SGW-61093
Revision 0

Borehole Summary Report for the Installation of One Vapor Injection Well and Four Monitoring Wells at the 200-WA-1 Operable Unit, FY 2017

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

Approved for Public Release;
Further Dissemination Unlimited

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Document Type: RPT

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CH2M HILL Plateau Remediation Company

Date Published
October 2017

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APPROVED
By Julia Raymer at 6:23 am, Oct 12, 2017

Release Approval | Date

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Contents

1 Introduction 1-1

1.1 Purpose and Scope 1-1

2 Drilling, Sampling, and Well Construction Activities 2-1

2.1 General Information 2-1

2.1.1 Drilling, Sampling and Borehole Logging 2-1

2.1.2 Health and Safety Screening 2-1

2.1.3 Well Construction 2-2

2.2 Well-Specific Information 2-2

2.2.1 Well 299-W22-117 (C9515) 2-2

2.2.2 Well 299-W22-119 (C9517) 2-6

2.2.3 Well 299-W22-120 (C9518) 2-9

2.2.4 Well 299-W22-121 (C9519) 2-13

2.2.5 Well 299-W22-124 (C9583) 2-16

3 Geologic Observations 3-1

3.1 Geology of the 200-WA-1 Operable Unit 3-1

3.2 Borehole Geology 3-1

3.2.1 Borehole Geology for C9515 (299-W22-117) 3-1

3.2.2 Borehole Geology for C9517 (299-W22-119) 3-2

3.2.3 Borehole Geology for C9518 (299-W22-120) 3-2

3.2.4 Borehole Geology for C9519 (299-W22-121) 3-2

3.2.5 Borehole Geology for C9583 (299-W22-124) 3-2

4 Waste Management 4-1

5 Civil Survey 5-1

6 Well Acceptance 6-1

7 References 7-1

Figures

Figure 1-1. New Well Locations in the 200-WA-1 Operable Unit 1-3
Figure 2-1. Full-sized Track-Mounted Sonic Drilling Rig 2-1

Tables

Table 1-1. Identification and Location of New Wells in the 200-WA-1 Operable Unit 1-2
Table 2-1. Radiological Contamination at Borehole C9515 2-3
Table 2-2. C9515 Well Construction and Sensor-Array Placement Information 2-5
Table 2-3. Air and Radiological Monitoring Measurements Exceeding Background at Well C9517 2-7
Table 2-4. C9517 Well Construction and Sensor-Array Placement Information 2-8
Table 2-5. Radiological Contamination at Borehole C9518 2-10
Table 2-6. C9518 Well Construction and Sensor-Array Placement Information 2-11
Table 2-7. Radiological Contamination at Borehole C9519 2-14
Table 2-8. C9519 Well Construction and Sensor-Array Placement Information 2-15
Table 2-9. Radiological Monitoring Measurements Exceeding Background at Well C9583 2-17
Table 2-10. C9583 Well Construction and Sensor-Array Placement Information 2-18

Appendices

A. Well Documentation for C9515 (299-W22-117) ..... A-i
B. Well Documentation for C9517 (299-W22-119) ..... B-i
C. Well Documentation for C9518 (299-W22-120) ..... C-i
D. Well Documentation for C9519 (299-W22-121) ..... D-i
E. Well Documentation for C9583 (299-W22-124) ..... E-i
F. Other Supporting Information for 200-WA-1 Opreable Unit Wells ..... F-i

Terms

bgs	below ground surface
Cascade	Cascade Drilling L.P.
CERCLA	*Comprehensive Environmental Response, Compensation and Liability Act of 1980*
CHPRC	CH2M Hill Plateau Remediation Company
DOE	U.S. Department of Energy
dpm	disintegrations per minute
Ecology	Washington State Department of Ecology
ERDF	Environmental Restoration Disposal Facility
ft	foot/ feet
HEIS	Hanford Environmental Information System
ID	identification
in.	inch/inches
NMLS	Neutron Moisture Logging System
OU	operable unit
ppmv	parts per million by volume
PVC	Polyvinyl Chloride
RCRA	*Resource Conservation and Recovery Act of 1976*
SGLS	Spectral Gamma Logging System
SN3	Stoller Newport News Nuclear, Inc.
TD	total depth
USPT	Uranium Sequestration Pilot Test
VOC	volatile organic compound
WAC	Washington Administrative Code

