 133.9 | 6-in | +2.00 – 36.78 | 36.78 – 127.20 | 50 | 127.20 – 132.20 | 0 – 13.4 | 13.4 – 32.6 | 32.6 – 33.4 | 33.4 – 133.9 (8-16) |
| C8296 | 154.6 | 6-in | +1.90 – 88.18 | 88.18 – 148.10 | 50 | 148.10 – 153.11 | 0 – 13.0 | 13.0 – 83.1 | 83.1 – 84.1 | 84.1 – 154.6 (8-16) |

All measurements in feet below ground surface unless otherwise marked.

a. Schedule 10, Type 304/304L Stainless Steel

b. Type I/II Portland cement grout

c. Cetco medium bentonite chips or crumbles

d. Pel-Plug coated bentonite pellets (3/8-in)

e. Premier Colorado Silica sand (CSS), 10-20 or 8-16 mesh

f. Borehole slough

+ = above ground surface

N/A = not applicable

* = C8291 has additional blank casing from 117.21 to 127.21

Table 2-2. Well Development Information

| Well ID | Static Water Level (ft bgs w/ date) | Intake Depth (ft bgs) | Duration (minutes) | Average Flow Rate (gpm) | Final Turbidity (NTU) | Final Drawdown (ft) | Total Gallons Pumped |
|---------|--|---|-------------------------------------|--|--|---|--|
| C8290 | 74.4 (2/5/15) | U: 86.9 MU: 107.9 ML: 128.9 L: 149.9 | U: 86 MU: 40 ML: 126 L: 78 | U: 100 MU: 166 ML: 165 L: 159 | U: 0.69 MU: 1.67 ML: 3.31 L: 4.88 | U: 9.0 MU: 14.5 ML: 13.2 L: 14.4 | U: 8,600 MU: 6,640 ML: 20,790 L: 11,910 |
| C8291 | 76.7 (10/21/14) | U: 99.9 MU: 110.9 ML: 131.9 L: 152.9 | U: 49 MU: 27 ML: 40 L: 62 | U: 82 MU: 170 ML: 157 L: 151 | U: 0.82 MU: 1.45 ML: 2.04 L: 3.75 | U: 8.82 MU: 16.94 ML: 21.71 L: 22.37 | U: 4,018 MU: 4,590 ML: 6,280 L: 9,362 |
| C8294 | 67.7 (2/10/15) | U: 82.9 MU: 103.9 ML: 124.9 L: 145.9 | U: 42 MU: 29 ML: 34 L: 43 | U: 100 MU: 163 ML: 158 L: 154 | U: 0.69 MU: 3.38 ML: 1.74 L: 2.91 | U: 9.3 MU: 17.0 ML: 15.6 L: 17.2 | U: 4,200 MU: 4,727 ML: 5,372 L: 6,622 |
| C8295 | 41.8 (2/24/2015) | U: 59.6 MU: 80.6 ML: 101.6 L: 122.6 | U: 61 MU: 37 ML: 52 L: 80 | U: 92 MU: 148 ML: 141 L: 135 | U: 0.72 MU: 1.45 ML: 1.81 L: 4.06 | U: 11.4 MU: 15.8 ML: 14.6 L: 15.7 | U: 5,610 MU: 6,060 ML: 7,330 L: 10,800 |
| C8296 | 97.3 (3/5/2015) | U: 114.9 M: 124.9 L: 145.9 | U: 54 M: 32 L: 54 | U: 97 M: 139 L: 132 | U: 0.85 M: 2.87 L: 1.11 | U: 10.6 M: 19.3 L: 16.1 | U: 5,200 M: 4,450 L: 7,150 |

gpm = gallons per minute
 NTU = nephelometric turbidity unit
 U = upper interval
 MU = middle upper interval
 ML = middle lower interval
 L = lower interval

2.2.1 Well 199-K-203 (C8290)

Borehole C8290 was drilled from August 6, 2014 to November 24, 2014 by Stillwater Drilling, Inc. using a Bucyrus-Erie 22-W Series 3 cable-tool rig (Figure 2-1) and both 13 $\frac{3}{8}$ -inch and 11 $\frac{3}{4}$ -inch nominal diameter carbon steel casing to reach a total depth (TD) of 161.8 ft bgs. The 13 $\frac{3}{8}$ -in casing was used to 64.44 ft bgs and the 11 $\frac{3}{4}$ -in casing to TD. All temporary casing was removed during well construction.



Figure 2-1. Stillwater Drilling, Inc. Bucyrus-Erie 22-W Cable-Tool Rig

Geologic archive grab samples were collected from drill cuttings at 5-ft intervals throughout the borehole and samples for sieve analysis were collected every 5 ft and composited over 10 ft intervals throughout the aquifer. Split-spoon soil samples and pumped groundwater samples were collected at the top and bottom of the unconfined aquifer and the midpoint of the planned screened interval. Groundwater characterization samples were collected using a submersible pump. Sample information is included in Tables 2-3 and 2-4.

The borehole was logged on August 25, 2014 using both SGLS and NMLS after placement of the 11¾-in temporary casing to a depth of 69.5 ft bgs. The casing was later removed and replaced with 13¾-in until 59.5 ft. Drilling continued using 11¾-in casing to 159.5 ft bgs. The lower 90 ft of the borehole was logged using SGLS on September 25, 2014. A borehole straightness test was successfully performed on November 25, 2014. Well construction was performed from December 23, 2014 to January 5, 2015. Well development occurred on February 5, 2014 and February 9, 2014 and one groundwater sample was taken with the intake set at 86.85 ft bgs. Static water level was measured before well development at 74.4 ft bgs on February 5, 2015.

Table 2-3. C8290 Split-Spoon Samples

| Date | Sample Depth (ft bgs) | Sample Method | Media | Recovery % | HEIS number |
|----------|-----------------------|---------------|-------|------------|----------------|
| 11/5/14 | 81.9 – 84.4 | Split-Spoon | Soil | 100 | B2XN93, B2XN96 |
| 11/12/14 | 111.5 – 115.0 | Split-Spoon | Soil | 100 | B2XN94, B2XN97 |
| 11/18/14 | 150.7 – 153.2 | Split-Spoon | Soil | 100 | B2XN95, B2XN98 |

HEIS = Hanford Environmental Information System

Table 2-4. C8290 Groundwater Samples Collected During Drilling

| Date | Depth (ft bgs) | Sample Method | Pump Rate (gpm) | Volume Purged (gal) | Turbidity (NTU) | D.O at Sample Collection (mg/L) | HEIS number |
|----------|----------------|--------------------|-----------------|---------------------|-----------------|---------------------------------|------------------------|
| 11/5/14 | 81.9 | Groundwater pumped | 0.94 | 103.4 | >1,000 | 7.02 | B2XN99, B2XNB0 |
| 11/12/14 | 111.04 | Groundwater pumped | 7.6 | 697.4 | >1,000 | 7.53 | B2XNB1 |
| 11/19/14 | 150.0 | Groundwater pumped | 2.5 | 882 | >1,000 | 2.86 | B2XNB2, B2XNB3 |
| 2/9/15 | 86.85 | Groundwater pumped | 100 | 8,600 | 0.69 | 8.99 | B2XNB4, B2XNB5, B2XNB6 |

D.O. = dissolved oxygen

gpm = gallons per minute

HEIS = Hanford Environmental Information System

NTU = nephelometric turbidity unit

2.2.2 Well 199-K-204 (C8291)

Drilling at borehole C8291 was performed from August 21, 2014 to September 22, 2014 by Stillwater Drilling, Inc. using a Bucyrus-Erie 22-W Series 3 cable-tool rig (Figure 2-1) and temporary 11¾-inch nominal diameter threaded carbon steel casing from ground surface to a TD of 163.0 ft bgs. All temporary casing was removed during well construction.

Geologic archive grab samples were collected from drill cuttings at 5-ft intervals throughout the borehole and samples for sieve analysis were collected every 5 ft and composited over 10 ft intervals through the saturated zone. Three split-spoon samples and three groundwater samples were collected at the top and bottom of the unconfined aquifer and at the midpoint of the planned screened interval. Sample information for C8291 is summarized in Tables 2-5 and 2-6.

The entire borehole was logged using SGLS on September 26, 2014. The entire dry portion of the borehole was logged with NMLS on September 24, 2014. A borehole straightness test was successfully performed on October 13, 2014. Well construction was performed from October 13, 2014 to October 20, 2014 using a Pulstar Pump Rig. Well development occurred October 21, 2014 and October 22,, 2014 and one groundwater sample was taken with the intake set at 96.85 ft bgs. Static water level was measured before well development at 76.7 ft bgs on October 21, 2014.

Table 2-5. C8291 Split-Spoon Samples

| Date | Sample Depth (ft bgs) | Sample Method | Media | Recovery % | HEIS number |
|---------|-----------------------|---------------|-------|------------|------------------------|
| 9/2/14 | 81.5 – 84 | Split-Spoon | Soil | 75 | B2XPH3, B2XPH4, B2XPH5 |
| 9/9/14 | 115.8 – 118.3 | Split-Spoon | Soil | 100 | B2XPH6, B2XPH7, B2XPH8 |
| 9/18/14 | 156.2 – 158.7 | Split-Spoon | Soil | 100 | B2XPH9, B2XPJ0, B2XPJ1 |

HEIS = Hanford Environmental Information System

Table 2-6. C8291 Groundwater Samples Collected During Drilling

| Date | Depth (ft bgs) | Sample Method | Pump Rate (gpm) | Volume Purged (gal) | Turbidity (NTU) | D.O at Sample Collection (mg/L) | HEIS number |
|----------|----------------|---------------------|-----------------|---------------------|-----------------|---------------------------------|---|
| 9/2/14 | 81.5 | Groundwater Pumping | 1.7 | 61 | 667 | 5.52 | B2XPJ2, B2XPK6 |
| 9/9/14 | 115.8 | Groundwater Pumping | 4.5 | 535 | >1,000 | 1.49 | B2XPJ6, B2XPJ7, B2XPK7 |
| 9/18/14 | 156.2 | Groundwater Pumping | 8.4 | 1,600 | 8.3 | 6.62 | B2XPJ8, B2XPJ9, B2XK8 |
| 10/22/14 | 96.9 | Groundwater Pumping | 65 | 6,500 | 0.61 | 8.98 | B2XPK0, B2XPK1, B2XPK2, B2XPK3, B2XPK4, B2XPK5, B2XPK9 |

D.O. = dissolved oxygen

gpm = gallons per minute

HEIS = Hanford Environmental Information System

NTU = nephelometric turbidity unit

2.2.3 Well 199-K-207 (C8294)

Drilling at borehole C8294 was performed from December 1, 2014 to December 31, 2014 by Stillwater Drilling, Inc. using a Bucyrus-Erie 22-W Series 3 cable-tool rig (Figure 2-1) and both 13 $\frac{3}{8}$ -inch and 11 $\frac{3}{4}$ -inch nominal diameter carbon steel casing to reach a TD of 155.5 ft bgs. The 13 $\frac{3}{8}$ -in casing was used to 59.5 ft bgs and the 11 $\frac{3}{4}$ -in casing to TD. All temporary casing was removed during well construction.

Geologic archive grab samples were collected from drill cuttings at 5-ft intervals throughout the borehole and samples for sieve analysis were collected every 5 ft and composited over 10 ft intervals through the aquifer. Split-spoon soil samples and pumped groundwater samples were collected at the top and bottom of the unconfined aquifer and at the midpoint of the planned screened interval. Three additional split-spoons were collected for further chemical analysis: below the bottom of the backfill, midway between the bottom of the backfill and the water table, and at the base of the vadose. Sample information for C8294 is summarized in Tables 2-7 and 2-8.

The borehole was logged on December 8, 2014 using SGLS and NMLS following placement of the 13 $\frac{3}{8}$ -in temporary casing to a depth of 59.5 ft bgs. On January 5, 2015, following the placement of the 11 $\frac{3}{4}$ -in casing, the remainder of the borehole was logged to 153 ft bgs with SGLS and 64.5 ft bgs with NMLS. A borehole straightness test was performed on January 28, 2015 and well construction was performed from January 28, 2015 to February 4, 2015. Well development occurred on January 10, 2015 using a Pulstar Pump Rig and one groundwater sample was taken with the intake set at 82.85 ft bgs. Static water level was measured before well development at 67.7 ft bgs on February 10, 2015.

Table 2-7. C8294 Split-Spoon Samples

| Date | Sample Depth (ft bgs) | Sample Method | Media | Recovery % | HEIS number |
|----------|-----------------------|---------------|-------|------------|----------------|
| 12/1/14 | 21.9 – 24.4 | Split-Spoon | Soil | 100 | B2YRK0 |
| 12/3/14 | 51.8 – 52.4 | Split-Spoon | Soil | 100 | B2YRK1 |
| 12/9/14 | 68.5 – 71.0 | Split-Spoon | Soil | 100 | B2YRK3, B2YRK4 |
| 12/9/14 | 78.8 – 81.3 | Split-Spoon | Soil | 100 | B2YRK5, B2YRK6 |
| 12/23/14 | 114.2 – 116.7 | Split-Spoon | Soil | 90 | B2YRK7, B2YRK8 |
| 12/31/14 | 146.5 – 151.0 | Split-Spoon | Soil | 100 | B2YRN4, B2YRN5 |

HEIS = Hanford Environmental Information System

Table 2-8. C8294 Groundwater Samples Collected During Drilling

| Date | Depth (ft bgs) | Sample Method | Pump Rate (gpm) | Vol. Purged (gal) | Turbidity (NTU) | D.O at Sample Collection (Mg/L) | HEIS number |
|----------|----------------|--------------------|-----------------|-------------------|-----------------|---------------------------------|--------------------------------|
| 12/9/14 | 77.2 | Groundwater pumped | 3.3 | 113 | >1,000 | 8.40 | B2YRN6, B2YRN7 |
| 12/22/14 | 113.0 | Groundwater pumped | 10.0 | 530 | 339 | 6.60 | B2YRP0, B2YRP1 |
| 12/30/14 | 149.3 | Groundwater pumped | 8.6 | 551 | >1,000 | 3.60 | B2YRP2, B2YRP3, B2YRP4, B2YRP5 |
| 2/10/15 | 82.9 | Groundwater pumped | 100 | 4,200 | 0.69 | 8.59 | B2YRP6, B2YRP7, B2YRP8 |

D.O. = dissolved oxygen

gpm = gallons per minute

HEIS = Hanford Environmental Information System

NTU = nephelometric turbidity unit

2.2.4 Well 199-K-208 (C8295)

Drilling at borehole C8295 was performed from December 3, 2014 to January 29, 2015 by Stillwater Drilling, Inc. using a Bucyrus-Erie 22-W Series 3 cable-tool rig (Figure 2-1) and both 13 $\frac{3}{8}$ -inch and 11 $\frac{3}{4}$ -inch nominal diameter carbon steel casing to reach a TD of 133.9 ft bgs. The 13 $\frac{3}{8}$ -in casing was used to 39.71 ft bgs and the 11 $\frac{3}{4}$ -in casing to TD. All temporary casing was removed during well construction.

Geologic archive grab samples were collected from drill cuttings at 5-ft intervals throughout the borehole and samples for sieve analysis were collected every 5 ft and composited over 10 ft intervals through the aquifer. Split-spoon soil samples and pumped groundwater samples were collected at the top and bottom of the unconfined aquifer and at the midpoint of the planned screened interval. Sample information for C8295 is summarized in Tables 2-9 and 2-10.

The borehole was on December 10, 2014 using SGLS and NMLS following placement of the 13¾-in temporary casing to a depth of 39.71 ft bgs. On February 2, 2015, following the placement of the 11¾-in casing, the remainder of the borehole was logged to 133 ft bgs with SGLS and 42.25 ft bgs with NMLS. A borehole straightness test was performed on February 17, 2015 and well construction was performed from February 17, 2015 to February 23, 2015. Well development occurred from February 24, 2015 to February 25, 2015 using a Pulstar Pump Rig and one groundwater sample was taken with the intake set at 59.6 ft bgs. Static water level was measured before well development at 41.8 ft bgs on February 24, 2015.

Table 2-9. C8295 Split Spoon Samples

| Date | Sample Depth (ft bgs) | Sample Method | Media | Recovery % | HEIS number |
|---------|-----------------------|---------------|-------|------------|-------------|
| 1/14/15 | 51.6 – 52.4 | Split-Spoon | Soil | 100 | B2YRR3 |
| 1/19/15 | 74.6 – 76.6 | Split-Spoon | Soil | 70 | B2YRR4 |
| 1/26/15 | 117.3 – 119.8 | Split-Spoon | Soil | 100 | B2YRR5 |

HEIS = Hanford Environmental Information System

Table 2-10. C8295 Groundwater Samples Collected During Drilling

| Date | Depth (ft bgs) | Sample Method | Pump Rate (gpm) | Vol. Purged (gal) | Turbidity (NTU) | D.O at Sample Collection (Mg/L) | HEIS number |
|---------|----------------|--------------------|-----------------|-------------------|-----------------|---------------------------------|--|
| 1/14/15 | 50.8 | Groundwater pumped | 3.5 | 143 | 461 | 8.22 | B2YRR6, B2YRR7, B2YRR8 |
| 1/19/15 | 73.5 | Groundwater pumped | 7.5 | 503 | >1,000 | 7.41 | B2YRT1, B2YRT2, B2YRT3 |
| 1/27/15 | 117.1 | Groundwater pumped | 11.1 | 1,100 | >1,000 | 5.22 | B2YRT4, B2YRT5, B2YRT6 |
| 2/24/15 | 59.6 | Groundwater pumped | 92 | 5,610 | 1.2 | 8.61 | B2YRV0, B2YRV1, B2YRV2, B2YRV3, B2YRV4, B2YRV5, B2YRV6 |

D.O. = dissolved oxygen

gpm = gallons per minute

HEIS = Hanford Environmental Information System

NTU = nephelometric turbidity unit

2.2.5 Well 199-K-209 (C8296)

Drilling at borehole C8296 was performed from January 27, 2015 to February 19, 2015 by Stillwater Drilling, Inc. using a Bucyrus-Erie 22-W Series 3 cable-tool rig (Figure 2-1) and both 13½-inch and 11¾-inch nominal diameter carbon steel casing to reach a TD of 154.6 ft bgs. The 13½-in casing was used to 59.4 ft bgs and the 11¾ -in casing to TD. All temporary casing was removed during well construction.

Geologic archive grab samples were collected from drill cuttings at 5-ft intervals throughout the borehole and samples for sieve analysis were collected every 5 ft and composited over 10 ft intervals through the aquifer. Split-spoon soil samples and pumped groundwater samples were collected at the top and bottom of the unconfined aquifer and at the midpoint of the planned screened interval. Sample information for C8296 is summarized in Tables 2-11 and 2-12.

The borehole was on February 2, 2015 using SGLS and NMLS following placement of the 13½-in temporary casing to a depth of 59.4 ft bgs. On February 23 and 24, 2015, following the placement of the 11¾-in casing, the remainder of the borehole was logged to 153 ft bgs with SGLS and 100.25 ft bgs with NMLS. A borehole straightness test was performed on February 26, 2015 and well construction was performed from February 26, 2015 to March 4, 2015. Well development occurred on March 5, 2015 using a Pulstar Pump Rig and one groundwater sample was taken with the intake set at 114.85 ft bgs. Static water level was measured before well development at 97.3 ft bgs on March 5, 2015.

Table 2-11. C8296 Split Spoon Samples

| Date | Sample Depth (ft bgs) | Sample Method | Media | Recovery % | HEIS number |
|---------|-----------------------|---------------|-------|------------|-------------|
| 2/9/15 | 108.7 – 111.2 | Split-Spoon | Soil | 90 | B30C55 |
| 2/11/15 | 127.2 – 129.7 | Split-Spoon | Soil | 90 | B30C56 |
| 2/17/15 | 145.9 – 148.4 | Split-Spoon | Soil | 95 | B30C57 |

HEIS = Hanford Environmental Information System

Table 2-12. C8296 Groundwater Samples Collected During Drilling

| Date | Depth (ft bgs) | Sample Method | Pump Rate (gpm) | Vol. Purged (gal) | Turbidity (NTU) | D.O at Sample Collection (Mg/L) | HEIS number |
|---------|----------------|--------------------|-----------------|-------------------|-----------------|---------------------------------|------------------------|
| 2/10/15 | 109.3 | Groundwater pumped | 4.4 | 620 | 9.18 | 9.00 | B30C66, B30C58 |
| 2/12/15 | 126.6 | Groundwater pumped | 10.0 | 220 | 76.1 | 2.88 | B30C60, B30C67 |
| 2/19/15 | 146.7 | Groundwater pumped | 6.3 | 350 | 56.8 | 2.72 | B30C68, B30C61, B30C62 |
| 3/5/15 | 114.9 | Groundwater pumped | 96.9 | 5,200 | 0.65 | 8.81 | B30C63, B30C64, B30C65 |

D.O. = dissolved oxygen

gpm = gallons per minute

HEIS = Hanford Environmental Information System

NTU = nephelometric turbidity unit

3 Geologic Observations

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

3.1 General Geology Description

The major stratigraphic units encountered during this project included backfill and/or Holocene eolian deposits, cataclysmic flood deposits of the Hanford formation and fluviially-derived Ringold Formation deposits. The sandy gravel facies dominates the Hanford formation within the project area and consists of coarse-grained basaltic sands, gravels, and boulders. At the three borehole locations, the interpreted Hanford formation was thickest at C8296 (73 ft) and thinnest at C8295 (20 ft). The Hanford formation overlies the interpreted Ringold Formation within the project area.

The Ringold Formation encountered during this drilling project includes the Ringold Formation member of Wooded Island Unit E (Ringold unit E) and the Ringold Upper Mud unit (RUM). The Ringold unit E is characterized as clast-supported gravels with fine to coarse-grained sand matrix and lesser silt fractions. Clasts associated with the Ringold unit E are predominately quartzite and silicic volcanics with lesser amounts of basalt. The sand matrix mineralogy is predominately quartzo-feldspathic. At the five borehole locations, the Ringold unit E was thickest at C8291 (134 ft) and thinnest at C8296 (75 ft). The Ringold unit E overlies the lacustrine silt and clay deposit of the RUM encountered at the five boreholes.

3.2 Borehole Geology

The following discussion focuses on the geologic conditions encountered at each individual borehole. Original borehole logs are presented in Appendices A through E.

Stratigraphic unit contacts included in this document are based on field drill cuttings examination (i.e., lithology, texture, color, reaction to 10 percent dilute hydrochloric acid [HCl], etc.) and drilling observations (i.e., drill rate) in the field. As such, the unit contacts included herein should not be considered final. Final stratigraphic unit contact depths will be determined during the remedial investigation data review and will incorporate the field observations, borehole geophysical logging information, and regional stratigraphic interpretations. The basis for the field stratigraphic unit contacts is included in the individual borehole summaries below.

3.2.1 Borehole Geology for Well 199-K-203 (C8290)

The sediments encountered from the ground surface to 34 ft bgs coarsened downward from a gravelly sandy silt at the ground surface to sandy gravel at 34 ft bgs. The gravel fraction increased from 25 to 70 percent, mud content decreased from 55 to 10 percent, and sand was 20 percent. The gravel fraction consists of poorly to moderately sorted, subangular to rounded, very fine to very coarse, 80 to 90 percent basaltic pebbles. The sand fraction transitioned from a very well sorted, very fine grained sand comprised of 90 percent felsic grains into a poorly sorted, very fine to very coarse sand comprised of 90 percent basalt. The mud fraction was predominantly silt with occasional clay nodules observed from 10 to 25 ft bgs. The fines range from light olive brown (2.5Y 5/3) to black (2.5Y 2.5/1) based on a Munsell soil color chart^[1]. Occasional weak reactions to HCl were observed throughout the interval, with a strong reaction to a carbonate cement found at 10 ft bgs. At 34 ft bgs a distinct change in color and lithology, and a decrease in drill rate occurred. These changes coincide with descriptions previously made of the

[1] Munsell Soil Color Charts is a registered trademark of X-Rite, Inc. Grand Rapids, Michigan.

Hanford/Ringold contact and therefore is interpreted as the contact between the Hanford and Ringold Formation.

The sediment was sandy gravel to 38 ft bgs, then silty gravel to 60 ft bgs. The gravel fraction consisted of moderately sorted, subrounded to rounded, very fine pebbles to large cobbles comprised of 60 to 90 percent felsic grains. The sand fraction consisted of poorly to moderately sorted, angular to subrounded, very fine to very coarse sand comprised of 70 to 80 percent felsic grains. The mud ranged from silt to medium plasticity clay and light olive brown (2.5Y 5/3) to light gray (2.5Y 7/1). Moderate reactions to HCl were observed in the interval 57-60 ft bgs where cementation was observed.

Sandy gravel was observed from 60 to 155.7 ft bgs, except for a silty gravel and gravel interval at 99 to 100 and 124 to 125 ft bgs, respectively. The gravel content ranged from 50 to 70 percent and the sand content ranged from 30 to 40 percent. The highest mud percentage was 10 percent, except for the silty gravel interval where the mud content reached 30 percent. The gravel fraction consisted of very poorly to moderately sorted, angular to subrounded, very fine pebbles to large cobbles comprised of 60 to 90 percent felsic clasts. The sand fraction consisted of very poorly to well sorted, angular to subrounded, very fine to very coarse, 70 to 80 percent felsic grains. Reactions to HCl ranged from no reaction to a mild reaction throughout this interval, with the exception to a strong reaction that occurred at the dark gray (N 4/) silty gravel interval from 99 to 100 ft bgs. The color of the fine fraction throughout this interval ranged from very dark grayish brown (2.5Y 3/2) to light olive brown (2.45Y 5/3).

At 155.7 ft bgs, a distinct contact with a pale yellow (5Y 8/2) clayey silt exhibited medium plasticity and no reaction with HCl. Based on the distinct change in lithology and the color change, this was interpreted to be the contact between the Ringold unit E and RUM. Drilling continued into the RUM until a TD at 161.8 ft bgs.

3.2.2 Borehole Geology for Well 199-K-204 (C8291)

The sediments encountered at C8291 consisted of unconsolidated sandy gravels and silty sandy gravels from the ground surface to 23 ft bgs. The sandy gravels were 65 percent gravel and 35 percent sand. The gravel fraction consisted of poorly sorted, very fine to very coarse, subangular to subrounded, 90 percent basalt clasts. The sand fraction of the sediment consisted of moderately to poorly sorted, very fine to very coarse, angular to subrounded, 70 percent felsic grains. The fine fraction was dark grayish brown (2.5Y 4/2) to very dark grayish brown (2.5Y 3/1). Slight to Strong reactions to HCl were observed throughout. At 23 ft bgs, 2 ft of silt was encountered. The observed change in lithology and composition coincides with descriptions previously made of the Hanford/Ringold contact and therefore is interpreted as the contact between the Hanford and Ringold Formations.

A fining upward sequence, grading from clayey silt to sandy gravel, was observed from 23 to 32 ft bgs. The clay fraction exhibited low plasticity and a strong reaction to HCl. The sand fraction graded from well sorted, very fine to fine sand to a poorly sorted, angular to subangular, very fine to very coarse, 80 percent felsic sand. The gravel fraction consisted of very fine to very coarse, 70 to 80 percent pebbles. Neither the gravel nor sand had any reaction to HCl. The color of the fine fraction ranged from grayish brown (2.5Y 5/4) to light brownish gray (2.5Y 6/2).

Sandy gravels with occasional finer intervals were encountered from 30 to 98 bgs. The sandy gravels ranged from 65 to 75 percent gravel and 25 to 35 percent sand. The mud content ranged from trace to 5 percent. The gravel fraction consisted of poorly sorted, subangular to subrounded, very fine to very coarse pebble clasts comprised of 50 to 80 percent felsic clasts. The sand fraction consists of poorly sorted, angular to subangular grains comprised of 65 to 75 percent felsic grains. The color of the fines fraction

ranged from light olive brown (2.5Y 5/3) to light gray in color (2.5Y 7/1). Moderate reactions to HCl occurred from 65 to 95 ft bgs with an occasional strong reaction at 70 ft bgs.

Multiple fining and coarsening sequences were present from 98 to 119 ft bgs. The sediment ranged from gravelly sand to gravel, with the exception of a silty gravel interval from 113 to 115 ft bgs. The gravel consisted of moderately sorted, subrounded, fine pebble to small cobbles comprised of 75 to 90 percent felsic clasts. The sand fraction consisted of moderate to well sorted, very fine to very coarse intervals comprised of 70 to 80 percent felsic grains. The fines fraction ranged from light olive brown (2.5Y 5/3) to dark grayish brown (2.5Y 4/2). There were no reactions to HCl, except at 110 to 119 ft bgs where a strong reaction to HCl was observed. From 113 to 115 ft bgs there was a silty gravel interval, comprised of very poorly sorted, subangular to rounded gravels situated in a moderately cemented, low plasticity clay. The color of the clay fraction was dark grayish brown (2.5Y 3/2).

A fining upward sequence, grading from clayey silt into sandy gravel, was observed from 119 to 127 ft bgs. The gravel fraction consisted of subangular to rounded, very fine to very coarse pebble clasts comprised of 90 percent felsic clasts. The sand fraction graded from a well sorted, very fine to fine sand into a moderately sorted, subrounded, medium to coarse sand comprised of 80 percent felsic grains. The clay fraction exhibited low plasticity. Throughout the interval, the color of the fines fraction ranged from light olive brown (2.5Y 5/4) to light olive brown (2.5Y 5/3). No reaction to HCl was observed.

Sandy gravels were observed from 127 to 157 ft bgs. The gravel content ranged from 55 to 65 percent and the sand percentage was 35 percent. Mud content was estimated at 10 percent at 140 and 152.5 ft bgs. The gravel fraction consisted of very poorly sorted, angular to subangular, very fine to very coarse, 80 percent felsic pebbles. The sand fraction consisted of very poor to moderately sorted, very fine to very coarse, 90 percent felsic grains. The fine fraction ranged from grayish brown (2.5Y 5/2) to light olive brown (2.5Y 5/6). No reactions to HCL were observed except for at 152.5 ft bgs where moderate cementation and a strong reaction to HCL was observed.

At 157 ft bgs, a distinct contact with a light olive brown (2.5Y 5/3) clayey silt exhibiting medium plasticity and a strong reaction to HCl was encountered. Based on the observed changes in color and lithology, this was interpreted to be the contact between the Ringold unit E and RUM. Drilling continued into the RUM until a TD at 163.0 ft bgs.

3.2.3 Borehole Geology for Well 199-K-207 (C8294)

The sediments encountered at C8294 consisted of unconsolidated sandy gravels from the ground surface to 25 ft bgs. The sandy gravels were 65 to 75 percent gravel and 15 to 35 percent sand. At 20 and 22 feet the mud content was observed at 5 and 15 percent, respectively. The gravel fraction consisted of very poorly sorted, subangular to subrounded, very fine pebbles to small cobble clasts comprised of 80 percent basalt. The sand fraction consisted of poorly sorted, angular to subangular, very fine to very coarse sand comprised of 50 percent felsic grains. The color of the fine fraction ranged from light olive brown (2.5Y5/3) to very dark grayish brown (2/5Y3/2). No reactions to HCl were observed until 20 ft, where there were occasional moderate reactions. Based on the increasing felsic content, color change from very dark grayish brown (2.5Y3/2) to light brownish gray (2.5Y6/2), and slight laminations observed at 25 ft bgs, the contact is inferred to grade from 22 to 30 ft bgs.

The sediment from 25 to 60 ft bgs was predominately sandy gravel, with interspersed gravels found at 25 to 30 and 35 to 40 ft bgs. The gravel fraction consisted of very poorly to well sorted, subangular to subrounded, very fine pebble to small cobbles comprised of 70 to 75 percent felsic clasts. The sand fraction consisted of very poorly to moderately sorted, angular, very fine to very coarse, 70 to 90 percent felsic grains. The fine fraction ranged from very dark gray (2.5Y 3/1) at 25 ft bgs to light yellowish brown

(2.5Y 6/3) at 60 ft bgs. Occasional moderate reactions to HCl were observed from 25 to 30 ft bgs, no further reactions to HCl were observed.

The sediment was predominately sandy gravel from 60 to 140 ft bgs. Gravel was encountered from 85 to 92.5 ft bgs and silty gravel was encountered from 92.5 to 95 ft bgs. The gravel fraction consisted of very poorly to well sorted, subangular to subrounded, very fine pebble to large cobbles comprised of 70 to 80 percent felsic clasts. The sand fraction consisted of very poorly to well sorted, angular to subrounded, very fine to very coarse, 70 to 95 percent felsic grains. The fine fraction ranged from light olive brown (2.5Y 5/3) to light yellow brown (2.5Y 6/3). Weak to no reaction to HCl was observed until 92.5 to 95 ft bgs, where a strong reaction to HCl occurred. At 92.5 to 95 ft bgs the silty gravel was cemented with a basalt content of 60 percent and fines ranging from dark gray (2.5Y 4/1) to reddish yellow (7.5YR 7/8). Several feet of flowing sands were encountered at 123 ft bgs.

From 140 to 150 ft bgs the sediments consisted of unconsolidated gravelly sand. The gravelly sand was 20 to 25 percent gravel and 75 to 80 percent sand. The gravel fraction consisted of well sorted, subangular to subrounded, very fine to very coarse, 75 percent felsic pebbles. The sand fraction ranged from well sorted, subrounded, very fine to very coarse sand grains comprised of 80 percent felsic grains. The fine fraction was light olive brown (2.5Y 5/3) and no reaction to HCl was observed. Several feet of flowing sands were encountered from 140 to 144 ft bgs.

At 150 ft bgs, a distinct contact with a gray (2.5Y 6/1) mud exhibiting low plasticity and no reaction to HCl was encountered. Based on the observed changes in color and lithology, this was interpreted as the contact between the Ringold unit E and RUM. Drilling continued into the RUM until a TD at 155.5 ft bgs.

3.2.4 Borehole Geology for Well 199-K-208 (C8295)

The sediments encountered at C2895 consisted of primarily sandy gravels from the ground surface to 95 ft bgs. The sandy gravels were 65 to 80 percent gravel and 15 to 35 percent sand. Two finer intervals were observed throughout this interval, one from 43 to 45 ft bgs, consisting of 95 percent sand, and the other at 80 to 85 ft bgs, consisting of 70 percent sand and 30 percent gravel. From the ground surface to 95 ft bgs the gravel consisted of subangular to subrounded, very fine pebble to boulders comprised of 20 to 80 percent felsic clasts. The sand fraction consisted of very poorly to well sorted, angular to subrounded, very fine to very coarse sand, 60 to 85 percent felsic grains. The fine fraction ranged from brown (10YR 5/3) to light yellow brown (2.5YR 6/3). No reactions to HCl were observed. Due to a decrease in basalt content in the gravel fraction and a color change to pale brown (10YR 6/3), the contact is inferred to be gradational between 20 and 25 ft bgs.

The sediment from 95 to 110 ft bgs ranged from gravel to gravelly sand and a coarsening upward sequence was observed. The gravel ranged from 80 percent gravel at the top to 15 percent gravel at the bottom of the interval. The sand ranged from 15 percent sand at the top to 85 percent sand at the bottom of the interval. The gravel fraction consisted of very poorly to moderately sorted, subangular to subrounded, very fine pebbles to small cobble comprised of 60 to 75 percent felsic clasts. The sand fraction consists of moderately to well sorted, subangular to subrounded, very fine to very coarse, 80 percent felsic grains. The fine fraction ranged from dark olive brown (2.5Y 3/3) to light olive brown (2.5Y 5/3). No reactions to HCl were observed.

From 110 to 127.5 ft bgs the sediments consisted of unconsolidated sandy gravel. The sandy gravel was 50 to 75 percent gravel and 25 to 40 percent sand. The gravel fraction consisted of very poorly to moderately sorted, angular to rounded, very fine pebbles to large cobbles comprised of 60 to 70 percent felsic clasts. The sand fraction consisted of poorly sorted to well sorted, subangular, very fine to very

coarse, 80 percent felsic grains. The fine fraction was light yellowish brown (2.5Y 6/3) No reaction to HCl was observed. Eight feet of flowing sand was observed at 115 ft bgs.

At 127.5 ft bgs, a distinct contact with a light greenish gray (5GY 8/1) mud exhibiting low to moderate plasticity and a strong reaction to HCl was observed. Based on the changes in color and lithology, this was interpreted as the contact between the Ringold unit E and RUM. Drilling continued into the RUM until a TD of 133.9 ft bgs.

3.2.5 Borehole Geology for Well 199-K-209 (C8296)

The sediments encountered at C8296 consisted of primarily sandy gravels from the ground surface to 73 ft bgs. The sandy gravels were 50 to 80 percent gravel and 15 to 45 percent sand. Two silty sandy gravel intervals were observed from 9 to 11.5 ft bgs and 60 to 63 ft bgs. From the ground surface to 73 ft bgs, the gravel fraction consisted of angular to rounded, very fine pebble to boulder clasts comprised of 80 to 95 percent basalt. The sand fraction consisted of angular to subrounded, very fine to very coarse sand comprised of 20 to 95 percent basalt. The color of the fine fraction ranged from pale brown (10YR 6/3) to very dark brown (10YR 2/2). Occasional weak reactions to HCl were observed, except at a calcareous zone at 5 ft bgs that exhibited a strong reaction to HCL. At 73 ft bgs, a distinct increase in felsic content and a color change to light olive brown (2.5Y 5/3) was observed and interpreted as the contact between the Hanford formation and the Ringold unit E.

The sediment from 73 to 148 ft bgs consisted of multiple fining and coarsening intervals containing sand, gravelly sand, and sandy gravels. The gravel fraction consisted of poorly to well sorted, angular to rounded, very fine pebbles to very coarse pebbles 40 to 90 percent felsic grains. The sand fraction consisted of very poorly to well sorted, angular to rounded, very fine sand to very coarse, 40 to 95 percent felsic grains. The fine fraction ranged from light olive brown (2.5Y 5/3) to dark grayish brown (2.5Y 4/2). Weak to no reaction to HCl was observed, except in an interval of highly cemented caliche at 120 to 125 ft bgs where reactions were moderate to strong. Approximately 4 to 8 ft of sand heaved three times during the interval at 98 to 99 ft bgs.

At 148 ft bgs, a distinct contact with a silty gravel was observed that transitioned to a sandy silt at 148.5 ft bgs. The gravel fraction of the silty gravel was iron stained and had a very strong reaction to HCl. The sandy silt was comprised of 30 percent sand and 65 percent mud. The sand fraction consisted of poorly sorted, very fine to coarse sand comprised of 75 percent felsic grains. The mud fraction consisted of approximately 25 percent clay and 75 percent silt. The clayey silt exhibited medium to high plasticity. The color of the fines was brown (10YR 5/3) and did not react to HCl. Based on the distinct change in color and lithology, this was interpreted as the contact between the Ringold unit E and the RUM. Drilling continued into the RUM until a TD of 154.6 ft bgs.

3.3 Hydrogeology

The regional groundwater flow in the 100-K Area is primarily to the northwest toward the Columbia River. At these well locations, groundwater flow is influenced by pump-and-treat operations, the fluctuations in river stages, and erosional channels in the RUM (DOE/RL-2006-75, *Supplement to the 100-HR-3 and 100-KR-4 Remedial Design Report and Remedial Action Work Plan for the Expansion of the 100-KR-4 Pump-and-Treat System*).

At the five borehole locations, the vadose zone occurs within the Holocene deposits, Hanford formation, and the uppermost Ringold Formation unit E, and ranges in thickness from 41.8 ft at C8295 to 96.4 ft at

C8296. The unconfined aquifer occurs entirely within the Ringold Formation unit E and ranges in thickness from 51.6 ft at C8296 to 85.7 ft at C8295. The RUM is an aquitard, and defines the bottom of the unconfined aquifer in the 100-KR-4 OU. The RUM was encountered at all five of the borehole locations and ranged in depth from 127.5 ft bgs at C8295 to 157.0 ft bgs at C8291.

Well development data are summarized in Table 2-2. Maximum drawdown levels measured during final well development varied from 8.82 ft at C8291 (82 gallons per minute pumping rate) to 22.37 ft at C8291 (151 gallons per minute pumping rate). Pumping rates during final well development were primarily influenced by pump capacity and pump depth.

3.4 Contaminants

Groundwater contamination at the 100-KR-4 OU originated from planned and unplanned discharges of contaminated waste water and chemical solutions during and after operation of the 105-KE and 105-KW plutonium production reactors. The primary contaminant of concern in the 100-KR-4 OU is Cr(VI). Other contaminants of concern are strontium-90, carbon-14, nitrate, trichloroethylene, and tritium. Groundwater samples were collected during drilling and following well development at each location. Groundwater analytical results are not included in this report.

4 Waste Management

Waste from individual wells was managed according to DOE/RL-97-01, *Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Units*, as amended by TPA-CN-623. Waste generated during drilling activities included drill cuttings, decontamination water, and miscellaneous solid waste.

4.1 Vadose Zone Cuttings

All vadose zone drill cuttings from above the historic high water mark were contained in designated roll off boxes. The roll off boxes were periodically surveyed by Radiological Control Technicians and Industrial Hygiene personnel and transferred to Environmental Restoration Disposal Facility for disposal. Miscellaneous solid waste associated with vadose zone cuttings, including nitrile gloves, plastic bags used to collect drill cuttings, and other waste associated with sampling activities, were contained in clear plastic bags and placed in the designated roll off box. Roll off boxes were transported to the Environmental Restoration and Disposal Facility 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 Saturated Zone Cuttings

All drill cuttings collected at or below the water table were released into tip dumpsters, dewatered, and placed in designated waste roll off boxes. Dewatered fluid was treated as purgewater. Water-absorbing crystals were spread over the dewatered drill cuttings to capture free liquids that could not be dewatered, allowing the waste container to be designated as solid waste. Miscellaneous solid waste associated with saturated zone cuttings, including nitrile gloves, plastic bags, and other waste associated with sampling activities, were containerized in clear plastic bags in the roll off boxes. Roll off boxes were transported to the Environmental Restoration and Disposal Facility for disposal.

4.3 Purgewater

Purgewater was generated during well drilling, development activities, and from water decanted from the tip dumpster containing saturated drill cuttings. All purgewater was contained on site in a poly-tank or purgewater truck and later transported to the Purgewater Storage and Treatment Facility.

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5 Civil Survey

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

| Well Name | Well ID | Type | Northing ^a (m) | Easting ^a (m) | Ground Surface Elevation ^b (Brass Cap) (m) |
|-----------|-----------|-----------------------|------------------------------|-----------------------------|--|
| C8290 | 199-K-203 | Monitoring/Extraction | 146848.90 | 569212.43 | 142.016 |
| C8291 | 199-K-204 | Monitoring/Extraction | 146572.85 | 568648.34 | 142.476 |
| C8294 | 199-K-207 | Monitoring | 146979.80 | 569409.77 | 141.272 |
| C8295 | 199-K-208 | Monitoring/Extraction | 147170.23 | 569291.76 | 133.004 |
| C8296 | 199-K-209 | Monitoring/Extraction | 147065.85 | 572552.36 | 150.250 |

- a Northing and easting coordinates are based on Washington State Plane Coordinates NAD83, *North American Datum of 1983*.
- b Vertical Elevation values are based on NAVD88, *North American Vertical Datum of 1988* and are rounded to 0.01 m.

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6 Well Acceptance

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

Representatives from Stillwater Drilling Inc. and CHPRC participated in the acceptance inspection for C8290, C8291, C8294, C8295 and C8296 wells on March 25, 2015. Final well acceptance was documented by completion of a checklist and signatures from representatives of the drilling contractor and CHPRC. A Quality Assurance Work Site Assessment will be prepared to document well acceptance.

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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-50047 (GRP-FS-04-G-012), *Sample Packaging, Transporting and Shipping*

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

Other References:

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.

DOE/RL-97-01, 2005, *Interim Action Waste Management Plan for the 100-HR-3 and 100-KR-4 Operable Units*, Rev. 5, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2006-75, 2008, *Supplement to the 100-HR-3 and 100-KR-4 Remedial Design Report and Remedial Action Work Plan for the Expansion of the 100-KR-4 Pump-and-Treat System*, Rev. 1, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2013-36, 2013, *100-KR-4 Groundwater Operable Unit Well Installation Sampling and Analysis Plan*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2013-36-ADD1, 2013, *100-KR-4 Groundwater Operable Unit Well Installation Sampling and Analysis Plan, Addendum 1: 199-K-202, 199-K-205, 199-K-206, and 199-K-207*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE/RL-2013-36-ADD2, 2013, *100-KR-4 Groundwater Operable Unit New Well Installation Sampling and Analysis Plan, Addendum 2*, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, EPA, and DOE, 1989, *Hanford Federal Facility Agreement and Consent Order*, 2 vols., as amended, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington. Available at: <http://www.hanford.gov/?page=90&parent=91>.

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.

ROD/R10-96/134, 1996, *Declaration of the Record of Decision for the 100-HR-3 and 100-KR-4 Operable Units*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.
Available at: <http://www5.hanford.gov/arpir/?content=findpage&AKey=D196097243>

Resource Conservation and Recovery Act of 1976, 42 U.S.C 6901, et seq.

SGW-57478, 2014, *Description of Work for the Installation of Three Wells in the 100-KR-4 Groundwater Operable Unit, with an Option of Three Wells FY 2014*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

SGW-54543, 2013, *Recommendations and Technical Justification for New and Replacement Wells and Re-Alignment of Existing Wells Associated with Interim Remedial Actions at 100-K Area*, Rev. 0, CH2M HILL Plateau Remediation Company, Richland, Washington.