Metric Conversion Chart

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

1 Introduction

This report summarizes field activities that took place during the drilling, sampling, and installation of one injection well and four vapor monitoring wells in the 200-WA-1 Operable Unit (OU). These vapor wells and boreholes were installed to obtain data of sufficient quality and quantity to support the Uranium Sequestration Pilot Test (USPT) as described by the *Field Test Plan for the Uranium Sequestration Pilot Test*, DOE/RL-2010-87. The installation of these wells and boreholes supports Ecology et al., (1989), *Hanford Federal Facility Agreement and Consent Order*, and are in compliance with requirements of the *Resource Conservation and Recovery Act of 1976* (RCRA) as well as the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). The installation of the boreholes and wells included well drilling, soil sampling, and well-construction in accordance with DOE/RL-2010-88, *Sampling and Analysis Plan for the Uranium Sequestration Pilot Test*.

The five wells are located on the central plateau of the Hanford Site, south of the 216-U-8 Crib and within the 200 West Area. Liquid wastes associated with the plutonium-separation and uranium recovery operations were disposed of into the ground via ponds, cribs, ditches, and trenches. As effluent was discharged to these sites in the past, the more mobile contaminants migrated through the vadose zone to the groundwater. The USPT is testing significant remedial action methodology for source-term remediation in the vadose zone. This test seeks to immobilize vadose zone uranium contamination by injecting ammonia into the vadose zone and monitor the effectiveness of the technology.

The 216-U-8 Crib waste site was selected for the USPT because historic characterization data indicated the site likely contains a significant inventory of mobile uranium. Well C9519 will serve as the ammonia injection well. The monitoring wells are equipped with instrumentation to monitor the ammonia/sediment pore water reaction process and collect data to evaluate ammonia injection as a potential remedy to protect groundwater from mobile contaminants.

Drilling and construction of the five wells occurred from March 13, 2017 through June 28, 2017, and was performed by Cascade Drilling, L.P. (Cascade), under the direction of CH2M HILL Plateau Remediation Company (CHPRC). Freestone Environmental Services, Inc., provided well site geology and well construction documentation services and Stoller Newport News Nuclear, Incorporated (SN3) provided geophysical logging services. Sediment samples were collected by the CHPRC Soil and Groundwater Remediation Project. Additional technical support was provided by Pacific Northwest National Laboratory, working in cooperation with the drilling contractor for installation.

1.1 Purpose and Scope

This document summarizes the observations and measurements made during the drilling and installation of five wells in the 200-WA-1 OU. This borehole summary report includes the field notes and forms prepared during the drilling, sampling, and construction of the wells. Additional information provided in this report includes geophysical log data reports, results of the well location and elevation civil survey, descriptions of the management and disposition of drilling-derived waste, and a summary of the well acceptance activity.

Technical requirements, applicable CHPRC procedures, and other supporting information were summarized in SGW-58715, *Description of Work for the Installation of One Vapor Injection Well, Five Instrumented Monitoring Vapor Wells and Two Characterization Boreholes in the 200-WA-1 Operable Unit in Support of the Uranium Sequestration Pilot Test*.

Appendix A contains the Well Summary Sheet, Borehole Geologic Log, sample collection information, and Log Data Report for C9515. Appendix B contains the Well Summary Sheet, Borehole Geologic Log,

and Log Data Report for C9717. Appendix C contains the Well Summary Sheet, Borehole Geologic Log, photographs of core samples, sample collection information, and Log Data Report for C9718. Appendix D contains the Well Summary Sheet, Borehole Geologic Log, sample collection information, and Log Data Report for C9519. Appendix E contains the Well Summary Sheet, Borehole Geologic Log, and Log Data Report for C9583. Appendix F contains the variance to drill four monitoring wells and the Well Survey Data Reports for five wells.

All drilling data are reported in the original units recorded at the time of measurement. Table 1-1 lists the wells' identification numbers and names, and Figure 1-1 presents the well locations. The five wells will hereafter be referred to in the text by the borehole identification number (e.g. C9515).

Table 1-1. Identification and Location of New Wells in the 200-WA-1 Operable Unit

Borehole ID	Well Name	Ecology Well ID	Northing[a]	Easting[a]	Elevation of Brass Marker[b]	Field Activity Dates	
			meters			Initiate Drilling	Conclude Field Work
C9515	299-W22-117	BJH 292	134659.96	567619.03	212.07	April 24, 2017	June 19, 2017
C9517	299-W22-119	BJH 293	134662.99	567624.05	212.08	March 29, 2017	June 21, 2017
C9518	299-W22-120	BJH 294	134662.99	567621.01	212.15	March 22, 2017	June 28, 2017
C9519	299-W22-121	BJH 290	134662.99	567618.98	212.10	March 13, 2017	May 18, 2017
C9583	299-W22-124	BJH 291	134657.00	567619.00	212.00	May 1, 2017	May 30, 2017

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 meter.
Ecology = Washington State Department of Ecology.
ID = identification.

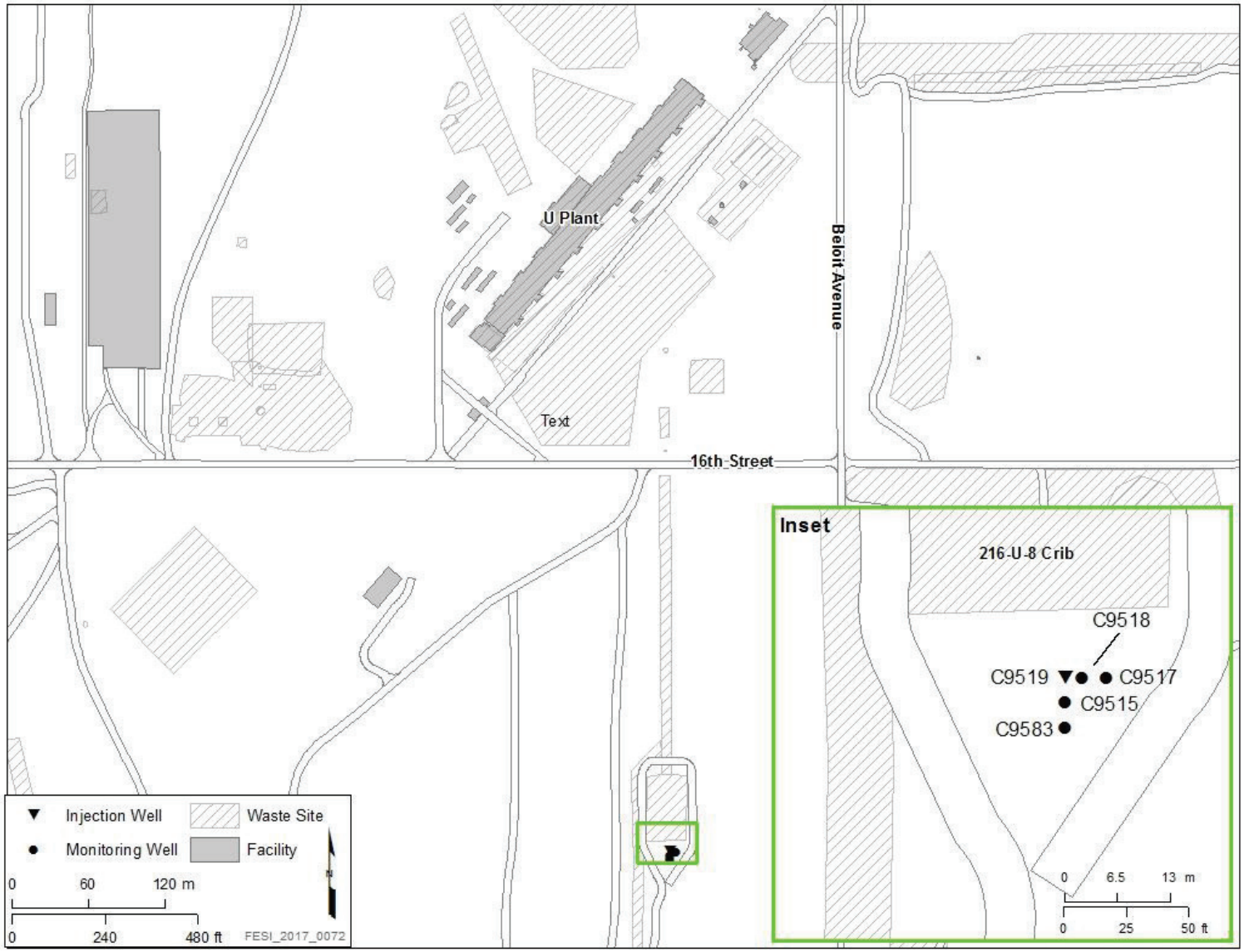

Figure 1-1. New Well Locations in the 200-WA-1 Operable Unit

2 Drilling, Sampling, and Well Construction Activities

This section summarizes the field activities associated with one vapor injection well and four vapor monitoring wells. Drilling, sampling, and construction details common to all the wells are summarized in Section 2.1. Well-specific information is presented in Section 2.2.