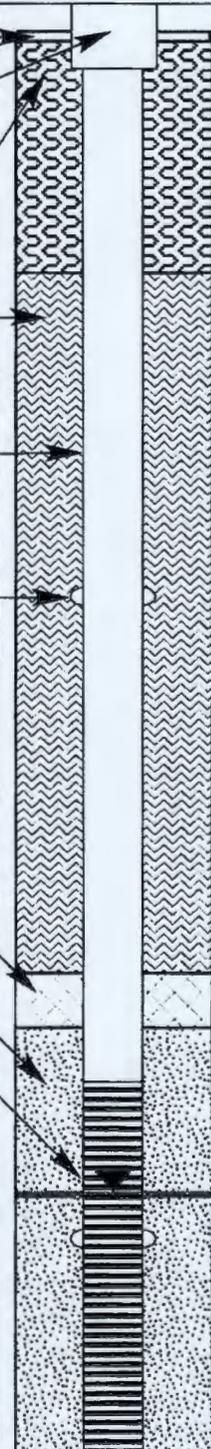
WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

Appendix A

Well Documentation for C8290 (199-K-203)

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

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| WELL SUMMARY SHEET | | Start Date: 8/6/2014 | | Page 1 of 2 | |
|---|--|---|--|----------------------------------|--|
| Well ID: C8290 | | Well Name: 199-K-203 | | | |
| Location: 150m NNE of 105 KE reactor | | Project: 2 Plus 3 Optional Wells In 100-KR-4 OU | | | |
| Prepared By: Joshua Holland | | Date: 3/10/15 | | Reviewed by: J.D. MEHRER | |
| Signature: <i>[Signature]</i> | | Date: 4/3/15 | | Signature: <i>[Signature]</i> | |
| CONSTRUCTION DATA | | | GEOLOGIC/HYDROLOGIC DATA | | |
| Description | Diagram | Depth in Feet | Graphic Log | Lithologic Description (ft bgs) | |
| Concrete Pad: 0.5 ft above ground surface (ags) |  | 0 |  | 0 - 10 Gravelly Sandy Silt (gsM) | |
| 8-in Protective Casing: 3.10 ft ags - 1.90 ft below ground surface (bgs) | | 10 | | 10 - 20 Silty Sandy Gravel (msG) | |
| Type I/II Portland Cement Grout: 0 - 15.0 ft bgs | | 20 | | 20 - 38 Sandy Gravel (sG) | |
| 3/8 in Cetco Medium Bentonite Chips: 15.0 - 58.5 ft bgs | | 30 | | | |
| 6-in I.D. Schedule 10, Type 304/304L, Stainless Steel Blank Casing: 2.12 ft ags - 64.92 ft bgs | | 40 | | 38 - 60 Silty Gravel (mG) | |
| Stainless steel centralizer installed from the top of the sump at 40 ft intervals | | 50 | | | |
| 3/8 in Cetco Coated Bentonite Pellet Seal: 58.5 - 61.2 ft bgs | | 60 | | 60 - 99 Sandy Gravel (sG) | |
| 8-16 mesh Premier Colorado Silica Filter Pack Sand: 61.2 - 161.8 ft bgs | | 70 | | | |
| 6-in I.D. Schedule 10, Type 304/304L, 50-slot (0.050 in.) Stainless Steel Screen: 64.92 - 155.01 ft bgs | | 80 | | | |
| <p>Depths are in ft below ground surface.</p> <p>Borehole drilled with 13 3/8-in O.D conductor casing from 0 - 59.5 ft bgs and with 11 3/4-in O.D. casing from 0 ft bgs - 159.5 ft bgs</p> <p>All temporary drill casing was removed from the ground.</p> | | | | | Static Water Level: 72.1 ft bgs (11/24/2014) |

| | | |
|---------------------------|-----------------------|-------------|
| WELL SUMMARY SHEET | Start Date: 8/6/2014 | Page 2 of 2 |
| | Finish Date: 2/9/2015 | |

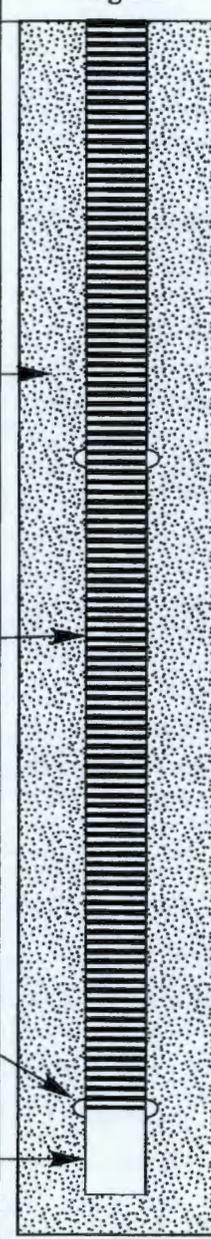
Well ID: C8290 Well Name: 199-K-203

Location: 150 m NNE of 105 KE reactor Project: 2 Plus 3 Optional Wells In 100-KR-4 OU

Prepared By: Joshua Holland Date: 3/10/15 Reviewed By: **MEHRER** Date: 5/3/15

Signature: *[Signature]* Signature: *[Signature]*

| | |
|--------------------------|---------------------------------|
| CONSTRUCTION DATA | GEOLOGIC/HYDROLOGIC DATA |
|--------------------------|---------------------------------|

| Description | Diagram | Depth in Feet | Graphic Log | Lithologic Description (ft bgs) |
|-------------|--|---------------|---|---------------------------------|
| |  | 90 |  | 60 - 99 Sandy Gravel (sG) |
| | | 100 |  | 99 - 100 Silty Gravel (mG) |
| | | 110 |  | 100 - 124 Sandy Gravel (sG) |
| | | 120 |  | 124 - 125 Gravel (G) |
| | | 130 |  | 125 - 155.7 Sandy Gravel (sG) |
| | | 140 | | |
| | | 150 | | |
| | | 160 |  | 155.7 - 161.8 Silt (M) |
| | | 170 | | |

8-16 mesh Premier Colorado Silica Filter Pack Sand: 61.2 - 161.8 ft bgs

6-in I.D. Schedule 10, Type 304/304L, 50-slot (0.050 in.) Stainless Steel Screen: 64.92 - 155.01 ft bgs

Stainless steel centralizer installed from the top of the sump at 40 ft intervals

6-in I.D. Schedule 10, Type 304/304L, Stainless Steel Sump: 155.01 - 160.02 ft bgs

Depths are in ft below ground surface.

Borehole drilled with 13 3/8-in O.D conductor casing from 0 - 59.5 ft bgs and with 11 3/4-in O.D. casing from 0 ft bgs - 159.5 ft bgs

All temporary drill casing was removed from the ground.

Straightness Test: 10/13/2014, Pass
Total Depth: 161.8 ft bgs

| BOREHOLE LOG | | | | | Page 1 of 5 |
|----------------------------------|----------|----------------------|---|---|--|
| Well ID: C8290 | | Well Name: 199-k-203 | | Location: 150 m NNE of 105 KE reactor | |
| Project: 2 + 3 wells in 100-KR-4 | | | Reference Measuring Point: Ground level | | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
| | Type No. | Blows Recovery | | | |
| 0 | | | | 0-10' Gravelly sandy silt (qsm) 25% gravel, 20% sand, 55% mud. Gravel: max 50mm, avg = mp-qp, 85% basalt SR, MS. Sands: 100% VF, 90% felsic, VWS. 2.5 Y 4/3 | ~.5 ft drill pad Cable tool, drive barrel 10 3/4 dia. casing |
| 5 | G | | | olive brown, moist, slight rxn HCl @ 0.5' one 200mm large cobble @ 6' large cobble, difficult to advance casing | |
| | | | | @ 8-10' ocd. cobble | |
| 10 | G | | | 10-20' Silty sandy gravel (msG) 65% gravel, 20% sand, (5% mud. Gravel: 70mm max, 90% basalt, VF-Fc C-vc (bimodal), >20mm GR-R + 420mm angular Sands: VF-VC, P, 90% basalt, SA-A. 2.5 Y 5/2 grayish brown | *moisture likely due to dust suppression work done previous week |
| 15 | G | | | clay nodules present (2.5 Y 6/2 light brownish gray) HCl rxn on CaCO ₃ coating. Slightly moist @ 15' light olive brown (2.5 Y 5/3) | Strong |
| 20 | G | | | 20-38' Sandy gravel (SG) 70% gravel, 20% sand, 10% silt. Gravel: max = 55mm, 90% basalt, VFP-VCP, SA-WR. Sands: 90% basalt, VF-VC, P, A. 2.5 Y 3/2. Very dark grayish brown. Moist, no rxn HCl. Rare clay nodules | @ 20' drillrate ↑↑ |
| 25 | G | | | @ 25' mud decrease to 5%, no clay. | @ 25' drillrate ↑↑ |
| 30 | G | | | @ 30' Sand: basalt % ↓ to 80%, 2.5 Y 2.5/1 black | |
| 35 | G | | | @ 35' Gravel: 75% felsic + quartzite Sands: 70% felsic, trace mica, low-moist plastic clay w/ ocd wear rxn HCl matrix: grayish brown 2.5 Y 5/2 clay: olive brown 2.5 Y 4/3 | @ 34' proposed ringold F contact based on Δ Color + Δ lithology @ 34' ↓ drillrate, driller says formation is tight. |

Reported By: Joshua Holland

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: *J. Holland*

Date: 8/6/14

Signature: *Kevin Bergstrom*

Date: 4-6-15

| BOREHOLE LOG | | | | | Page <u>2</u> of <u>5</u> |
|---------------------------------------|-----------------|-----------------------------|---|---|--|
| | | | | | Date: <u>8/11/14</u> |
| Well ID: <u>C8290</u> | | Well Name: <u>199-k-203</u> | | Location: <u>150m NNE of 105 KE reactor</u> | |
| Project: <u>2+3 wells in 100-kR-4</u> | | | Reference Measuring Point: <u>ground level.</u> | | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
| | Type No. | Blows Recovery | | | |
| 40 | G | | | 38-60' ^{sandy} gravel (MS) 40% gravel, 40% mud, 20% sand Gravel: 75% felsic, max=SC, avg=CP MS, R, MP-VCP. Sand: 90% felsic, trace mica, VF-VF, A-SR, avg=VF-E, 50% of mud is low-med plasticity clay. Moist, 2.5Y 6/2 light brownish gray | @ 39' large cobble partially collapsed drive barrel |
| | G TH | | | @ 41' drill rate ↓↓ | @ 41' drill rate ↓↓ |
| 45 | G | | | @ 40' gravel ↑↑ 65%, ^{SH} mud ↓↓ 25% | difficult to get recovery from DB |
| | | | | @ 45' No clay, dry, light gray (2.5Y 7/1) | |
| 50 | G | | | @ 50' No clay, slightly moist, greyish brown (2.5Y 5/2) | |
| 55 | G | | | @ 55' sands ↑↑ 90% felsic, VF-m, light brownish grey (2.5Y 6/2) | |
| | G | | | @ 57' gravel: ↓↓ 60% felsic, avg=VCP, one deteriorated basalt present with clay coating, moist mod HCl rxn, clay: olive yellow (2.5Y 6/5) | |
| 60 | G | | | 60-65' Sandy Gravel (SR) 50% gravel, 40% sand, 10% silt Gravel: 70% felsic, max 85mm, avg=VCP SR-R. Sand: 80% felsic, trace mica, VF-C with (70% being VF-E, MS mod rxn HCl, Greyish brown (2.5Y 5/2) Moist | @ 60' drill rate ↓↓ very tight w/ cobbles 60-65 texture may not be representative due to pulverization |
| 65 | G | | | @ 65: Wet due to water added, Dark Olive brown (2.5Y 3/3) | @ 64' add 4 gallon H ₂ O |
| | | | | | @ 67' ↓↓ drill rate @ 67' switch to hard tool @ 67' add 350 gallon H ₂ O |
| 70 | G | | @ 70': gravel: 50% felsic, color changes Greyish Brown (2.5Y 5/2) | @ 70' 8,000 DPM beta gamma, 500 DPM alpha detected | |
| | | | | 70 + 75 texture is NOT representative + was collected with a barler due to hard tooling. All gravel was fractured and 4.5mm in size. | |
| 75 | G | | @ 75: gravel: 60% felsic | 70 + 75 gravel texture assumed to be unchanged from 60' | |
| | | | Hand tool was used from 67' to 77' log and then the same area was redrilled using drive barrel drill method | | |
| Reported By: <u>Joshua Holland</u> | | | Reviewed By: <u>Kevin Bergstrom</u> | | |
| Title: <u>Geologist</u> | | | Title: <u>Sr. Geologist</u> | | |
| Signature: <u>[Signature]</u> | | Date: <u>8/26/14</u> | Signature: <u>[Signature]</u> | | Date: <u>4-6-15</u> |

| BOREHOLE LOG | | | | | | Page 3 of 5 |
|----------------------------------|----------|-----------------------|-------------|---|--|--|
| Well ID: C8290 | | Well Name: 199-KR-203 | | Location: 150 m NNE of 105 KE reactor | | Date: 11/5/14 |
| Project: 2 + 3 wells in 100-KR-4 | | | | Reference Measuring Point: Ground level | | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments | |
| | Type No. | Blows Recovery | | | Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl | Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level |
| 80 | G | | | 80-99' Sandy Gravel (SG) 65% G, 35% S, trace M Gravels: 60% felsic, max=80mm, VFP-SC, avg=CP, MS, SA-SR, Sands: 80% felsic, VFS-VC, WS, 80% MS, wet, ocl ^{tr} rxn to HCl. Grayish brown (2.5 Y 5/2) | | |
| 85 | G | | | @ 85' gravels sorting ↓ to PS, felsic ↑ to 75% | @ 85' ↓ drill rate | |
| 90 | G | | | @ 90' Gravels sorting ↓ to VPS, A-SA Sands: sorting ↓ to VPS. moderate rxn to HCl. color change to Light Olive Brown (2.5 Y 5/3) | | @ 93' ↑ drill rate |
| 95 | G | | | @ 95' Gravels max ↑ to 250mm, felsic ↓ to 30%. No rxn to HCl. One 250mm basalt rock sandy [#] MS | | @ 97' ↓ drill rate |
| 99 | G | | | 99-100' Silty Gravel (SG) 60% G, 10% S, 30% M Gravels: 50% felsic, max=110mm, VFP-SC, VPS, A-SR Sands: 80% felsic, VFS-CS, WS, 80% VFS-F9, trace mica | | @ 98' large cobble, ↓ drill rate |
| 100 | G | | | wet. Strong rxn to HCl. Light Olive brown (2.5 Y 5/3) some mod plasticity clay. Dark gray (G) eq 1 4' | | @ 100' ↑ drill rate |
| 100-124' | G | | | 100-124' Sandy Gravel (SG) 55% G, 40% S, 5% M Gravels: 50% basalt, max=160mm, VFP-L0, VPS, SA-SR Sands: 80% felsic, VFS-VC, VPS, A-SA, trace mica. | | @ 103' ↑ drill rate |
| 105 | G | | | Wet. Ocl. weak rxn to HCl. Olive brown (2.5 Y 4/3) @ 105' Gravels ↑ to 77% Gravel ↓ to 40, sand ↑ to 55. Gravel becomes MS, avg=30mm. Color change to gray brown (2.5 Y 5/2) | | Additional changes: @ 110' |
| 110 | G | | | @ 110' *Gravels felsic ↑ to 70%, max=180mm, A-SA. Sands: felsic ↓ to 70%. Color change to light olive brown (2.5 Y 5/3) No rxn to HCl | | * 55% G, 40% S, 5% M |
| 115 | G | | | @ 115' Gravels: felsic ↑ to 90, FP-MC Sands: becomes WS, 80% of sand is MS-CS | | |

| | |
|-----------------------------|------------------------------|
| Reported By: Joshua Holland | Reviewed By: Kevin Bergstrom |
| Title: Geologist | Title: Sr. Geologist |
| Signature: | Signature: |
| Date: 11/12/14 | Date: 4-6-15 |

BOREHOLE LOG

Page 4 of 5

Date: 11/12/14

Well ID: C8290

Well Name: 199-K-203

Location: 150 m NNE of 105 kE reactor

Project: 2+3 wells in 100-KR-4 OU

Reference Measuring Point: ground level

| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
|-------------|----------|----------------|-------------|--|--|
| | Type No. | Blows Recovery | | | |
| 120 | G | | | 100-124' Sandy Gravel (SG) 55%G, 40%S, 5%M Gravels 50% felsic, max=160mm, VFS-1C, VPS, SA-SR Sands 80% felsic, VFS-VCS, VPS, A-SA, trace mica wet. | @122.5' ↑ drillrate |
| 125 | G | | | @120' Gravels felsic % at 20%, average size ↑ to 70 mm. Sands mod sorted, 80% MS-CS. Color change to gray brown (2.5 Y 5/2) No rxn to HCl. | |
| 130 | G | | | 124-125' Gravel (G) 80%G, 15%S, 5%M Gravels 90% felsic, max=130mm, SP-LG Avg=20, PS, A-SR Sands 80% felsic, PS, VFS-VCS, 60% MS-CS, SA. wet. No rxn to HCl. Very dark brown (2.5 Y 3/2) | @130' ↓ drillrate |
| 135 | G | | | Gravel portion is degraded, with some rocks easily breakable. 125-155' Sandy Gravel (SG) 70%G, 30%S, trace M Gravels 90% felsic, max=130mm, FP-SC, avg=20mm, PS, SA-SR. Sands 80% felsic, VFS-VCS, MS, 80% MS-CS, SA. wet. No rxn to HCl. Dark Grayish Brown (2.5 Y 4/2) | |
| 140 | G | | | @130' Gravel % ↓ to 60, sand % ↑ to 40. Gravels avg ↑ to 35mm. Sands WS, 70% MS. Color change to light Olive Brown (2.5 Y 5/3) | 140-150' occ. heaving |
| 145 | G | | | @133' 6" thick layer with laminated silty sandy gravel | sand, heaving up to 1' inside the casing |
| 150 | G | | | @135' One 170mm cobble | |
| 155 | G | | | @140' Sand % ↓ to 30%, mud % ↑ to 10% 140mm cobble, Sands mod sorting, 70% MS-CS. | |
| | | | | @145' max gravel size ↓ to 20mm, color change to Olive Brown (2.5 Y 4/3) | |
| | | | | @150' color change to grayish brown (2.5 Y 5/2) | @150' 25' heaving sand following water sample purging |
| | | | | @155' Gravel % ↑ to 75, sand % ↓ to 15. Color change to dark gray (2.5 Y 4/1) | Add 40 gallons H ₂ O to balance hydraulic head. After driller got outside the shoe again, 15' heaving sand. 350 gallons H ₂ O added. |
| | | | | 155.7-161.8' Mud (M) 10%S, 90%M. sands VFS, 90% felsic. mud is med plasticity clay. moist. No rxn to HCl. Pale Yellow (5 Y 6/2) | First contact with proposed RUM @ 155.7' on 11/24/14 |
| | | | | Reddish Yellow (7.5 YR 6/8) | Δ Lithology |

Reported By: Joshua Holland

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: [Signature]

Date: 11/25/14

Signature: [Signature]

Date: 4-6-15

199-K-203 (C8290)

Log Data Report

Borehole Information:

| | | | | | |
|----------------------------------|-----------------|------------------------------|----------------------------------|-------------------------|-------------|
| Log Date: | 2014-11-25 | Filename: | C8290_HG-NM_2014-11-25 | Site: | 100-K |
| Coordinates (WA St Plane) | | DTW¹ (ft): | 61.25 | DTW Date: | 11/24/14 |
| North (m) | East (m) | Drill Date | TOC² Elevation | Total Depth (ft) | Type |
| N/A | N/A | 11/24/14 | N/A | 161.8 | Cable Tool |

Casing Information:

| Casing Type | Stickup (ft) | Diameter (in.) | | Thickness (in.) | Top (ft) | Bottom (ft) |
|----------------|--------------|----------------|--------|-----------------|----------|-------------|
| | | Outer | Inside | | | |
| Threaded Steel | 0.35 | 10 3/4 | 9 3/4 | 0.5 | 0.35 | 69.5 |
| Threaded Steel | 5.4 | 11 3/4 | 10 3/4 | 0.5 | 5.4 | 159.5 |
| Threaded Steel | 0.95 | 13 3/8 | 12 3/8 | 0.5 | 0.95 | 59.5 |

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 inside the casing was measured at 61.25 ft by the logging engineer with an e-tape on August 25, 2014. On November 25, 2014, the depth to water inside the casing was measured with an e-tape at 70.3 ft. The maximum logging depth achieved was 160 ft.

The first log runs on August 25 were conducted inside a 10 3/4-in. OD/9 3/4-in. ID casing to 69.5 ft. After logging, this casing was removed and replaced with a 13 3/8-in. OD/12 3/8 in. ID casing to 59.5 ft. Drilling continued with 11 3/4-in. OD/10 3/4-in. ID casing to 159.5 ft. The second log runs on November 25, 2014 were conducted inside this casing.

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 |

| | | | |
|------------------------------------|---------------------|---------------------------|----------------------|
| Logging System: | Gamma 1L | Type: | 60% HPGe SGLS |
| Effective Calibration Date: | 11/12/14 | Serial No.: | 47-TP32211A |
| Calibration Reference: | HGLP-CC-111, Rev. 0 | Logging Procedure: | HGLP-MAN-002, Rev. 1 |

¹ depth to water inside casing

² top of casing

³ Neutron Moisture Logging System

**SGLS Log Run Information:**

| Log Run | 1 | 2 Repeat | 5 | 6 Repeat | |
|--------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|--|
| HEIS Number | 1018591 | 1018592 | 1018593 | 1018594 | |
| Date | 08/25/14 | 08/25/14 | 11/25/14 | 11/25/14 | |
| Logging Engineer | Pope | Pope | Felt | Felt | |
| Start Depth (ft) | 0.0 | 34.0 | 69.0 | 100.0 | |
| Finish Depth (ft) | 70.0 | 41.0 | 160.0 | 110.0 | |
| 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 | AL209CAB | AL209CAB | AL229CAB | AL229CAB | |
| Start File | AL209000 | AL209071 | AL229000 | AL229092 | |
| Finish File | AL209070 | AL209078 | AL229091 | AL229102 | |
| Post-Verification | AL209CAA | AL209CAA | AL229CAA | AL229CAA | |
| Depth Return Error (in.) | N/A | 0.5 low | N/A | 1.0 high | |
| Comments | No fine gain adjustments made | |

NMLS Log Run Information:

| Log Run | 3 | 4 Repeat | | | |
|--------------------------|----------|----------|--|--|--|
| HEIS Number | 1018595 | 1018596 | | | |
| Date | 08/25/14 | 08/25/14 | | | |
| Logging Engineer | Pope | Pope | | | |
| Start Depth (ft) | 0.0 | 32.0 | | | |
| Finish Depth (ft) | 61.0 | 38.0 | | | |
| Count Time (sec) | 15 | 15 | | | |
| Live/Real | R | R | | | |
| Shield (Y/N) | N | N | | | |
| MSA Interval (ft) | 0.25 | 0.25 | | | |
| Log Speed (ft/min) | N/A | N/A | | | |
| Pre-Verification | AH172CAB | AH172CAB | | | |
| Start File | AH172000 | AH172245 | | | |
| Finish File | AH172244 | AH172269 | | | |
| Post-Verification | AH172CAA | AH172CAA | | | |
| Depth Return Error (in.) | N/A | 0.0 | | | |
| Comments | 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: | 01/07/15 | Reference: | HGLP-MAN-003, Rev. 0 |
|-----------------|--------------|--------------|----------|-------------------|----------------------|

A casing correction for a 1/2-in. thick casing was applied to the log data. .

A correction for water inside the casing was applied below 61 ft in depth for the first log runs (0 to 70 ft) on August 25, 2014 and below 71 ft for the second log runs on November 25, 2014.

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 1L20141112 using efficiency functions 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. The MDLs for Cs-137 and Pu-239 are plotted 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:

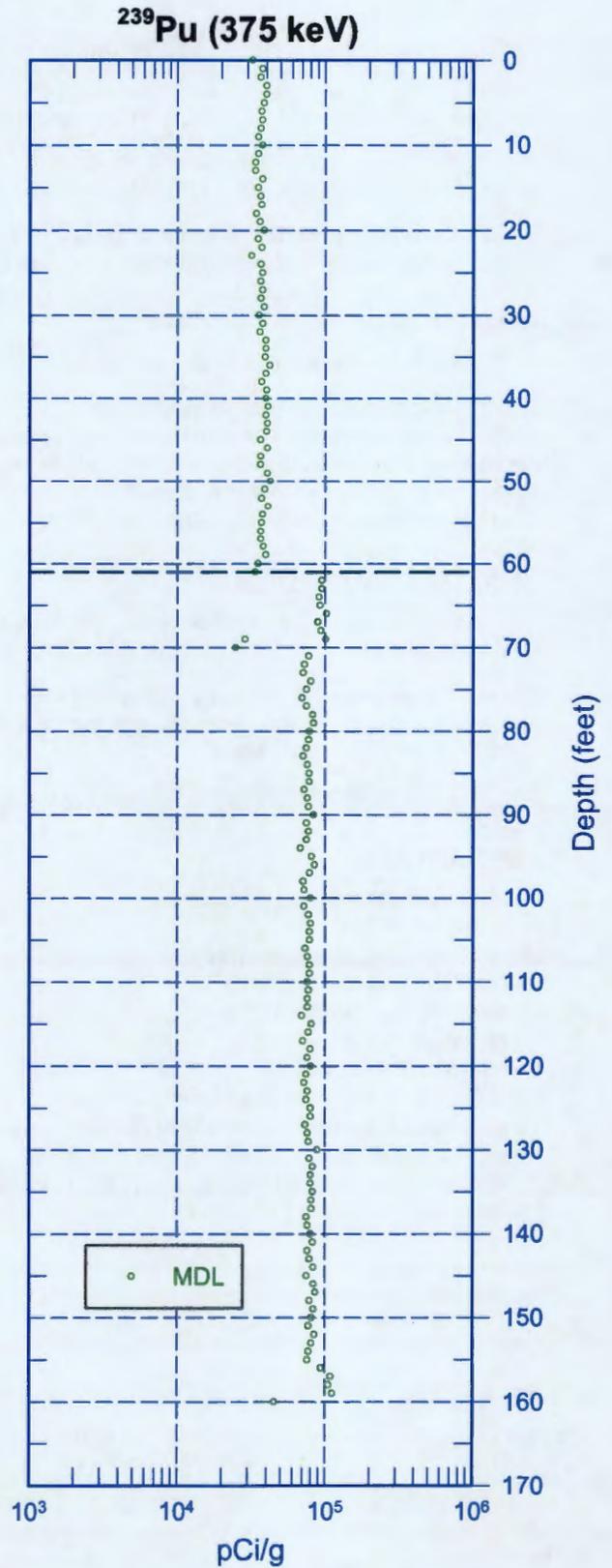
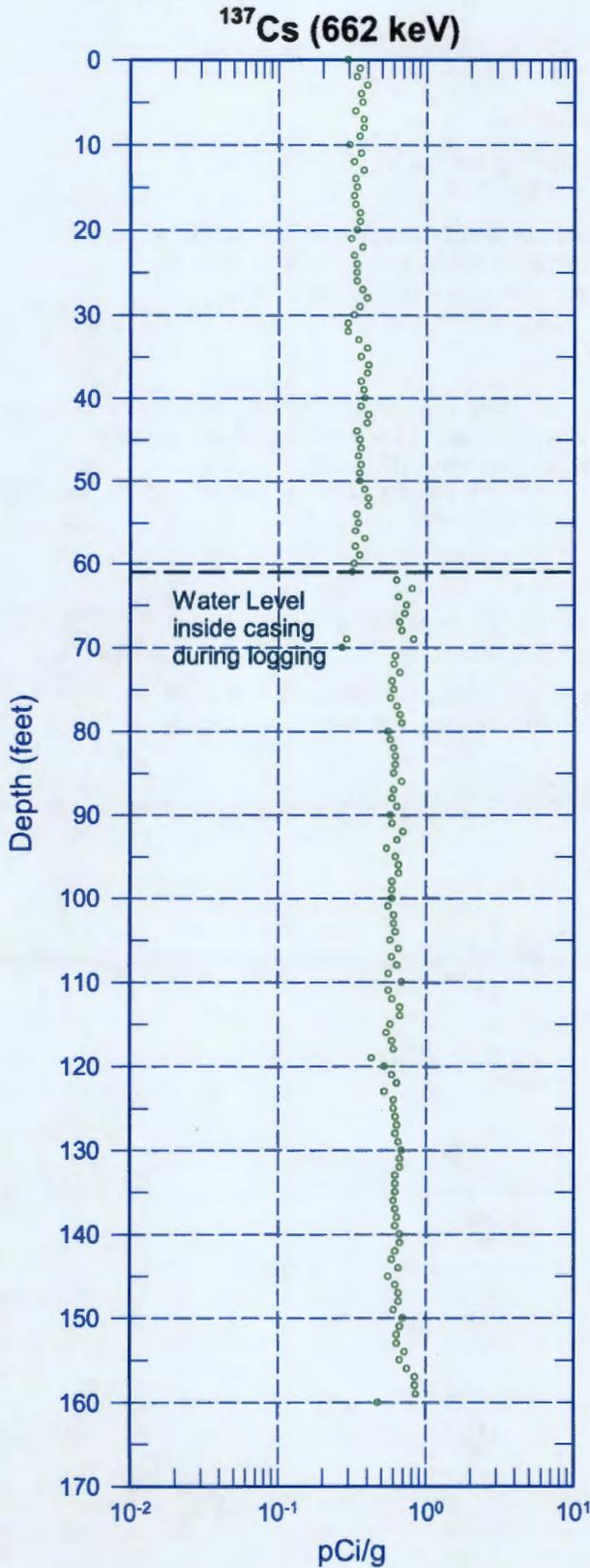
Depth Reference is ground surface.

Manmade Radionuclides (0-170 ft)
 Natural Gamma Logs (0-170 ft)
 Combination Plot (0-120 ft)
 Combination Plot (110-230 ft)
 Combination Plot (0-170 ft)
 Total Gamma & Moisture (0-170 ft)
 Total Gamma & Hanford Gamma Unit (0-170 ft)
 Repeat Section of Natural Gamma Logs (34 to 41 ft)
 Repeat Section of Natural Gamma Logs (100 to 110 ft)
 Moisture Repeat Section (32 to 38 ft)

⁴ Hanford Gamma Unit



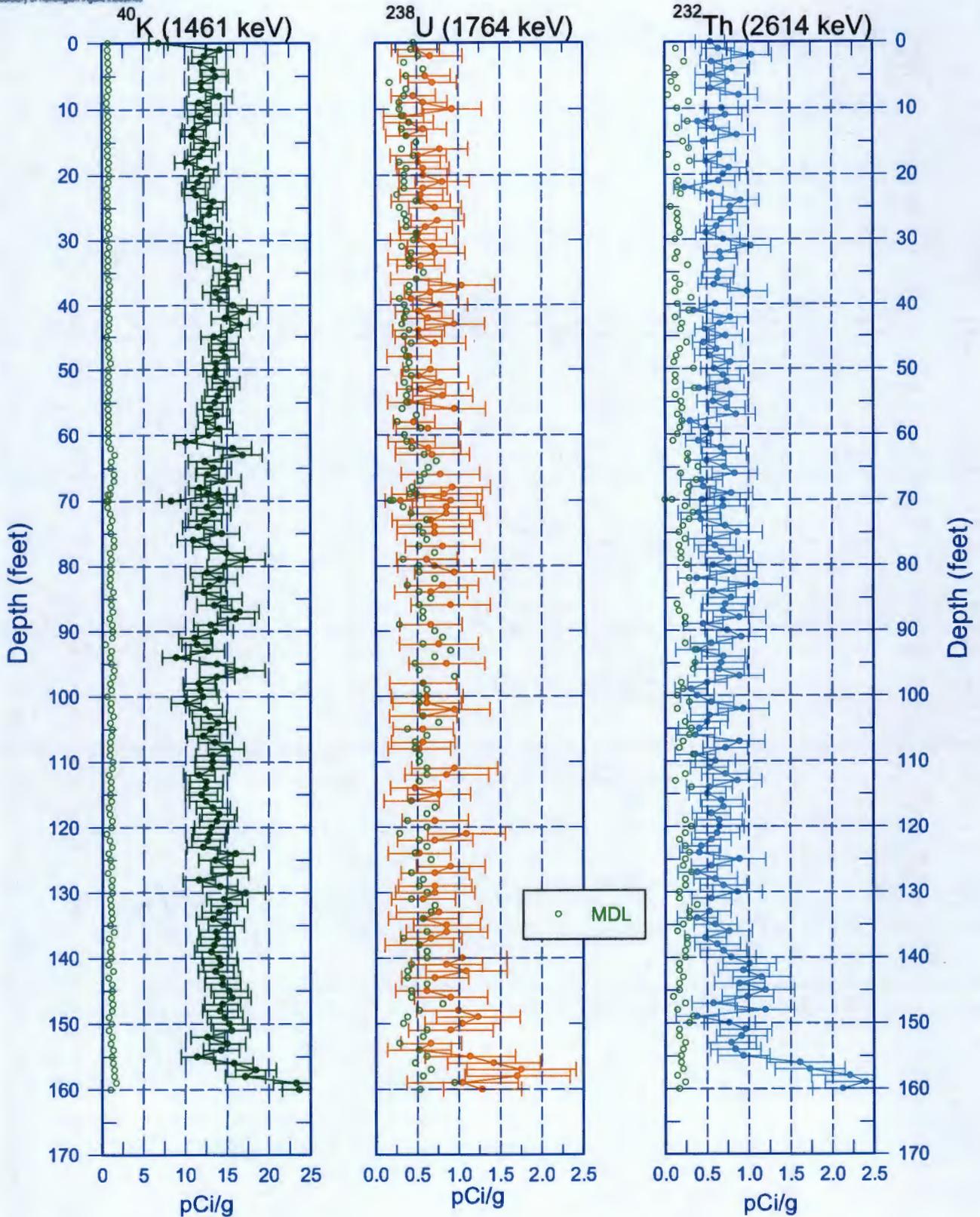
199-K-203 (C8920) Manmade Radionuclides



Zero Reference - Ground Surface



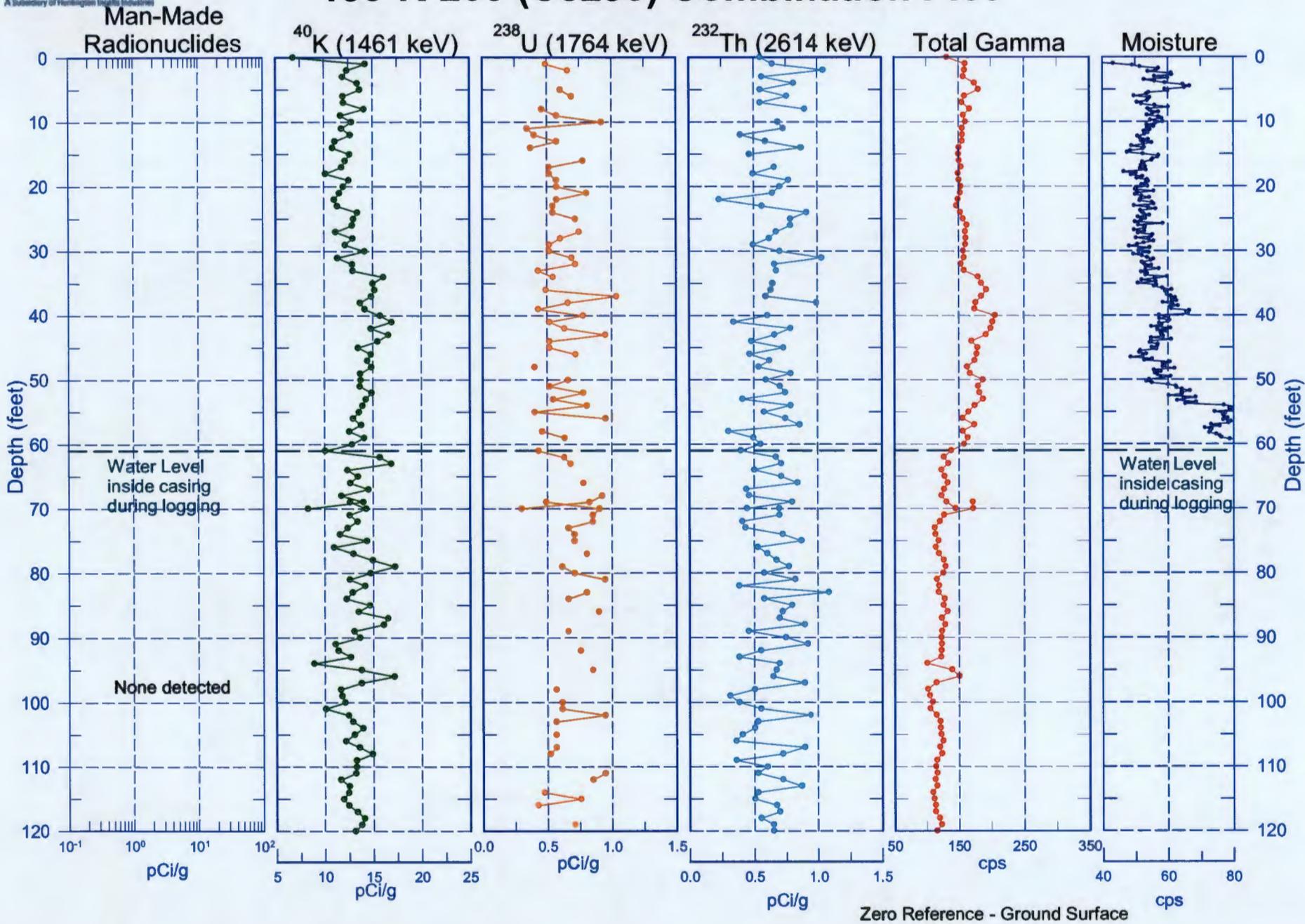
199-K-203 (C8920) Natural Gamma Logs



Zero Reference - Ground Surface



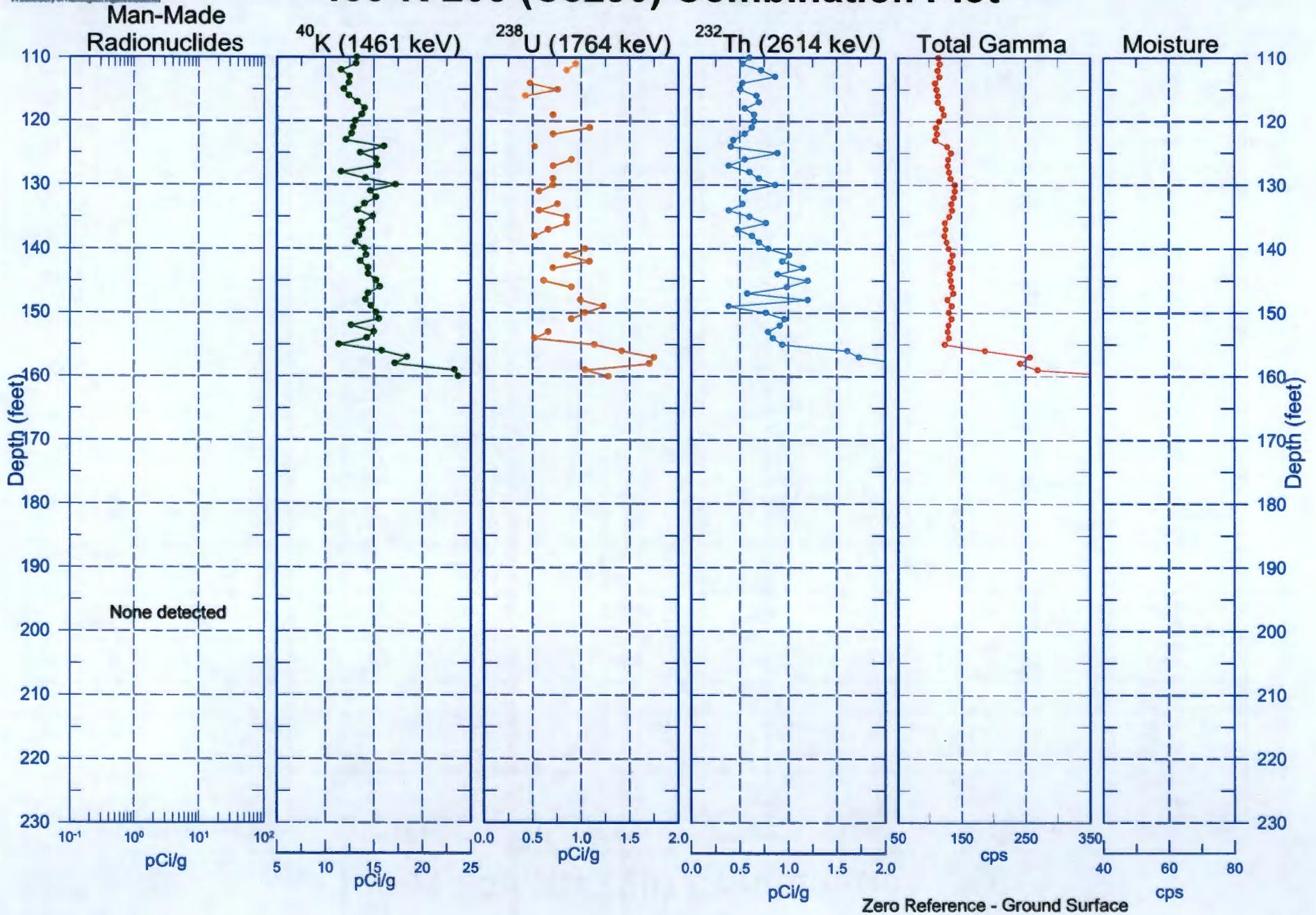
199-K-203 (C8290) Combination Plot





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A Subsidiary of Huntington Ingalls Industries

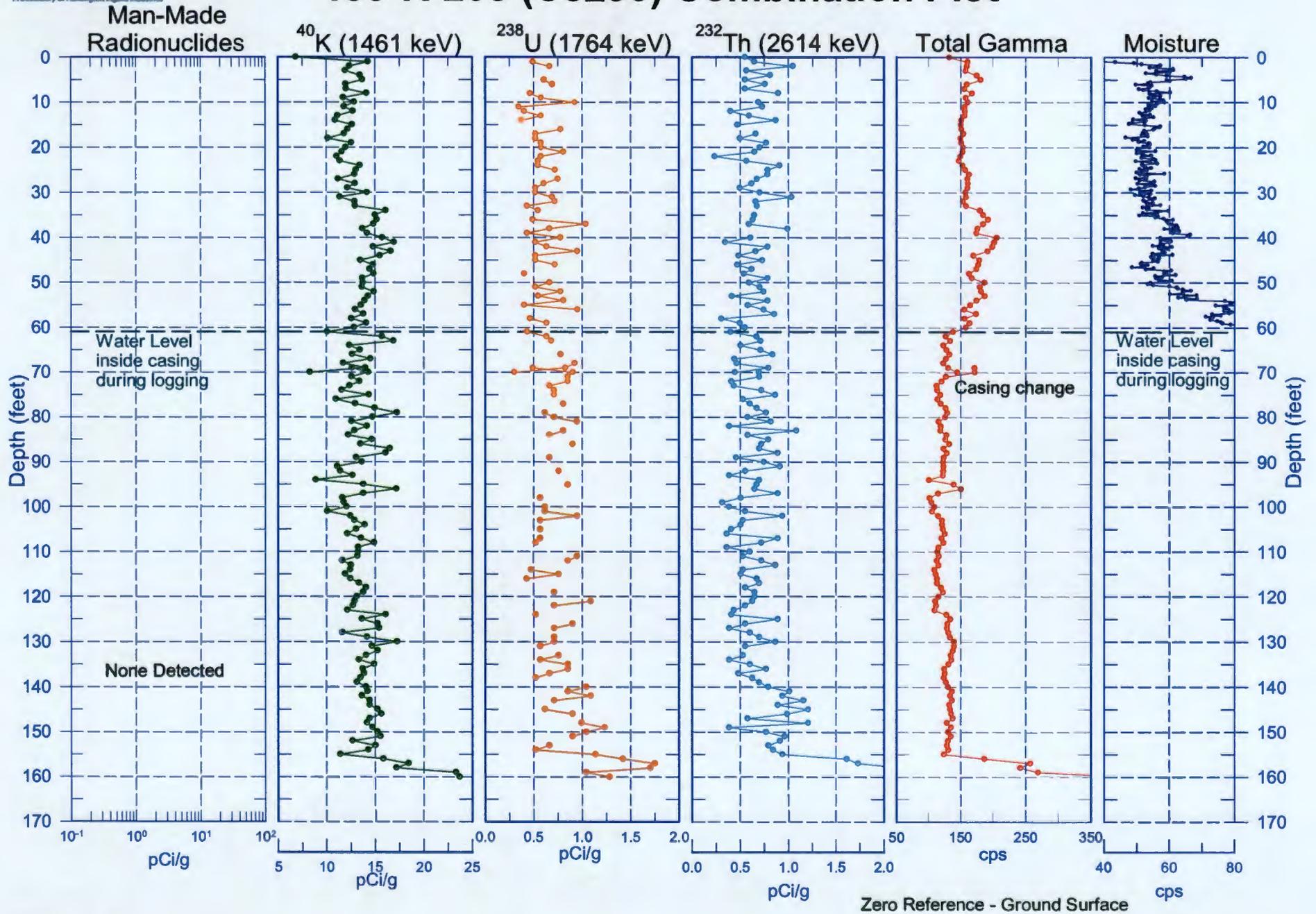
199-K-203 (C8290) Combination Plot





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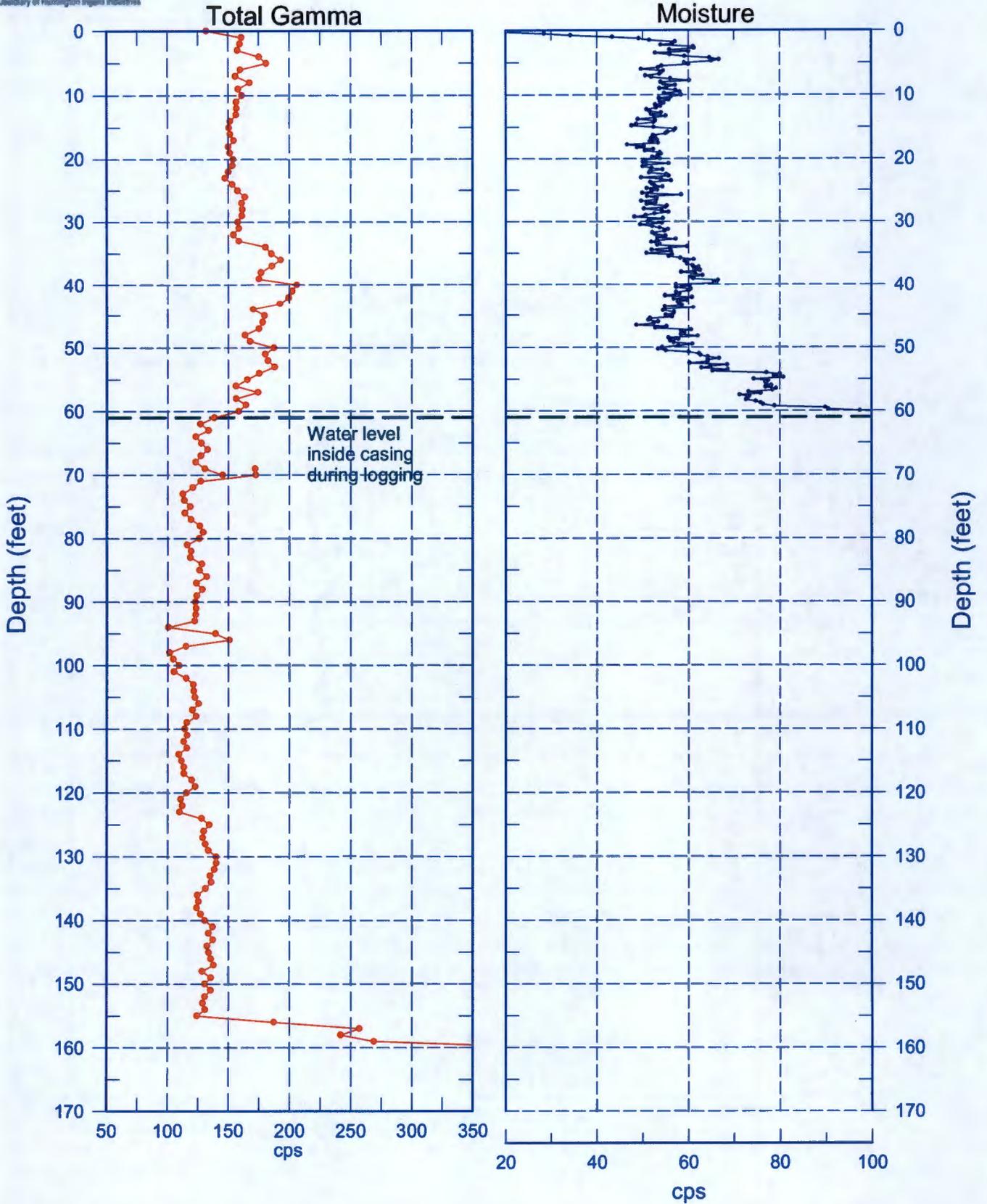
199-K-203 (C8290) Combination Plot