2.1 General Information

The new wells were constructed in compliance with 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.*

2.1.1 Drilling, Sampling and Borehole Logging

The boreholes were advanced to a depth between 80.5 and 87.3 ft below ground surface (bgs) into the Hanford formation. Boreholes were drilled and constructed using a full-sized track-mounted sonic drilling rig (Figure 2-1). Due to the drilling and sampling methods, soil cuttings were not available for photographs (except at C9518), sieve analysis or detailed geologic logging. To the extent possible, drill cuttings were logged in accordance with CHPRC procedure SGRP-PRO-EN-50025 (GRP-EE-01-7.0), *Geologic Logging.*

Figure 2-1. Full-sized Track-Mounted Sonic Drilling Rig

Continuous-core samples were collected from C9515, C9518, and C9519 using a hollow core barrel equipped with LEXAN™ liners. The samples were collected by driving the core barrel and decontaminated 3 1/2-in.-diameter liner through the sampling interval or until refusal. LEXAN™ liner sample depths and associated Hanford Environmental Information System (HEIS) numbers are included for C9515 in Appendix A, C9518 in Appendix C, and C9519 in Appendix D. During sample collection at C9518, photographs of exposed sediment at the LEXAN™ liner ends were taken are presented in Appendix C.

After total depth (TD) was achieved and prior to well construction, 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 near-borehole sediments. Log Data Reports of all geophysical logging results, provided by SN3, are presented in Appendices A through E.

2.1.2 Health and Safety Screening

Radiological field screening was conducted under radiological work permit GW-068 REV. 1, which called for full time coverage. A radiological control technician performed continuous surveys of the soil

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cuttings, LEXAN™ liners, temporary drive casing, core barrel and drill rods, and driller's control station using standard field screening instruments to measure alpha, beta and gamma radiological contamination. Radiological field screening measurements exceeding background activity are included in Section 2.2.

Air quality monitoring was performed by an industrial hygienist technician using a hand-held ammonia gas meter and a photo-ionization detector. Monitoring was performed at least twice daily of the drillers' breathing zone near the wellhead and fresh drill cuttings. Air quality monitoring measurements exceeding background levels are included in Section 2.2.

2.1.3 Well Construction

The vapor injection well was constructed using 4-in. nominal diameter, Schedule 80 polyvinyl chloride (PVC) casing, 20-slot screen, and a sump with an end cap. The well was pre-designed with a sensor array including thermistors, resistivity electrodes, and one temperature sensor cable. The sensor array was attached to the outside of the well casing using stainless steel zip ties and PVC tape. The annular materials included type I/II cement grout, 3/8-in. bentonite pellets, and 10-20 mesh silica sand. To provide a gas-tight seal, an ammonia-compatible sealant was used on all permanent casing couplings, in accordance with SGW-58715.

The vapor monitoring wells were constructed using 2-in. nominal diameter, Schedule 40 PVC casing, and a sump with an end cap. The wells were pre-designed with gas samplers, thermistors, and electrodes attached to the outside of the well casing. In addition to the gas samplers, thermistors, and electrodes, there was a series of cables and tubes, designed to be used as sample ports accessible from ground surface. The gas samplers, thermistors, electrodes, and cables were attached using stainless steel zip ties and PVC tape. The annular materials included type I/II cement grout, 3/8-in. bentonite crumbles, and a filter pack design that alternated intervals of 100 mesh and 200 mesh silica sand.

The temporary casing diameter of all wells was selected to ensure the annulus was a "minimum of four inches greater in diameter than the nominal size of the permanent casing", in accordance with WAC 173-160.

The surface completion consists of an 18-in. diameter flush mount manhole access that extends 11 in. bgs. Well tags with unique Ecology identification numbers were affixed in the manhole access at each well. These identification numbers are found in Table 1-1.

2.2 Well-Specific Information

This section summarizes borehole drilling, sampling, geophysical logging, well construction, and sensor installation activities specific to each well. Nested resource protection wells are prohibited per WAC 173-160-420(3). A variance was issued on November 30, 2016, to allow for construction of the four monitoring wells (Appendix F).

2.2.1 Well 299-W22-117 (C9515)

Borehole C9515 was drilled from April 24, 2017 through June 12, 2017 to a TD of 87.3 ft bgs. The borehole was drilled using 6-in. nominal diameter threaded carbon-steel casing to a depth of 85.5 ft bgs and a 4-in. core barrel to TD. One hundred and two core samples were collected from 29.3 to 81.2 ft bgs using 4-in. nominal diameter LEXAN™ liners. Sample date, depth interval, recovery, sample temperatures, and HEIS numbers are summarized in Appendix A. No water was added to the borehole during drilling, however 60 gallons of water was added at 75.7 ft bgs to aid in the removal of temporary casing prior to well construction. Radiological contamination encountered during drilling is summarized in Table 2-1.

Following placement of the 6-in. temporary casing, the borehole was logged on April 27, 2017 and April 28, 2017 using SGLS and NMLS from ground surface to a depth of 80.01 ft bgs.

Well construction took place May 31, 2017 through June 19, 2017. Well construction information is summarized in Table 2-2 and in documentation contained in Appendix A. During well construction on May 31, 2017, the well dropped two feet while removing the temporary casing. The well was removed on June 1, 2017, and the borehole was re-drilled to a depth of 83.0 ft bgs. The well was re-installed on June 6, 2017, but could not be maintained at its designed depth while removing the temporary casing. The well was removed for the second time on June 7, 2017, and the borehole was re-drilled to 87.3 ft bgs. The final well was installed on June 13, 2017 and was constructed as a 2-in. nominal diameter monitoring well with 80.33 ft of Schedule 40 PVC, including an end cap. Sixteen individual resistivity electrodes were installed on the well at 3-ft intervals from 72.0 to 270.0 ft bgs. Six individual thermistors were installed on the well every 6 ft from 31.5 to 43.5 ft bgs and from 55.5 to 67.5 ft bgs. Three additional thermistors were installed at 3-ft intervals from 43.5 to 55.5 ft bgs. Five gas samplers were installed on the well at 6-ft intervals from 37.5 to 61.5 ft bgs. A temperature sensing cable was installed on the well from 0.17 to 78.00 ft bgs.

From TD, the well annulus was filled with 4.10 ft of natural fill, 2.80 ft of cement grout, 54.17 ft of alternating 1.50-ft intervals of 200 mesh and 100 mesh silica sand, 6.38 ft of 3/8-in. bentonite crumbles, and a 19.85 ft of cement grout. All temporary casing was removed during well construction. The flush mount monument, and surface seal, were installed on June 19, 2017.

Table 2-1. Radiological Contamination at Borehole C9515

Date	Depth (ft bgs)	Media	Maximum Radiological Contamination (dpm, beta/gamma)
4/25/2017	29.3 – 32.3	LEXAN™ liner	Direct, $15x10^3$
	32.3	Solid shoe	Direct, $10x10^3$
	31.0 – 34.0	LEXAN™ liner	Direct, $440x10^3$
	34.0	Solid shoe	Direct, $40x10^3$
	33.6 – 36.6	LEXAN™ liner	Direct, $360x10^3$
	36.6	Solid shoe	Direct, $200x10^3$
	35.7 – 37.7	LEXAN™ liner	Direct, $360x10^3$
	39.3 – 42.3	LEXAN™ liner	Direct, $240x10^3$
	42.0 – 45.0	LEXAN™ liner	Direct, $160x10^3$
4/26/2017	45.0 – 46.7	Solid Shoe	Direct, $100x10^3$ Removable, $2x10^3$
	46.7 – 49.7	LEXAN™ liner	Direct, $120x10^3$
	49.7	Solid Shoe	Direct, $30x10^3$ Removable, $3x10^3$
	49.6 – 52.6	LEXAN™ liner	Direct, $50x10^3$

Table 2-1. Radiological Contamination at Borehole C9515

Date	Depth (ft bgs)	Media	Maximum Radiological Contamination (dpm, beta/gamma)
4/26/2017	52.6	Solid Shoe	Removable, $2x10^3$
	52.8	Solid Shoe	Direct, $50x10^3$
	52.8 – 55.8	LEXAN™ liner	Direct, $8x10^3$
	54.9 – 57.9		Direct, $8x10^3$
	58.3 – 61.3		Direct, $10x10^3$
	60.7 – 63.7		Direct, $15x10^3$
4/27/2017	65.9 – 68.9		Direct, $6x10^3$
	68.2 – 71.2		Direct, $3x10^3$
	72.1 – 75.1		Direct, $3x10^3$

dpm = disintegrations per minute.
ft bgs = feet below ground surface.