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199-K-203 (C8290) Total Gamma & Moisture

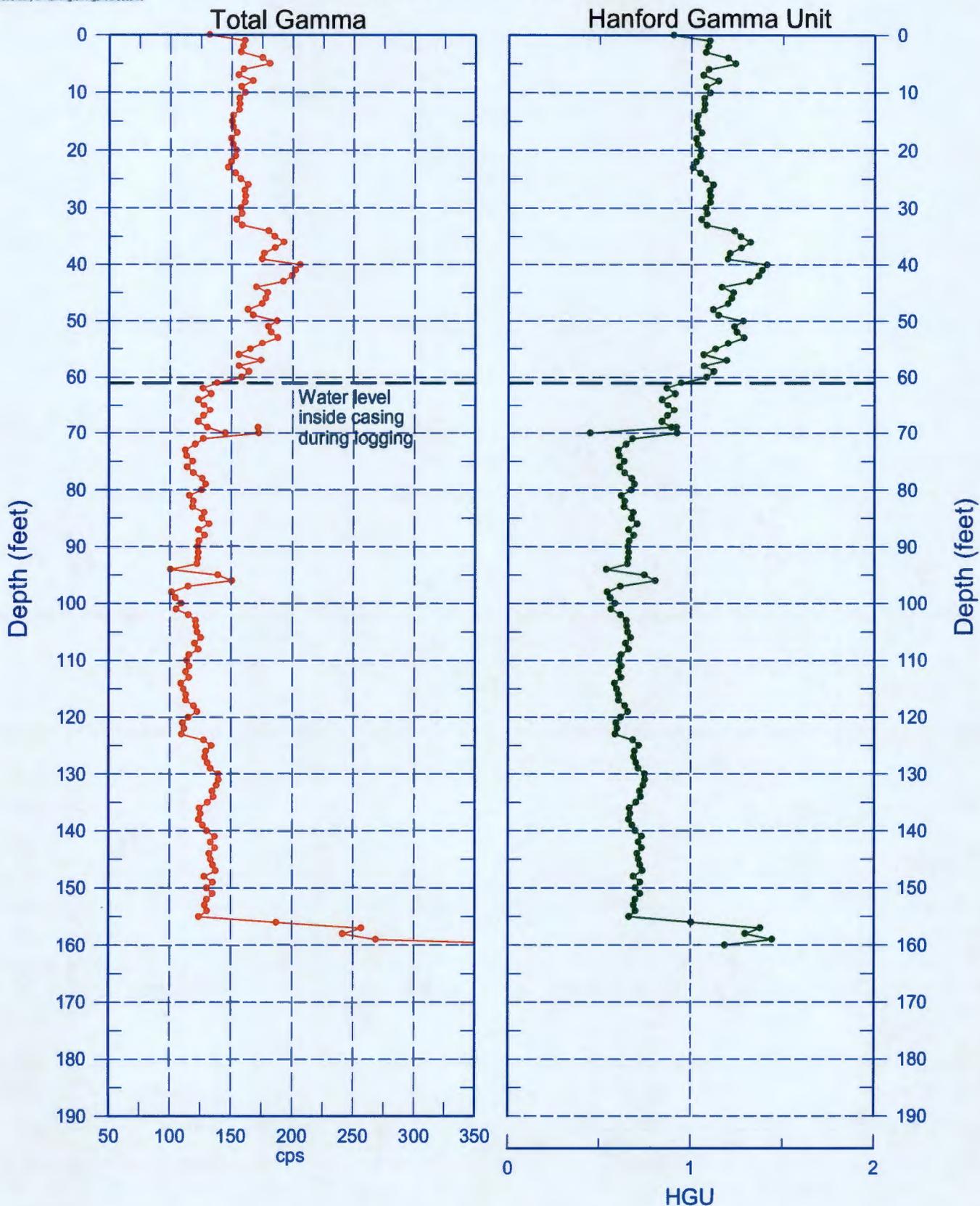


Reference - Ground Surface



199-K-203 (C8290)

Total Gamma & Hanford Gamma Unit

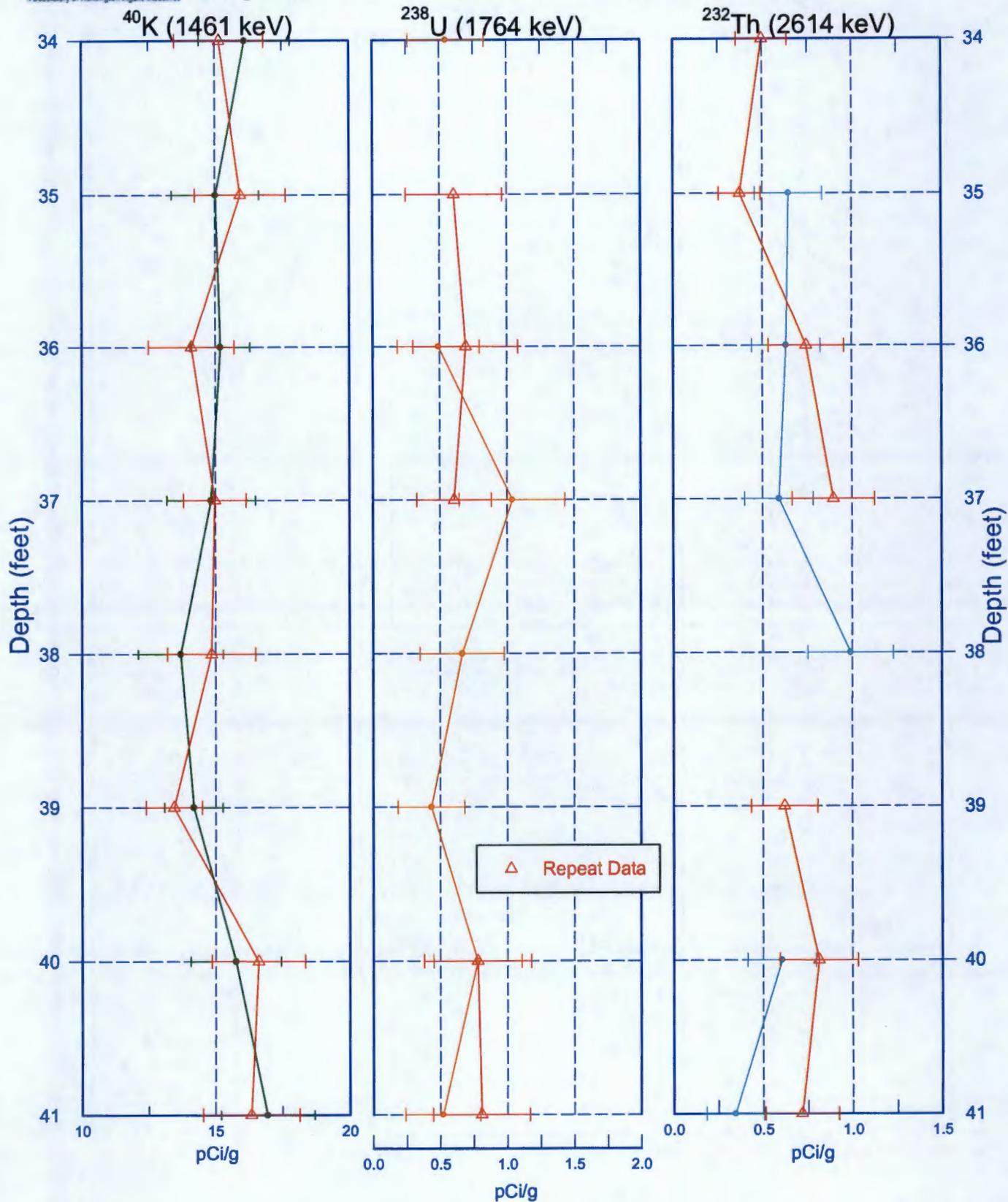


Reference - Ground Surface



199-K-203 (C8290)

Repeat Section of Natural Gamma Logs



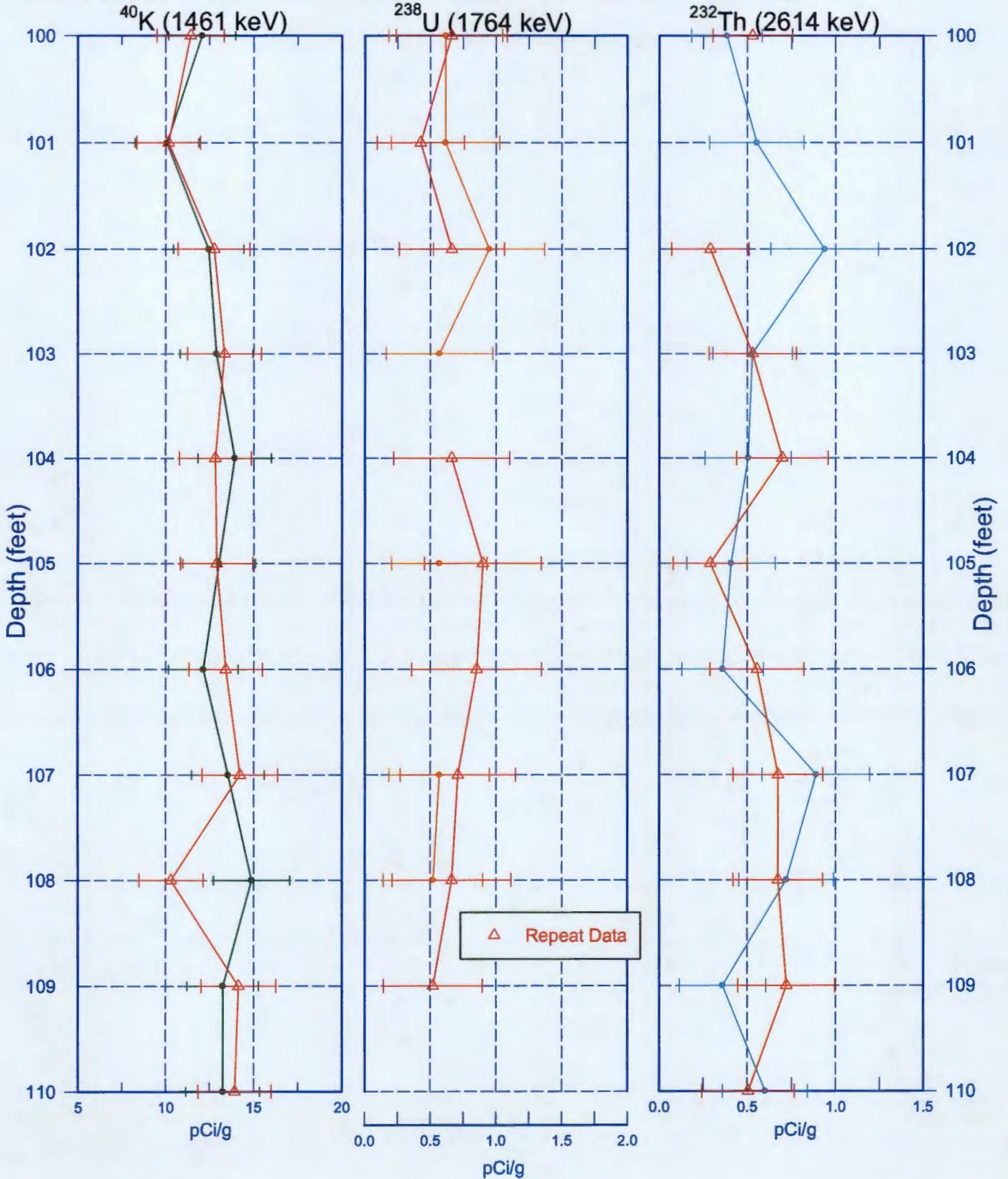
Zero Reference - Ground Surface



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199-K-203 (C8290)

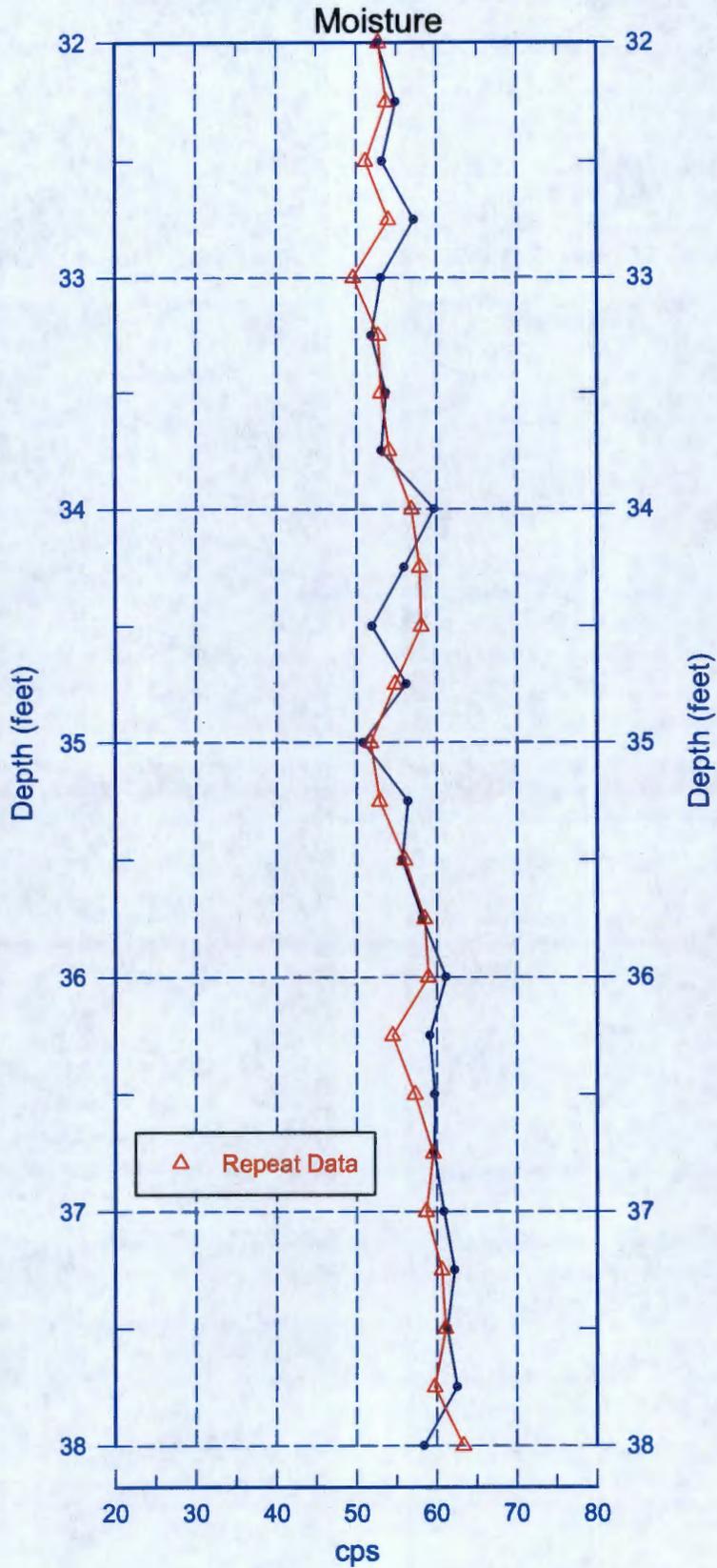
Repeat Section of Natural Gamma Logs



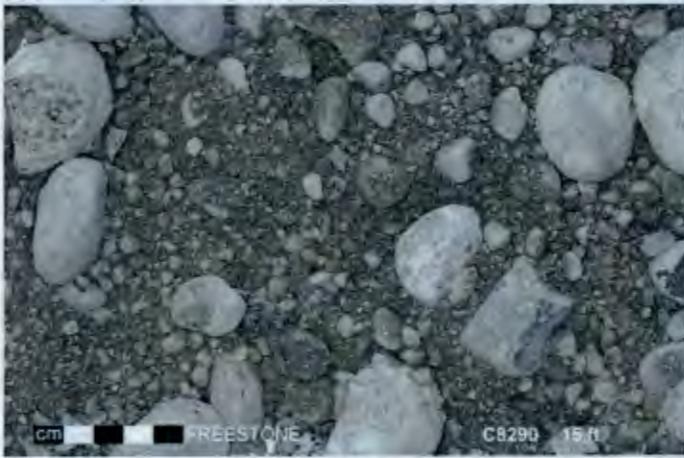
Zero Reference - Ground Surface

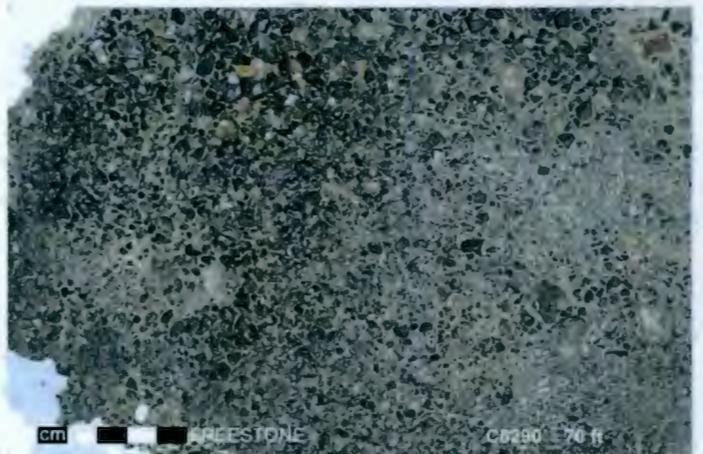


199-K-203 (C8290) Moisture Repeat Section

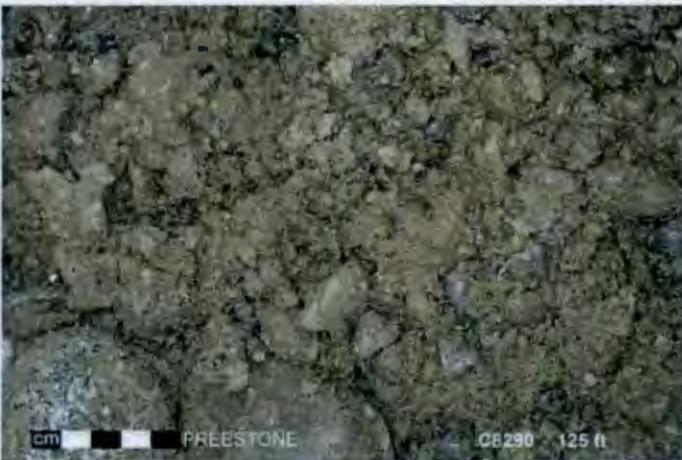


Reference - Ground Surface











| SURVEY DATA REPORT | | | | Request No. 152-078 | | |
|---|---|-----------------|------------------------|------------------------|------|-----|
| Project No. | Title KR-4 Wells C8290, C8294, C8295 & C8296 Final Surveys | | | File No. 1KT14R26 | | |
| Job No. CACN: 303412- JPRC | Prepared By N.P. Fastabend | Date 3/19/15 | Reviewer <i>CBM</i> | | | |
| DESCRIPTION OF WORK | | | DISTRIBUTION | SDR | PLOT | DWG |
| Obtained final coordinates (C/L Casings) and elevations of completed KR-4 Wells C8290 (199-K-203), C8294 (199-K-207), C8295 (199-K-208) and C8296 (199-K-209). Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters) | | | Survey File | OR | | |
| | | | K.M. Whitley | 1 | | |
| | | | S.J. Trent | 1 | | |
| | | | J.D. Mehrer | 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: 03/11/15 | Requestor: Kelly Whitley (CHPRC) |
| Date of Survey: 03/17/15 | 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 Well C8290 (199-K-203). | Horizontal Datum: NAD83(91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 100K |

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
M49 (COE) and T324 (COE)

| Well ID | Well Name | Easting | Northing | Elevation | |
|---------|-----------|-----------|-----------|-----------|---------------------|
| C8290 | 199-K-203 | 569212.43 | 146848.90 | | Center of Casing |
| | | | | 142.777 | "X" on Rim |
| | | | | 142.016 | Brass Survey Marker |
| | | | | | |

Notes:

142.482 Top Inner Casing, North Edge

Elevation on Brass Survey Marker was measured to Top Domed Brass Cap in concrete.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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



3-19-15

Appendix B

Well Documentation for C8291 (199-K-204)

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

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| WELL SUMMARY SHEET | | Start Date: 8/21/2014 | | Page 1 of 2 |
|---|---------------|---|--------------|---|
| | | Finish Date: 10/22/2014 | | |
| Well ID: C8291 | | Well Name: 199-K-204 | | |
| Location: 100m N of 105-KW reactor | | Project: 2 Plus 3 Optional Wells In 100-KR-4 OU | | |
| Prepared By: Joshua Holland | Date: 3/10/15 | Reviewed By: J.D. MEHRER | Date: 8-3-15 | |
| Signature: <i>[Signature]</i> | | Signature: <i>[Signature]</i> | | |
| CONSTRUCTION DATA | | GEOLOGIC/HYDROLOGIC DATA | | |
| Description | Diagram | Depth in Feet | Graphic Log | Lithologic Description (ft bgs) |
| Concrete Pad: 0.5 ft above ground surface (ags) | | 0 | | 0 - 23 Sandy Gravel (sG) |
| 8-in Protective Casing: 2.99 ft ags - 2.01 ft below ground surface (bgs) | | 10 | | |
| Type I/II Portland Cement Grout: 0 - 10.2 ft bgs | | 20 | | |
| 3/8 in Cetco Medium Bentonite Chips: 10.2 - 55.0 ft bgs | | 23 | | 23 - 25 Silt (M) |
| | | 25 | | 25 - 26 Silty Sand (mS) |
| | | 26 | | 26 - 30 Sand (S) |
| 6-in I.D. Schedule 10, Type 304/304L, Stainless Steel Blank Casing: 2.00 ft ags - 62.22 ft bgs | | 30 | | 30 - 98 Sandy Gravel (sG) |
| Stainless steel centralizer installed from the top of the sump at 40 ft intervals | | 40 | | |
| 3/8 in Cetco Coated Bentonite Pellet Seal: 55.0 - 57.7 ft bgs | | 50 | | |
| 8-16 mesh Premier Colorado Silica Filter Pack Sand: 57.7 - 163.0 ft bgs | | 60 | | |
| 6-in I.D. Schedule 10, Type 304/304L, 50-slot (0.050 in.) Stainless Steel Screen: 62.22 - 117.21 ft bgs | | 70 | | |
| Depths are in ft below ground surface. | | | | Static Water Level: 74.9 ft bgs (8/28/2014) |
| Borehole drilled with 11 3/4-in O.D. casing from 0.0 - 160.2 ft bgs | | 80 | | |
| All temporary drill casing was removed from the ground. | | | | |

BOREHOLE LOG

Page 1 of 5

Date: 8/25/14

Well ID: C8291 Well Name: 199-k-204 Location: 100m N of 105 kW reactor

Project: 2+3 wells in 100-kR-4 OU Reference Measuring Point: ground surface

| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
|-------------|----------|----------------|-------------|---|--|
| | Type No. | Blows Recovery | | | |
| 0 | | | | <p>0-23' Sandy Gravel (SG) 65%G, 30%S, 5%M Gravel: 90% basalt, max=70mm, FP-SC, avg=CP, P9, SR-R. Sand: 75% felsic, VF-VCS, PS, A-SR, Avg= VF-F + V (bimodal) moist, strong rxn to HCL Dark Grayish Brown (2.5 Y 4/2)</p> | <p>Cable Tools Drive Barrel 1 1/4" diameter casing Added 2 gallons H₂O @ 0'</p> |
| 5 | G | | | | @ 5' Add 2 gallons H ₂ O |
| 10 | G | | | | @ 10' sand % ↓↓ to 20%, mud % ↑↑ to 15% (mud) mod rxn to HCL. Sand basalt % ↑↑ to 40%. |
| 15 | G | | | | @ 15' sand % ↑↑ to 35%, trace mud, ocl mild rxn to HCL. Sand coarsens to C-VG. Sand basalt % ↑↑ to 80%. Very dark grayish brown (2.5 Y 3/1) |
| 20 | G | | | | @ 20' gravel basalt content ↓↓ to 75% |
| 23 | G | | | | @ 23' ↑↑ drill rate |
| 25 | G | | | | @ 23' sharp SG → M contact, proposed ringold E |
| 26 | G | | | | contact based on lithology |
| 26 | G | | | | 26-30' Silty Sand (MS) 70% S, 30% M. Sand: VF-F, WS, 80% felsic. Mud: low plasticity clay. moist. ocl strong rxn to HCL. Grayish Brown (2.5 Y 5/4) |
| 30 | G | | | | 26-30' Sand (S) 100% S, VFS-FS, WS, 80% felsic. moist. No rxn to HCL. Light brownish Gray (2.5 Y 6/2) |
| 30 | G | | | 30-38' Sandy Gravel (SG) 30%G, 70%S, trace mud. Several interbedded finer intervals. Gravel: 70% felsic, PS, SA-SR, VFP-VCP, avg=CP, max=90mm. sand: 80% felsic, VFS-VCS, A-SA, trace mica, PS. moist. No rxn to HCL. Light olive brown (2.5 Y 5/3) | |
| 35 | G | | | @ 32' ↑↑ gravel % to 65%, ↓↓ sand % to 35% | |
| | | | | @ 35-36.5' gravelly sand interval, gravel ↓↓ in size to avg VFP. Sand is 50% VFS, MS. | |

Reported By: Joshua Holland

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: [Signature]

Date: 8/25/14

Signature: [Signature]

Date: 4-6-15

| BOREHOLE LOG | | | | | Page <u>2</u> of <u>5</u> |
|--|----------|----------------------|---|--|---|
| Well ID: 199-K-504 ^{199-K-504} C8291 | | Well Name: 199-K-504 | | Location: 100 m N of 105 kW reactor | |
| Project: 2+3 wells in 100-KR-4 OQ. | | | Reference Measuring Point: ground surface | | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
| | Type No. | Blows Recovery | | | |
| 40 | G | | | 30-98' Sandy Gravel (SG) 65%G, 35% S, trace mud. Several interbedded finer intervals. Gravel 70% felsic, PS, SA-SR, VFP-VCP, avg=CP, max=90mm. Sand 80% felsic, VFS-VCS, A-SA, trace mica, PS. moist. No rxn to HCL. Light Olive brown (2.5 Y 5/3) | Cable Tool-Drives Barrel 1 3/4" diameter casing |
| | G | | | @ 40-41' Sand interval, 80% C-VCS, WS with ocd VFP-P. | |
| 45 | G | | | @ 43-44' Silty gravel interval, ^{SH 2M} gravel one max 170mm cobble present, several cps mud is low plasticity clay. Light Yellowish brown (2.5 Y 6/4) | |
| | G | | | @ 45' color change to light brownish gray (2.5 Y 6/2). dry | |
| | G | | | @ 55' Sand size ↓ to 70% FS-MS. ^{mod sorting} color change to light gray (2.5 Y 7/1) | @ 55' ↓↓ drillrate, frequent cobble |
| | G | | | @ 60' gravels ↓ to 50% felsic, sand ↓ sorting to VPS. color change to light olive brown (2.5 Y 5/3) moist. | @ 60' ↓↓ drillrate, tight formation, added 2 gallon H ₂ O |
| | G | | | @ 65' gravel felsic % ↑ to 70%. sand ^{SH 5%} content ↓ to 25% ^{25%} , mud content ↑ to 10% ^{10%} mod rxn to HCL | @ 65' cobble in formation slowing drilling, added 2 gallon H ₂ O |
| | G | | | @ 70' color change to olive brown (2.5 Y 4/3). Mod with ocd strong rxn to HCL | |
| | G | | | @ 75' Iron staining, sand size decreases to 70% VFS-FS, 30% MS-VCS. mod sorting. | @ 73' ↑↑ drillrate @ 73' encountered saturated soil on 8/28/14 First DTW = 72.45 ^{74.9'} on 8/28/14 |
| | G | | | | |
| | G | | | | |

| | | | |
|-----------------------------|---------------|------------------------------|--------------|
| Reported By: Joshua Holland | | Reviewed By: Kevin Bergstrom | |
| Title: Geologist | | Title: Sr. Geologist | |
| Signature: | Date: 8/26/14 | Signature: | Date: 4-6-15 |

BOREHOLE LOG

Page 3 of 5

Date: 8/28/14

Well ID: C8291 Well Name: 199-K-204 Location: 100 m N of 105 kW reactor

Project: 2+3 wells in 100-KR-4 OU Reference Measuring Point: ground surface

| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
|-------------|----------|----------------|-------------|--|---|
| | Type No. | Blows Recovery | | | |
| 80 | G | 225 75% | | 30-98' Sandy Gravel (gs) 65% G, 25% S, 10% M Gravels: 70% felsic, VFP-VCP, avg=CP, max=90mm, PS, SA-SR. Sands: 80% felsic, VFS-VCS, A-SA, PS, trace mica. moist. ocl strong rxn to HCL. Light olive brown (2.5 Y 5/3) | @ 80' ↓ drillrate heaving sands cable Tool: Drive Bar 1 3/4" diameter casing |
| 85 | G | | | @ 80' one 230mm cobble, ↑ gravel felsics to 80% wet. color change to dark gray brown (2.5 Y 3/2) @ 85' color change to light olive brown (2.5 Y 5/3) | From 85'-115' added 220 gallons H ₂ O to stabilize hydraulic head + prevent heaving sands |
| 90 | G | | | @ 90' sand sorting ↑ to MS | |
| 95 | G | | | @ 95' sand size M to 80% MS-VCS mod sort. color change to grayish brown (2.5 Y 5/2) No rxn to HCL. | |
| 100 | G | | | 98-103' Gravelly Sand (gs) 25% G, 75% S, trace mud. Gravels: 80% felsic, Max=20mm, FP-CP, avg=mp, MS, SA-R. Sands: 80% felsic, FS-VCS, 80% CS-VCS, WS, A-SR, trace mica. wet. no rxn HCL. Olive brown (2.5 Y 4/4) | @ 98' looser frm. ↑ drillrate some heaving sand |
| 105 | G | | | 103-105' Gravel (G) 95% G, 5% S, trace mud. Gravels: 80% felsic, max=15mm, FP-CP, avg=mp, SA-R, MS. Sands: 90% felsic, WS, F-CS, 80% CS, trace mica. Wet. No rxn to HCL. Olive Brown (2.5 Y 4/4) | @ 103' ↓ drillrate |
| 110 | G | | | 105-106' Gravelly Sand (gs) 25% G, 75% S, trace mud Gravels: 90% felsic, max=50mm, FP-VCP, PS, SA-SR. Sands: 95% felsic, FS-VCS, 70% MS-CS, Mod sort, SA-SR, trace mica wet. no rxn to HCL. Light Olive brown (2.5 Y 5/3) | @ 105' ↑ drillrate |
| 115 | G | | | 106-110' Sandy Gravel (gs) 60% G, 35% S, 5% M. Gravels: 90% felsic, max=100mm, FP-VCP, VPS, SA-SR. Sands: 90% felsic, PS, VFS-VCS, A-SA. Wet. No rxn HCL. Light Olive brown (2.5 Y 5/3) | @ 113' ↓ drillrate, casing tight |
| 115 | G | 693 100% | | 110-113' Gravel (G) 80% G, 10% S, 10% M. Gravels: 75% felsic, max=90mm, FP-SC, avg=MP, SA-R. Sands: 90% felsic, MS, 70% VFS-MS, A-SR. Wet. strong rxn to HCL. Iron staining. Light Olive brown (2.5 Y 5/3) | @ 115' ↓ drillrate |
| 115 | G | | | 113-115' Silty Gravel (gs) (MG) 65% G, 10% S, 25% M gravels: 75% felsic, max=90mm, VPS, SA-WR. Sands: 70% felsic, VFS-VCS, A-R. moist, strong rxn to HCL. ↑ | @ 118.5' ↑ drillrate |

Reported By: Joshua Holland Title: Geologist Signature: [Signature] Date: 9/11/14

Reviewed By: Kevin Bergstrom Title: Sr. Geologist Signature: [Signature] Date: 4-6-15

| BOREHOLE LOG | | | | | Page 4 of 5 |
|-------------------------------------|----------|-----------------------|---|--|---|
| Well ID: C8291 | | Well Name: 199-TR-204 | | Location: 100 m N of LOS RW reactor | |
| Project: 2 + 3 wells in 100-TR-4 OU | | | | Reference Measuring Point: ground surface | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
| | Type No. | Blows Recovery | | | |
| 120 | G | | | 113-115' cont. mod. cementation, mud & low plasticity clay. very dark grayish brown (2.5 Y 3/2) | From 115' to 156' |
| | | | | 115-118.5' Sandy Gravel (SG) 65% G, 30% S, 5% M Gravels 75% felsic, max=100mm, VPS, FP-SG, SA-R. Sands 70% felsic, VFS-VCS, mod sort, trace mica. Wet mod rxn to HCL, dark grayish brown (2.5 Y 4/2) | Added 470 gallons H ₂ O to stabilize hydraulic head & prevent heaving sands. |
| 125 | G | | | 118.5-119' Silt (M) 100% M, trace sand, ocd. F-MP, max=0mm No rxn to HCL. Wet. Nonplastic. Light Olive brown (2.5 Y 5/4) | Cable Tool: Drive Barrel |
| | | | | 119-121' Sandy Silt (GM) 40% S, 60% M, ocd fine pebble. Sands 80% felsic, WS, FS-VFS. Wet. No rxn to HCL. | 1 1/4" diameter casing |
| 130 | G | | | Nonplastic. Light Olive brown (2.5 Y 5/4) | |
| | | | | 121-125' Sand (S) 100% S, trace mica, ocd fine pebble. Sands 80% felsic, VFS-VCS, 80% MS, WS. Wet. No rxn to HCL. | |
| 135 | G | | | light olive brown (2.5 Y 5/4) | |
| | | | | 125-127' Gravelly Sand (GS) 15% G, 80% S, 5% M Gravels 90% felsic, VFR-VCP, max=50mm, MS, SA-R. Sands 80% felsic, FS-VCS, 90% MS-VCS, WS, SR-R, trace mica. Wet. | |
| 140 | G | | | no rxn to HCL. Light Olive brown (2.5 Y 5/3) | |
| | | | | 127'-157' Sandy Gravel (SG) 65% G, 35% S, trace mud Gravels 80% felsic, max=110mm, VFR-VCP, VPS, Avg=CP, A-SR | |
| 145 | G | | | Sands 90% felsic, VFS-VCS, MS, 70% VFS-MS, SA, trace mica. Wet. No rxn HCL. Light Olive brown (2.5 Y 5/2) | |
| | | | | @ 135' sand coarsens to 40% CS, VFS-VCS | |
| 150 | G | | | @ 140' sand coarsens to 60% CS, mud content | |
| | | | | @ 145' M to 10%, gravel content ↓ to 55%. | |
| 155 | G | | | Slight cementation. Light olive brown (2.5 Y 5/6) | |
| | | | | @ 145' Gravel content ↑ to 65, mud ↓ to trace amount. Sand sorting ↓ to VPS, Iron staining. No cementation. light yellowish brown (2.5 Y 5/2) | |
| | | | | @ 150' Sand sorting ↑ to WS, 80% VFS-MS. Grayish brown (2.5 Y 5/2) | |
| | | | | @ 152.5 mud content ↑ to 10%, gravel ↓ to 55% moderate cementation, strong rxn to HCL. | |
| | | | | @ 155' No cementation | @ 152.5' cemented, |
| | | | | 157-163' Silt (M) 100% mud, trace VFS, ocd fine pebbles. Wet. strong rxn to HCL | casing tight, ↓ drillrate |
| | | | mud is medium plasticity clay. light olive brown (2.5 Y 5/3) | First contact with proposed RUM on 9/18/14 at 157' bgs. | |
| | | | | Δ lithology | |
| Reported By: Joshua Holland | | | | Reviewed By: Kevin Bergstrom | |
| Title: Geologist | | | | Title: Sr. Geologist | |
| Signature: <i>J. Holland</i> | | Date: 9/27/14 | Signature: <i>Kevin Bergstrom</i> | | Date: 4-6-15 |

BOREHOLE LOG

Page 5 of 5

Date: 9/22/14

Well ID: C8291 Well Name: 199-KR204 Location: 100 m N of 105 kW reactor

Project: 2+3 wells in 100-KR-4 OU Reference Measuring Point: ground surface

| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
|-------------|----------|----------------|---|---|---|
| | Type No. | Blows Recovery | | | |
| 160 | G | |  | 157-163' Silt(M) 100% Mud, trace VFS, oocl FP. wet. strong rxn to HCl. mud is medium plasticity clay. light olive brown (2.5 Y 5/3) @ 160' mud content \downarrow to 95%, sand content \uparrow to 5%, VFS, 95% felsic. | TD=163.0' bgs on 9/22/14 IDTW=76.3 on 9/22/14 |
| 165 | | | | | casing shoe @ 160.2' bgs |
| 170 | | | | | @ 163 drillers added 50 gallons H ₂ O to balance hydraulic head. |
| 175 | | | | | |
| 180 | | | | | |
| 185 | | | | | |
| 190 | | | | | |
| 195 | | | | | |

Reported By: Joshua Holland Reviewed By: Kevin Bergstrom
 Title: Geologist Title: Sr. Geologist
 Signature: [Signature] Date: 9/22/14 Signature: [Signature] Date: 4-6-15



199-K-204 (C8291) Log Data Report

Borehole Information:

| | | | | | |
|----------------------------------|-----------------|------------------------------|----------------------------------|-------------------------|-------------|
| Log Date: | 2014-09-26 | Filename: | C8291_HG-NM_2014-09-26 | Site: | 100-K |
| Coordinates (WA St Plane) | | DTW¹ (ft): | 76.3 | DTW Date: | 09/22/14 |
| North (m) | East (m) | Drill Date | TOC² Elevation | Total Depth (ft) | Type |
| N/A | N/A | 09/19/14 | N/A | 163 | Cable Tool |

Casing Information:

| Casing Type | Stickup (ft) | Diameter (in.) | | Thickness (in.) | Top (ft) | Bottom (ft) |
|----------------|--------------|----------------|--------|-----------------|----------|-------------|
| | | Outer | Inside | | | |
| Threaded Steel | 4.8 | 11 3/4 | 10 3/4 | 0.5 | 4.8 | 160.2 |

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 76.3 ft by the geologist and confirmed by moisture logging. The maximum logging depth achieved was 161 ft.

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 | 3 | 4 Repeat | | | |
|-------------------|----------|----------|--|--|--|
| HEIS Number | 1018510 | 1018511 | | | |
| Date | 09/26/14 | 09/26/14 | | | |
| Logging Engineer | Pope | Pope | | | |
| Start Depth (ft) | 0.0 | 100.0 | | | |
| Finish Depth (ft) | 161.0 | 116.0 | | | |
| Count Time (sec) | 100 | 100 | | | |
| Live/Real | R | R | | | |
| Shield (Y/N) | N | N | | | |

¹ depth to water inside casing

² top of casing

³ Neutron Moisture Logging System



| Log Run | 3 | 4 Repeat | | | |
|--------------------------|-------------------------------|-------------------------------|--|--|--|
| MSA Interval (ft) | 1.0 | 1.0 | | | |
| Log Speed (ft/min) | N/A | N/A | | | |
| Pre-Verification | AL218CAB | AL218CAB | | | |
| Start File | AL218000 | AL218162 | | | |
| Finish File | AL218161 | AL218178 | | | |
| Post-Verification | AL218CAA | AL218CAA | | | |
| Depth Return Error (in.) | N/A | 2.0 high | | | |
| Comments | No fine gain adjustments made | No fine gain adjustments made | | | |

NMLS Log Run Information:

| Log Run | 1 | 2 Repeat | | | |
|--------------------------|----------|----------|--|--|--|
| HEIS Number | 1018512 | 1018512 | | | |
| Date | 09/24/14 | 09/24/14 | | | |
| Logging Engineer | Pope | Pope | | | |
| Start Depth (ft) | 0.0 | 20.0 | | | |
| Finish Depth (ft) | 76.0 | 28.0 | | | |
| Count Time (sec) | 15 | 15 | | | |
| Live/Real | R | R | | | |
| Shield (Y/N) | N | N | | | |
| MSA Interval (ft) | 0.25 | 0.25 | | | |
| Log Speed (ft/min) | N/A | N/A | | | |
| Pre-Verification | AH180CAB | AH180CAB | | | |
| Start File | AH180000 | AH180305 | | | |
| Finish File | AH180304 | AH180337 | | | |
| Post-Verification | AH180CAA | AH180CAA | | | |
| Depth Return Error (in.) | N/A | 1.0 high | | | |
| Comments | 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:

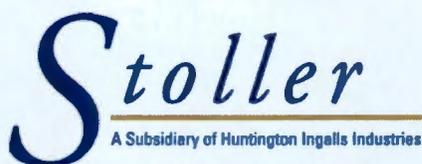
| | | | | | |
|-----------------|--------------|--------------|----------|-------------------|----------------------|
| Analyst: | P.D. Henwood | Date: | 10/02/14 | Reference: | HGLP-MAN-003, Rev. 0 |
|-----------------|--------------|--------------|----------|-------------------|----------------------|

A casing correction for a 1/2-in. thick casing was applied to the log data. .

A correction for water inside the casing was applied below 76 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 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 a 10 3/4-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 at 0.2 pCi/g at one ft in depth. The MDLs for Cs-137 and Pu-239 are plotted 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:

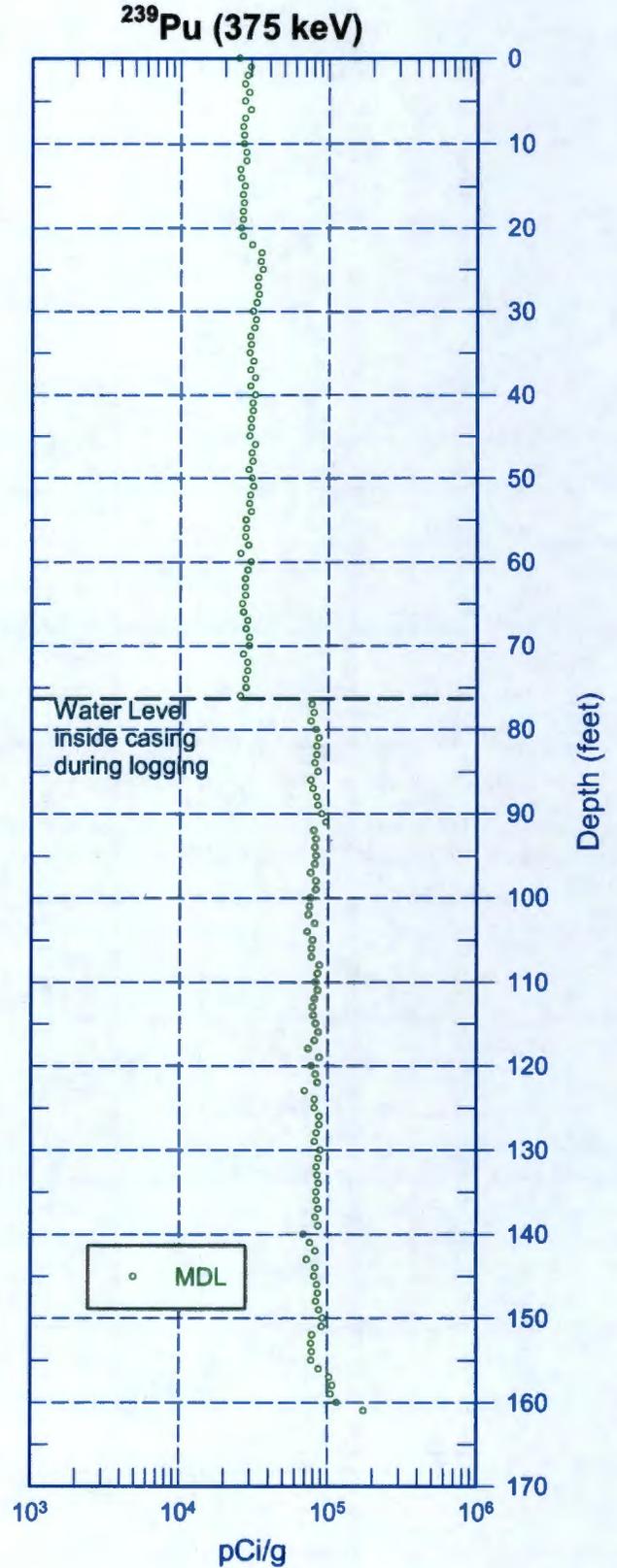
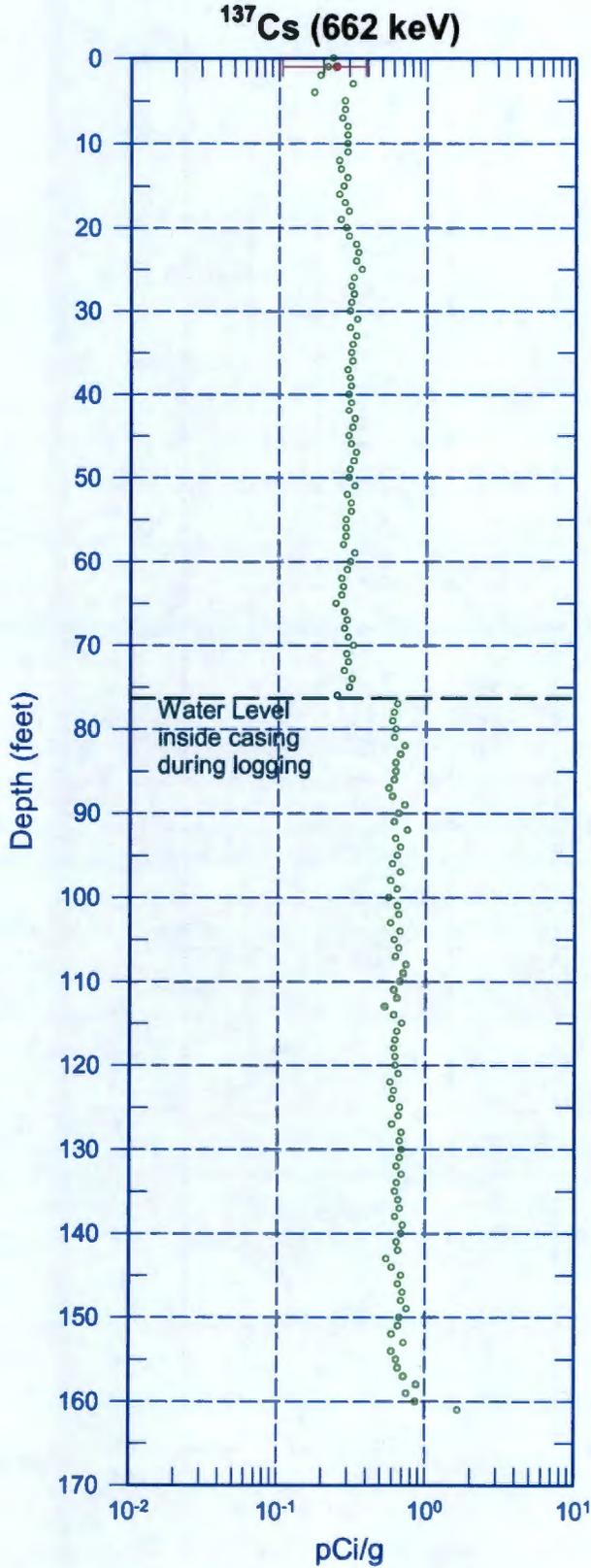
Depth Reference is ground surface.

Manmade Radionuclides (0-170 ft)
 Natural Gamma Logs (0-170 ft)
 Combination Plot (0-120 ft)
 Combination Plot (110-230 ft)
 Combination Plot (0-170 ft)
 Total Gamma & Moisture (0-170 ft)
 Total Gamma & Hanford Gamma Unit (0-170 ft)
 Repeat Section of Natural Gamma Logs (100 to 116 ft)
 Moisture Repeat Section (20 to 28 ft)

⁴ Hanford Gamma Unit



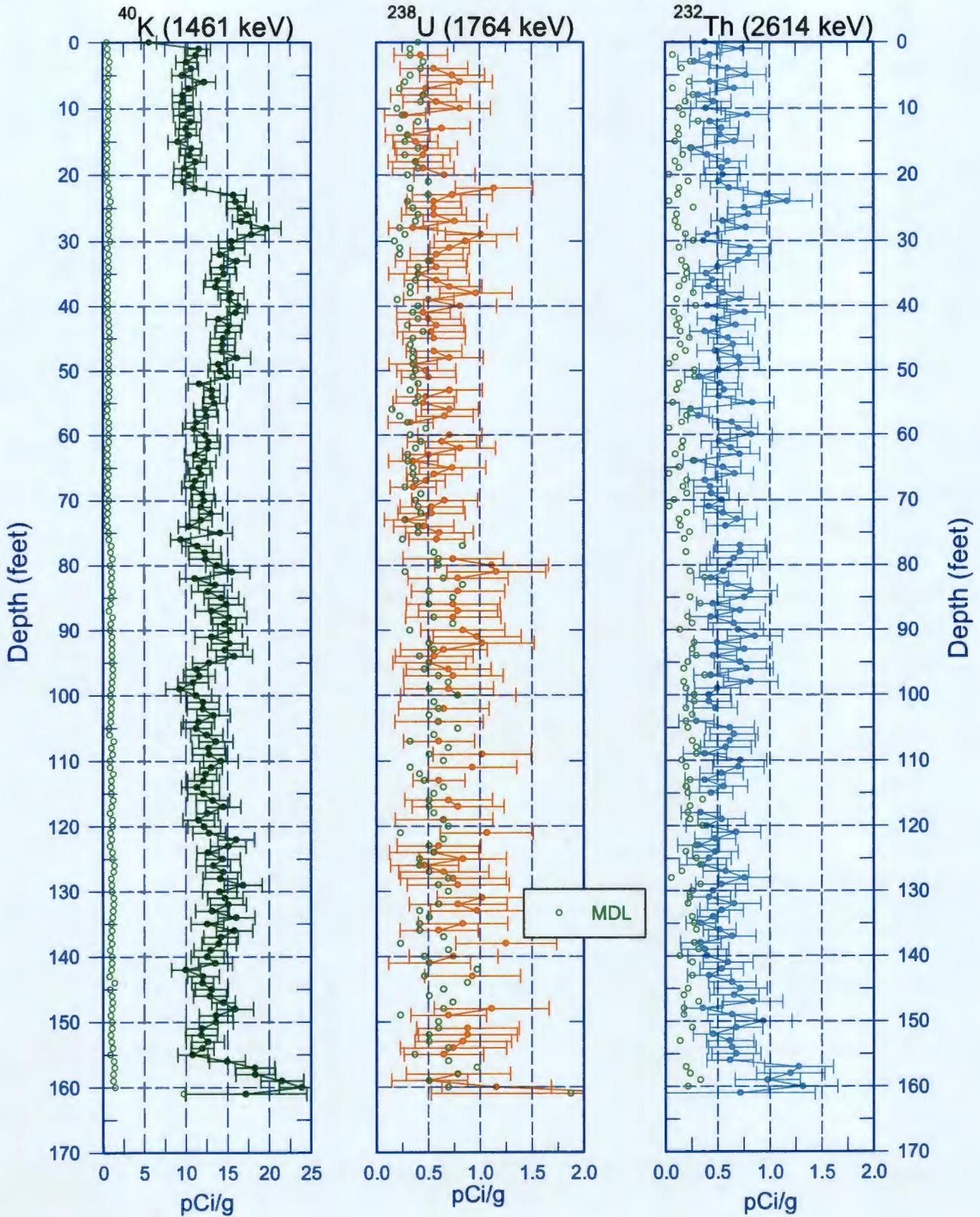
199-K-204 (C8291) Manmade Radionuclides



Zero Reference - Ground Surface



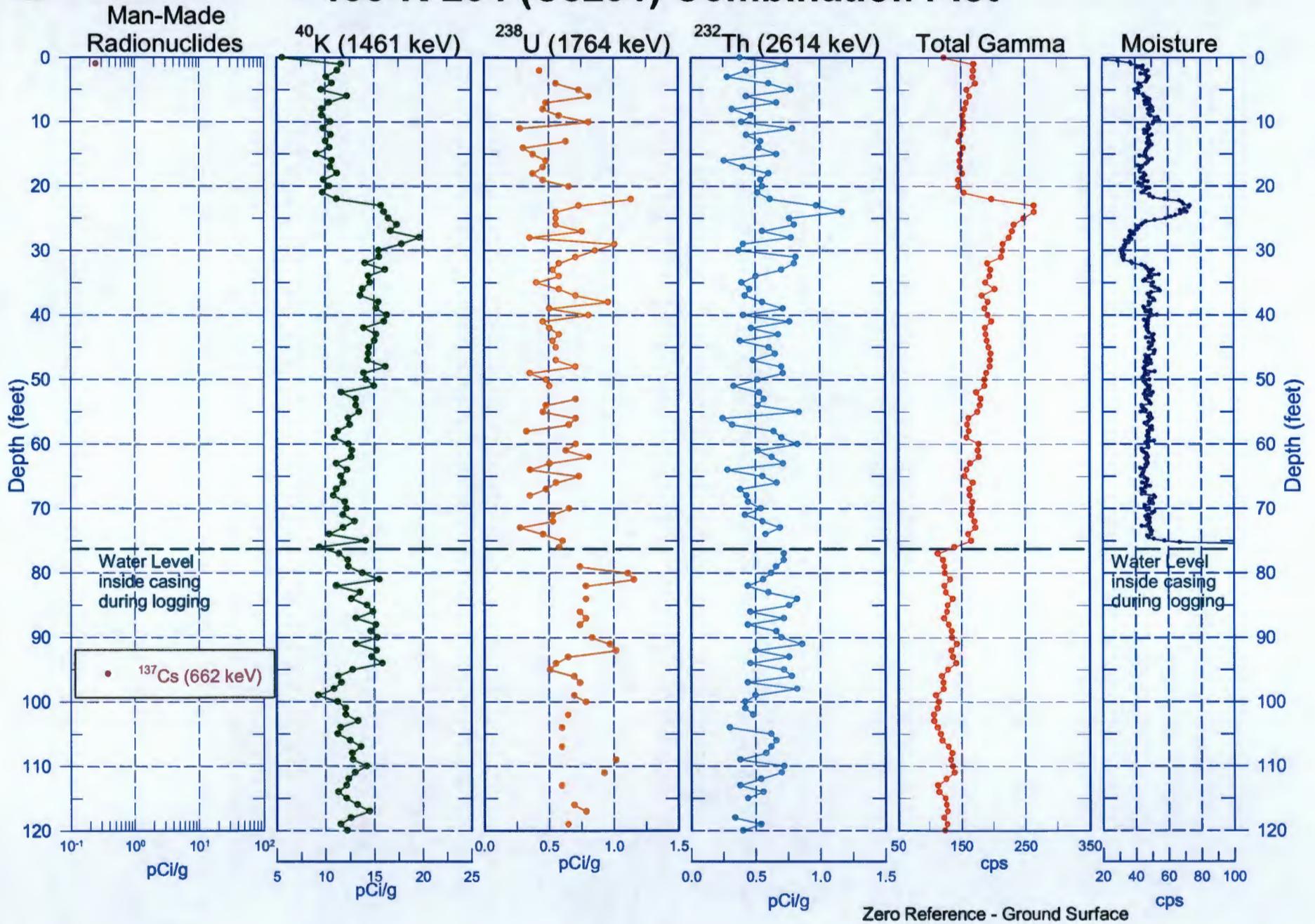
199-K-204 (C8291) Natural Gamma Logs



Zero Reference - Ground Surface

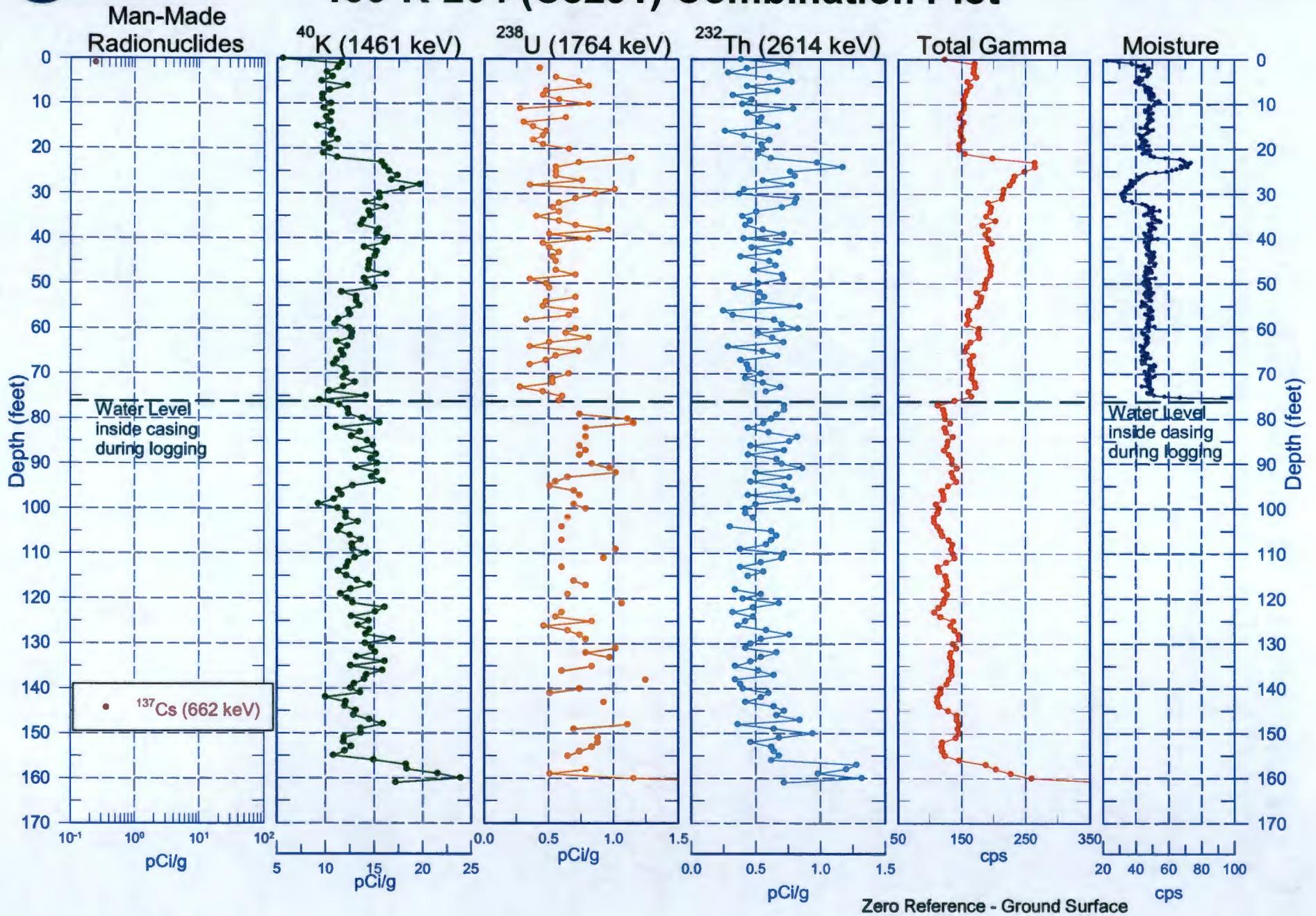


199-K-204 (C8291) Combination Plot



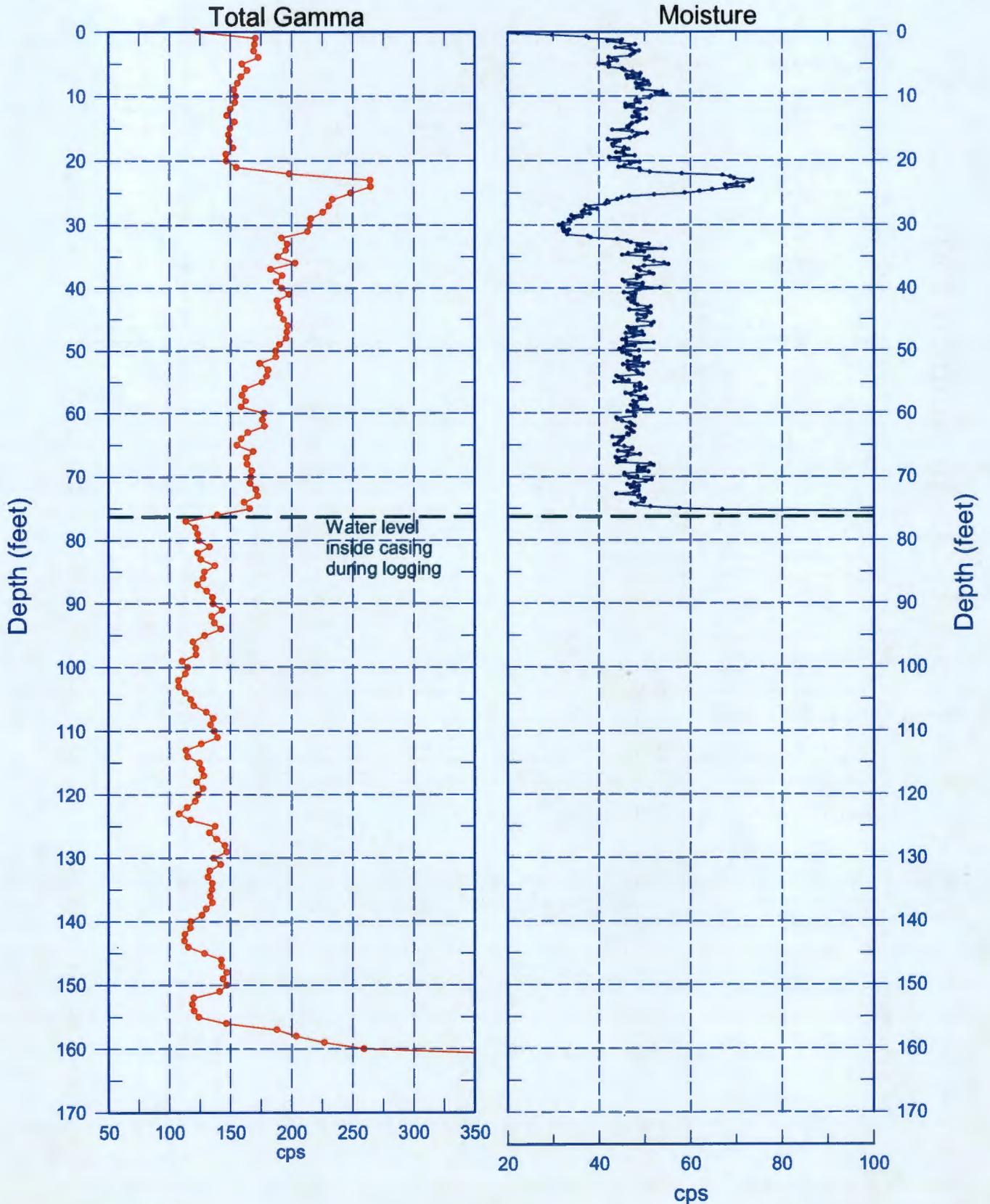


199-K-204 (C8291) Combination Plot





199-K-204 (C8291) Total Gamma & Moisture

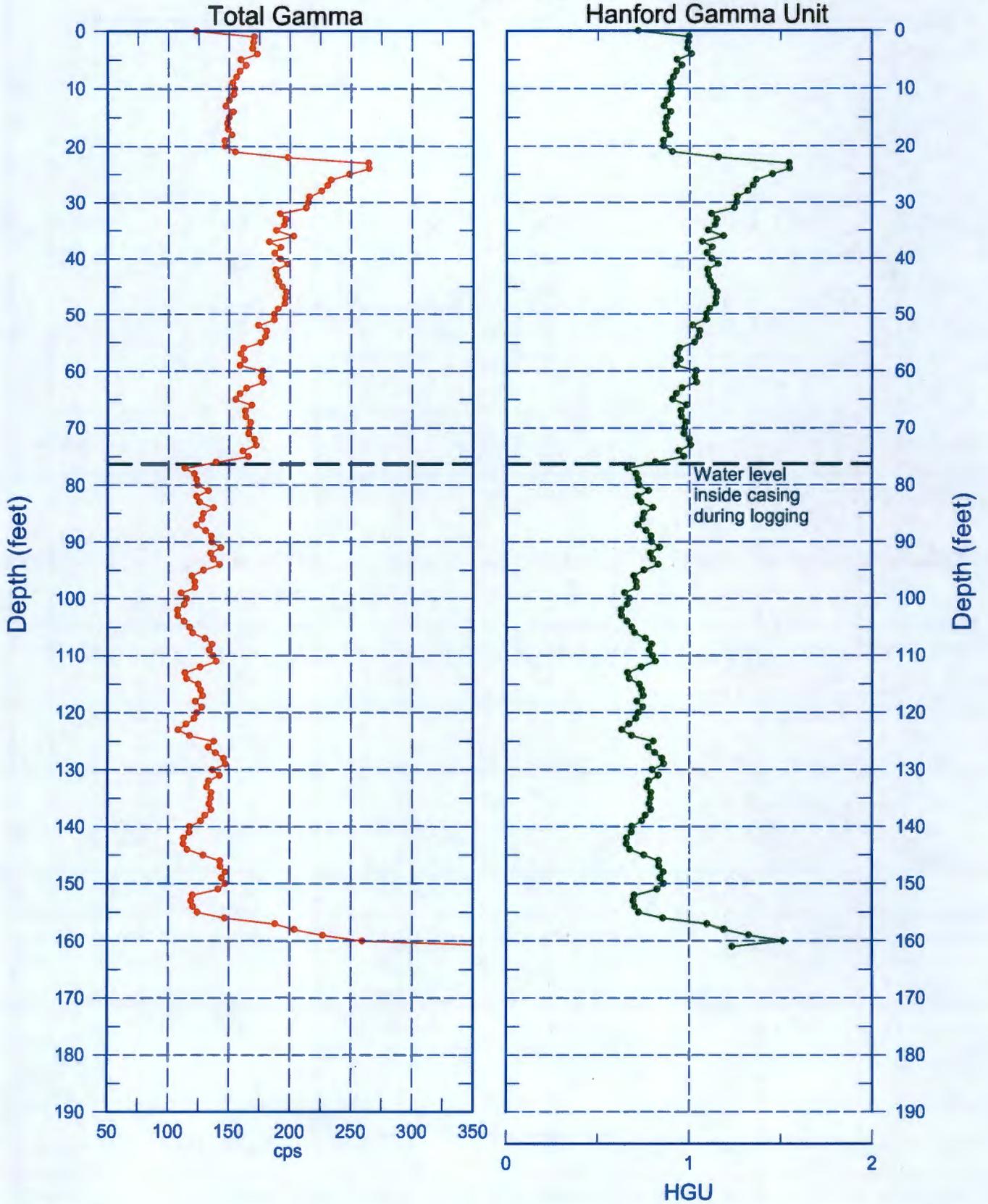


Reference - Ground Surface



199-K-204 (C8291)

Total Gamma & Hanford Gamma Unit

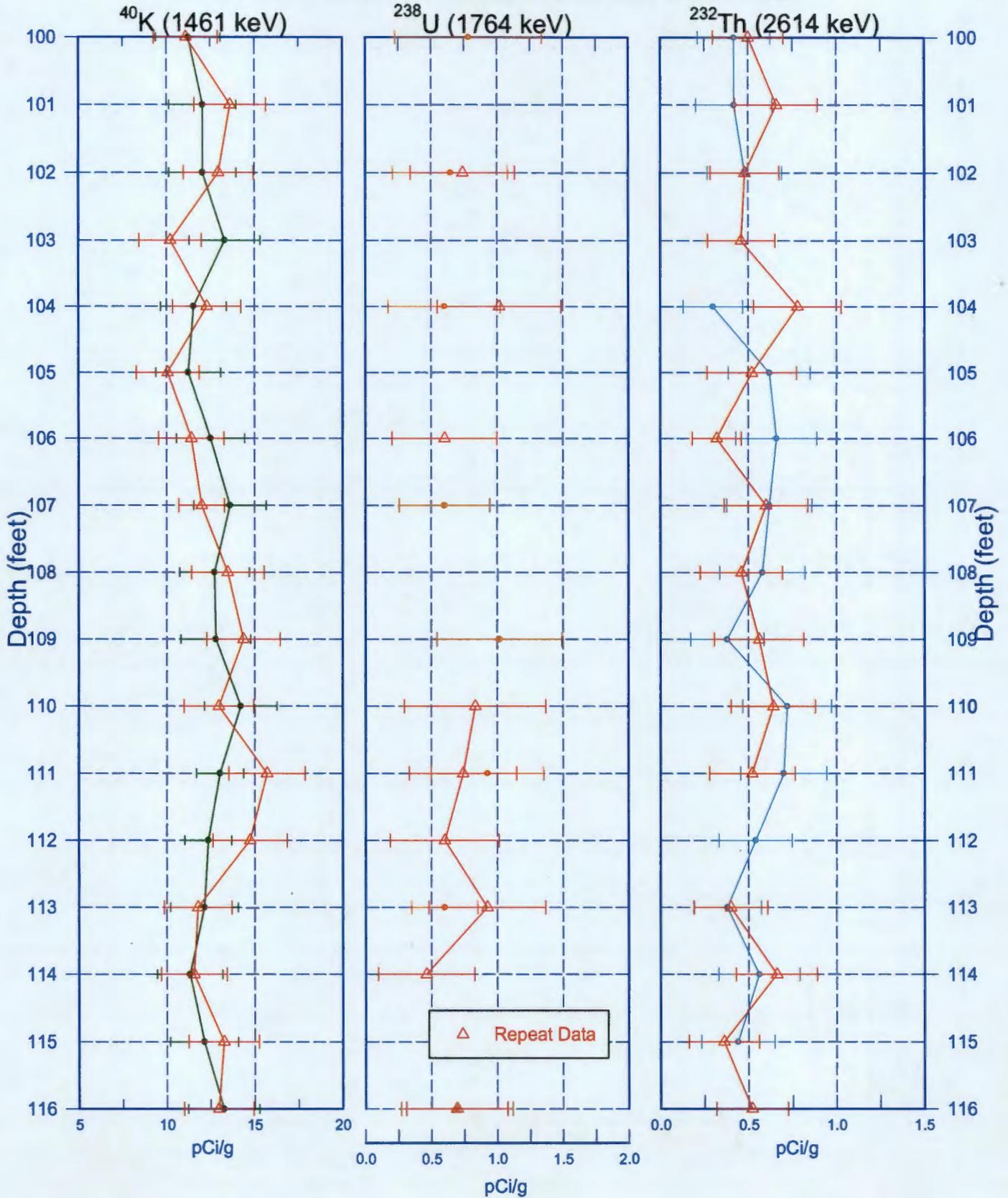


Reference - Ground Surface



199-K-204 (C8291)

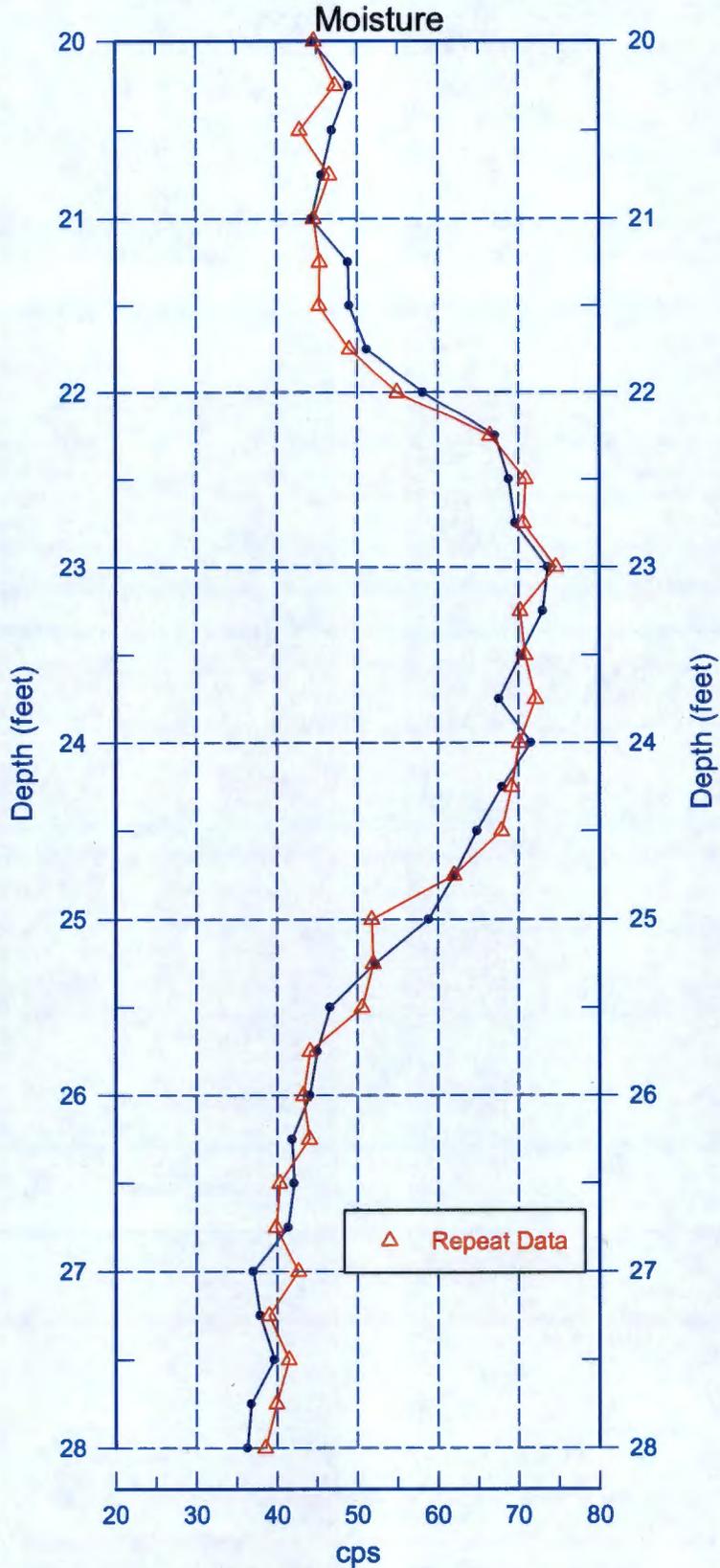
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface



199-K-204 (C8291) Moisture Repeat Section



Reference - Ground Surface













| SURVEY DATA REPORT | | | Request No. | | |
|--|--|--------------|-------------|------|-----|
| | | | 152-077 | | |
| Project No. | Title | | File No. | | |
| | KR-4 Well C8291 (199-K-204) Final Survey | | 1KT13R26 | | |
| Job No. | Prepared By | Date | Reviewer | | |
| CACN:303412- JPRC | N.P. Fastabend | 3/18/15 | <i>LBM</i> | | |
| DESCRIPTION OF WORK | | DISTRIBUTION | SDR | PLOT | DWG |
| Obtained final coordinates (C/L Casing) and elevations of completed KR-4 Well C8291 (199-K-204) inside 100K Area. Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters) | | Survey File | OR | | |
| | | K.M. Whitley | 1 | | |
| | | S.J. Trent | 1 | | |
| | | J.D. Mehrer | 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: 03/11/15 | Requestor: Kelly Whitley (CHPRC) |
| Date of Survey: 03/17/15 | 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 Well C8291 (199-K-204) in 100K Area. | Horizontal Datum: NAD83 (91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 100K |

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
100K-13 (CHPRC) and 100K-14 (CHPRC)

| Well ID | Well Name | Easting | Northing | Elevation | |
|---------|-----------|-----------|-----------|-----------|---------------------|
| C8291 | 199-K-204 | 568648.34 | 146572.85 | | Center of Casing |
| | | | | 143.228 | "X" on Rim |
| | | | | 142.476 | Brass Survey Marker |
| | | | | | |

Notes:

142.932 · Top Inner Casing,
North Edge

Elevation on Brass Survey Marker was measured to Top Domed Brass Cap in concrete.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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



3-19-15

Appendix C

Well Documentation for C8294 (199-K-207)

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

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WELL SUMMARY SHEET

Start Date: 12/1/2014

Page 1 of 2

Finish Date: 2/10/2015

Well ID: C8294

Well Name: 199-K-207

Location: 250m NE of 105 KE reactor

Project: 2 Plus 3 Optional Wells In 100-KR-4 OU

Prepared By: Joshua Holland

Date: 2/25/15

Reviewed By: **D. MEHRER**

Date: 4-3-15

Signature: *[Signature]*

Signature: *[Signature]*

CONSTRUCTION DATA

GEOLOGIC/HYDROLOGIC DATA

| Description | Diagram | Depth in Feet | GEOLOGIC/HYDROLOGIC DATA | |
|--|---------|---------------|--------------------------|---|
| | | | Graphic Log | Lithologic Description (ft bgs) |
| Concrete Pad: 0.5 ft above ground surface (ags) | | 0 | | 0- 25 Sandy Gravel (gS) |
| 8-in Protective Casing: 3.01 ft ags - 1.99 ft below ground surface (bgs) | | | | |
| Type I/II Portland Cement Grout: 0 - 14.1 ft bgs | | | | |
| 3/8 in Cetco Medium Bentonite Chips: 14.1 - 59.4 ft bgs | | | | |
| 6-in I.D. Schedule 10, Type 304/304L, Stainless Steel Blank Casing: 2.00 ft ags - 63.80 ft bgs | | | | |
| Stainless steel centralizer installed from the top of the sump at 40 ft intervals | | | | |
| 3/8 in Cetco Coated Bentonite Pellet Seal: 59.4 - 60.4 ft bgs | | | | |
| 6-12 mesh Premier Colorado Silica Filter Pack Sand: 60.4 - 155.5 ft bgs | | | | |
| 6-in I.D. Schedule 10, Type 304/304L, 40-slot (0.040 in.) Stainless Steel Screen: 63.80 - 148.80 ft bgs | | | | |
| Depths are in ft below ground surface. Borehole drilled with 13 3/8 O.D. conductor from 0 to 59.5 ft bgs and 11 7/8-in O.D. casing from 0.0 - 153.1 ft bgs All temporary drill casing was removed from the ground. | | | | |
| | | 25 | | 25- 30 Gravel (G) |
| | | 30 | | 30- 35 Sandy Gravel (sG) |
| | | 35 | | 35- 45 Gravel (G) |
| | | 40 | | 45- 55 Sandy Gravel (sG) |
| | | 50 | | 55- 60 Gravel (G) |
| | | 60 | | 60- 85 Sandy Gravel (sG) |
| | | 68.2 | | Static Water Level: 68.2 ft bgs (12/9/2014) |
| | | 85 | | 85- 92.5 Gravel (sG) |

What am I? (REV 1)

| BOREHOLE LOG | | | | | Page 1 of 4 |
|---|----------|-----------------|-------------------------------------|---|---|
| Well ID: C8294 | | | Well Name: 199-K-207 | | Date: 12/1/14 |
| Project: 2+3 wells in 100-KR 4 OU | | | Location: 250m NE of 105 KE reactor | | |
| Reference Measuring Point: ground level | | | | | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
| | Type No. | Blows Recovery | | | |
| 0 | | | | 0-25' Sandy Gravel (SG) 70%G, 30%S, Trace M Gravel: 80% basalt, max=100mm, VFP-SC, VPS, SA-SR. Sand: 60% basaltic, VFS-VCS, PS, 50% of sand VCS, A-SA. Moist. No rxn to HCL. Light Olive Brown (2.5 Y 5/3) | Cable Tools Drive Barrel 0-59.5': 13 3/8" casing 0-11 3/4" casing |
| 5 | G | | | | |
| 10 | G | | | @10': max gravel size ↓ to 80mm, angularity ↑ to SA. Color change to Olive brown (2.5 Y 4/3) | |
| 15 | G | | | @15': max gravel size ↓ to 60mm | |
| 20 | G | | | @20': ↓ G% to 65, ↑ M% to 5. color change to very dark grayish brown (2.5 Y 3/2). Occl. mod rxn to HCL. | |
| 25 | G | SS 25%, 100% | | @22': ↑ G% to 75, ↓ S% to 15, ↑ M% to 10. Gravel ↓ to 50% B, sand ↓ to 50% B | |
| 25 | G | | | 25-30' Gravel (G) 80%G, 5%S, 15%M. Gravel: 60% felsic, max=140, VFP-LG, VPS, SA-SR. Sand: 60% basalt, VFS, VFS-VCS, A-SA. moist. occl. mod rxn to HCL. Very dark gray (2.5 Y 3/1) ← occl. Reddish yellow (7.5 YR 7/8). very slightly laminated | @28' ↓ Drill rate, boulder |
| 30 | G | | | 30-35' Sandy Gravel (SG) 75%G, 25%S, trace M. Gravel: 75% felsic, max=80mm, VFP-SC, avg=CP, MS. SA-SR. Sand: 70% felsic, PS, VFS-VCS, 50% VCS, A-SA. Light brownish gray (2.5 Y 6/2) No rxn HCL slightly moist. | |
| 35 | G | | | 35-40' Gravel (G) 85%G, 15%S, trace M. Gravel: 75% felsic, max=110mm, VFP-SC, avg=CP, SA-SR. Sand: 70% felsic, VFS-VCS, PS, 50% VCS, A No rxn to HCL. slightly moist. Light brownish Gray. (2.5 Y 6/2) | |
| | | | | @37' silty lens, low plasticity, mod. rxn HCL | |
| Reported By: Joshua Holland | | | Reviewed By: Kevin Bergstrom | | |
| Title: Geologist | | | Title: Sr. Geologist | | |
| Signature: | | Date: 12/2/14 | Signature: | | Date: 3-24-15 |

| BOREHOLE LOG | | | | | Page 2 of 4 |
|-------------------------------------|----------|----------------------|---|--|--|
| Well ID: C8294 | | Well Name: 199-K-207 | | Location: 250m NE of 105 KE reactor | |
| Project: 2 + 3 wells in 100-KR-4 OU | | | Reference Measuring Point: Ground Surface | | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
| | Type No. | Blows Recovery | | | |
| 40 | G | | | 40-45' Gravel (G) 85%G, 15%S, trace M. Gravel: 75% felsic, max=70mm, VFP-SC, 80% CP, WS, SA-SR. Sands: 70% felsic, VFS-VCS, PS, 50% VCS, A. No rxn to HCl. Light yellowish brown (2.5 Y 6/3) | Cable Tools Drive barrel @ 41' ↓ drillrate, tight |
| | | | | @ 42' ↑ sand lens | @ 43' ↓ drillrate, possible cementation/boulder |
| 45 | G | | | 45-55' Sandy Gravel (SG) 60%G, 40%S, trace M. Gravel: 75% felsic, max=70mm, avg=CP, VFP-SC, PS, SA-SR. Sands: 70% felsic, VFS-VCS, PS, 50% VCS, A. Dry. No rxn to HCl. Light Yellowish Brown (2.5 Y 6/3) | @ 48' ↑ drillrate |
| | | | | @ 50' Max gravel=90mm, gravel is med sorted, 70% CP. Sand felsic 77 to 90. Sand sorting 77 to WS, 70% FS/MS. | @ 52' ↓ drillrate, large cobbles/boulder |
| 50 | G | | | 55-60' Gravel (G) 85%G, 15%S, Trace M. Gravel: 70% felsic, max=400mm, VFP-SR, VPS, avg=CP, SA | |
| | | | | Sands: 90% felsic, sorting, size + angularity impossible to determine due to large % of rock flour. No rxn to HCl. Light Yellowish Brown (2.5 Y 4/3) | @ 58' ↑ drillrate |
| 55 | G | | | 60-85' Sandy Gravel (SG) 60%G, 40%S, Trace M. Gravel: 80% felsic, max=120, VFP-SC, PS, avg=30mm SR. Sands: 80% felsic, VFS-VCS, 70% FS/MS, MS, SA, trace mica. No rxn to HCl. Light Yellowish Brown (2.5 Y 6/3) | @ 64' ↑ drillrate |
| | | | | @ 65' Gravel sorting 77 to MS, 70% CP/VCP. Sand sorting 77 to WS, 80% FS/MS. Occl mild rxn to HCl. | @ 68' Heavy soil moisture DTW encountered @ 68' bp on 12/9/2014. |
| 60 | G | | | @ 70' Gravel sorting W to PS. Wet. No rxn to HCl. Color change to Light Olive Brown (2.5 Y 5/3) | |
| | | | | @ 75' Sand sorting W to MS. | |
| 65 | G | | | | |
| 70 | G | | | | |
| 75 | G | | | | |

| | |
|-----------------------------|------------------------------|
| Reported By: Joshua Holland | Reviewed By: Kevin Bergstrom |
| Title: Geologist | Title: Sr. Geologist |
| Signature: | Signature: |
| Date: 12/10/14 | Date: 3-24-15 |

| BOREHOLE LOG | | | | | Page <u>3</u> of <u>4</u> |
|--|----------|-----------------------------|----------------------------|--|---|
| Well ID: <u>C8294</u> | | Well Name: <u>199-k-207</u> | | Location: <u>250m NE of 105 kE reader</u> | |
| Project: <u>2+3 wells in 100-kr-4 O.U.</u> | | | Reference Measuring Point: | | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
| | Type No. | Blows Recovery | | | |
| 80 | G SS | 300, 100% | | 80-85' Sandy Gravel (SG) 60%G, 40%S, Trace M. Gravels 80% felsic, max=120mm, VFP-SC, VPS, SA-SR. Sands 80% felsic, VFS-VCS, 70% F3/M3, mod sorting, SR. wet. ocd. HCl rxn. Light Olive Brown (2.5 Y 5/3) | |
| 85 | G | | | 85-92.5' Gravel (G) 80%G, 20%S, Trace M Gravels 80% felsic, max=130mm, VFP-VCP, 70% CP, WS, SR-R. Sands 70% felsic, VFS-VCS, VPS, SA-SR. wet. No rxn to HCL. Light Olive Brown (2.5 Y 5/3) | |
| 90 | G | | | @90': average gravel size \downarrow to 15mm. Sand sorting \uparrow to WS. 80% MS/FS. ms G \downarrow to 15' | |
| | G | | | 92.5-95' Silty Gravel (MG) 55%G, 15%S, 30%M Gravels 40% felsic, max=120mm, VFP-SC, PS, SA-SR. Sands 50% felsic, VFS-VCS, VPS, SA-SR. wet. | @92' \downarrow drillrate |
| 95 | G | | | Strong rxn to HCL. mud portion is low med plasticity clay. cemented, degraded appearance. Dark Gray (2.5 Y 4/1) + Reddish Yellow (7.5 YR 7/8) | @95' Abrupt contact \uparrow drillrate |
| | G | | | 95-140' Sandy Gravel (SG) 60%G, 40%S, Trace M Gravels 80% felsic, max=140mm, VFP-LC, VPS, SA. Sands 90% felsic, VFS-VCS, VPS, A, micaceous wet. No rxn to HCL. Light Olive Brown (2.5 Y 5/4) | |
| 100 | G | | | @100': gravel % \downarrow to 30. Sand % \uparrow to 70. gravel sorting \uparrow to Mod. sorting, 60% VCP, sand sorting \uparrow to VWS, 90% MS-CS. Color change to Light Yellowish Brown (2.5 Y 6/3) | |
| 105 | G | | | @105': Gravel sorting \downarrow to PS, Avg=VCP. Sand sorting \downarrow to WS. 80% CS/VCS. | @106' \uparrow drillrate |
| 110 | G | | | @110': Gravel % \uparrow to 40, Sand % \downarrow to 60. max gravel size 200mm, gravel sorting \downarrow to VPS Sand sorting \downarrow to MS, 70% CS/VCS. | |
| 115 | G SS | 220, 100% | | @115': Max gravel size 140mm, ocd. mod rxn to HCL. | |

| | |
|------------------------------------|-------------------------------------|
| Reported By: <u>Joshua Holland</u> | Reviewed By: <u>Kevin Bergstrom</u> |
| Title: <u>Geologist</u> | Title: <u>Sr. Geologist</u> |
| Signature: | Signature: |
| Date: <u>12/23/14</u> | Date: <u>3-24-15</u> |

| BOREHOLE LOG | | | | | Page 4 of 4 |
|-------------------------------------|----------|----------------------|---|---|--|
| Well ID: C8294 | | Well Name: 199-k-207 | | Location: 250 m NE of 105 KE reactor | |
| Project: 2+3 wells in 100-kR-4 O.U. | | | Reference Measuring Point: ground level | | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
| | Type No. | Blows Recovery | | | |
| 120 | G | | | 120-140' Sandy Gravel (SG) 55% G, 40% S, 5% M. Gravels 75% felsic, max=140mm, avg=VCP, VIP-LC, SA-SR. Sands 80% felsic, VFS-VCS, VPS, SA, wet. No rxn to HCL. Light Yellowish Brown (2.5 Y 6/3) | @123' ↓ drillrate, slight heaving |
| 125 | G | | | @125' Gravel content ↓ to 30%, sand content ↑ to 70%, trace mud. Gravel avg ↓ to CP. Sand sorting ↑ to WS, 80% CS. | |
| 130 | G | | | | |
| 135 | G | | | @135' Gravel max=100, VFP-80, sorting ↓ to MS, avg=CP. Sand sorting ↓ to MS, 70% med-coarse sand. | @135' ↑ drillrate |
| 140 | G | | | @140-150' Gravelly Sand (gS) 25% G, 75% S, trace M. Gravels 75% felsic, max=60, VFP-MS, avg=VCP, WS, SA-SR. Sands 80% felsic, VFS-VCS WS, 80% CS, SR, wet. No rxn to HCL. Light Olive Brown (2.5 Y 5/3) | @140' ↓ drillrate, heaving sands from 140-144' |
| 145 | G | | | @145' gravel size ↓ to avg=CP. gravel % ↓ to 20, Sand % ↑ to 80. | @144' ↑ drillrate |
| 150 | G | 350 100% | | 150-155.5' Silt (M) 10% S, 90% M. Sands VFS, 100% felsic, VWS, wet. No rxn to HCL. Non-plastic clay. Gray. (2.5 Y 6/1) | @148' Added 150 gallons H ₂ O to stabilize head First contact with proposed RUM @ 150' bgs on 12/31/14 ΔLithology TD=155.5' bgs on 12/31/14 DTW=69.1' bgs on 12/31/14 |
| 155 | G | | | @155' sand % ↓ to 0, Mud % ↑ to 100. plasticity M to low plasticity clay. Light Gray (2.5 Y 7/2) | Casing shoe @ 153.1' bgs @155.5' Add 50 gallons H ₂ O to stabilize head. |

| | |
|-------------------------------|-------------------------------|
| Reported By: Joshua Holland | Reviewed By: Kevin Bergstrom |
| Title: Geologist | Title: Sr. Geologist |
| Signature: <i>[Signature]</i> | Signature: <i>[Signature]</i> |
| Date: 12/31/14 | Date: 3-24-15 |



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199-K-207 (C8294) Log Data Report

Borehole Information:

| | | | | | |
|----------------------------------|-----------------|------------------------------|----------------------------------|-------------------------|-------------|
| Log Date: | 2015-01-05 | Filename: | C8294_HG-NM_2015-01-05 | Site: | 100 K |
| Coordinates (WA St Plane) | | DTW¹ (ft): | 64.35 | DTW Date: | 01/05/15 |
| North (m) | East (m) | Drill Date | TOC² Elevation | Total Depth (ft) | Type |
| N/A | N/A | 12/31/14 | N/A | 155.5 | Cable Tool |

Casing Information:

| Casing Type | Stickup (ft) | Diameter (in.) | | Thickness (in.) | Top (ft) | Bottom (ft) |
|----------------|--------------|----------------|--------|-----------------|----------|-------------|
| | | Outer | Inside | | | |
| Threaded Steel | 1 | 13 3/8 | 12 3/8 | 1/2 | 1 | 59.5 |
| Welded Steel | 2 | 11 7/8 | 10 3/4 | 9/16 | 2 | 153.1 |

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 determined by the logging engineer using an e-tape. The maximum logging depth achieved was 153 ft.