Table 2-2. C9515 Well Construction and Sensor-Array Placement Information

Permanent Casing	Permanent Casing Interval (ft bgs)	Annual Fill Material	Annual Fill Interval (ft bgs)	Sensor	Depth of Sensor (ft bgs)
2-in. Schedule 40, PVC Blank Casing	0.17 – 80.40	Cement grout	0.00 – 19.85	Temperature Sensor Cable	0.17 – 78.00
		3/8-in. bentonite crumbles	19.85 – 26.23		
		200 mesh sand	26.23 – 27.80	Electrode	27.00
		100 mesh sand	27.80 – 29.30		
		200 mesh sand	29.30 – 30.61	Electrode	30.00
		100 mesh sand	30.61 – 32.14	Thermistor	31.50
		200 mesh sand	32.14 – 33.80	Electrode	33.00
		100 mesh sand	33.80 – 35.15		
		200 mesh sand	35.15 – 36.77	Electrode	36.00
		100 mesh sand	36.77 – 38.39	Thermistor / Gas Sampler	37.50
		200 mesh sand	38.39 – 39.89	Electrode	39.00
		100 mesh sand	39.89 – 41.36		
		200 mesh sand	41.36 – 42.75	Electrode	42.00
		100 mesh sand	42.75 – 44.24	Thermistor / Gas Sampler	43.50
		200 mesh sand	44.24 – 45.85	Electrode	45.00
		100 mesh sand	45.85 – 47.22	Thermistor	46.50
		200 mesh sand	47.22 – 48.78	Electrode	48.00
		100 mesh sand	48.78 – 50.35	Thermistor / Gas Sampler	49.50
		200 mesh sand	50.35 – 51.76	Electrode	51.00
		100 mesh sand	51.76 – 53.31	Thermistor	52.50
		200 mesh sand	53.31 – 54.83	Electrode	54.00

Table 2-2. C9515 Well Construction and Sensor-Array Placement Information

Permanent Casing	Permanent Casing Interval (ft bgs)	Annual Fill Material	Annual Fill Interval (ft bgs)	Sensor	Depth of Sensor (ft bgs)
2-in. Schedule 40, PVC Blank Casing	0.17 – 80.40	100 mesh sand	54.83 – 56.26	Thermistor / Gas Sampler	55.50
		200 mesh sand	56.26 – 57.77	Electrode	57.00
		100 mesh sand	57.77 – 59.25		
		200 mesh sand	59.25 – 60.87	Electrode	60.00
		100 mesh sand	60.87 – 62.29	Thermistor / Gas Sampler	61.50
		200 mesh sand	62.29 – 63.86	Electrode	63.00
		100 mesh sand	63.86 – 65.27		
		200 mesh sand	65.27 – 66.79	Electrode	66.00
		100 mesh sand	66.79 – 68.38	Thermistor	67.50
		200 mesh sand	68.38 – 69.73	Electrode	69.00
		100 mesh sand	69.73 – 71.13		
		200 mesh sand	71.13 – 80.40	Electrode	72.00
		Cement grout	80.40 – 83.20		
		Natural fill	83.20 – 87.30		

ft bgs = feet below ground surface.
PVC = polyvinyl chloride.

2.2.2 Well 299-W22-119 (C9517)

Borehole C9517 was drilled from March 29, 2017 through June 19, 2017 to a TD of 81.5 ft bgs. The borehole was drilled using 6-in. nominal diameter threaded carbon-steel casing to a depth of 80.5 ft bgs and a 4-in. core barrel to TD. No sediment samples were collected from C9517. No water was added to the borehole during drilling, however one gallon of water was added to the borehole at a depth of 76.0 ft bgs prior to well construction. Radiological and chemical contamination encountered during drilling is summarized in Table 2-3.

Following placement of the 6-in. temporary casing, the borehole was logged on April 20, 2017 using SGLS and NMLS from ground surface to a depth of 80.0 ft bgs.

Well construction took place June 20, 2017 through June 21, 2017. Well construction information is summarized in Table 2-4 and in documentation contained in Appendix B. The well was constructed as a 2-in. nominal diameter monitoring well with 79.73 ft of Schedule 40 PVC riser and an end cap. Sixteen individual resistivity electrodes were installed on the well at 3-ft intervals from 27.0 to 72.0 ft bgs. Six individual thermistors were installed on the well every 6-ft from 31.5 to 43.5 ft bgs and from 55.5 to 67.5 ft bgs. Three additional thermistors were installed at 3-ft intervals from 43.5 to 55.5 ft bgs. Five gas samplers were installed on the well at 6-ft intervals from 37.5 to 61.5 ft bgs. A temperature sensing cable was installed on the well from 0.17 to 78.00 ft bgs. From TD to surface, the annulus was filled with 1.75 ft of natural fill, 53.46 ft of alternating 1.50-ft intervals of 200 mesh and 100 mesh filter pack sand, 6.24 ft of 3/8-in. bentonite crumbles, and 20.05 ft of cement grout. All temporary casing was removed during well construction. The flush mount monument, and surface seal, were installed on June 21, 2017.