Zero reference is ground surface.

Logging Equipment Information:

| | | | |
|------------------------------------|---------------------|---------------------------|----------------------|
| Logging System: | Gamma 1L | Type: | 60% HPGe SGLS |
| Effective Calibration Date: | 11/12/14 | Serial No.: | 47-TP32211A |
| Calibration Reference: | HGLP-CC-111, Rev. 0 | Logging Procedure: | HGLP-MAN-002, Rev. 1 |

| | | | |
|------------------------------------|---------------------|---------------------------|----------------------|
| Logging System: | Gamma 1H | Type: | NMLS ³ |
| Effective Calibration Date: | 11/13/14 | Serial No.: | H310700352 |
| Calibration Reference: | HGLP-CC-112, Rev. 0 | Logging Procedure: | HGLP-MAN-002, Rev. 1 |

SGLS Log Run Information:

| Log Run | 3 | 4 Repeat | 5 | 6 Repeat | |
|-------------------|----------|----------|------------|------------|--|
| HEIS Number | 1018605 | 1018606 | 1018607 | 1018608 | |
| Date | 12/08/14 | 12/08/14 | 01/05/15 | 01/05/15 | |
| Logging Engineer | Spatz | Spatz | Spatz/Felt | Spatz/Felt | |
| Start Depth (ft) | 0.0 | 35.0 | 59.0 | 90.0 | |
| Finish Depth (ft) | 60.0 | 41.0 | 153.0 | 100.0 | |
| Count Time (sec) | 100 | 100 | 100 | 100 | |
| Live/Real | R | R | R | R | |

¹ depth to water inside casing

² top of casing

³ Neutron Moisture Logging System

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| Log Run | 3 | 4 Repeat | 5 | 6 Repeat | |
|--------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|--|
| Shield (Y/N) | N | N | N | N | |
| MSA Interval (ft) | 1.0 | 1.0 | 1.0 | 1.0 | |
| Log Speed (ft/min) | N/A | N/A | N/A | N/A | |
| Pre-Verification | AL230CAB | AL230CAB | AL232CAB | AL232CAB | |
| Start File | AL230000 | AL230061 | AL232000 | AL232095 | |
| Finish File | AL230060 | AL230067 | AL232094 | AL232105 | |
| Post-Verification | AL230CAA | AL230CAA | AL232CAA | AL232CAA | |
| Depth Return Error (in.) | N/A | 0.0 | N/A | 0.0 | |
| Comments | No fine gain adjustments made | |

NMLS Log Run Information:

| Log Run | 1 | 2 Repeat | 7 | 8 Repeat | |
|--------------------------|----------|----------|------------|------------|--|
| HEIS Number | 1018609 | 1018610 | 1018611 | 1018612 | |
| Date | 12/08/14 | 12/08/14 | 01/05/15 | 01/05/15 | |
| Logging Engineer | Spatz | Spatz | Spatz/Felt | Spatz/Felt | |
| Start Depth (ft) | 0.0 | 15.0 | 59.0 | 60.0 | |
| Finish Depth (ft) | 60.25 | 21.0 | 64.5 | 62.0 | |
| 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 | AH189CAB | AH189CAB | AH191CAB | AH191CAB | |
| Start File | AH189000 | AH189242 | AH191000 | AH191023 | |
| Finish File | AH189241 | AH189266 | AH191022 | AH191031 | |
| Post-Verification | AH189CAA | AH189CAA | AH191CAA | AH191CAA | |
| Depth Return Error (in.) | N/A | 1.5 high | N/A | 0.0 | |
| 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.

Analysis Notes:

| | | | | | |
|-----------------|--------------|--------------|----------|-------------------|----------------------|
| Analyst: | P.D. Henwood | Date: | 01/20/15 | Reference: | HGLP-MAN-003, Rev. 0 |
|-----------------|--------------|--------------|----------|-------------------|----------------------|

Casing corrections for a 1/2-in. thick casing from ground surface to 59 ft and for a 9/16-in. thick casing from 60 to 153 ft were applied to the log data.

A correction for water was applied below 64 ft in depth.

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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 1L20141112, 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 and Pu-239 are plotted 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:

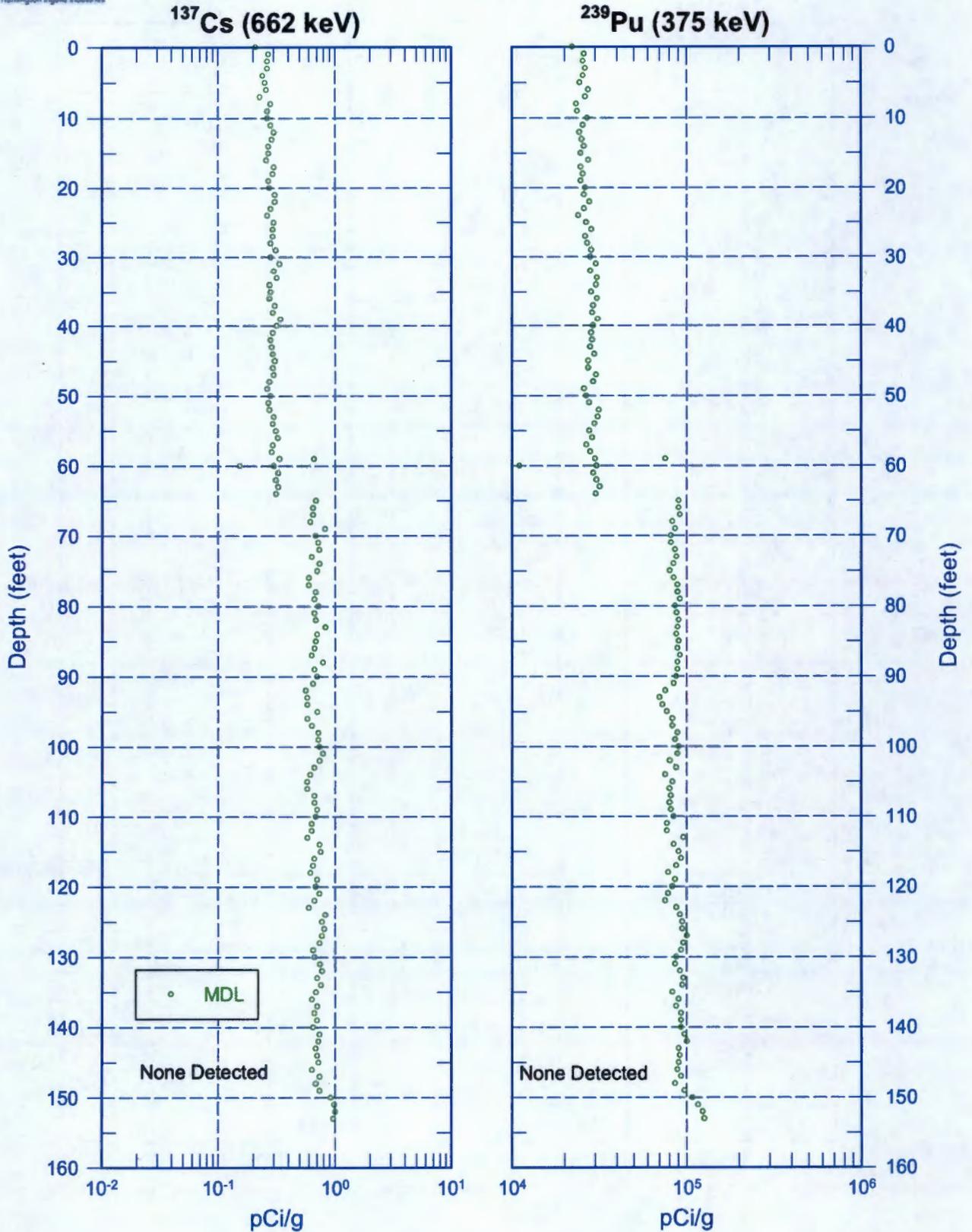
Depth Reference is ground surface.

- Manmade Radionuclides (0-160 ft)
- Natural Gamma Logs (0-160 ft)
- Combination Plot (0-120 ft)
- Combination Plot (110-230 ft)
- Combination Plot (0-160 ft)
- Total Gamma & Moisture (0-160 ft)
- Total Gamma & Hanford Gamma Unit (0-160 ft)
- Repeat Section of Natural Gamma Logs (35 to 41 ft)
- Repeat Section of Natural Gamma Logs (90 to 100 ft)
- Moisture Repeat Section (15 to 21 ft)
- Moisture Repeat Section (60 to 62 ft)

⁴ Hanford Gamma Unit



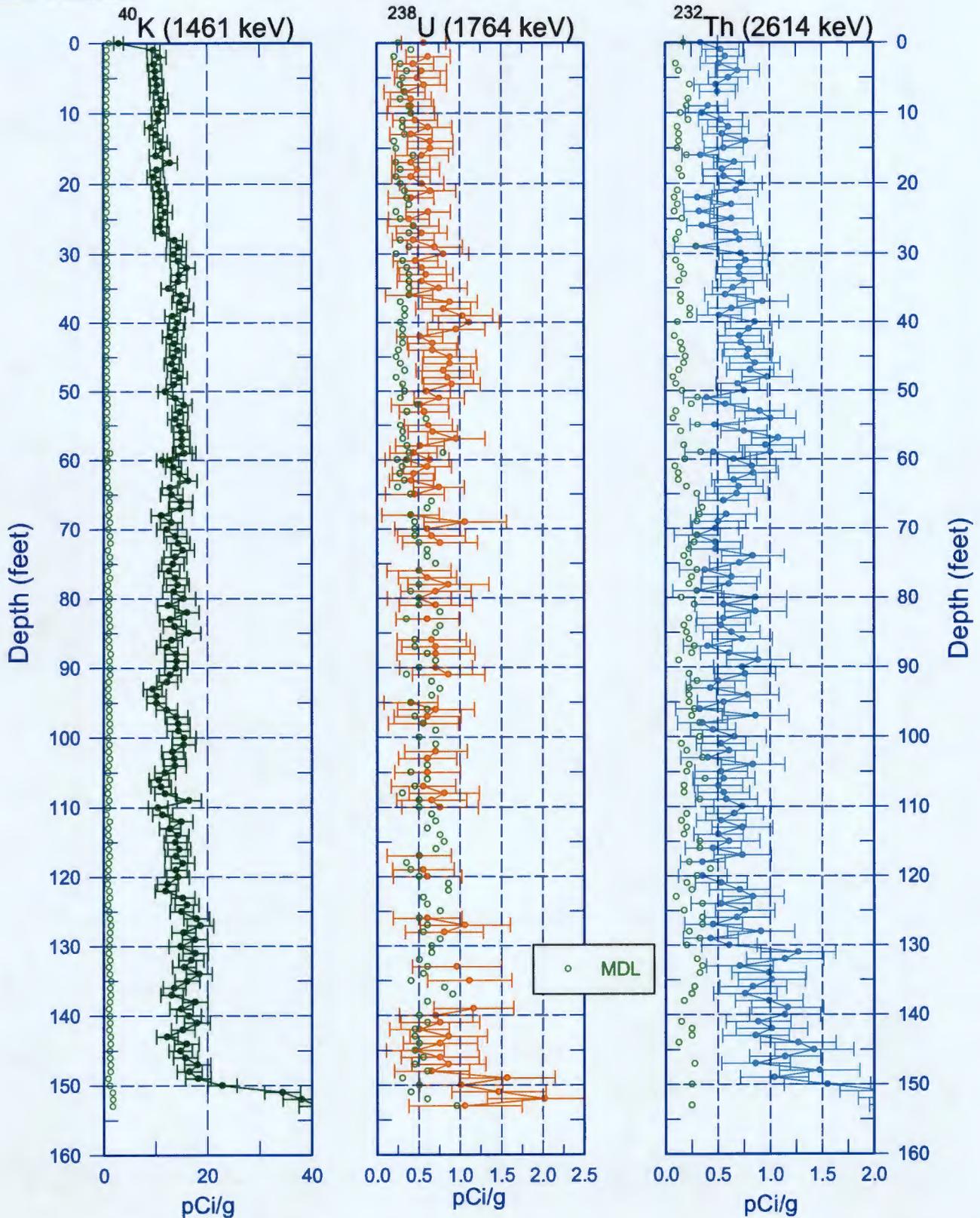
199-K-207 (C8294) Manmade Radionuclides



Zero Reference - Ground Surface



199-K-207 (C8294) Natural Gamma Logs

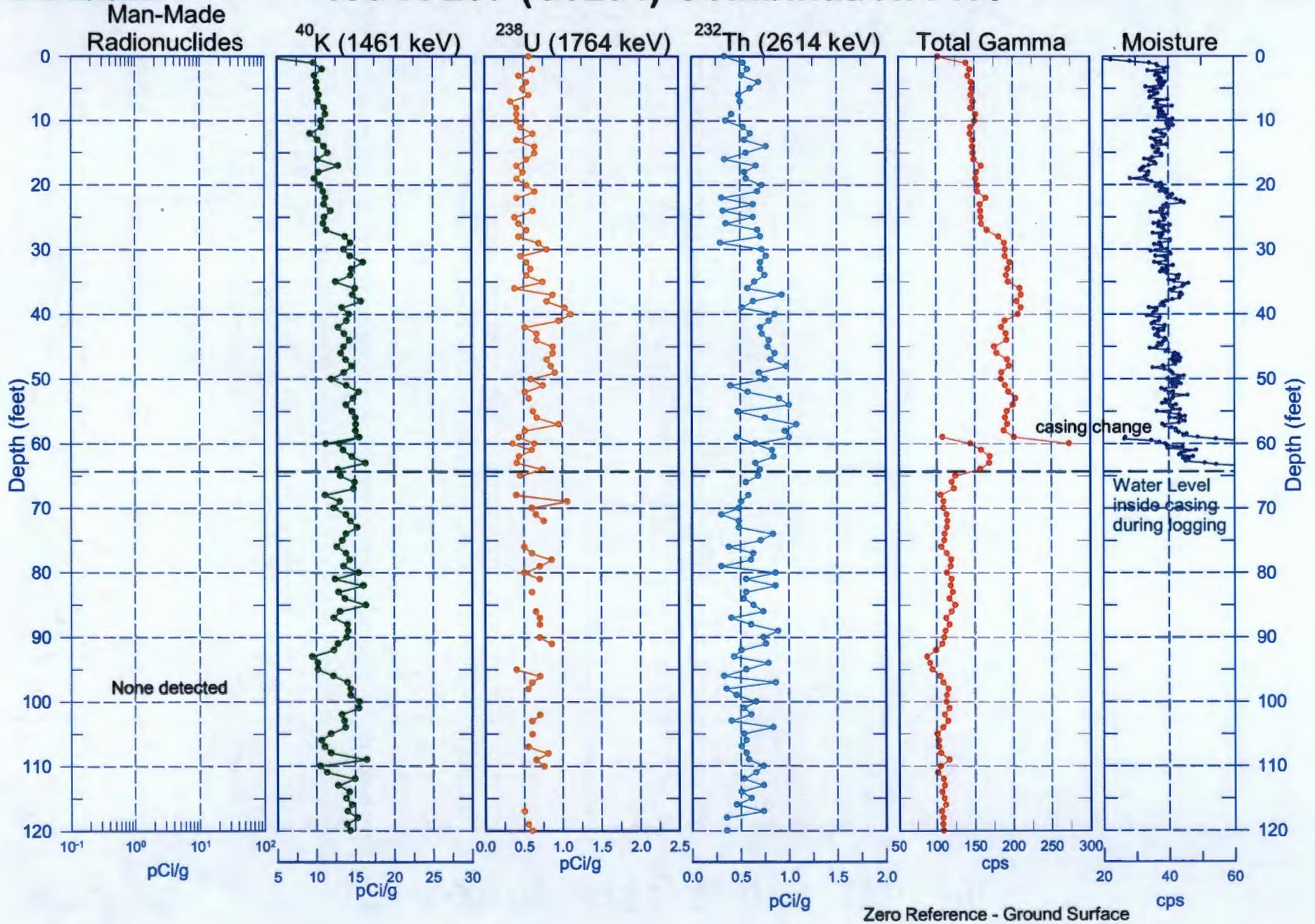


Zero Reference - Ground Surface



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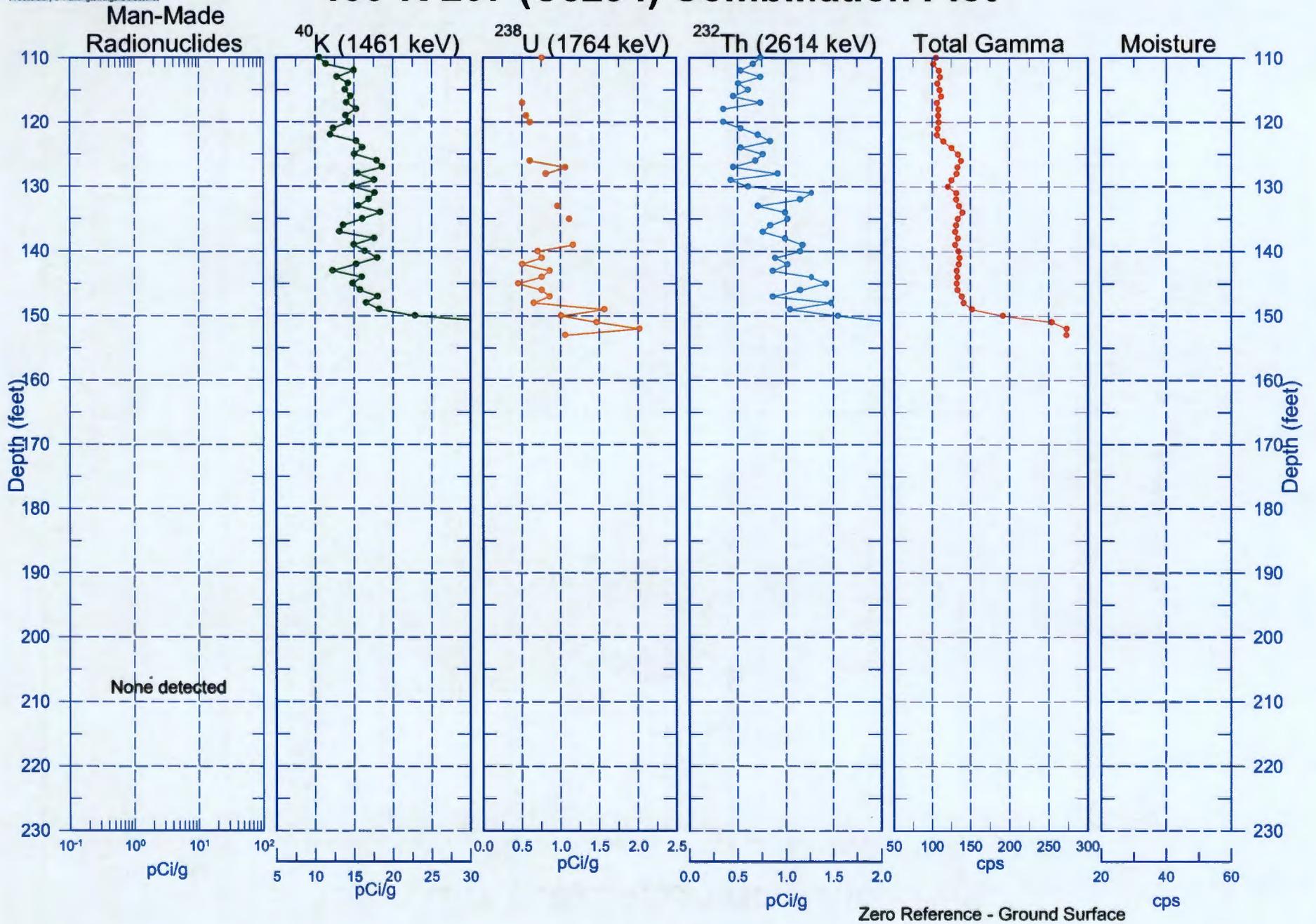
199-K-207 (C8294) Combination Plot





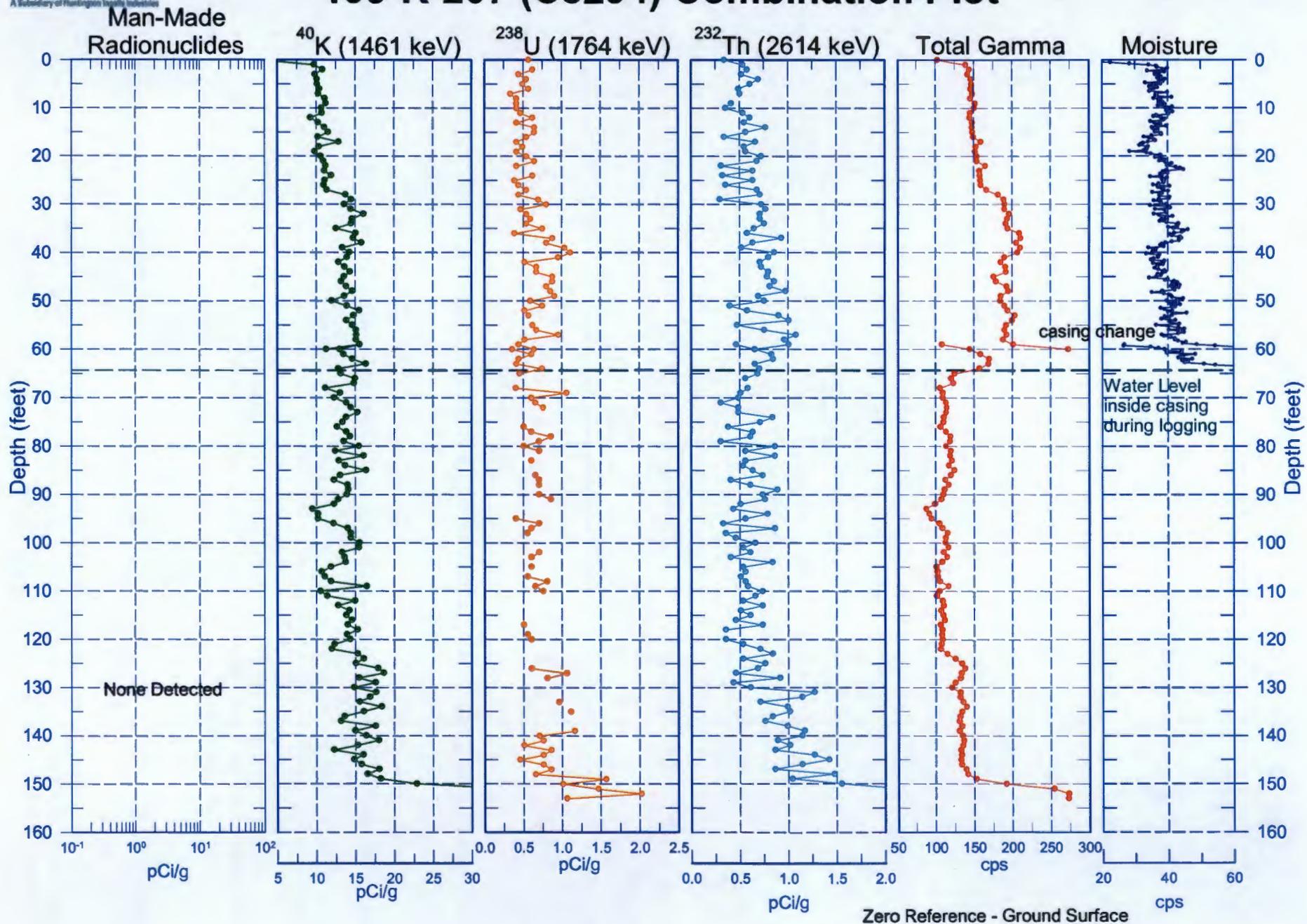
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199-K-207 (C8294) Combination Plot





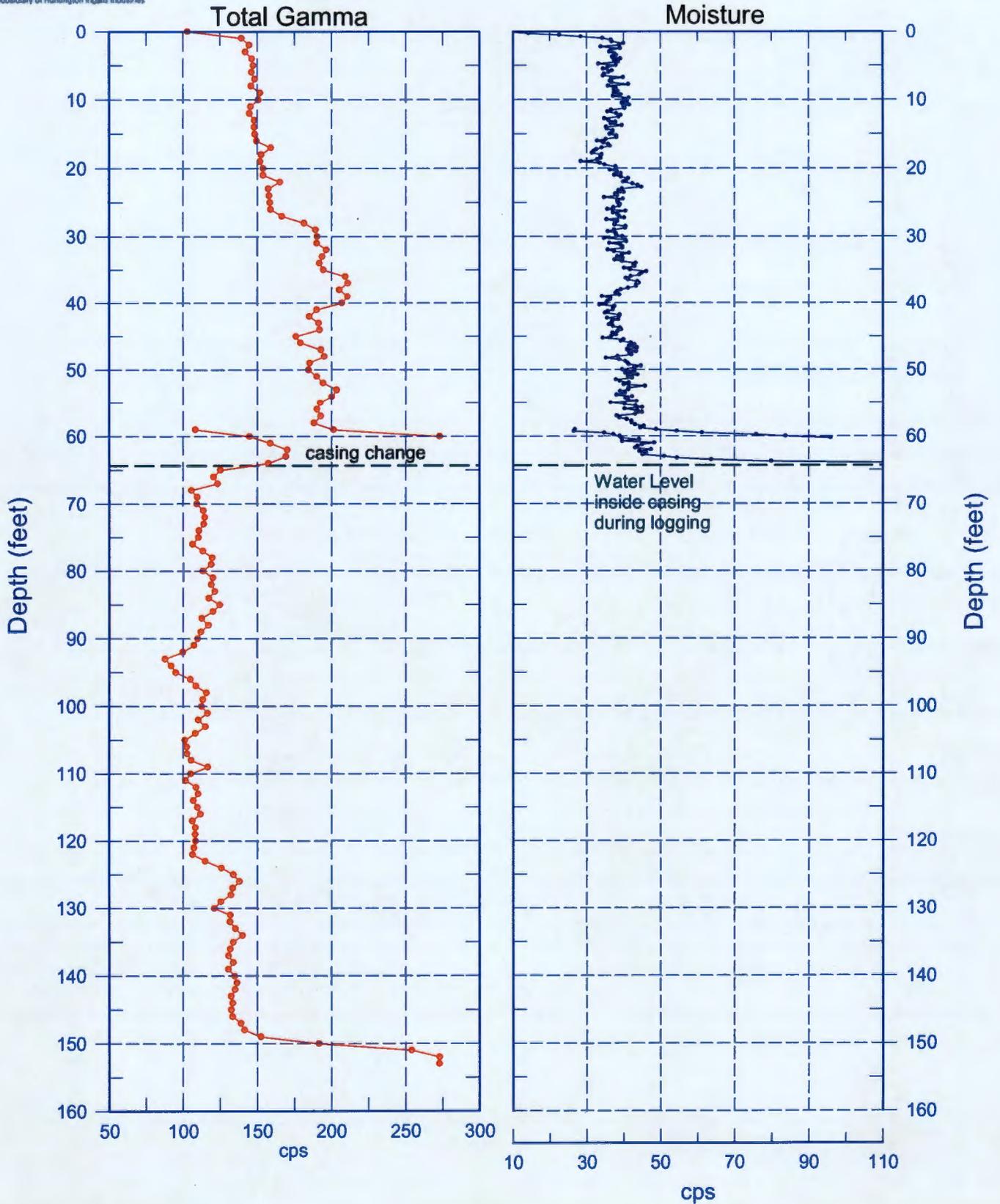
199-K-207 (C8294) Combination Plot





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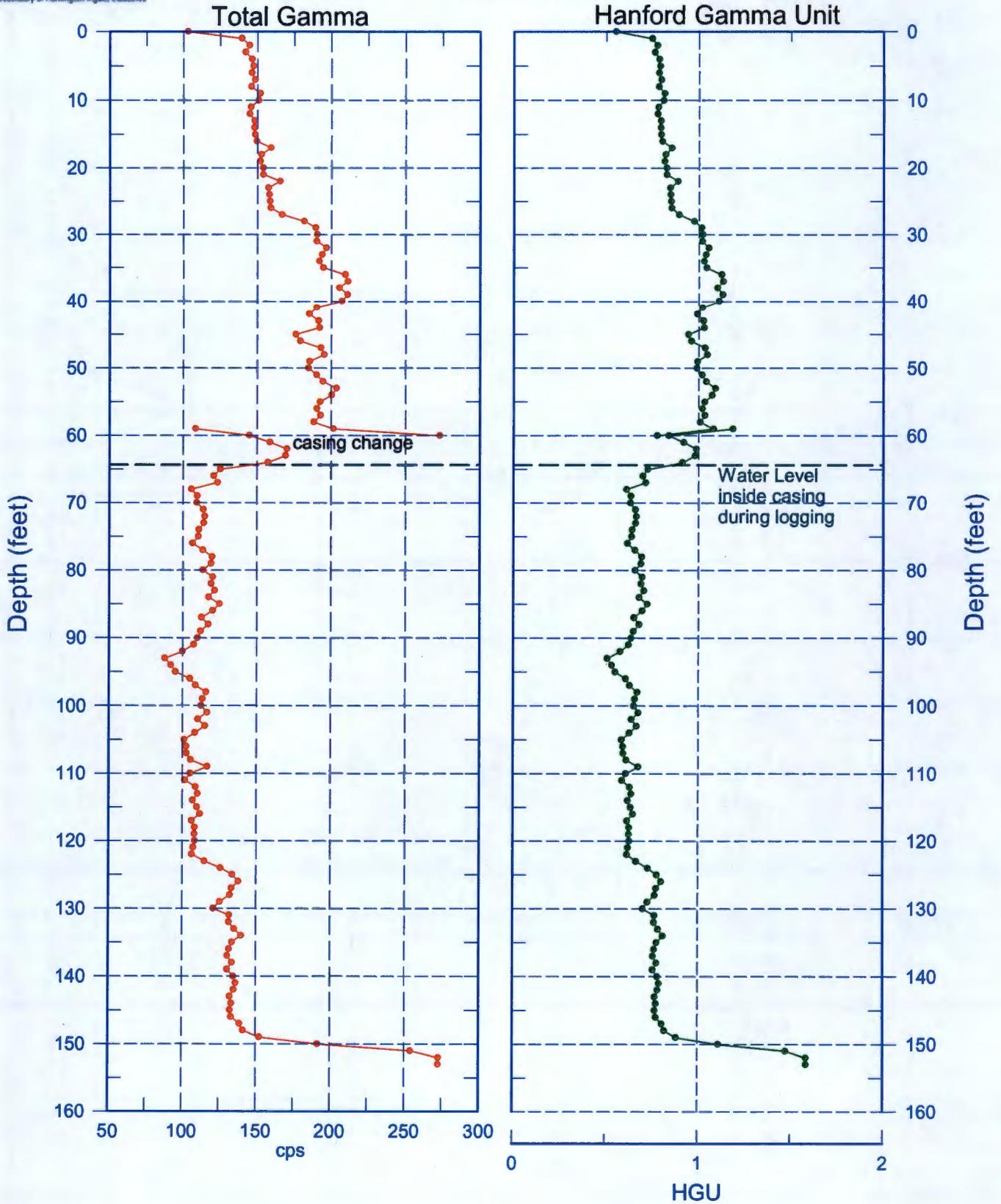
199-K-207 (C8294) Total Gamma & Moisture



Reference - Ground Surface



199-K-207 (C8294) Total Gamma & Hanford Gamma Unit

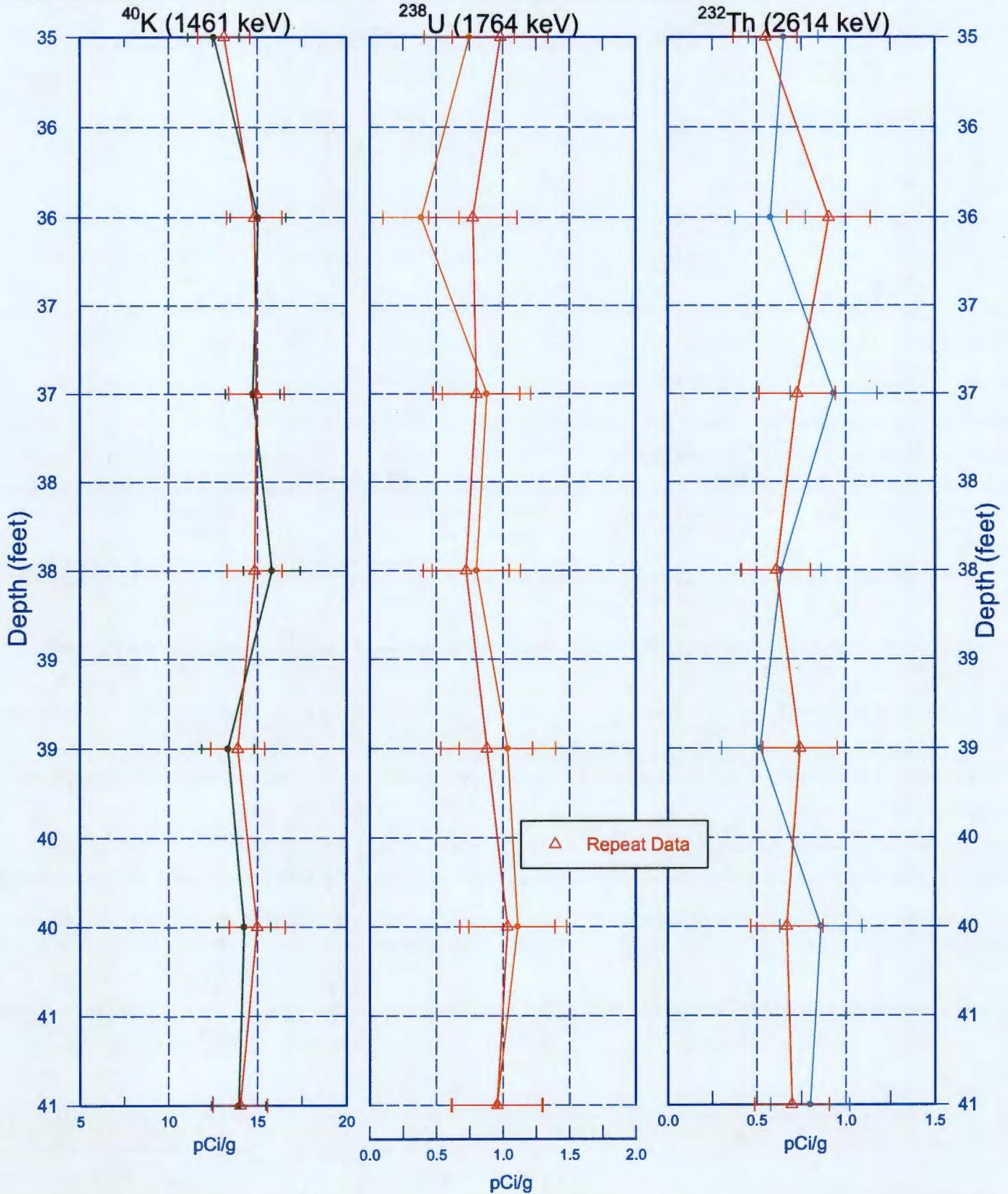


Reference - Ground Surface



199-K-207 (C8294)

Repeat Section of Natural Gamma Logs

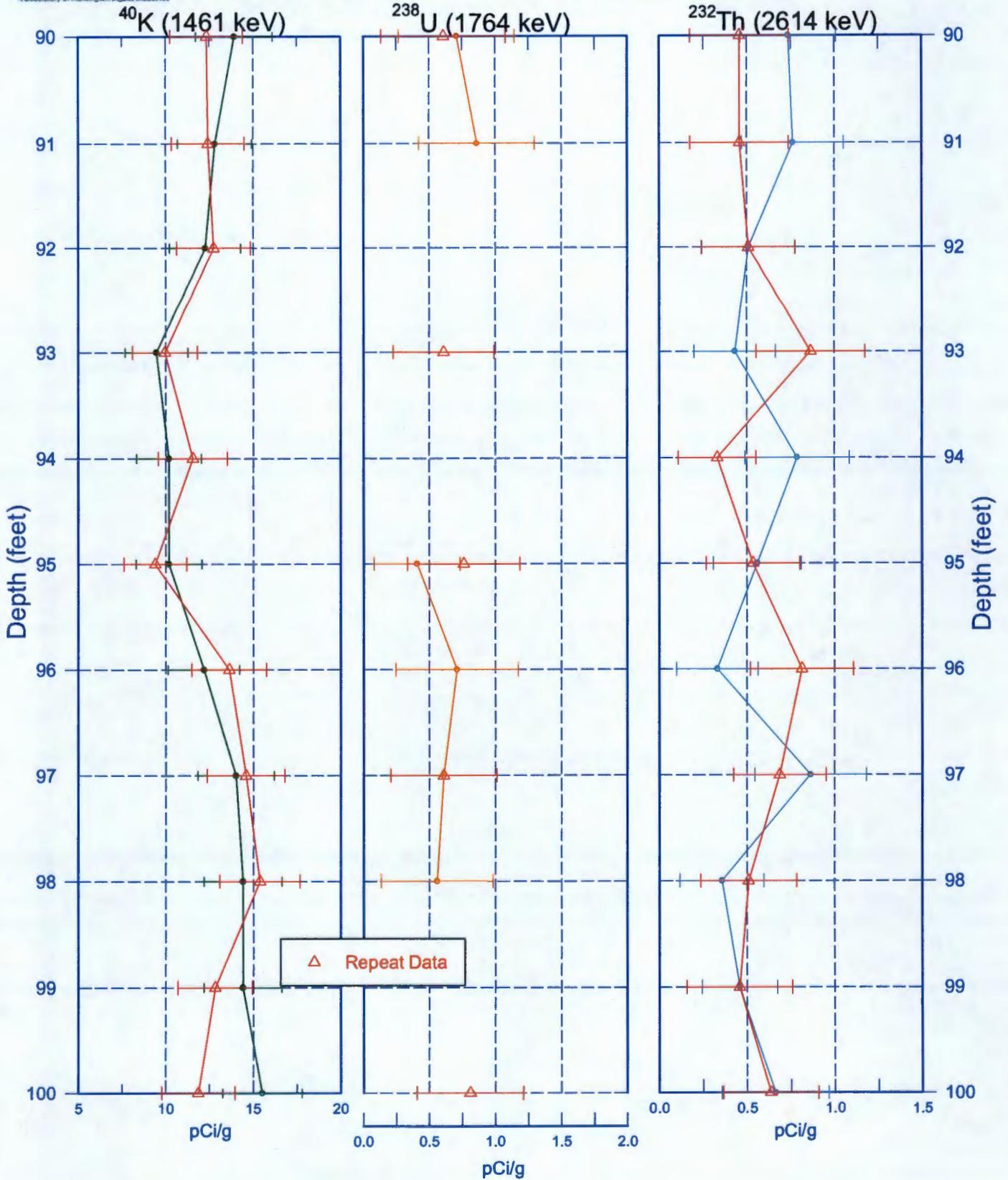


Zero Reference - Ground Surface



199-K-207 (C8294)

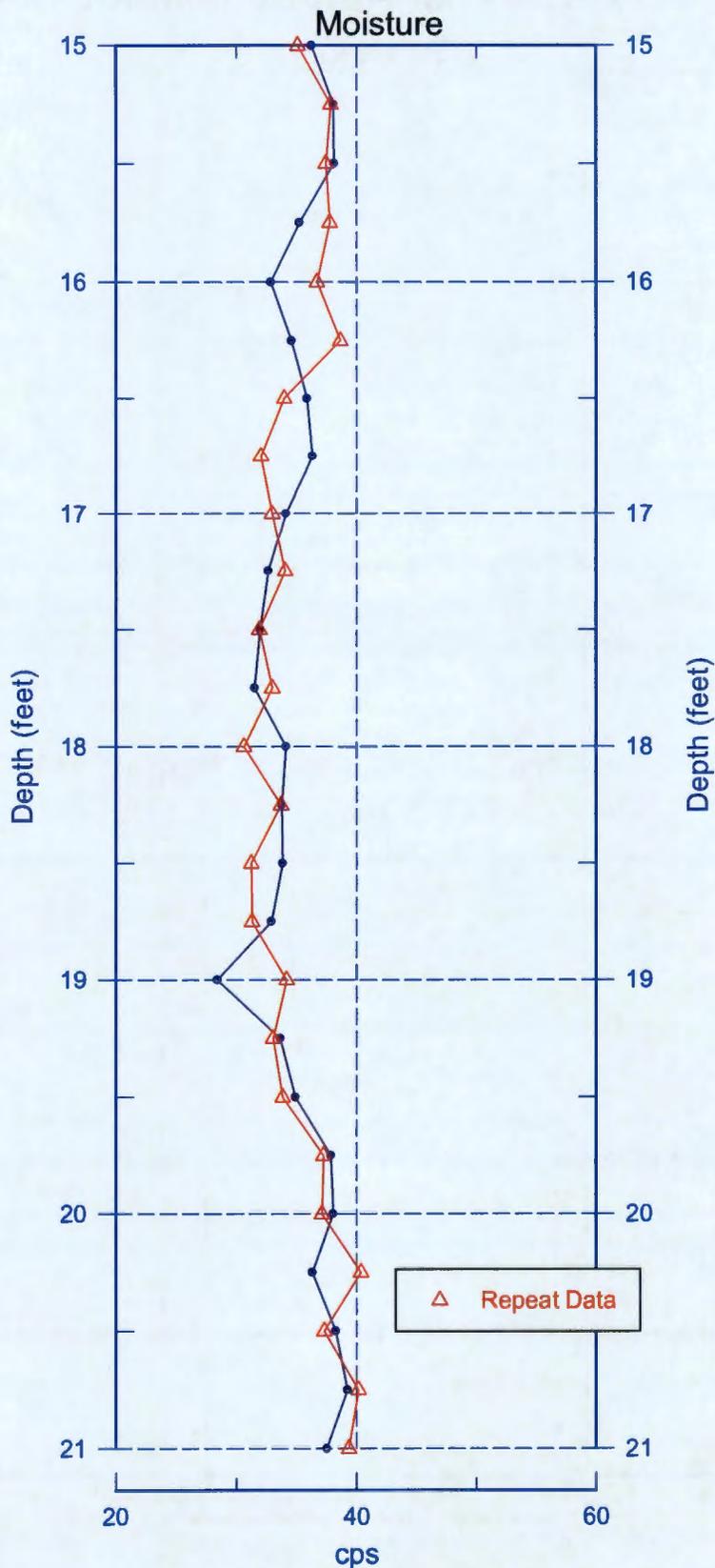
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface



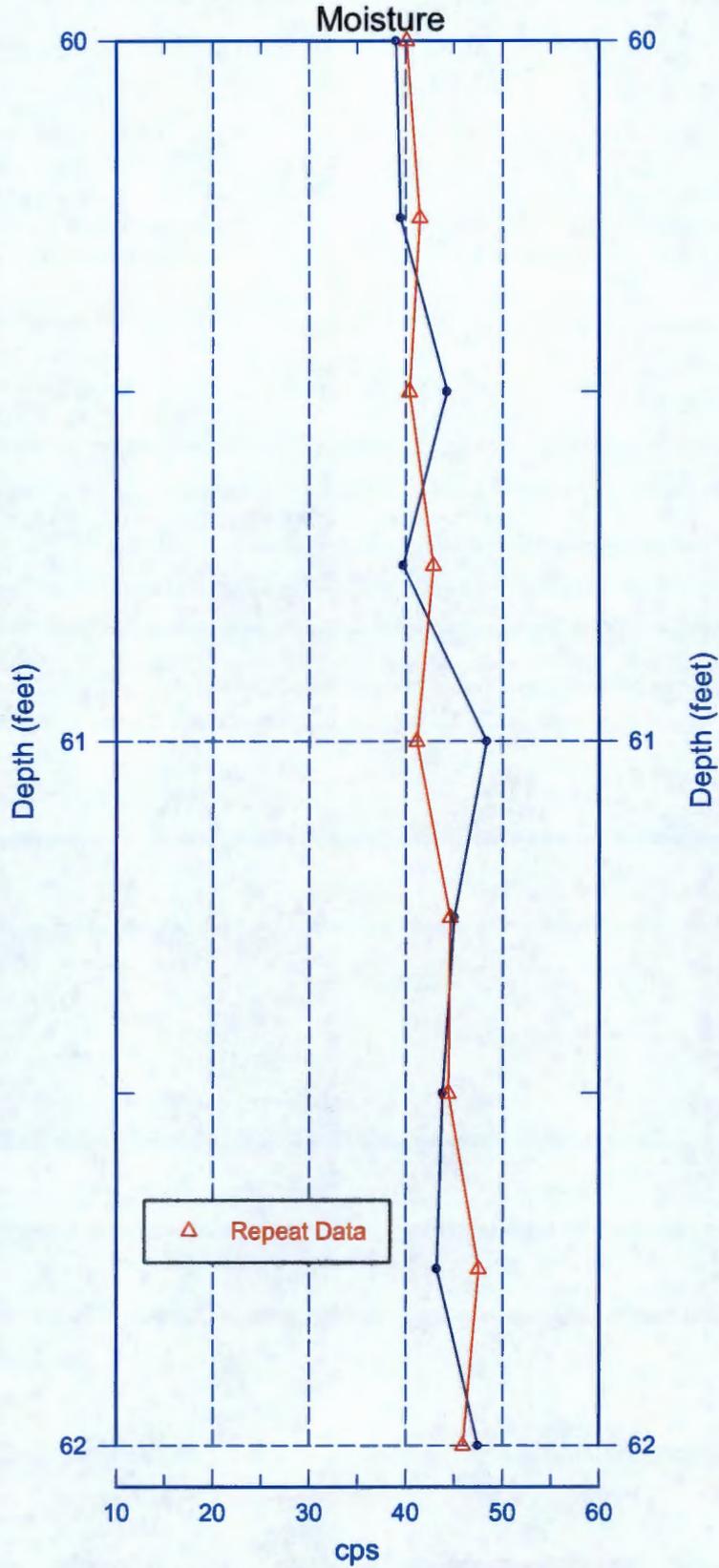
199-K-207 (C8294) Moisture Repeat Section



Reference - Ground Surface



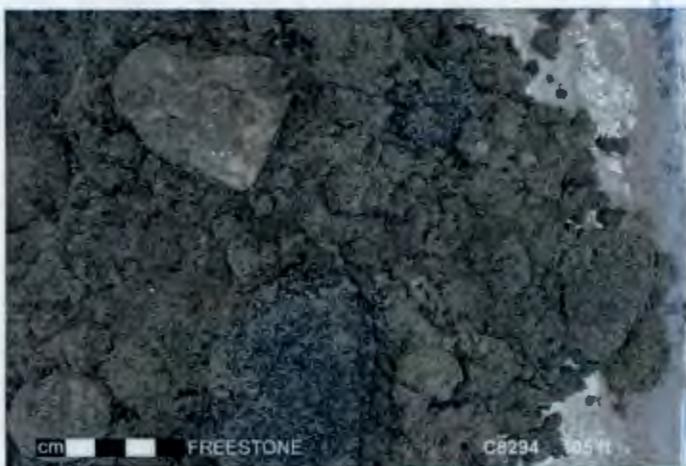
199-K-207 (C8294) Moisture Repeat Section



Reference - Ground Surface











| SURVEY DATA REPORT | | | | Request No. 152-078 | | |
|---|---|-----------------|------------------------|------------------------|------|-----|
| Project No. | Title KR-4 Wells C8290,C8294,C8295 & C8296 Final Surveys | | | File No. 1KT14R26 | | |
| Job No. CACN:303412- JPRC | Prepared By N.P. Fastabend | Date 3/19/15 | Reviewer <i>CBM</i> | | | |
| DESCRIPTION OF WORK | | | DISTRIBUTION | SDR | PLOT | DWG |
| Obtained final coordinates (C/L Casings) and elevations of completed KR-4 Wells C8290 (199-K-203), C8294 (199-K-207), C8295 (199-K-208) and C8296 (199-K-209). Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters) | | | Survey File | OR | | |
| | | | K.M. Whitley | 1 | | |
| | | | S.J. Trent | 1 | | |
| | | | J.D. Mehrer | 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: 03/11/15 | Requestor: Kelly Whitley (CHPRC) |
| Date of Survey: 03/17/15 | 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 Well C8294 (199-K-207). | Horizontal Datum: NAD83 (91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 100K |

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
M49 (COE) and T324 (COE)

| Well ID | Well Name | Easting | Northing | Elevation | |
|---------|-----------|-----------|-----------|-----------|---------------------|
| C8294 | 199-K-207 | 569409.77 | 146979.80 | | Center of Casing |
| | | | | 142.061 | "X" on Rim |
| | | | | 141.272 | Brass Survey Marker |
| | | | | | |

Notes:

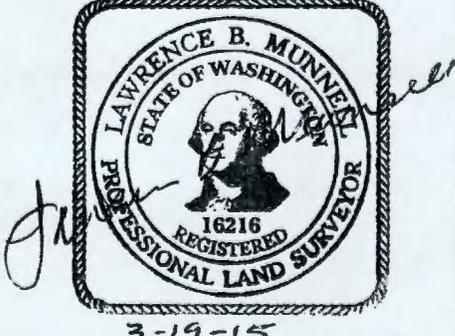
141.767 Top Inner Casing, North Edge

Elevation on Brass Survey Marker was measured to Top Domed Brass Cap in concrete.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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



3-19-15

Appendix D

Well Documentation for C8295 (199-K-208)

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

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| WELL SUMMARY SHEET | | Start Date: 12/3/2014 Finish Date: 2/25/2015 | | Page 1 of 2 | |
|---|---------|---|-------------|--|--|
| Well ID: C8295 | | Well Name: 199-K-208 | | | |
| Location: 600m SW of KE Pump and Treat | | Project: 2 Plus 3 Optional Wells In 100-KR-4 OU | | | |
| Prepared By: Joshua Holland | | Date: 3/3/15 | | Reviewed By: J.D. MEHRER | |
| Signature: <i>[Signature]</i> | | Signature: <i>[Signature]</i> | | | |
| CONSTRUCTION DATA | | GEOLOGIC/HYDROLOGIC DATA | | | |
| Description | Diagram | Depth in Feet | Graphic Log | Lithologic Description (ft bgs) | |
| Concrete Pad: 0.5 ft above ground surface (ags) | | 0 | | 0- 43 Sandy Gravel (sG) | |
| 8-in Protective Casing: 2.96 ft ags - 2.04 ft below ground surface (bgs) | | 10 | | | |
| Type I/II Portland Cement Grout: 0 - 13.4 ft bgs | | 20 | | | |
| 3/8 in Cetco Medium Bentonite Chips: 13.4 - 32.6 ft bgs | | 30 | | | |
| 6-in I.D. Schedule 10, Type 304/304L, Stainless Steel Blank Casing: 2.00 ft ags - 36.78 ft bgs | | 40 | | | |
| 3/8 in Cetco Coated Bentonite Pellet Seal: 32.6 - 33.4 ft bgs | | 41.8 | | Static Water Level: 41.8 ft bgs (12/11/2014) | |
| Stainless steel centralizer installed from the top of the sump at 40 ft intervals | | 50 | | 43- 45 Sand (S) | |
| 8-16 mesh Premier Colorado Silica Filter Pack Sand: 33.4 - 133.9 ft bgs | | 60 | | 45- 95 Sandy Gravel (sG) | |
| 6-in I.D. Schedule 10, Type 304/304L, 50-slot (0.050 in.) Stainless Steel Screen: 36.78 - 127.20 ft bgs | | 70 | | | |
| <p>Depths are in ft below ground surface.</p> <p>Borehole drilled with 13 5/8 O.D. conductor from 0 to 39.7 ft bgs and 11 7/8-in O.D. casing from 0.0 - 131.43 ft bgs.</p> <p>All temporary drill casing was removed from the ground.</p> | | 80 | | | |

| WELL SUMMARY SHEET | | Start Date: 12/3/2014 | | Page 2 of 2 | |
|---|--------------|---|--------------|---------------------------------|-------------------------------------|
| | | Finish Date: 2/25/2015 | | | |
| Well ID: C8295 | | Well Name: 199-K-208 | | | |
| Location: 600m SW of KE Pump and Treat | | Project: 2 Plus 3 Optional Wells In 100-KR-4 OU | | | |
| Prepared By: Joshua Holland | Date: 3/3/15 | Reviewed By: J.D. MEHRER | Date: 4-3-15 | | |
| Signature: <i>[Signature]</i> | | Signature: <i>[Signature]</i> | | | |
| CONSTRUCTION DATA | | GEOLOGIC/HYDROLOGIC DATA | | | |
| Description | Diagram | Depth in Feet | Graphic Log | Lithologic Description (ft bgs) | |
| 8-16 mesh Premier Colorado Silica Filter Pack Sand: 33.4 - 133.9 ft bgs | | 90 | | 45 - 95 Sandy Gravel (sG) | |
| | | | | 95 - 100 Gravel (G) | |
| | | | | 100 | 100 - 110 Gravelly Sand (gS) |
| | | | | 110 | 110 - 127.5 Sandy Gravel (sG) |
| | | | | 120 | |
| | | | | 130 | 127.5 - 133.9 Silt (M) |
| | | | | | Straightness Test: 02/17/2015, Pass |
| | | | | | Total Depth: 133.9 ft bgs |
| | | | | 140 | |
| | | | | 150 | |
| | | 160 | | | |
| | | 170 | | | |
| <p>6-in I.D. Schedule 10, Type 304/304L, 50-slot (0.050 in.) Stainless Steel Screen: 36.78 - 127.20 ft bgs</p> <p>Stainless steel centralizer installed from the top of the sump at 40 ft intervals</p> <p>6-in I.D. Schedule 10, Type 304/304L, Stainless Steel Sump: 127.20 - 132.20 ft bgs</p> | | | | | |
| <p>Depths are in ft below ground surface.</p> <p>Borehole drilled with 13 5/8 O.D. conductor from 0 to 39.7 ft bgs and 11 7/8-in O.D. casing from 0.0 - 131.43 ft bgs.</p> <p>All temporary drill casing was removed from the ground.</p> | | | | | |

BOREHOLE LOG

Page 1 of 4

Date: 12/5/14

Well ID: C8295 Well Name: 199-K-208 Location: 600m SW of KE Pump & Treat

Project: 7 Wells in the 100-KR-4 OU + 3 optimal Reference Measuring Point: Ground Surface

| Depth (Ft) | Sample | | Graphic Log | Sample Description | Comments |
|------------|----------|----------------|-------------|--|---|
| | Type No. | Blows Recovery | | | |
| 0 | | | | 0-1' Gravel drilling pad 1-4 3/8' bags SANDY GRAVEL (SG) Gravel: 37%, Sand: 58%, Silt: 5% Gravel is v.f. pb-ls; SR-SA, v.S, 50% v.f. & pb; max lrob; 50% mafic, 50% felsic Sand: A-SR; moderately sorted, v.f.-L, 50% m; 40% mafic, 60% felsic Silt: 10YR 5/3, brown, dry, no HCl rxn | 5' grab samples 10' compiled slur samples Cable Tool, drive barrel |
| 5 | G | | | 10' bags; SG; 75% gravel, 22% sand, 3% silt Gravel: SR, mod sorted (60% v.c. pb. Sand: same as above; 10YR 5/3, brown; no reaction to HCl, dry; lg cobbles slowing drilling | Drilling is slow 1.25"/hr Drive barrel: 9 3/4" OD |
| 10 | G | | | 15' bags; Sandy Gravel (SG); 75% G, 20% S 5% M 10YR 6/2 Lt. brownish gray Dry G=SC to VCP max 80mm SR-RND 80% mafic - 20% felsic VP sorted; S=Med; SAA; mod sorted 70% Qtz, no HCl rxn | |
| 15 | G | | | 20' bags; Sandy Gravel (SG); 80% G, 18% S, 2% M; 10YR 6/2 Lt. brownish gray dry G=SC-VCP; max 70mm; SR-R; 35% mafic 65% felsic; SAA; well sorted; 80% Qtz; NO HCl rxn | Hardford-Ringold E Contact not recognized Est. in 20'-25' interval |
| 20 | G | | | 25' bags) As Above, color now 10YR 6/3 Pale brown; NO HCl rxn | |
| 25 | G | | | 30' bags) Description as above, max gravel 120x80x60mm no HCl rxn | |
| 30 | G | | | 33' bags) Dry sed | |
| 35 | G | | | 35' bags) Sandy Gravel (SG); 75% G, 22% S 3% M; 10YR 6/2; Lt. brownish gray; dry v.f. sorted G=SC to VCP; max 100mm SR-RND 80% Felsic, 20% mafic; SR-RND; S=Med Gm SA-A; 80% Qtz, MOD HCl rxn 37) slight darkening due to moisture | |

Reported By: Janne Carter & Greg Kasza

Reviewed By: Kevin Bergstrom

Title: Geologists

Title: Sr. Geologist

Signature: Janne Carter & Greg Kasza
12/9/14

Date: 12/3/14

Signature: Kevin Bergstrom

Date: 5/14/2015

| BOREHOLE LOG | | | | | Page <u>2</u> of <u>4</u> |
|--|----------|----------------|---|---|---|
| Well ID: <u>C8295</u> | | | | | Date: <u>12/10/10</u> |
| Well Name: <u>199-K-208</u> | | | Location: <u>600 m SW of kW pump & treat</u> | | |
| Project: <u>2 WELLS IN THE 100RR-400+ 3 OPTIONAL WELLS</u> | | | Reference Measuring Point: <u>GROUND SURFACE</u> | | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
| | Type No. | Blows Recovery | | | |
| 40 | G | | | 40' - SAME AS ABOVE | Grab samples for archive & sieve analysis every 5'; only saturated samples for sieve analysis |
| 43 | G | | | 43'-45'; SAND;(S) | |
| 45 | G | | | @43' gravel, 95% sand; Gravel: vf-v peb, WR | |
| 45 | G | | | Sand: Well sorted, m-c, sub R, 15% mafic | @41.82' hit water |
| | | | | 85% felsic; 10YR 5/2, grey brown; dry; | @45'; 5' sand heave |
| | | | | no reaction to HCl; 1% mica | Switch Drive barrel to 8 3/8" OD |
| | | | | 45'-95'; SANDY GRAVEL;(SG) | |
| | | | | 75% gravel, 22% sand, 3% silt | |
| | | | | Gravel: SR; PS; med-c peb; 3% mafic 70% felsic | |
| | | | | Sand: SR; WS; m-c; 2.5% mafic 75% felsic | |
| | | | | Silt: 10YR 5/2, grey brown; 1% mica; | |
| | | | | no reaction to HCl; dry wet. | @ 50' Wk drillrate, tight |
| | | | | @ 50' ↓ gravel: 70%, ↑ sand: 27%, silt: 3% | Split spoon collected from 51.6' to 52.9' bgs until refusal |
| 55 | G | | | @ 55': avg gravel size VCP, gravel range from VFP-B | Groundwater sample collected at 50.8' bgs |
| | | | | one 300m boulder. Sand: range from VF5-VCS, | @ 57' ↑ drillrate |
| | | | 70% med sand. med sorting. wet. 4/23 | | |
| 60 | G | | @ 60': gravel felsic content 71 to 80%. | @ 60' ↑ drillrate | |
| | | | max gravel size 200mm. | | |
| 65 | G | | @ 65': Gravel sorting SH to TT to MS. max gravel size W to 40 mm. Color change to light olive brown (2.5 Y 5/3) | | |
| 70 | G | | @ 70': Gravel sorting W to VPS, max=80mm. Color change to light olive brown (2.5 Y 5/4) | @ 72' Wk drillrate | |
| 75 | G | | @ 75': max gravel size TT to 130mm. sand sorting W to VPS. | Split spoon collected from 74.6-76.6' bgs until refusal | |
| | | | | GW sample collected @ 73.5' bgs | |
| | | | | @ 78.5' TT drillrate, loose | |

Reported By: Greta Kasza

Janine Carter ^{Joshua Holland}

Reviewed By: Kevin Bergstrom

Title: Geologist

Geologist Geologist

Title: Sr. Geologist

Signature: Greta Kasza

Janine Carter

Date: 1/19/13

Signature: Kevin Bergstrom

Date: 5/19/2015

BOREHOLE LOG

Page 3 of 4

Date: 1/20/15

Well ID: C8295

Well Name: 199-kr-208

Location: 600m SW of kW pump + treat

Project: 2 wells in 100-RR-4 O.U. plus 1 optional

Reference Measuring Point: ground surface

| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
|-------------|----------|----------------|---|---|--|
| | Type No. | Blows Recovery | | | |
| 80 | G | | | 80-95' Sandy Gravel (SG) 30%G, 70%S, Trace M Gravels: 65% felsic, VFP-SR, VPS, SA-SR, max=80mm. Sands: 85% felsic, VFS-VCS, 80% MS/CS, med sorting, SR, trace mica. wet. No rxn to HCL. Light Yellowish Brown (2.5 Y 6/3) | Grab samples (G) collected every 5' and at Δ lithology Cable Tools Drive Barrel |
| 85 | G | | | @ 85' Gravel ↑ to 70%, Sand ↓ to 30%. gravels ↑ to 80% felsic, sorting ↑ to PG, max size ↑ to 160 mm, avg=80mm | @ 86' ↑ drillrate, loose |
| 90 | G | | | @ 90' Gravel sorting ↑ to MS, max ↓ to 80mm, avg ↓ to 30mm. Color change to Light Olive Brown (2.5 Y 5/3) | @ 92' ↓ drillrate, tight |
| 95 | G | | | 95-100' Gravel (G) 80%G, 15% S, 5%M. Gravels: 60% felsic, VFP-SR, VPS, max=110mm, SA-SR. Sands: 85% felsic, VFS-VCS, 60% MS/CS, PG, SA. Light Olive Brown (2.5 Y 5/3) + Dark olive brown (2.5 Y 3/3) laminated. wet. No rxn to HCL | @ 95' ↑ drillrate |
| 100 | G | | | 100-110' Gravelly Sand (GS) 25%G, 75%S, Trace M. Gravels: 75% felsic, VFP-SR, max=60mm, avg=CP, MS, SA-SR. Sands: 80% felsic, VFS-VCS, 70% CS, WS, SR-SA. wet. No rxn to HCL. Light Olive Brown (2.5 Y 5/3) | |
| 105 | G | | @ 105' Gravel content ↓ to 15%, sand content ↑ to 85%. | | |
| 110 | G | | 110-117.5' Sandy Gravel (SG) 70%G, 30%S, Trace M Gravels: 70% felsic, VFP-SR, MS, Avg=K/P, max=80mm, SR-R Sands: 80% felsic, VFS-VCS, 80% MS/CS, WS, SR. wet. no rxn to HCL. Light Yellowish Brown (2.5 Y 6/3) | SS sample collected from 117.3-118.8' bgs GW sample collected @ 117.1' bgs | |
| 115 | G | | @ 115' Gravel ↓ to 60%, sand ↑ to 40% | @ 115'-118.5' minor sand heave. 8' sand heave during water sample activities | |

T_{SS} GW T 180
T 100%

Reported By: Joshua Holland

Reviewed By: Kevin Bergstrom

Title: Geologist

Title: Sr. Geologist

Signature: [Signature]

Date: 1/24/15

Signature: [Signature]

Date: 5/19/2015



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199-K-208 (C8295) Log Data Report

Borehole Information:

| | | | | | |
|----------------------------------|-----------------|------------------------------|----------------------------------|-------------------------|-------------|
| Log Date: | 2015-02-02 | Filename: | C8295_HG-NM_2015-02-02 | Site: | 100 K |
| Coordinates (WA St Plane) | | DTW¹ (ft): | 42.3 | DTW Date: | 02/02/15 |
| North (m) | East (m) | Drill Date | TOC² Elevation | Total Depth (ft) | Type |
| N/A | N/A | 01/29/15 | N/A | 133.9 | Cable Tool |

Casing Information:

| Casing Type | Stickup (ft) | Diameter (in.) | | Thickness (in.) | Top (ft) | Bottom (ft) |
|----------------|--------------|----------------|--------|-----------------|----------|-------------|
| | | Outer | Inside | | | |
| Threaded Steel | 1.0 | 13 7/8 | 10 3/8 | 1/2 | 1.0 | 40.0 |
| Threaded Steel | 2.35 | 11 7/8 | 10 5/8 | 5/8 | 2.35 | 131.4 |

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 determined by the logging engineer using an e-tape. The driller reported that water was added into the borehole after setting casing in the mud at approximately 133.9. Approximately four days elapsed before logging started. The maximum logging depth achieved was 133.4 ft.

Zero reference is ground surface.

Logging Equipment Information:

| | | | |
|------------------------------------|---------------------|---------------------------|----------------------------|
| Logging System: | Gamma 1L | Type: | 60% HPGe SGLS ³ |
| Effective Calibration Date: | 11/12/14 | Serial No.: | 47-TP32211A |
| Calibration Reference: | HGLP-CC-111, Rev. 0 | Logging Procedure: | HGLP-MAN-002, Rev. 1 |

| | | | |
|------------------------------------|---------------------|---------------------------|----------------------|
| Logging System: | Gamma 4N | Type: | 60% HPGe SGLS |
| Effective Calibration Date: | 01/08/15 | Serial No.: | 47-TP22010A |
| Calibration Reference: | HGLP-CC-113, Rev. 0 | Logging Procedure: | HGLP-MAN-002, Rev. 1 |

| | | | |
|------------------------------------|---------------------|---------------------------|----------------------|
| Logging System: | Gamma 1H | Type: | NMLS ⁴ |
| Effective Calibration Date: | 11/13/14 | Serial No.: | H310700352 |
| Calibration Reference: | HGLP-CC-112, Rev. 0 | Logging Procedure: | HGLP-MAN-002, Rev. 1 |

| | | | |
|------------------------------------|---------------------|---------------------------|----------------------|
| Logging System: | Gamma 4M | Type: | NMLS |
| Effective Calibration Date: | 10/13/14 | Serial No.: | H340207279 |
| Calibration Reference: | HGLP-CC-109, 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

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SGLS Log Run Information:

| Log Run | 1 | 2 Repeat | 5 | 6 Repeat | |
|--------------------------|-------------------------------|-------------------------------|--|-------------------------------|--|
| HEIS Number | 1018627 | 1018628 | 1018629 | 1018630 | |
| Date | 12/10/14 | 12/10/14 | 02/02/15 | 02/02/15 | |
| Logging Engineer | Pope | Pope | Spatz | Spatz | |
| Start Depth (ft) | 0.0 | 10.0 | 38.0 | 71.0 | |
| Finish Depth (ft) | 39.0 | 14.0 | 133.0 | 81.0 | |
| 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 | AL231CAB | AL231CAB | DNL51CAB | DNL51CAB | |
| Start File | AL231000 | AL231040 | DNL51000 | DNL51097 | |
| Finish File | AL231039 | AL231044 | DNL51096 | DNL51106 | |
| Post-Verification | AL231CAA | AL231CAA | DNL51CAA | DNL51CAA | |
| Depth Return Error (in.) | N/A | 0.0 | N/A | 0.5 low | |
| Comments | No fine gain adjustments made | No fine gain adjustments made | Fine gain adjustment after files -002, -044, 049, and -088 | No fine gain adjustments made | |

NMLS Log Run Information:

| Log Run | 3 | 4 Repeat | 7 | 8 Repeat | |
|--------------------------|----------|----------|----------|----------|--|
| HEIS Number | 1018631 | 1018632 | 1018633 | 1018634 | |
| Date | 12/10/14 | 12/10/14 | 02/02/15 | 02/02/15 | |
| Logging Engineer | Pope | Pope | Spatz | Spatz | |
| Start Depth (ft) | 0.0 | 10.0 | 36.0 | 39.0 | |
| Finish Depth (ft) | 39.75 | 14.0 | 42.25 | 42.0 | |
| 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 | AH190CAB | AH190CAB | DMY42CAB | DMY42CAB | |
| Start File | AH190000 | AH190160 | DMY42000 | DMY42026 | |
| Finish File | AH190159 | AH190176 | DMY42025 | DMY42038 | |
| Post-Verification | AH190CAA | AH190CAA | DMY42CAA | DMY42CAA | |
| Depth Return Error (in.) | N/A | 0.0 | N/A | 0.0 | |
| Comments | None | None | None | None | |

Logging Operation Notes:

A centralizer was installed on the sondes.

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

Analysis Notes:

| | | | | | |
|-----------------|--------------|--------------|----------|-------------------|----------------------|
| Analyst: | P.D. Henwood | Date: | 02/10/15 | Reference: | HGLP-MAN-003, Rev. 0 |
|-----------------|--------------|--------------|----------|-------------------|----------------------|

A casing correction for a 5/8-in. thick casing was applied to the log data.

A correction for water was applied below 32 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 1L20141112 and DN20150108, using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

NMLS data are reported in count 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:

No manmade radionuclides were detected in the borehole. MDLs for Cs-137 and Pu-239 are plotted 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 decrease in moisture count rate from 36 to 42 ft is the result of a different detector and casing inside diameter used for log runs 7 and 8 and is not the result of decreasing moisture content.

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

List of Log Plots:

Depth Reference is ground surface.

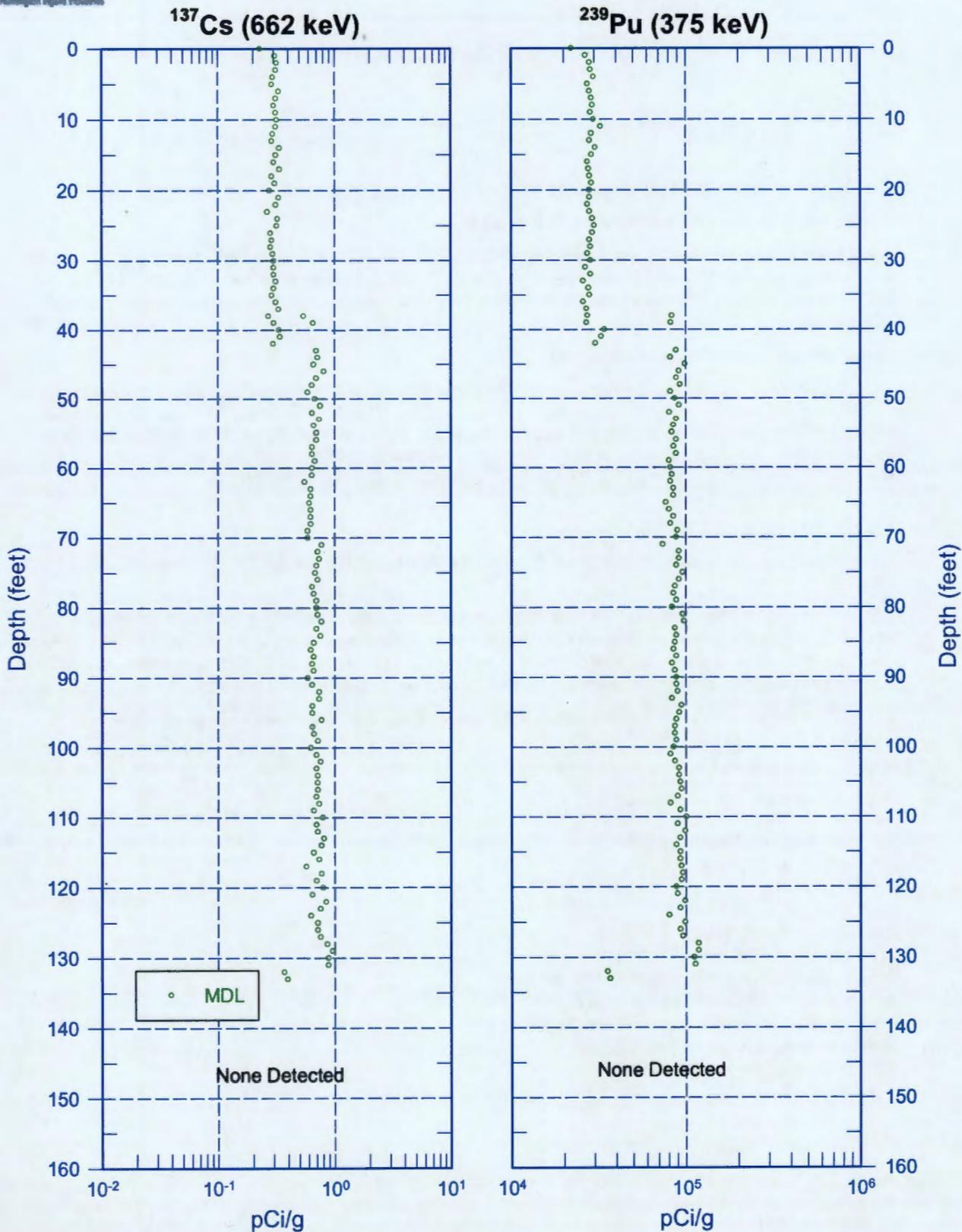
- Manmade Radionuclides (0-160 ft)
- Natural Gamma Logs (0-160 ft)
- Combination Plot (0-120 ft)
- Combination Plot (110-230 ft)
- Combination Plot (0-160 ft)
- Total Gamma & Moisture (0-160 ft)
- Total Gamma & Hanford Gamma Unit (0-160 ft)
- Repeat Section of Natural Gamma Logs (10 to 14 ft)
- Repeat Section of Natural Gamma Logs (71 to 81 ft)
- Moisture Repeat Section (10 to 14 ft)
- Moisture Repeat Section (39 to 42 ft)

⁵ Hanford Gamma Unit



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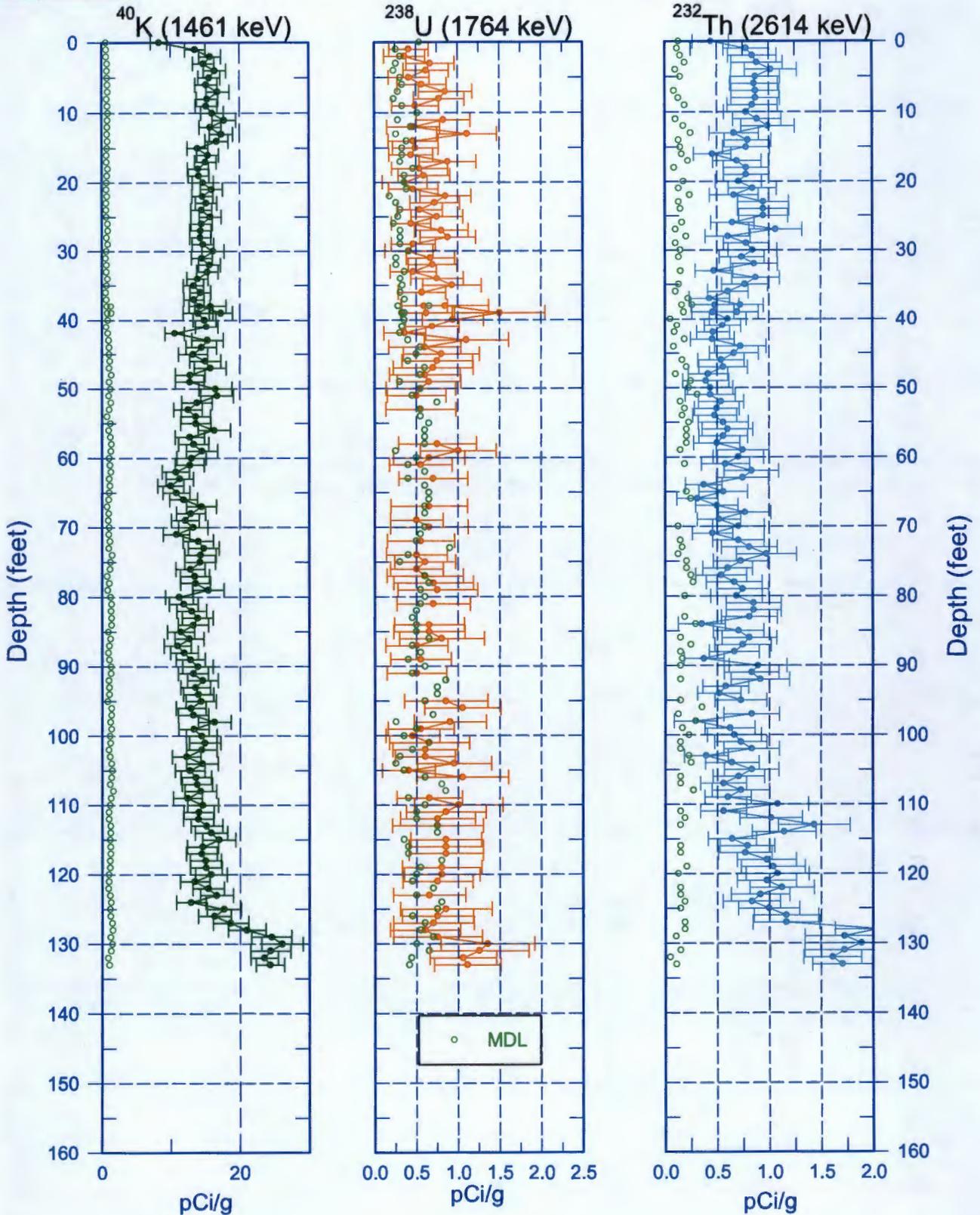
199-K-208 (C8295) Manmade Radionuclides



Zero Reference - Ground Surface



199-K-208 (C8295) Natural Gamma Logs

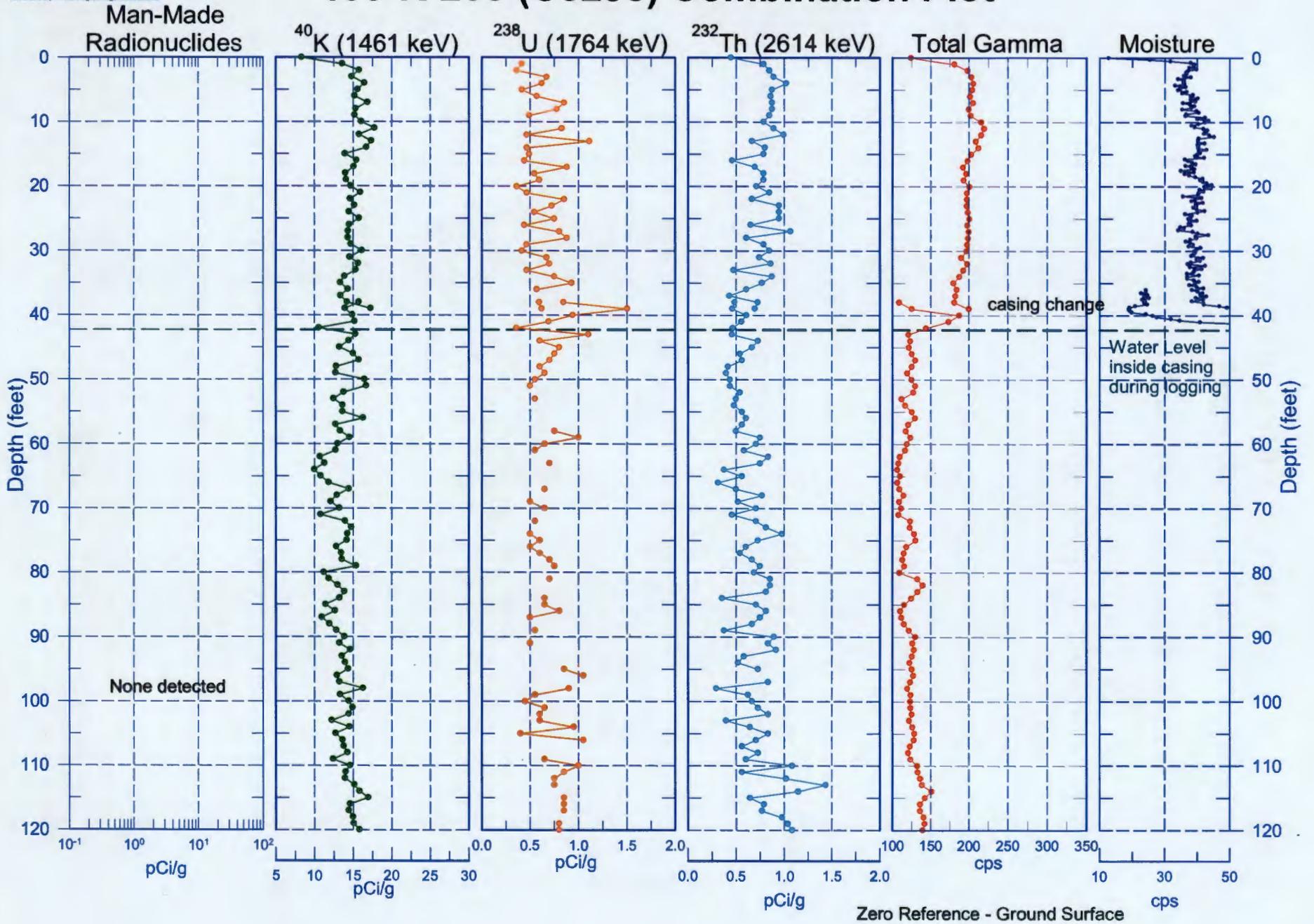


Zero Reference - Ground Surface



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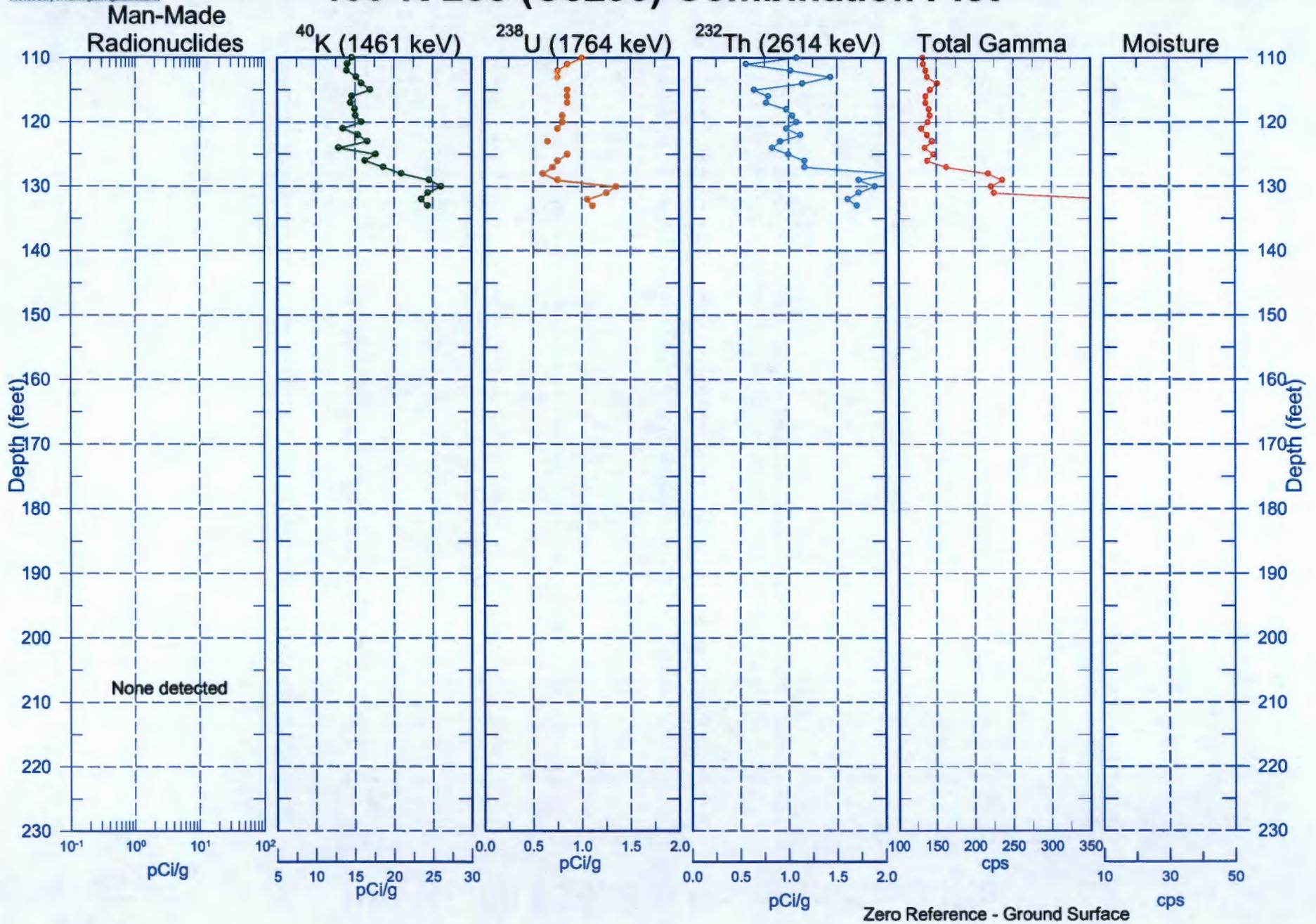
199-K-208 (C8295) Combination Plot





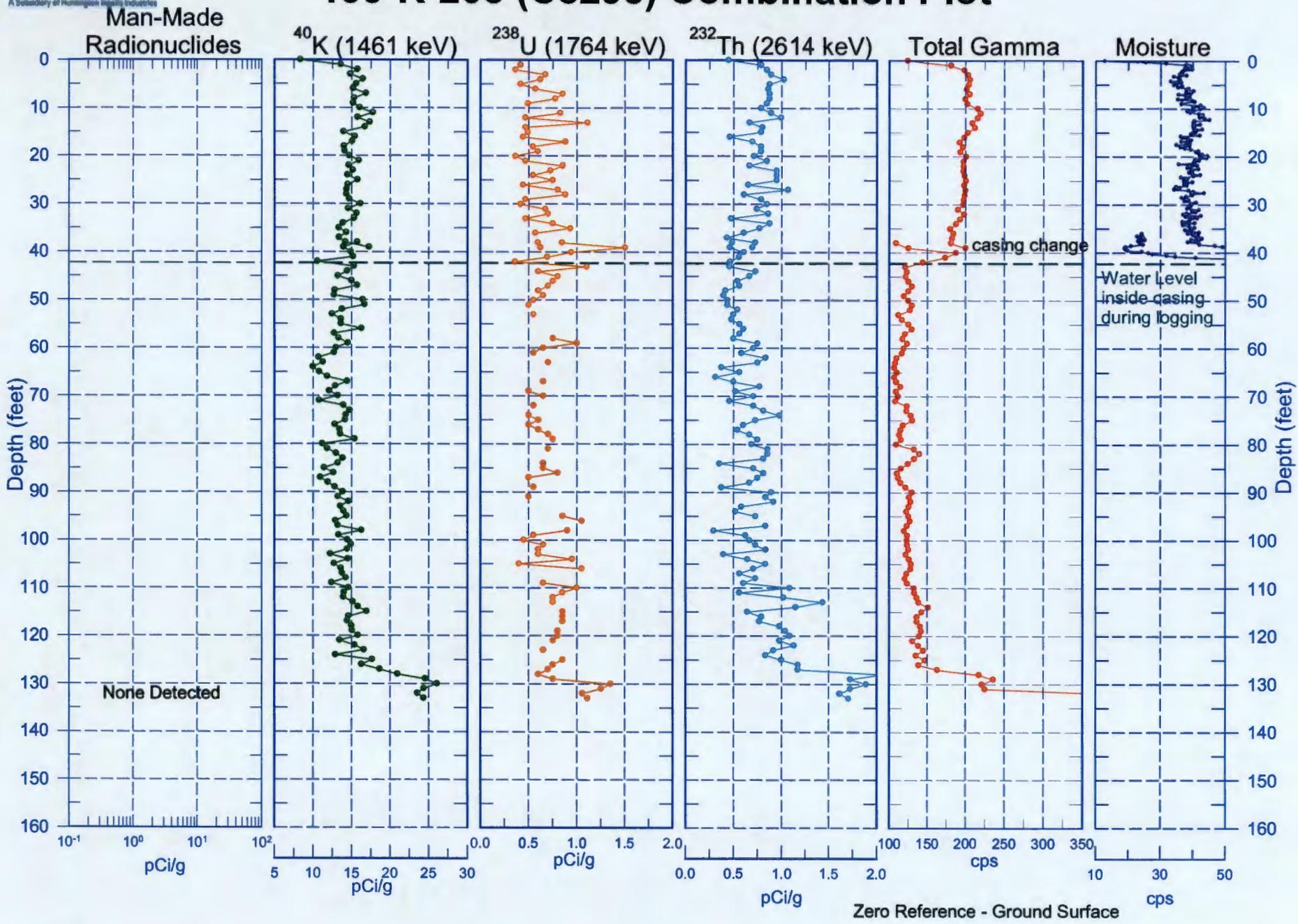
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199-K-208 (C8295) Combination Plot





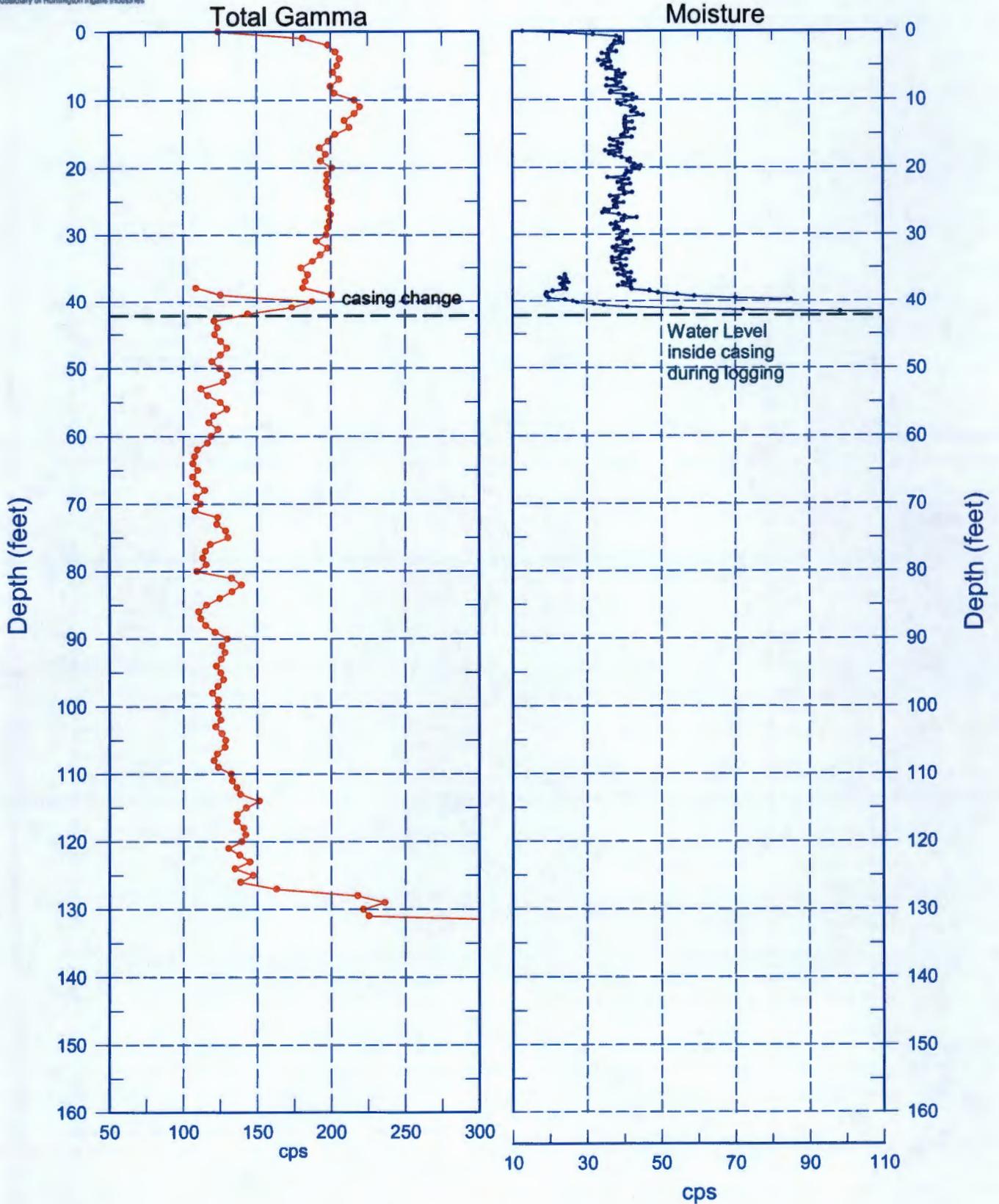
199-K-208 (C8295) Combination Plot





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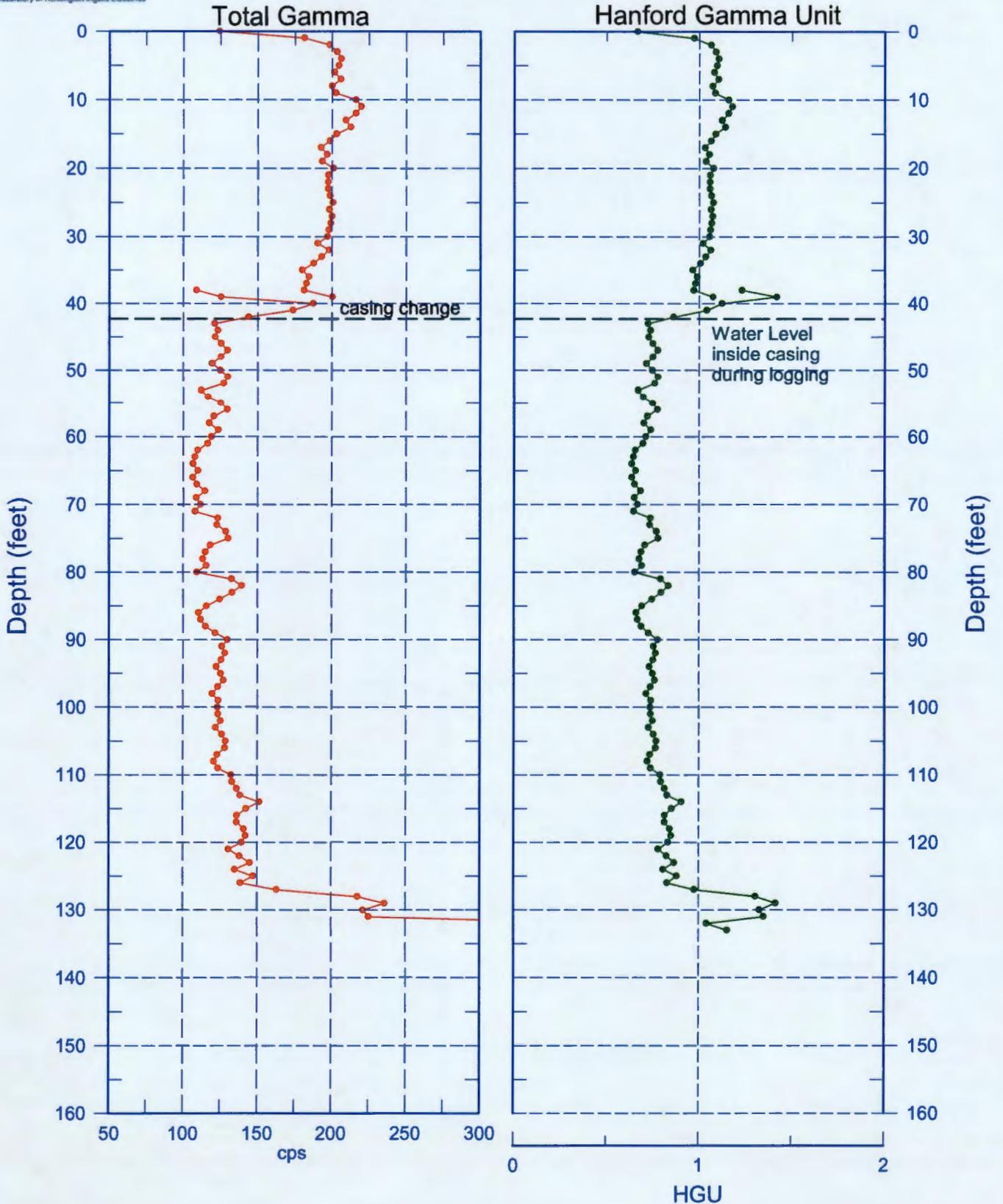
199-K-208 (C8295) Total Gamma & Moisture