Table 2-3. Air and Radiological Monitoring Measurements Exceeding Background at Well C9517

Date	Depth (ft bgs)	Media	Radiological Contamination (dpm, beta/gamma)	Maximum Chemical Contamination	
				VOC (ppmv)	Ammonia (ppmv)
3/30/2017	27.0 – 37.0	Sediment	Direct, 480×10^3	–	
4/3/2017	37.0	Air (well head)	–	1.0	0.0
		Sediment	Direct, 300×10^3	–	
	37.0 – 47.0	Sediment	Direct, 100×10^3		
	57.0	Air (well head)	–	1.5	0.0
4/4/2017	47.0 – 57.0	Sediment	Direct, 20×10^3	–	
4/17/2017	40.0	Air	–	6.0	3.0
	52.0 – 57.0	Sediment	Direct, 50×10^3	–	
	57.0 – 62.0	Sediment	Direct, 20×10^3		
	62.0 – 67.0	Sediment	–	8.0	0.0
4/19/2017	62.0 – 67.0	Sediment	Direct, 16×10^3	1.0	0.0
	67.0 – 72.0	Sediment	Direct, 8×10^3	0.0	0.0

dpm = disintegrations per minute.
ft bgs = feet below ground surface.
ppmv = part per million by volume.
VOC = volatile organic compound.

Table 2-4. C9517 Well Construction and Sensor-Array Placement Information

Permanent Casing	Permanent Casing Interval (ft bgs)	Annual Fill Material	Annual Fill Interval (ft bgs)	Sensor	Depth of Sensor (ft bgs)
2-in. Schedule 40, PVC Blank Casing	0.17 – 79.75	Cement grout	0.0 – 20.05	Temperature Sensor Cable	0.17 – 78.00
		3/8-in. bentonite crumbles	20.05 – 26.29		
		200 mesh sand	26.29 – 27.65	Electrode	27.00
		100 mesh sand	27.65 – 29.30		
		200 mesh sand	29.30 – 30.72	Electrode	30.00
		100 mesh sand	30.72 – 32.18	Thermistor	31.50
		200 mesh sand	32.18 – 33.86	Electrode	33.00
		100 mesh sand	33.86 – 35.28		
		200 mesh sand	35.28 – 36.67	Electrode	36.00
		100 mesh sand	36.67 – 38.38	Thermistor / Gas Sampler	37.50
		200 mesh sand	38.38 – 39.88	Electrode	39.00
		100 mesh sand	39.88 – 41.28		
		200 mesh sand	41.28 – 42.82	Electrode	42.00
		100 mesh sand	42.82 – 44.36	Thermistor / Gas Sampler	43.50
		200 mesh sand	44.36 – 45.87	Electrode	45.00
		100 mesh sand	45.87 – 47.32	Thermistor	46.50
		200 mesh sand	47.32 – 48.75	Electrode	48.00
		100 mesh sand	48.75 – 50.38	Thermistor / Gas Sampler	49.50
		200 mesh sand	50.38 – 51.75	Electrode	51.00
		100 mesh sand	51.75 – 53.16	Thermistor	52.50
		200 mesh sand	53.16 – 54.73	Electrode	54.00
		100 mesh sand	54.73 – 56.32	Thermistor / Gas Sampler	55.50

Table 2-4. C9517 Well Construction and Sensor-Array Placement Information

Permanent Casing	Permanent Casing Interval (ft bgs)	Annual Fill Material	Annual Fill Interval (ft bgs)	Sensor	Depth of Sensor (ft bgs)
2-in. Schedule 40, PVC Blank Casing	0.17 – 79.75	200 mesh sand	56.32 – 57.90	Electrode	57.00
		100 mesh sand	57.90 – 59.30		
		200 mesh sand	59.30 – 60.61	Electrode	60.00
		100 mesh sand	60.61 – 62.25	Thermistor / Gas Sampler	61.50
		200 mesh sand	62.25 – 63.89	Electrode	63.00
		100 mesh sand	63.89 – 65.30		
		200 mesh sand	65.30 – 66.89	Electrode	66.00
		100 mesh sand	66.89 – 68.37	Thermistor	67.50
		200 mesh sand	68.37 – 69.80	Electrode	69.00
		100 mesh sand	69.80 – 71.26		
		200 mesh sand	71.26 – 79.75	Electrode	72.00
		Natural fill	79.75 – 81.50		

ft bgs = feet below ground surface.
PVC = polyvinyl chloride.