Reference - Ground Surface



199-K-208 (C8295) Total Gamma & Hanford Gamma Unit

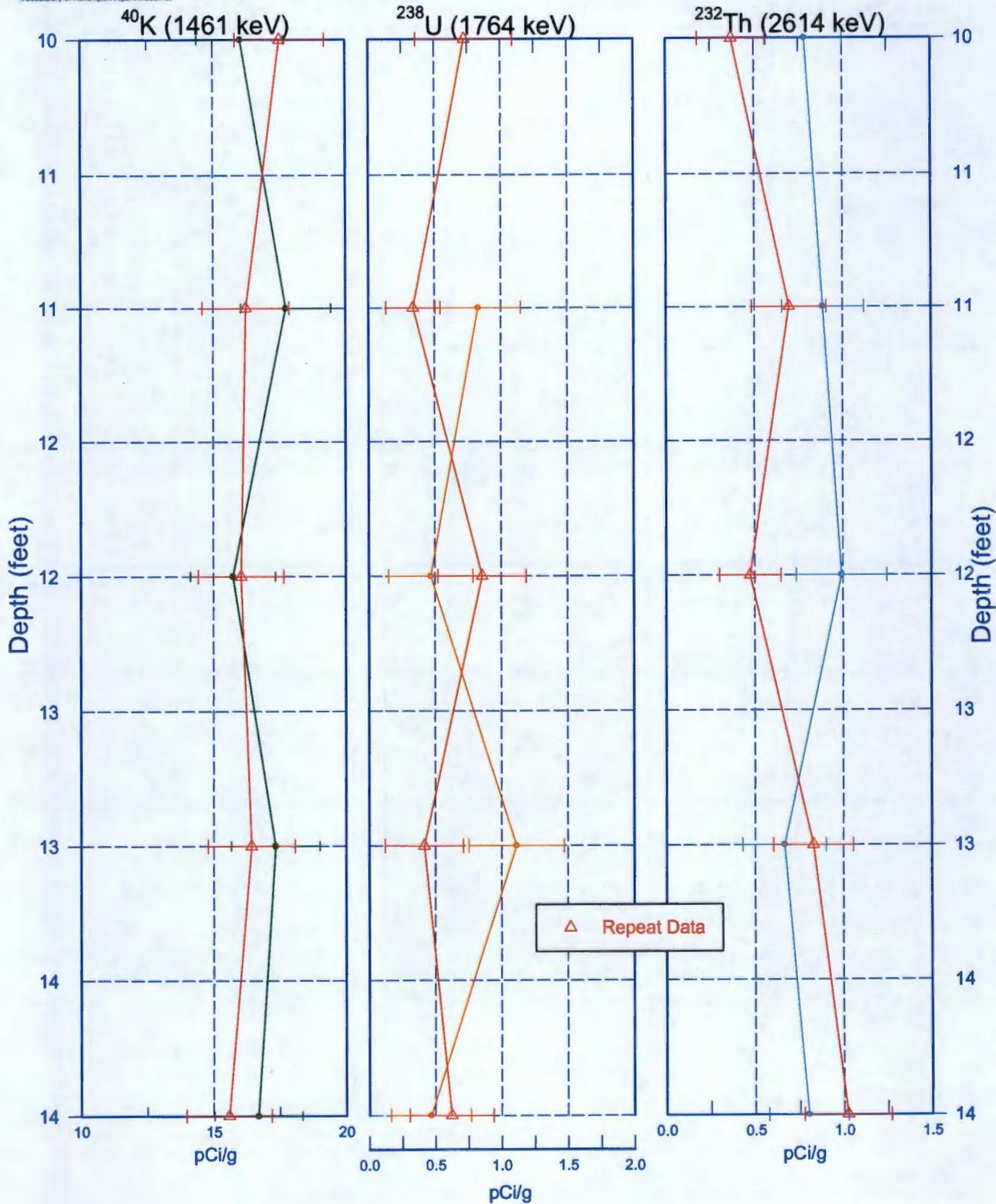


Reference - Ground Surface



199-K-208 (C8295)

Repeat Section of Natural Gamma Logs

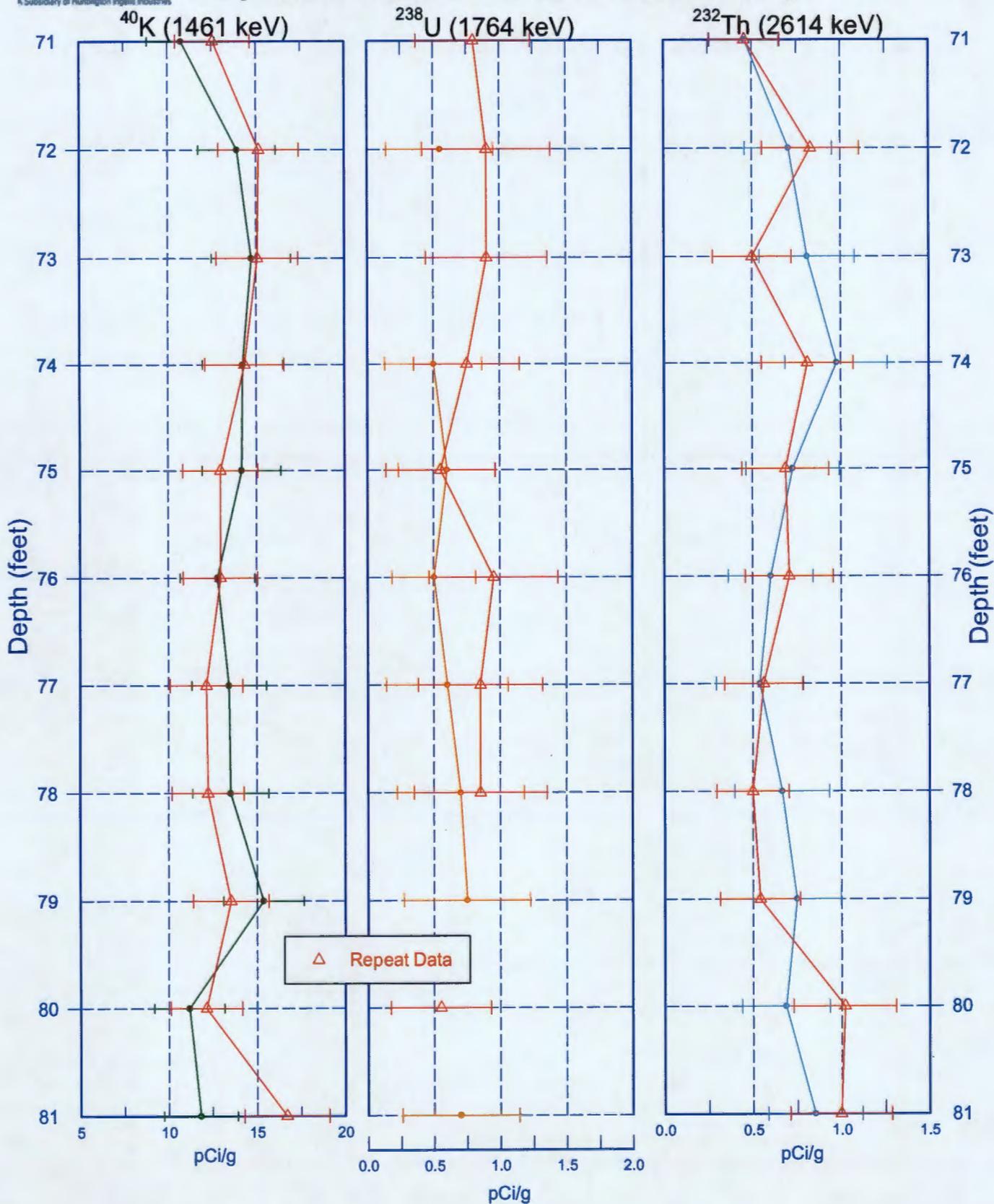


Zero Reference - Ground Surface



199-K-208 (C8295)

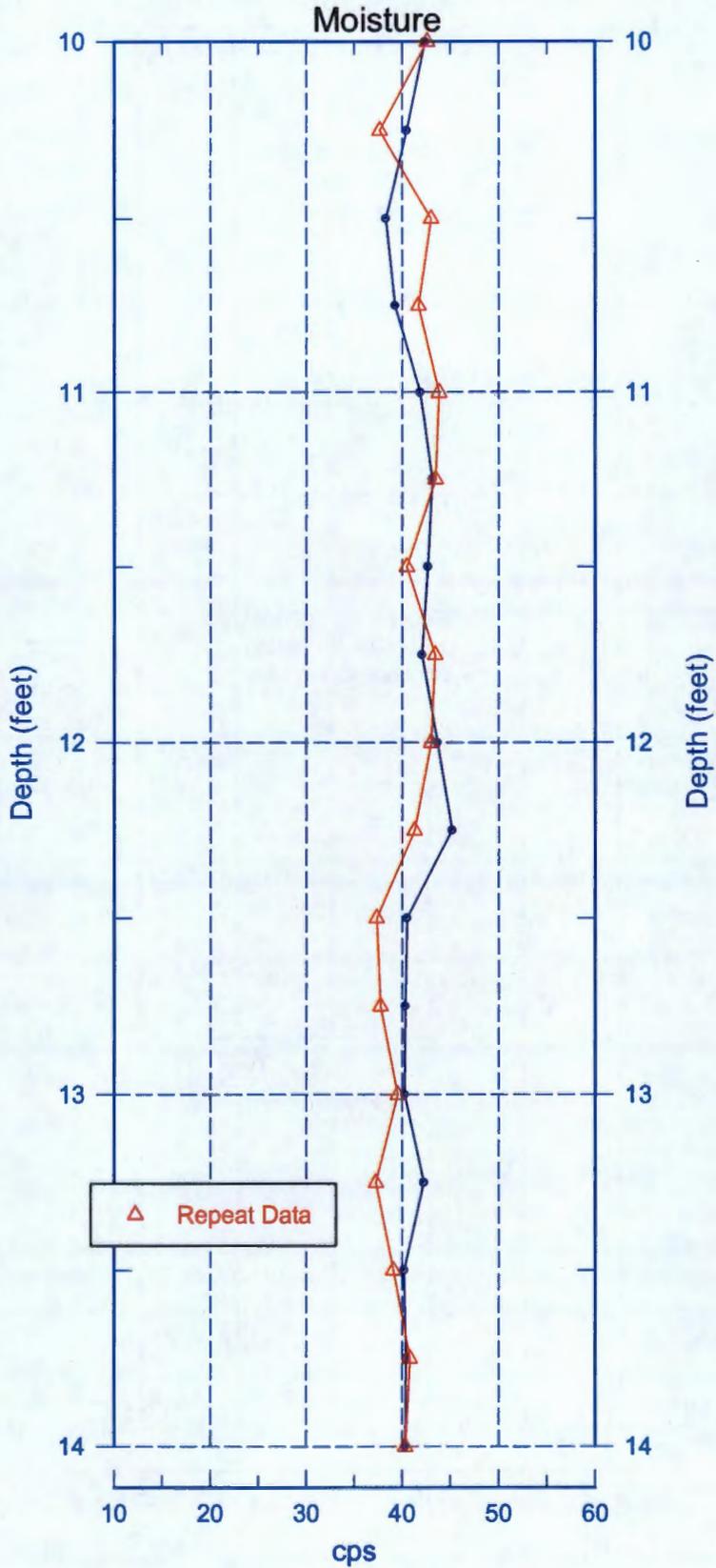
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface



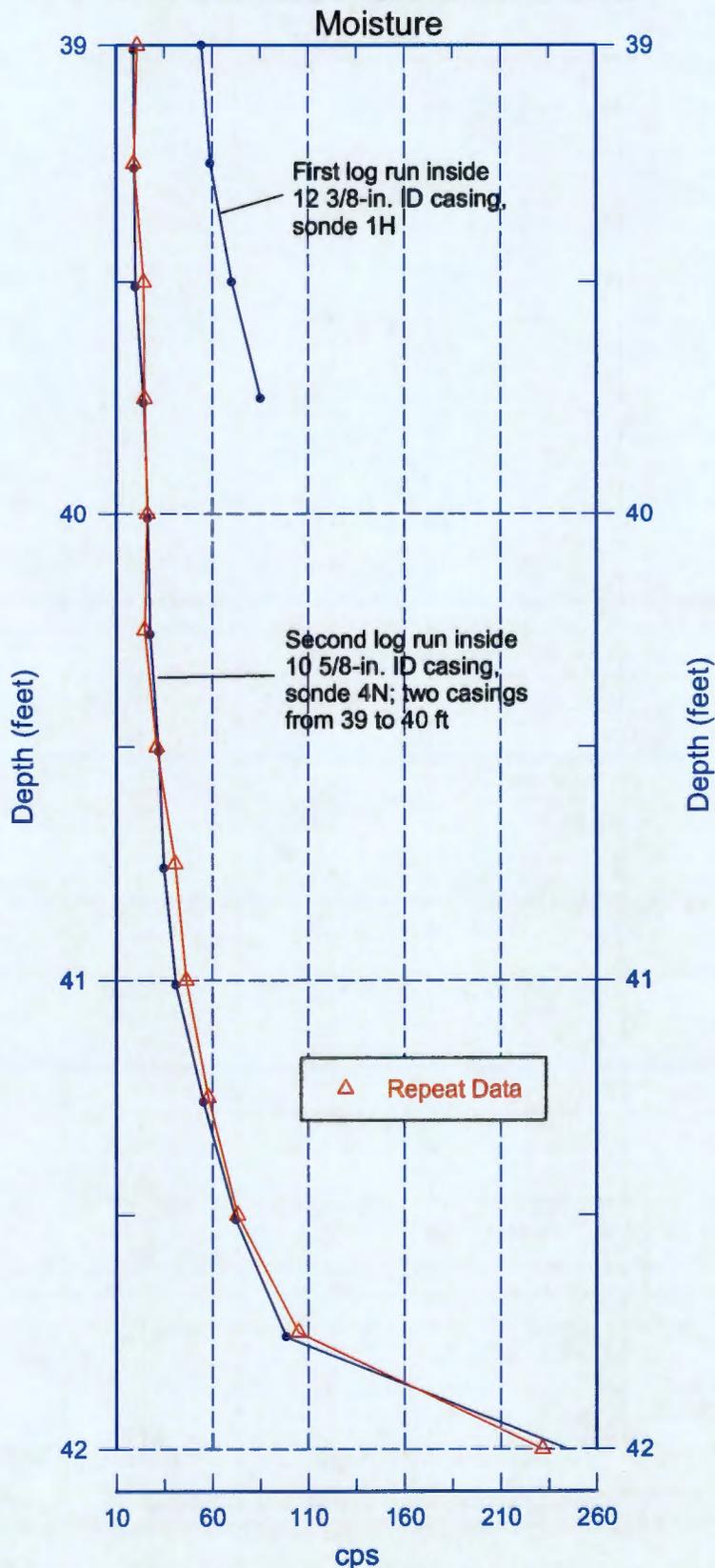
199-K-208 (C8295) Moisture Repeat Section



Reference - Ground Surface



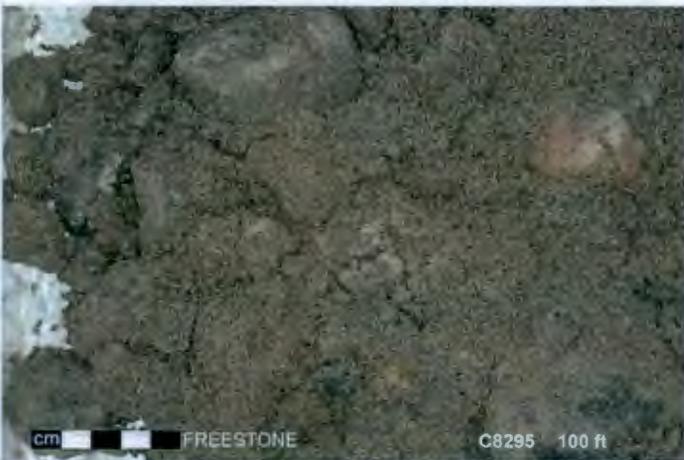
199-K-208 (C8295) Moisture Repeat Section



Reference - Ground Surface









| SURVEY DATA REPORT | | | | Request No. 152-078 | | |
|---|---|-----------------|------------------------|------------------------|------|-----|
| Project No. | Title KR-4 Wells C8290,C8294,C8295 & C8296 Final Surveys | | File No. 1KT14R26 | | | |
| Job No. CACN:303412-JPRC | Prepared By N.P. Fastabend | Date 3/19/15 | Reviewer <i>CBM</i> | | | |
| DESCRIPTION OF WORK | | | DISTRIBUTION | SDR | PLOT | DWG |
| Obtained final coordinates (C/L Casings) and elevations of completed KR-4 Wells C8290 (199-K-203), C8294 (199-K-207), C8295 (199-K-208) and C8296 (199-K-209). Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters) | | | Survey File | OR | | |
| | | | K.M. Whitley | 1 | | |
| | | | S.J. Trent | 1 | | |
| | | | J.D. Mehrer | 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: 03/11/15 | Requestor: Kelly Whitley (CHPRC) |
| Date of Survey: 03/17/15 | 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 Well C8295 (199-K-208). | Horizontal Datum: NAD83 (91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 100K |

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
M49 (COE) and T324 (COE)

| Well ID | Well Name | Easting | Northing | Elevation | |
|---------|-----------|-----------|-----------|-----------|---------------------|
| C8295 | 199-K-208 | 569291.76 | 147170.23 | | Center of Casing |
| | | | | 133.746 | "X" on Rim |
| | | | | 133.004 | Brass Survey Marker |
| | | | | | |

Notes:

133.453 · Top Inner Casing, North Edge

Elevation on Brass Survey Marker was measured to Top Domed Brass Cap in concrete.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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



3-19-15

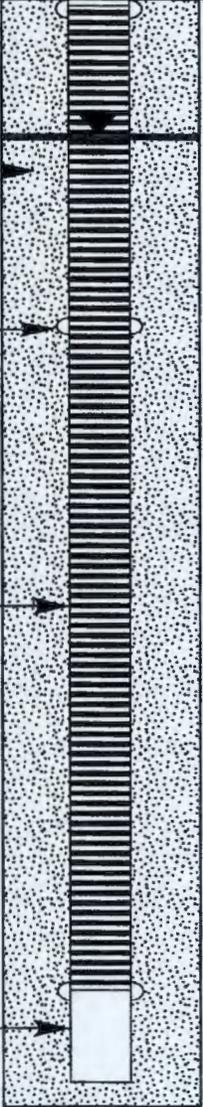
Appendix E

Well Documentation for C8296 (199-K-209)

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

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| WELL SUMMARY SHEET | | Start Date: 1/27/2015 Finish Date: 3/5/2015 | | Page 1 of 2 | |
|--|---------|---|-------------|---|--|
| Well ID: C8296 | | Well Name: 199-K-209 | | | |
| Location: 1/2 mi N of 100N Fire Station | | Project: 2 Plus 3 Optional Wells In 100-KR-4 OU | | | |
| Prepared By: Joshua Holland | | Date: 3/5/15 | | Reviewed By: D. MEHRER | |
| Signature: <i>J. Holland</i> | | Signature: <i>D. Meherer</i> | | | |
| CONSTRUCTION DATA | | GEOLOGIC/HYDROLOGIC DATA | | | |
| Description | Diagram | Depth in Feet | Graphic Log | Lithologic Description (ft bgs) | |
| Concrete Pad: 0.5 ft above ground surface (ags) | | 0 | | 0- 1 Gravel (G) 1- 9 Sandy Gravel (sG) | |
| 8-in Protective Casing: 3.00 ft ags - 2.00 ft below ground surface (bgs) | | 10 | | 9- 11.5 Silty Sandy Gravel (msG) 11.5- 60 Sandy Gravel (G) | |
| Type I/II Portland Cement Grout: 0 - 13.0 ft bgs | | 20 | | | |
| 3/8 in Cetco Medium Bentonite Chips: 13.0 - 83.1 ft bgs | | 30 | | | |
| 6-in I.D. Schedule 10, Type 304/304L, Stainless Steel Blank Casing: 2.00 ft ags - 36.78 ft bgs 88.18 ASG 3/30/15 | | 40 | | | |
| Stainless steel centralizer installed from the top of the sump at 40 ft intervals | | 50 | | | |
| Depths are in ft below ground surface. Borehole drilled with 13 1/2-in O.D. conductor from 0 to 59.4 ft bgs and 11 3/4-in O.D. casing from 0.0 - 150.6 ft bgs. All temporary drill casing was removed from the ground. | | 60 | | 60- 63 Silty Sandy Gravel (msG) 63- 98 Sandy Gravel (sG) | |
| 3/8 in Cetco Coated Bentonite Pellet Seal: 83.1 - 84.1 ft bgs | | 70 | | | |
| 8-16 mesh Premier Colorado Silica Filter Pack Sand: 84.1 - 154.6 ft bgs | | 80 | | | |

| WELL SUMMARY SHEET | | Start Date: 1/27/2015 | | Page 2 of 2 |
|--|--|--|--|--|
| | | Finish Date: 3/5/2015 | | |
| Well ID: C8296 | | Well Name: 199-K-209 | | |
| Location: 1/2 mi N of 100N Fire Station | | Project: 2 Plus 3 Optional Wells In 100-KR-4 OU | | |
| Prepared By: Joshua Holland | Date: 3/5/15 | Reviewed By: <i>J.D. MEHRER</i> | Date: 4-3-15 | |
| Signature: <i>[Signature]</i> | | Signature: <i>[Signature]</i> | | |
| CONSTRUCTION DATA | | GEOLOGIC/HYDROLOGIC DATA | | |
| Description | Diagram | Depth in Feet | Graphic Log | Lithologic Description (ft bgs) |
| <p>8-16 mesh Premier Colorado Silica Filter Pack Sand: 84.1 - 154.6 ft bgs</p> <p>Stainless steel centralizer installed from the top of the sump and at 40 ft intervals</p> <p>6-in I.D. Schedule 10, Type 304/304L, 50-slot (0.050 in.) Stainless Steel Screen: 88.18 - 148.10 ft bgs</p> <p>6-in I.D. Schedule 10, Type 304/304L, Stainless Steel Sump: 148.10 - 153.11 ft bgs</p> |  | 90 100 110 120 130 140 150 160 170 |  | <p>63- 98 Sandy Gravel (sG)</p> <p>Static Water Level: 96.4 ft bgs (3/2/2015)</p> <p>98 - 101 Gravelly Sand (gS)</p> <p>101- 107 Sand (S)</p> <p>107 - 122 Sandy Gravel (sG)</p> <p>122- 135 Gravelly Sand (gS)</p> <p>135- 145 Sandy Gravel (sG)</p> <p>145- 148 Sand(S)</p> <p>148- 148.5 Silty Gravel (mG)</p> <p>148.5- 154.6 Sandy Silt (sM)</p> <p>Straightness Test: 2/26/2015, Pass</p> <p>Total Depth: 154.6 ft bgs</p> |
| <p>Depths are in ft below ground surface.</p> <p>Borehole drilled with 13 1/2-in O.D. conductor from 0 to 59.4 ft bgs and 11 3/4-in O.D. casing from 0.0 - 150.6 ft bgs.</p> <p>All temporary drill casing was removed from the ground.</p> | | | | |

| BOREHOLE LOG | | | | | Page 1 of 5 |
|--|----------|----------------------|---|---|---|
| Well ID: C8296 | | Well Name: 199-K-209 | | Location: ~ 1/2 mi North of 100N Fire Station | |
| Project: 2 Wells + 3 optional in 100KRY DV | | | Reference Measuring Point: Ground Surface | | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
| | Type No. | Blows Recovery | | | |
| 0 | | | | 0-1' bgs; GRAVEL (G) for pad construction | Cable Tool Rig; 5' samples |
| 5 | G | | | 1-5' bgs; SANDY GRAVEL (SG) 50% Gravel, 45% Sand, 5% Silt Gravel: VPS; SR-R; 50% Mafic, 50% other; 10-50mm; max, 150mm; Sand: SA-A, VC-F 20% basalt, 80% Qtz/other, 7.5 YR 3/3 DK Brown, moist, no HCl Rxn, Roots Present | 12" x 12" x 16" boulder @ 5' |
| 10 | G | | | 5-9' bgs; SANDY GRAVEL (SG) 60% Gravel, 35% Sand, 5% Silt Gravel: PS; SR-R; 70% basalt, 30% other; max 80mm. Sand: PS; VC-F; 60% basalt, 40% other. 10YR 5/2 Greenish brown. Thin caliche @ 5', strong HCl Rxn; other - no HCl. Dry | |
| 15 | G | | | 9-11.5' SILTY SANDY GRAVEL (msG) 70% Gravel, 20% Sand, 10% Silt Gravel: SR-R; VPS; SmC - FP, 70mm max; 70% basalt, 30% other, Sand: VF; Tr Bk Med. Sand; 10YR 4/2 Pink Brn; no HCl Rxn, moist | ↓ Drill rate |
| 20 | G | | | 11.5-60' bgs; SANDY GRAVEL (SG) 78% Gravel, 17% Sand, 5% Silt Gravel: VFP-B; 80% CP-SmC; R, 10% A; VPS; 2-80mm max; 95% basalt, 5% felsic Sand: F-VC; 80% m-C; A; MS; 95% basalt, 5% felsic. Silt: 10YR 2/2 VDK brown; dry, no HCl Rxn; black sand. moist | Drive barrel deforming due to boulders - change to 1 1/4" DB ↑ drill rate @ 20'; slight consolidation & thin caliche coating on gravels |
| 25 | G | | | @ 25' bgs; ↓ basalt content (90%) both sd & G color change to 10YR 4/2 DK Gray Brn | ↓ drill rate @ 25' moderate consolidation thin caliche coating |
| 30 | G | | | @ 27' bgs; ↓ Gravel (65%), ↑ Sand 30% Gravel: VPS; VFP-C; 50% F-MP | @ 27'; moist sediment ↑ drill rate |
| 35 | G | | | @ 30' bgs; 65% Gravel, 32% Sand, 3% Silt Gravel: VPS; VFP-LP; 50% EP; 85% mafic, 15% felsic Sand: PS; VF-VC; 50% MP; 10YR 2/2 VDK Brn, moist | @ 30'; moist sediment, Unconsolidated |
| | | | | | ↓ drill rate @ 35'; 12" x 16" x 8" boulder |
| | | | | @ 35' bgs; 70% Gravel, 25% Sand, 5% Silt Gravel: PS; VFP-LP; 50% F-MP; max boulder; 90% mafic, 10% felsic; R-A Sand: 90% mafic, 10% felsic; 10YR 4/2 DK Gray brown, moist; weak HCl; slight consolidation | @ 35'; moist sediment, slight consolidation & caliche coating |
| Reported By: Janine Carter | | | Reviewed By: Kevin Bergstrom | | |
| Title: Geologist | | | Title: Sr. Geologist | | |
| Signature: Janine Carter | | Date: 1/29/15 | Signature: K. Ryan | | Date: 3-23-15 |

| BOREHOLE LOG | | | | | Page 2 of 5 |
|--|----------|----------------|---|---|-----------------------------|
| Well ID: C82916 | | | | | Date: 1/29-2/3 |
| Well Name: 199-K-209 | | | Location: ~1/2 mi North of Fire Station (100W) | | |
| Project: 100 KR 4.0U 2Wells + 3 Optional | | | Reference Measuring Point: Grand Surface | | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
| | Type No. | Blows Recovery | | | |
| 40 | G | | | 11.5-60' bgs; SANDY GRAVEL (<G) | Cable Tool, Drive barrel |
| | | | | @40' bgs; 70% Gravel, 25% Sand, 5% Silt | 5' sediment samples |
| | | | | Gravel is PS; VFP-VCP; 50% F-m P; boulder max | |
| | | | | R-A; 100% mafic | @40'; moist, unconsolidated |
| | | | | Sand: PS; VF-VL; 50% VF-M; 95% mafic; SR; B&K | ↑ drilling rate |
| 45 | G | | | 10YR 3/1 V DK Grey; no HCl rxn, moist | |
| | | | | @45'; ↓ Gravel 47%; ↑ Sand 50%; ↓ Silt 3% | @45' moist sediment |
| | | | | Sand: 100% mafic; 10YR 4/1 Black, no HCl rxn | |
| | | | | | |
| | | | | | |
| 50 | G | | @50'; ↓ Gravel 37%; ↑ Sand 60% | | |
| | | | Gravel is finer overall; VFP-MP, 60% FP | @50' v. moist sediment | |
| | | | Sand: MS; 50% M, VF-L; 100% mafic, moist | | |
| | | | | | |
| | | | | | |
| 55 | G | | @55'; ↑ Gravel 15%; ↓ Sand 30%; ↑ Silt 5% | @55' v. moist sediment | |
| | | | 10YR 4/1 DK grey; moist | | |
| | | | | | |
| | | | | | |
| 60 | G | | 60-63' bgs; SILTY SANDY GRAVEL (msG) | | |
| | | | 63% Gravel, 25% Sand, 12% Silt | @60' v. moist sediment, | |
| | | | Trace clay: nodules & rinds | mod. consolidated | |
| | | | | | |
| | | | | | |
| 65 | G | | 63-90' bgs; SANDY GRAVEL (sG) | ↑ drilling rate | |
| | | | 67% Gravel, 25% Sand, 8% Silt | @65' moist sediment | |
| | | | Gravel: VFP-LP; PS; A-SR; 50% M-LP, | | |
| | | | 90% basalt/mafic, 10% felsic | | |
| | | | Sand: F-L; 80% M-L; SR; MS; 90% mafic | | |
| | | | 10YR 3/2 V DK Gray Brown; no HCl rxn; Tr. clay | | |
| 70 | G | | @70'; 57% Gravel, 40% Sand, 3% Silt | @70' dry sediment | |
| | | | Gravel & Sand: 80% mafic, 20% felsic | | |
| | | | 10YR 3/1 V DK grey | | |
| | | | | @73'; Hanford-Ringold | |
| | | | | contact interpreted | |
| | | | | | |
| 75 | G | | @75' bgs; 50% Gravel, 49% Sand, 1% Silt | Drilling speed ↓ ↓ | |
| | | | Gravel: A-R; FP-MP, 30% MP; 20% mafic, 80% felsic, MS | | |
| | | | Sand: R; VF-M; MS; 30% mafic, 70% felsic; | | |
| | | | 40% VF-F. Trace mica; 2.5Y 5/6 lt. dr. brown | | |
| | | | Dry; no HCl rxn | | |

| | |
|---------------------------------|-----------------------------------|
| Reported By: Janine Carter | Reviewed By: Kevin Bergstrom |
| Title: Geologist | Title: Sr Geologist |
| Signature: <i>Janine Carter</i> | Signature: <i>Kevin Bergstrom</i> |
| Date: 2/3 | Date: 3-23-15 |

| BOREHOLE LOG | | | | | Page 3 of 5 |
|--|----------|----------------------|-----------------------------------|--|--|
| Well ID: C8296 | | Well Name: 199-K-209 | | Location: ~1/2 N of 100N Fire Station | |
| Project: 100-KR-4 OU, 2 Wells + 3 Optional | | | Reference Measuring Point: Ground | | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
| | Type No. | Blows Recovery | | | |
| 80 | G | | | 63-98' bgs; SANDY GRAVEL (SG) 40% Gravel, 58% Sand, 2% Silt Gravel: SR-R; Fp-MP, 70% FP; MS; 16% mafic, 40% felsic Sand: SA-SR; VF-VL; VPS; 70% fcl, 30% mafic 2.5 V 5/2, light dk brown; trace mica; No HCl rxn; dry | Cable Tool; Drive Barrel Samples every 5' |
| 85 | G | | | @95' bgs: ↑ Gravel: 45%, ↓ Sand: 50%, ↑ Silt: 5% Sand is more felsic (80%) & 50% M, f-c, MS Weak-mod. rxn to HCl; med. consolidation | Drilling speed ↓ @85; med. consolidated |
| | G | | | @86' bgs: ↓ Sand: 43%, ↑ Silt: 12% Trace mica; strong HCl reaction; clay rinds | |
| 90 | G | | | @90' bgs: ↑ Sand: 60%, ↓ Silt: 0%, ↓ Gravel: 40% Sand is f-c, 90% M-C, SR-R, WS, 80% felsic 20% mafic; trace mica; no rxn to HCl | Drilling speed ↑ |
| 95 | G | | | @95' bgs: Gravel: 44%, Sand: 55%, Silt: 19% Gravel: SR; FP-MP; 80% FP; MS; 60% mafic, 40% felsic Sand: f-c, 80% m; MS; 95% felsic; 5% mafic, trace mica; 2.5 V 7/2 light gray; No HCl rxn; moist | @95' bgs: moist sediment Drilling speed ↓ |
| | G | 97.8 2/11 | | 98'-101' bgs; GRAVELLY SAND (GS) 15% Gravel, 80% Sand, 5% Silt Gravel: SA-SR; vfp-mp, 60% fp; pS; 50% mafic, 50% felsic Sand: SR; vf-c, 70% f; pS; 65% felsic, 35% mafic 2.5 V 5/2 lt. olive brn; weak HCl rxn; moist | @98' low consolidation @97.7' bgs; water table 2/5 @98; 8' heaving sands |
| 100 | G | | | @100' bgs: 10% Gravel, 88% Sand, 2% Silt Sand: vf-c; 80% m; MS; 2.5 V 4/2 lt. greyish brn. | @99; 8' heaving sands + 3' @104; add 25 gal. H ₂ O Drilling speed ↓↓↓ |
| 105 | G | | | 101'-107' bgs; SAND (S) 5% Gravel, 93% Sand, 2% Silt Gravel: A-SR; vfp-fp; vfp 70%; MS; 90% felsic, 10% mafic Sand: SR-R; f-m, 80% m; MS; 95% felsic, 5% mafic 2.5 V 1/2 lt. yellowish brown; trace mica; weak HCl rxn | 105-122' bgs: formation is tight; difficult drilling |
| 110 | G | | | 107'-122' bgs SANDY GRAVEL (SG) 30% Gravel, 65% Sand, 5% Silt Gravel: SA-R; fp-rp, 60% mp; pS; 70% felsic, 30% mafic Sand: A-SR; f-c, 60% m; pS; 75% felsic, 25% mafic 2.5 V 4/2; dk grayish brn; trace mica; weak HCl rxn | |
| 115 | G | | | @115' Gravel 33%, Sand 60%, ↑ Silt 7% 2.5 V 3/4 lt. olive brn; weak HCl rxn - mainly on gravel | GW Sample Hcls # B30C66, B30C58 |

Reported By: Janine Carter Title: Geologist Signature: Janine Carter Date: 2/10

Reviewed By: Kevin Bergstrom Title: Sr. Geologist Signature: Kevin Bergstrom Date: 3-23-15

| BOREHOLE LOG | | | | | Page 4 of 5 |
|---|----------|---|---|---|--------------------------------|
| Well ID: C8296 | | Well Name: 199K209 | | Location: ~1/2 m N of 100N Fire Station | |
| Project: 2 wells + 3 optional in 100 KR4 OV | | | Reference Measuring Point: Ground Surface | | |
| Depth (Ft.) | Sample | | Graphic Log | Sample Description | Comments |
| | Type No. | Blows Recovery | | | |
| 120 | G | I-004 126.6' GW 2. 10 bpm 220 gal pump Heis # B30L60 B30C67 | | 107'-122' bgs SANDY GRAVEL (SG) | Cable Tool: Drive barrel |
| | G | | | @120' bgs: 40% Gravel, 55% Sand, 5% silt, wet | Samples every 5' |
| | G | | | Gravel: A-SR; f-p-vcp; 60% f-p; WS; 60% f-isc; 40% mafic | DTW = 97.5' bgs 2/11 |
| | G | | | Sand: SR; v-f-m; 80% f; WS; 95% f-isc; 5% mafic | Drilling speed ↓ |
| | G | | | 2.5 1/2; 1t. dive brn; strong HCl rxn; caliche | @122'; highly consolidated; |
| 125 | G | | | @122' bgs: 60% Gravel, 25% Sand, 5% silt; wet | very tight; difficult to |
| | GW | | | 2.5 1/2 1t. brnish gray; med-strength rxn to HCl; | drive casing |
| | SS | | | trace mica; high concentration/consolidation; Fe-staining | @122'; 1ft sand; 2' sand heave |
| | SS | | | 122'-135' bgs, GRAVELLY SAND (GS) | @125'; med-high |
| | SS | | | 125 (27% Gravel, 70% Sand, 3% silt) | consolidated |
| 130 | G | I-003 127.2 - 129.7 90% Recov 304 blows Slowness 2 Heis # B30C56 | | Gravel: SA-SR; f-p-mp; 60% f-p; WS; 60% f-isc; 40% mafic | @126'; low recharge rate |
| | G | | | Sand: SR; f-vc; 70% f-p; 70% f-isc; 20% mafic | |
| | G | | | 2.5 1/2 1t. dive brn; weak-med HCl rxn, | Drilling speed ↑ |
| | G | | | trace caliche; trace mica | @130; unconsolidated |
| | G | | | @130; ↓ Gravel 13% ↑ Sand 85%, 2% silt | |
| 135 | G | | | @135'; SANDY GRAVEL (SG); 50% gravel, 48% sand, 2% silt; | |
| | G | | | GRAVEL: SR-R; VFP-VCP; 50% mafic; 70% VFP-MP; PS; | |
| | G | | | max, 45mm. SAND: PS; V-F-VC; A-SA; 40% mafic; | |
| | G | | | 2.5 1/4 1/2 DK Greyish Bed; wet; weak HCl | |
| | G | | | @140' ↑ gravel 55%; ↓ sand 43%; 2% silt; A-SA | |
| 140 | G | I-005 145.9' - 148.4' bgs 95% Recov 190 Blows Slowness 2 Heis # B30C57 | | GRAVEL: PS; A-R; VFP-VCP; max, 155mm; 40% med | |
| | G | | | Pebbles; 70% mafic. SAND: PS; A-SA; V-F-C; 50% | |
| | G | | | medium grained; 60% mafic; 2.5 1/4 3 olive brown; | |
| | G | | | wet; weak HCl | |
| | G | | | @145'; SAND (S); 8% gravel, 90% sand, 1% silt; | |
| | G | | | GRAVEL: PS; A-SR; 60% v-f; max, 35mm; VFP-VCP; | |
| | GW | | | 50% mafic. SAND: PS; A-SR; F-VC; 50% medium | |
| | GW | | | grained; 60% mafic; 2.5 1/4 2 dark grayish | |
| | GW | | | brown; wet; very weak HCl | |
| | GW | | | @148' SILTY GRAVEL (mG); 35% gravel, 10% sand, | @148.5' Ringold |
| 148 | * | I-006 146.7' GW 5 ~6.5 gpm B30L62 B30C610p B30C68 | | 55% silt. GRAVEL: PS; A-R; VFP-CB; 50% A-VFP; max 150mm | Upper Mud contact |
| | * | | | 70% mafic. SAND: WS; V-F; 70% mafic. SILTY | |
| | * | | | CLAY: high plasticity; 2.5 1/4 3 olive brown. | |
| | * | | | Damp; transition zone with cemented cobbles & pebbles | |
| | * | | | with Fe-staining Fe-nodules, black cementation, clay | |
| | * | | | with depth, gravel & sand decreasing with depth. | |
| | * | | | Very strong reaction to HCl in cemented gravels (top), | |
| | * | | | no rxn in clay (bottom). | |
| | * | | | | |
| | * | | | | |

Reported By: Jamie Carter & Jessa V. Szecsony Reviewed By: Kevin Bergstrom
 Title: Geologist(s) Title: Sr. Geologist
 Signature: Jamie Carter Date: 2/23 Signature: Kevin Bergstrom Date: 3-27-15



Stoller Newport News Nuclear

199-K-209 (C8296) Log Data Report

Borehole Information:

| | | | | | |
|----------------------------------|-----------------|------------------------------|----------------------------------|-------------------------|-------------|
| Log Date: | 2015-02-24 | Filename: | C8296_HG-NM_2015-02-24 | Site: | 100 Area |
| Coordinates (WA St Plane) | | DTW¹ (ft): | 100.2 | DTW Date: | 02/24/15 |
| North (m) | East (m) | Drill Date | TOC² Elevation | Total Depth (ft) | Type |
| N/A | N/A | 02/17/15 | N/A | 154.6 | Cable Tool |

Casing Information:

| Casing Type | Stickup (ft) | Diameter (in.) | | Thickness (in.) | Top (ft) | Bottom (ft) |
|----------------|--------------|----------------|----------|-----------------|----------|-------------|
| | | Outer | Inside | | | |
| Threaded Steel | 0.2 | 13 3/8 | 12 3/8 | 1/2 | 0.2 | 59.4 |
| Threaded Steel | 1.7 | 11 15/16 | 10 11/16 | 5/8 | 1.7 | 150.6 |

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 estimated from the total gamma and moisture measurements. The maximum logging depth achieved was 153 ft, approximately two ft below the casing.

Zero reference is ground surface.

Logging Equipment Information:

| | | | |
|------------------------------------|---------------------|---------------------------|----------------------------|
| Logging System: | Gamma 1L | Type: | 60% HPGe SGLS ³ |
| Effective Calibration Date: | 11/12/14 | Serial No.: | 47-TP32211A |
| Calibration Reference: | HGLP-CC-111, Rev. 0 | Logging Procedure: | HGLP-MAN-002, Rev. 1 |

| | | | |
|------------------------------------|---------------------|---------------------------|----------------------|
| Logging System: | Gamma 1H | Type: | NMLS ⁴ |
| Effective Calibration Date: | 11/13/14 | Serial No.: | H310700352 |
| Calibration Reference: | HGLP-CC-112, Rev. 0 | Logging Procedure: | HGLP-MAN-002, Rev. 1 |

SGLS Log Run Information:

| Log Run | 3 | 4 Repeat | 5 | 6 | 7 Repeat |
|-------------------|-----------|-----------|--------------|--------------|--------------|
| HEIS Number | 1018639 | 1018640 | 1018641 | 1018642 | 1018643 |
| Date | 02/02/15 | 02/02/15 | 02/23/15 | 02/24/15 | 02/24/15 |
| Logging Engineer | Pope/Felt | Pope/Felt | Pope/Meisner | Pope/Meisner | Pope/Meisner |
| Start Depth (ft) | 0.0 | 20.0 | 57.0 | 140.0 | 153.0 |
| Finish Depth (ft) | 58.0 | 26.0 | 141.0 | 153.0 | 143.0 |

¹ depth to water inside casing

² top of casing

³ Spectral Gamma Logging System

⁴ Neutron Moisture Logging System

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| Log Run | 3 | 4 Repeat | 5 | 6 | 7 Repeat |
|--------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Count Time (sec) | 100 | 100 | 100 | 100 | 100 |
| Live/Real | R | R | R | R | R |
| Shield (Y/N) | N | N | N | N | N |
| 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 | AL236CAB | AL236CAB | AL238CAB | AL239CAB | AL239CAB |
| Start File | AL236000 | AL236059 | AL238000 | AL239000 | AL239014 |
| Finish File | AL236058 | AL236065 | AL238084 | AL239013 | AL239024 |
| Post-Verification | AL236CAA | AL236CAA | AL238CAA | AL239CAA | AL239CAA |
| Depth Return Error (in.) | N/A | 0.0 | 0.5 low | N/A | 0.25 low |
| Comments | No fine gain adjustments made |

NMLS Log Run Information:

| Log Run | 1 | 2 Repeat | 8 | 9 Repeat |
|--------------------------|-----------|-----------|---------------|---------------|
| HEIS Number | 1018644 | 1018645 | 1018646 | 1018647 |
| Date | 02/02/15 | 02/02/15 | 02/24/15 | 02/24/15 |
| Logging Engineer | Pope/Felt | Pope/Felt | Meisner/Spatz | Meisner/Spatz |
| Start Depth (ft) | 0.0 | 20.0 | 57.0 | 85.0 |
| Finish Depth (ft) | 59.0 | 26.0 | 100.25 | 92.0 |
| 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 | AH195CAB | AH195CAB | AH198CAB | AH198CAB |
| Start File | AH195000 | AH195237 | AH198000 | AH198174 |
| Finish File | AH195236 | AH195261 | AH198173 | AH198202 |
| Post-Verification | AH195CAA | AH195CAA | AH198CAA | AH198CAA |
| Depth Return Error (in.) | N/A | 0.0 | N/A | 0.0 |
| 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.

Analysis Notes:

| | | | | | |
|-----------------|--------------|--------------|----------|-------------------|----------------------|
| Analyst: | P.D. Henwood | Date: | 03/02/15 | Reference: | HGLP-MAN-003, Rev. 0 |
|-----------------|--------------|--------------|----------|-------------------|----------------------|

Casing corrections for a 1/2-in. thick casing from 0 to 59 ft, 1 1/8-in. for a casing overlap at 58 and 59 ft (log run 5), and 5/8-in. from 60 ft to 151 ft were applied to the log data; no correction was applied at 152 and 153 ft.

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A correction for water was applied below 100 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 1L20141112, using an efficiency function and corrections for casing and dead time as determined by annual calibrations.

NMLS data are reported in count 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:

No manmade radionuclides were detected in the borehole. MDLs for Cs-137 and Pu-239 are plotted 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:

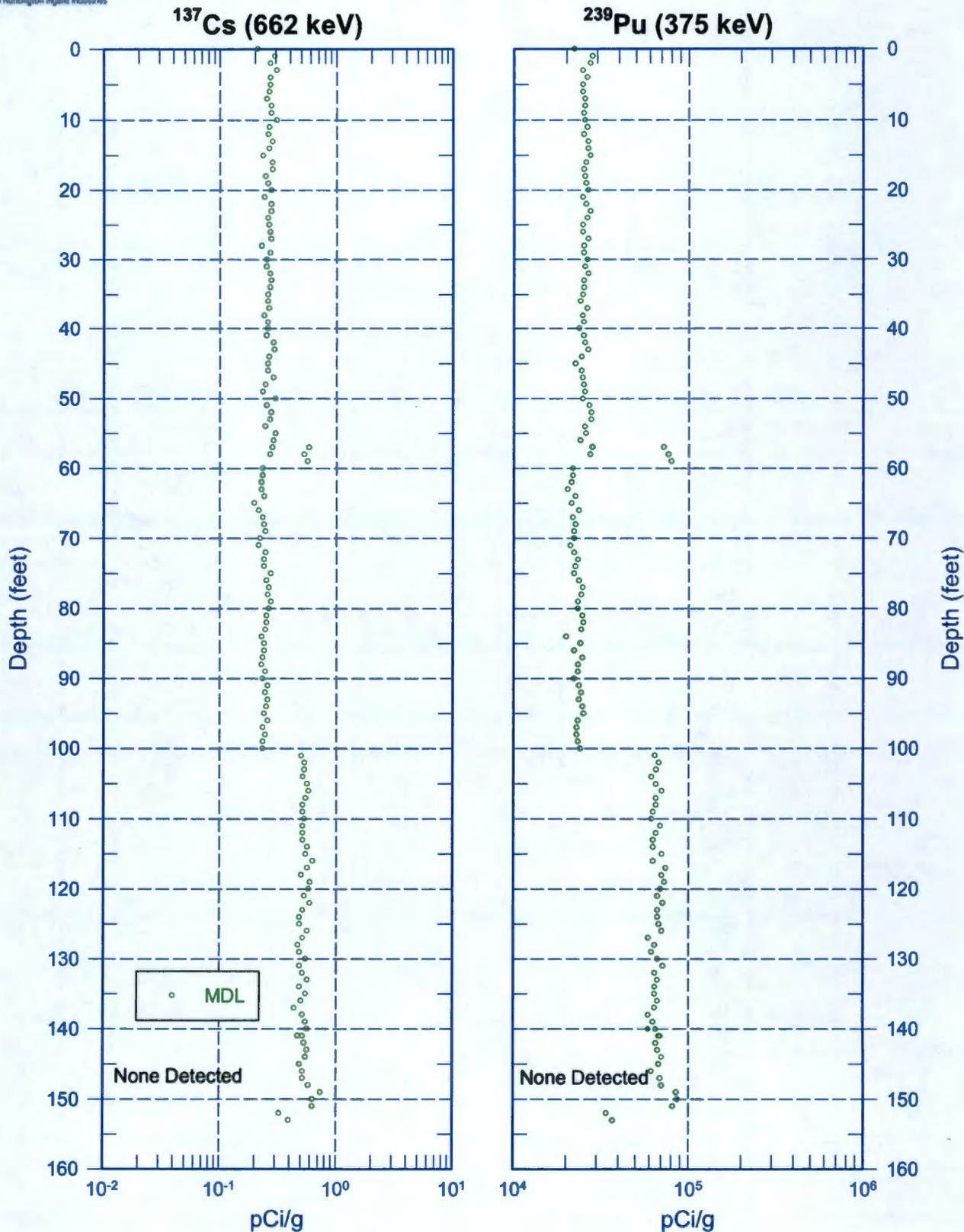
Depth Reference is ground surface.

Manmade Radionuclides (0-160 ft)
 Natural Gamma Logs (0-160 ft)
 Combination Plot (0-120 ft)
 Combination Plot (110-230 ft)
 Combination Plot (0-160 ft)
 Total Gamma & Moisture (0-160 ft)
 Total Gamma & Hanford Gamma Unit (0-160 ft)
 Repeat Section of Natural Gamma Logs (20 to 26 ft)
 Repeat Section of Natural Gamma Logs (143 to 153 ft)
 Moisture Repeat Section (20 to 26 ft)
 Moisture Repeat Section (85 to 92 ft)

⁵ Hanford Gamma Unit



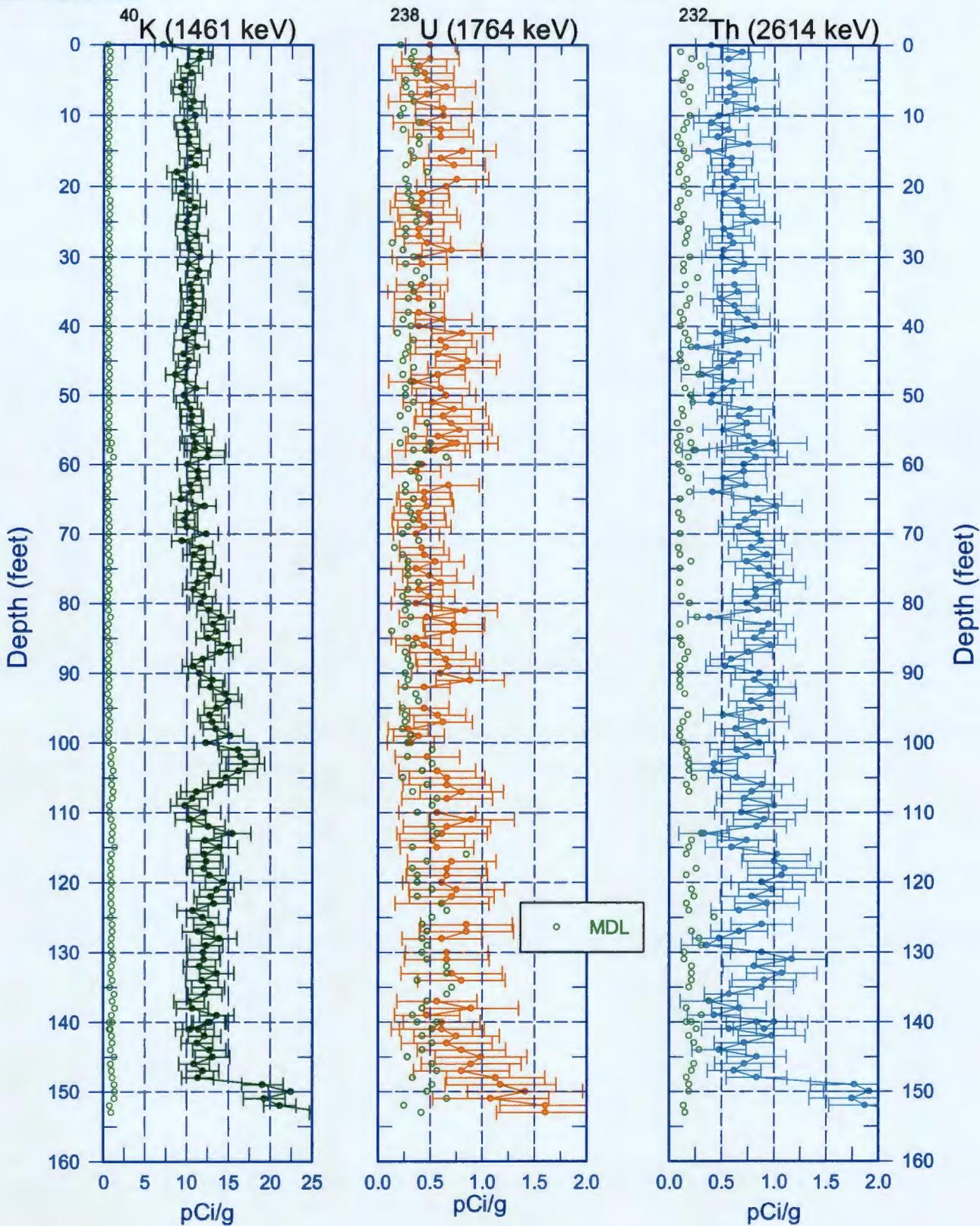
199-K-209 (C8296) Manmade Radionuclides



Zero Reference - Ground Surface

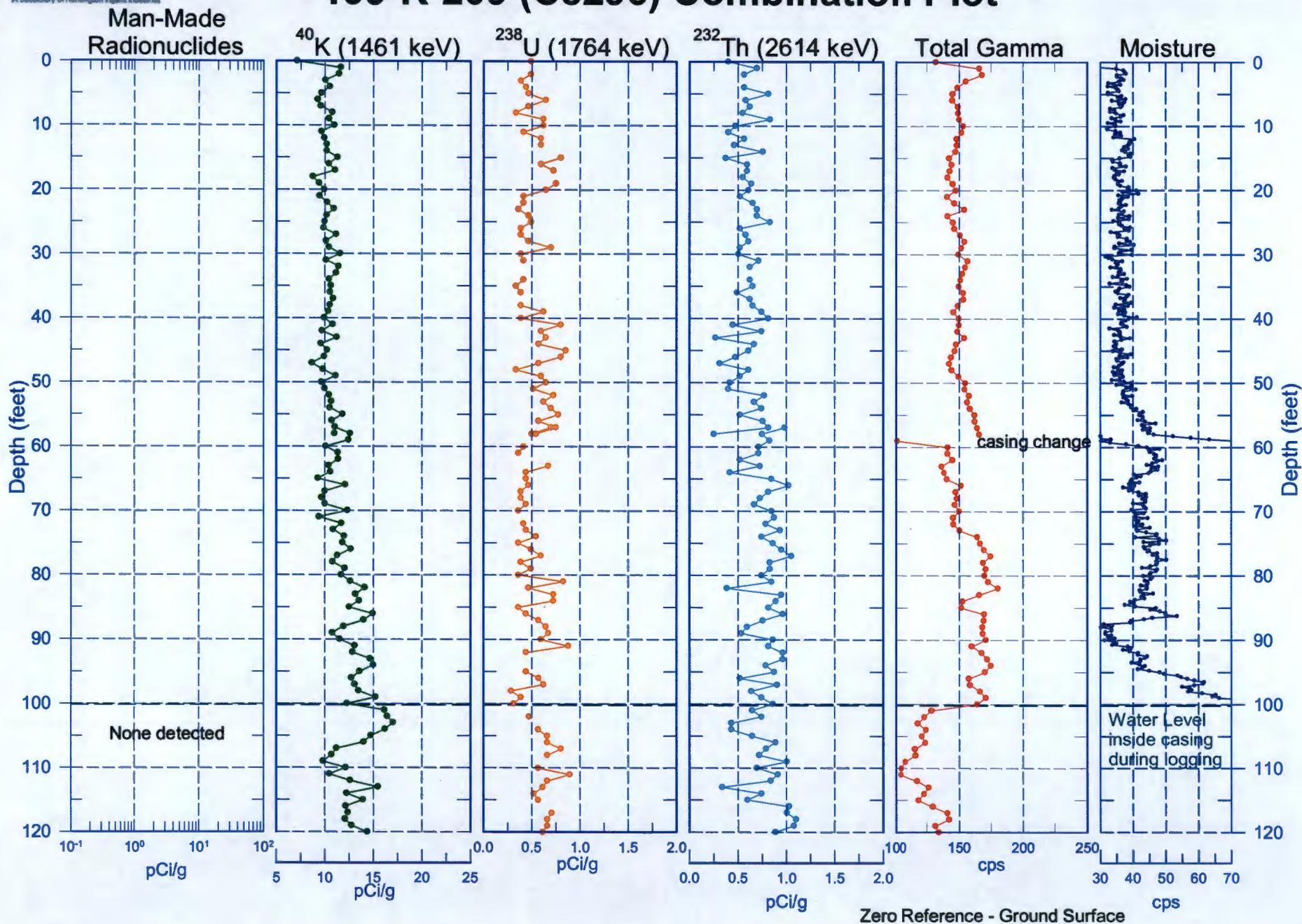


199-K-209 (C8296) Natural Gamma Logs



Zero Reference - Ground Surface

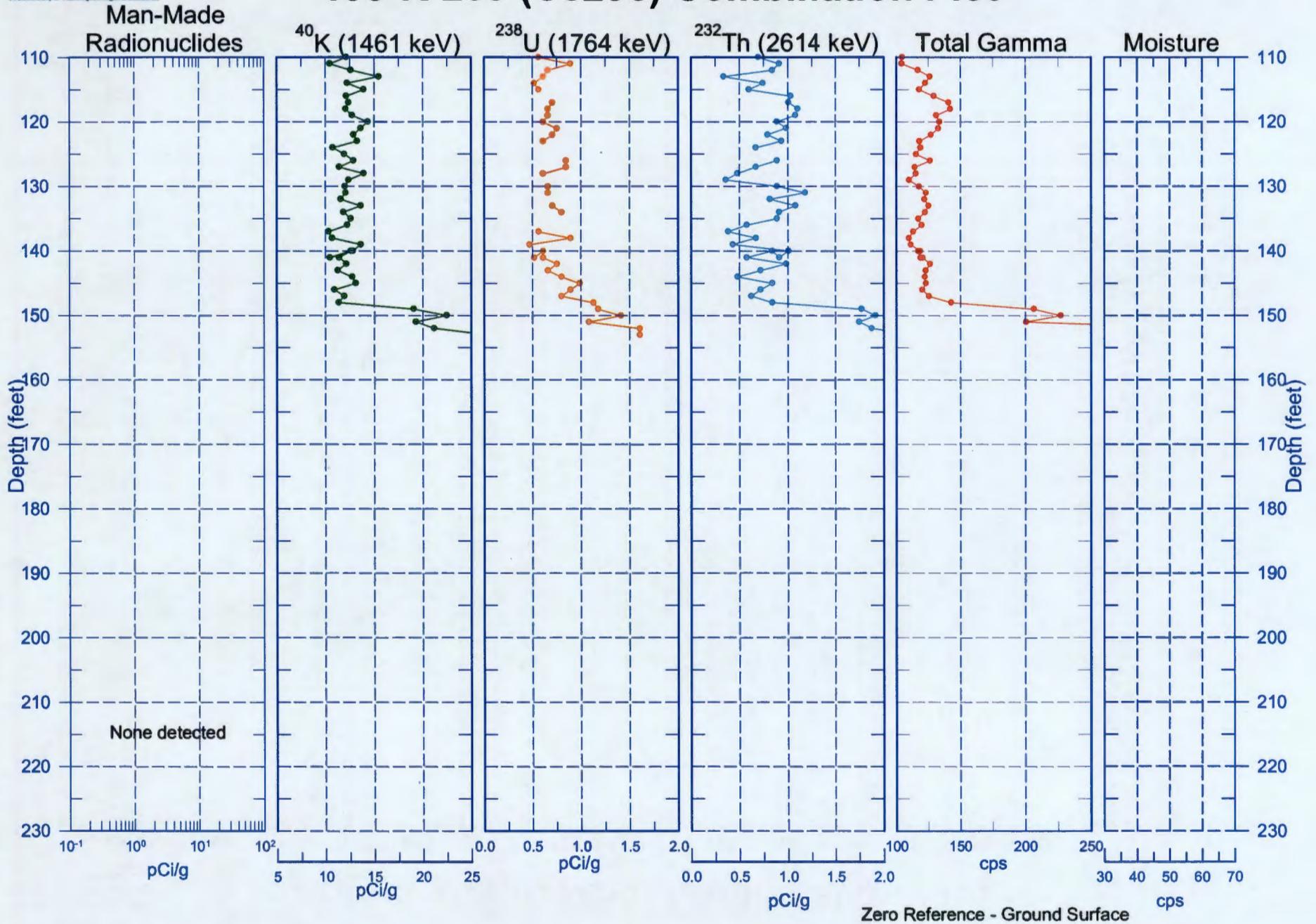
199-K-209 (C8296) Combination Plot



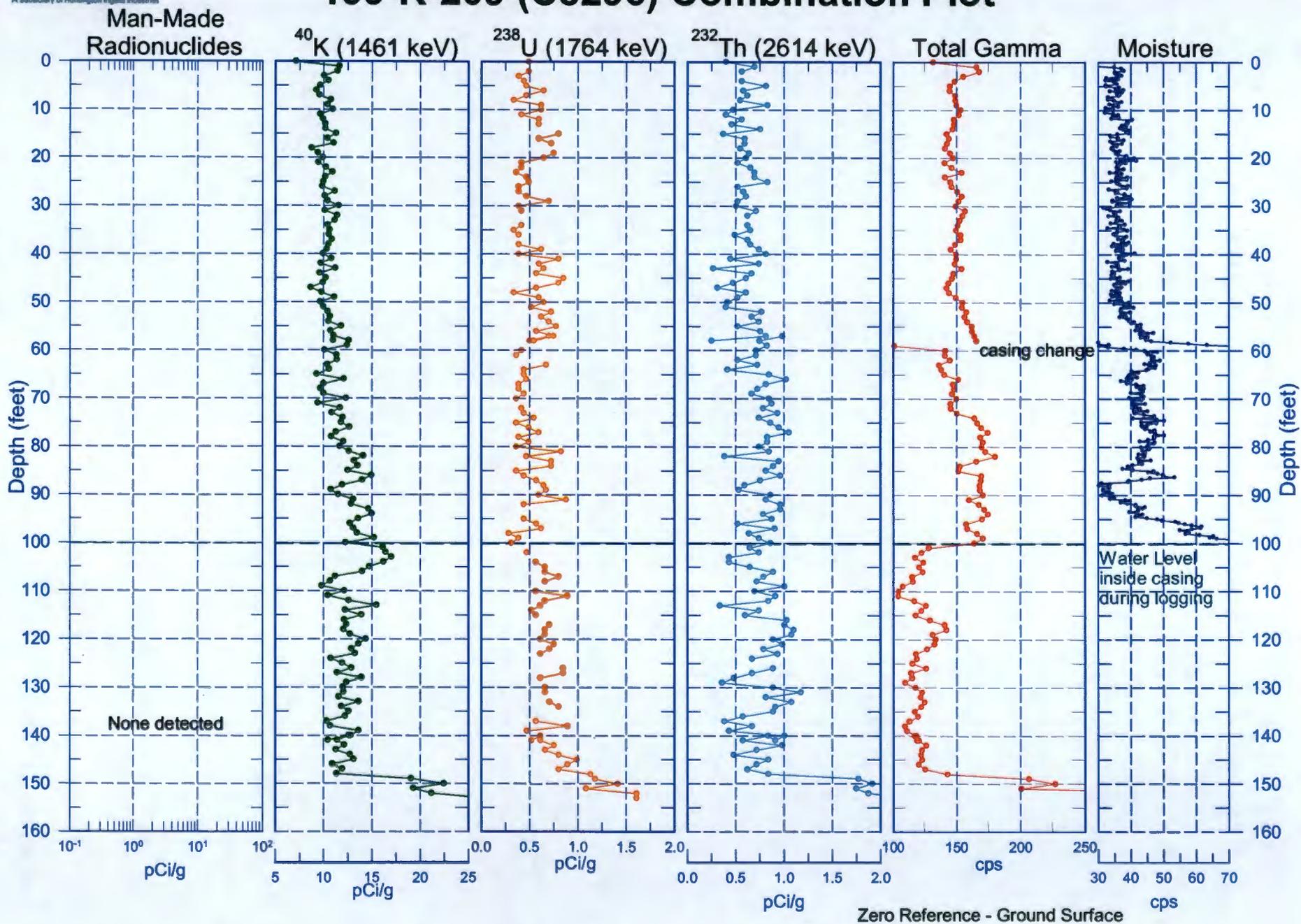


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199-K-209 (C8296) Combination Plot

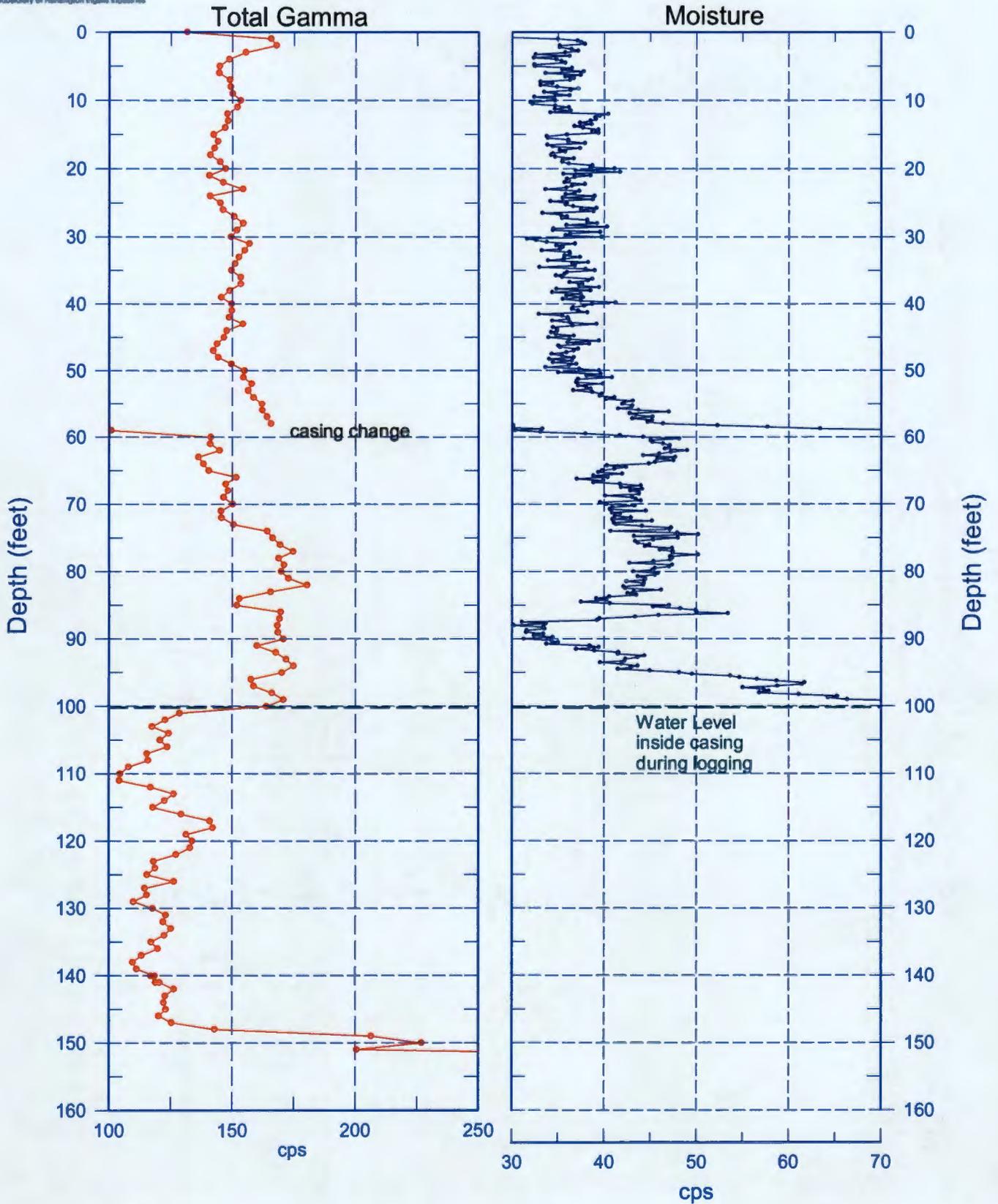


199-K-209 (C8296) Combination Plot





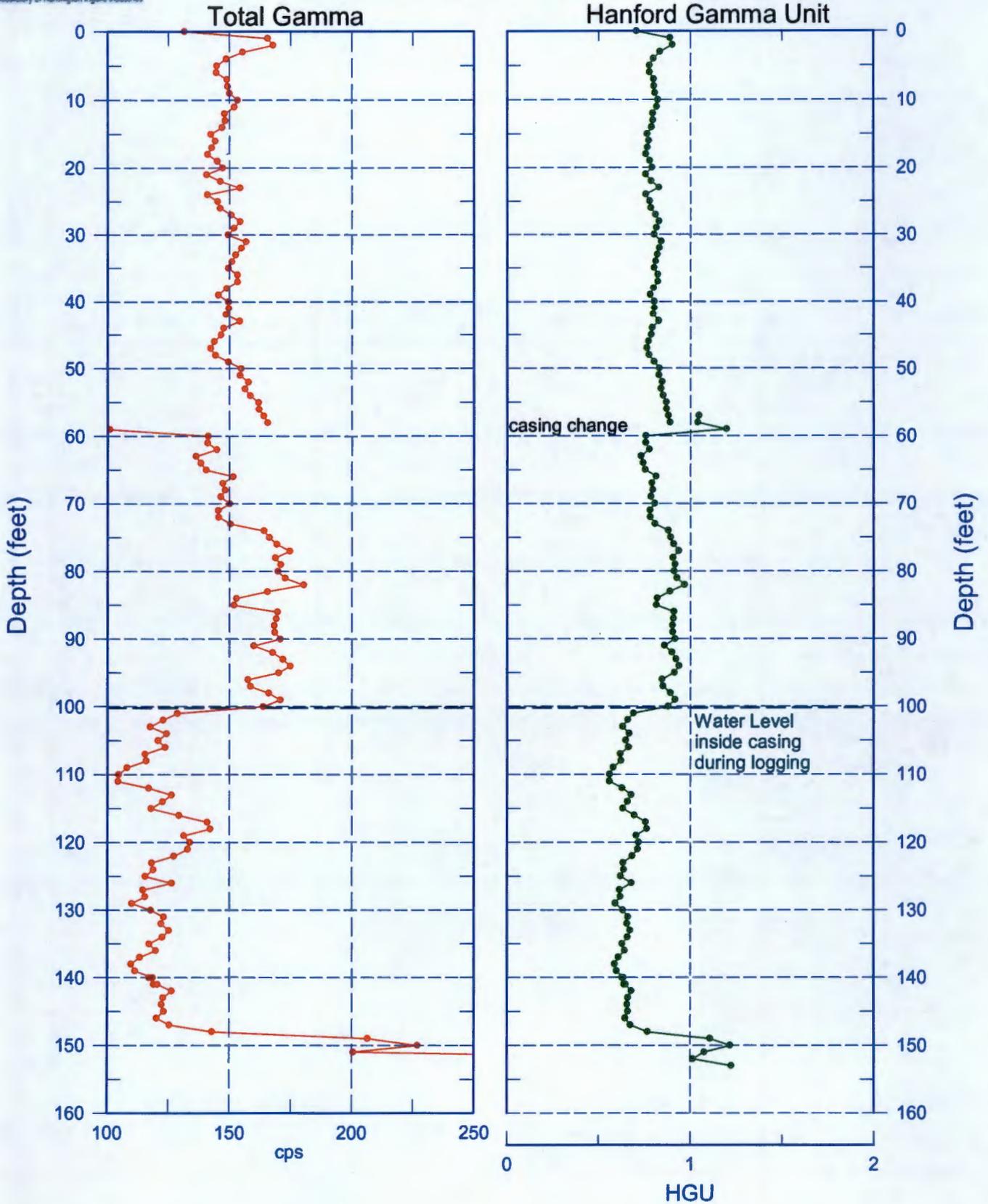
199-K-209 (C8296) Total Gamma & Moisture



Reference - Ground Surface



199-K-209 (C8296) Total Gamma & Hanford Gamma Unit

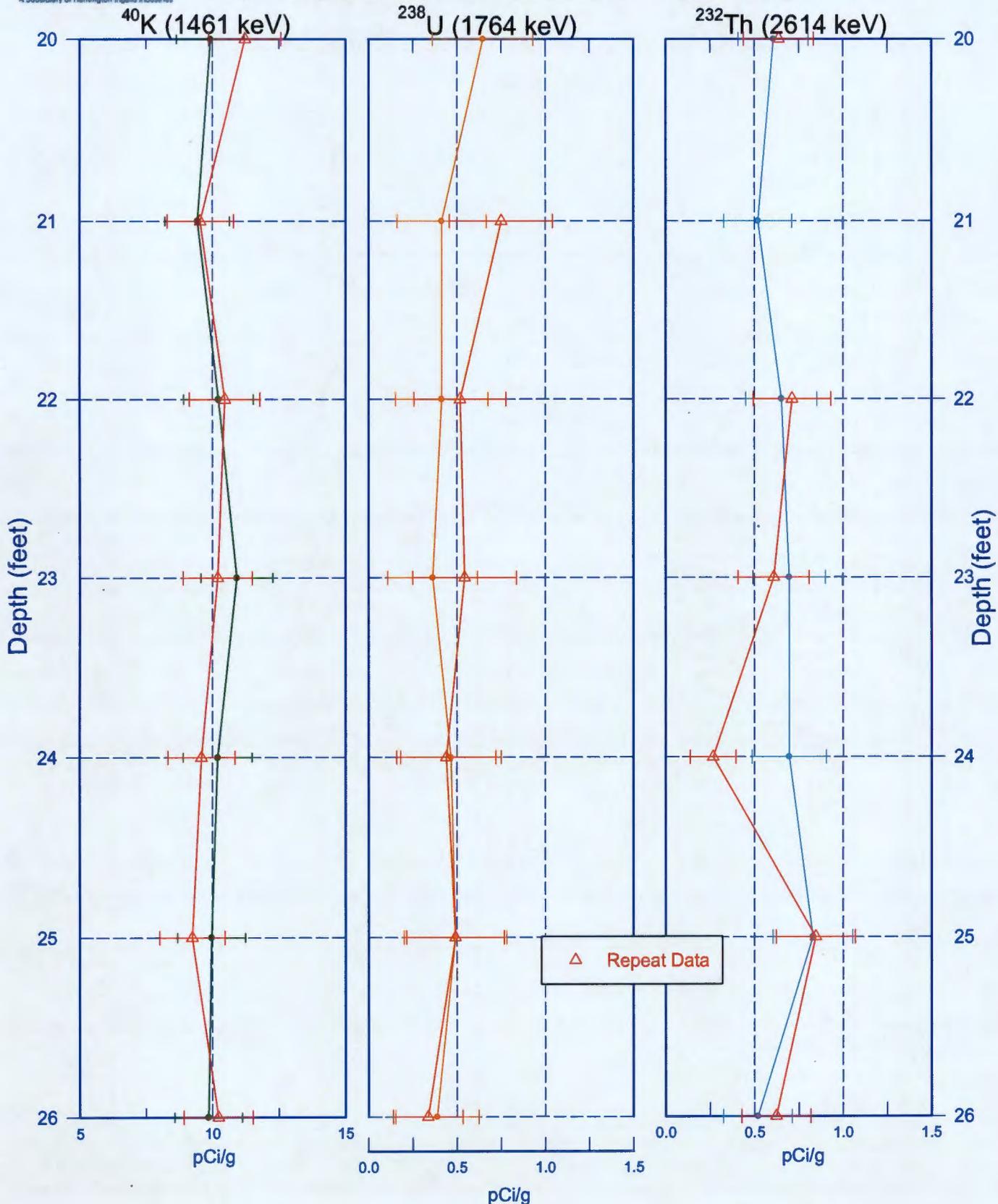


Reference - Ground Surface



199-K-209 (C8296)

Repeat Section of Natural Gamma Logs

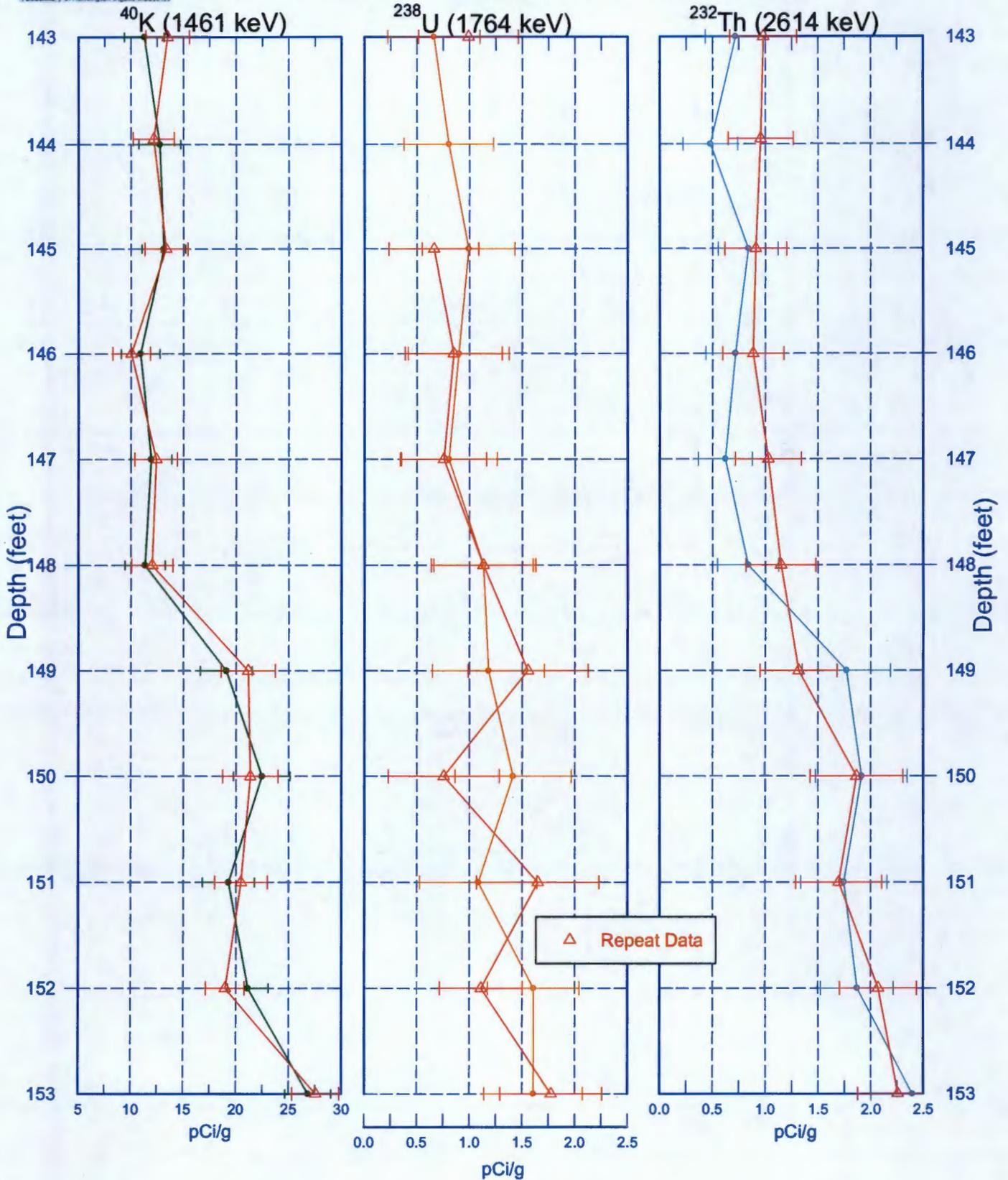


Zero Reference - Ground Surface.



199-K-209 (C8296)

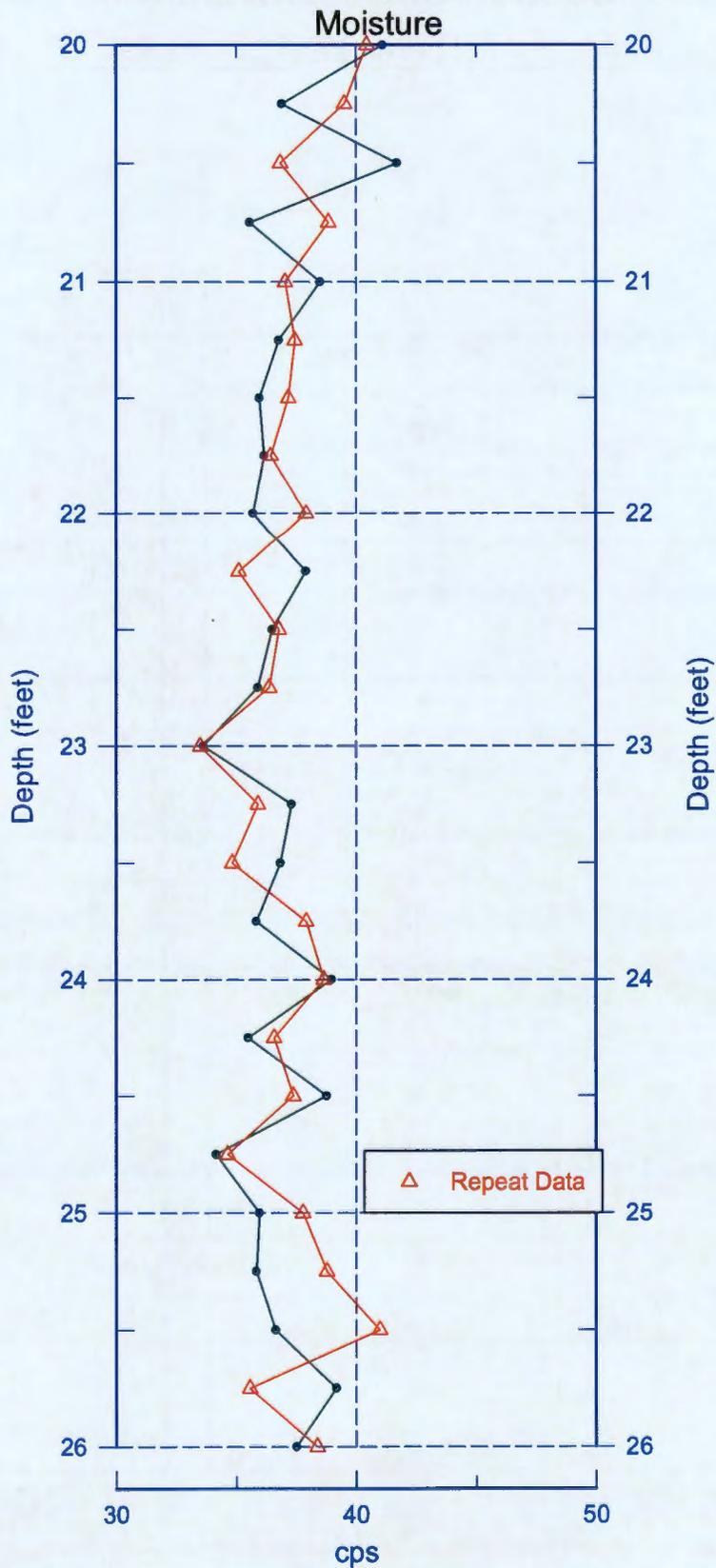
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface



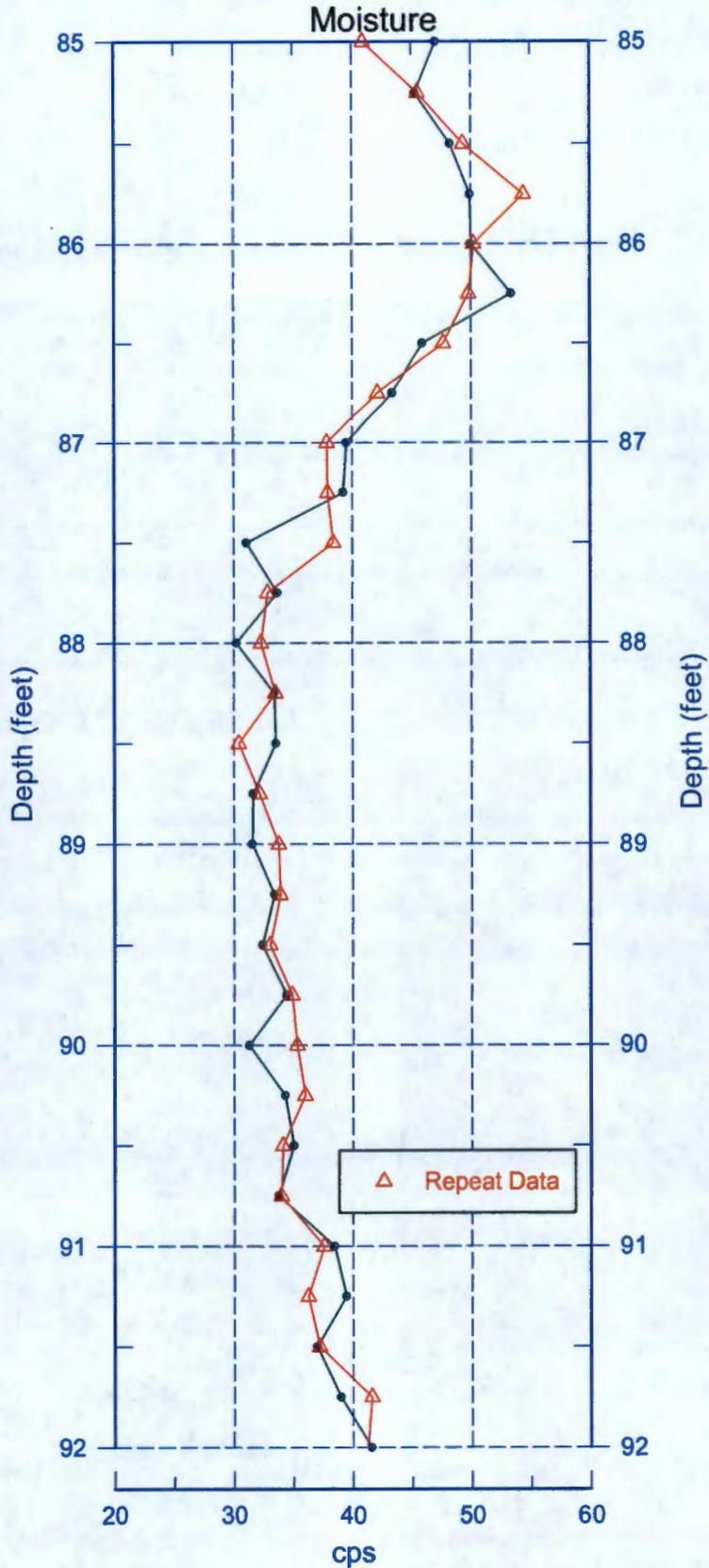
199-K-209 (C8296) Moisture Repeat Section



Reference - Ground Surface

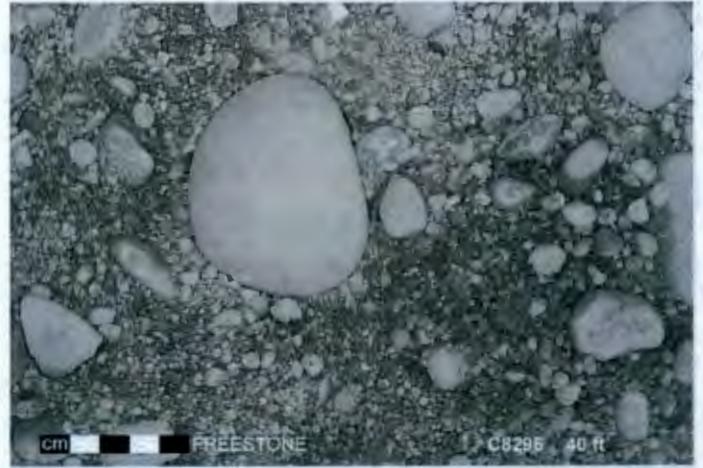


199-K-209 (C8296) Moisture Repeat Section



Reference - Ground Surface











| SURVEY DATA REPORT | | | | Request No. 152-078 | |
|---|--|--------------|----------|------------------------|-----|
| Project No. | Title | | File No. | | |
| | KR-4 Wells C8290,C8294,C8295 & C8296 Final Surveys | | 1KT14R26 | | |
| Job No. | Prepared By | Date | Reviewer | | |
| CACN:303412-JPRC | N.P. Fastabend | 3/19/15 | CBM | | |
| DESCRIPTION OF WORK | | DISTRIBUTION | SDR | PLOT | DWG |
| Obtained final coordinates (C/L Casings) and elevations of completed KR-4 Wells C8290 (199-K-203), C8294 (199-K-207), C8295 (199-K-208) and C8296 (199-K-209). Horizontal Coordinate System: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters) | | Survey File | OR | | |
| | | K.M. Whitley | 1 | | |
| | | S.J. Trent | 1 | | |
| | | J.D. Mehrer | 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: 03/11/15 | Requestor: Kelly Whitley (CHPRC) |
| Date of Survey: 03/19/15 | 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 Well C8296 (199-K-209). | Horizontal Datum: NAD83 (91) Vertical Datum: NAVD88 Units: Meters Hanford Area Designation: 100K |

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
T324 (COE) and HSWB-018 (COE)

| Well ID | Well Name | Easting | Northing | Elevation | |
|---------|-----------|-----------|-----------|-----------|---------------------|
| C8296 | 199-K-209 | 572552.36 | 147065.85 | | Center of Casing |
| | | | | 150.957 | "X" on Rim |
| | | | | 150.250 | Brass Survey Marker |
| | | | | | |

Notes:

150.660 Top Inner Casing, North Edge

Elevation on Brass Survey Marker was measured to Top Domed Brass Cap in concrete.

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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



3-19-15

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