2.2.3 Well 299-W22-120 (C9518)

Borehole C9518 was drilled from March 22, 2017 through June 26, 2017 to a TD of 82.5 ft bgs. The borehole was drilled using 6-in. nominal diameter threaded carbon-steel casing of to a depth of 80.5 ft bgs and a 4-in. core barrel to TD. One hundred core samples were collected from 30.8 to 80.7 ft bgs using 4-in. nominal diameter LEXAN™ liners. Sample date, depth interval, recovery, sample temperatures, and HEIS numbers are summarized in Appendix C. No water was added to the borehole during drilling. Radiological contamination encountered during drilling is summarized in Table 2-5.

Following placement of the 6-in. temporary casing, the borehole was logged on March 30, 2017 and March 31, 2017 using SGLS from ground surface to a depth of 77.01 ft bgs and NMLS to a depth of 78.01 ft bgs.

Well construction took place June 27, 2017 through June 28, 2017. Well construction information is summarized in Table 2-6 and in documentation contained in Appendix C. The well was constructed as a 2-in. nominal diameter monitoring well with 82.87 ft of Schedule 40 PVC, including an end cap. In addition, 46.33 ft and 52.33 ft of 1/4-in. blank PVC risers were installed for sediment coupon

sampling. Sediment coupons are a packet of moist sediment deployed at a location such that it can be removed at selected times for analysis (pH, electrical conductivity, pore water cations/anions, and uranium surface phases). Sixteen individual resistivity electrodes were installed on the well at 3-ft intervals from 27.0 to 72.0 ft bgs. Six individual thermistors were installed on the well every 6 ft from 31.5 to 43.5 ft bgs and from 55.5 to 67.5 ft bgs. Three additional thermistors were installed at 3-ft intervals between 43.5 and 55.5 ft bgs. Five gas samplers were installed at 6-ft intervals from 37.5 to 61.5 ft bgs. The two blank, 1/4-in. nominal diameter Schedule 40 PVC risers used for sediment coupons were installed on the well from 0.17 to 46.5 ft bgs and 0.17 to 52.5 ft bgs. From TD, the annulus was filled with a 56.47 ft of alternating 1.50-ft intervals of 200 mesh and 100 mesh filter pack sand, 5.81 ft of 3/8-in. bentonite crumbles, and 20.22 ft of cement grout. All temporary casing was removed during well construction. The flush mount monument and surface seal were installed on June 28, 2017.

Table 2-5. Radiological Contamination at Borehole C9518

Date	Depth (ft bgs)	Media	Maximum Radiological Contamination (dpm, beta/gamma)
3/27/2017	30.8 – 33.8	LEXAN™ liner	Direct, 500×10^3
	33.8	Solid shoe	Direct, 200×10^3 Removable, 2×10^3
	32.9 – 35.9	LEXAN™ liner	Direct, 400×10^3
	35.9	Solid shoe	Direct, 100×10^3
	36.0 – 39.0	LEXAN™ liner	Direct, 225×10^3
	39.0	Solid shoe	Direct, 20×10^3
	38.9 – 39.4	LEXAN™ liner	Direct, 60×10^3
3/28/2017	42.9 – 45.9	LEXAN™ liner	Direct, 22×10^3
	45.9	Solid shoe	Direct, 20×10^3
	44.9 – 47.9	LEXAN™ liner	Direct, 65×10^3
	48.4 – 51.4		Direct, 32×10^3
	51.4 – 54.4		Direct, 10×10^3
	54.2 – 57.2		Direct, 10×10^3
	57.2 – 60.7		Direct, 8×10^3
	60.1 – 63.1		Direct, 8×10^3
	62.6 – 65.6		Direct, 5×10^3

Table 2-5. Radiological Contamination at Borehole C9518

Date	Depth (ft bgs)	Media	Maximum Radiological Contamination (dpm, beta/gamma)
3/29/2017	66.1 – 71.1	LEXAN™ liner	Direct, $5x10^3$
	71.0 – 75.5		Direct, $5x10^3$
	75.7 – 80.7		Direct, $5x10^3$

dpm = disintegrations per minute.
ft bgs = feet below ground surface.

Table 2-6. C9518 Well Construction and Sensor-Array Placement Information

Permanent Casing	Permanent Casing Interval (ft bgs)	Annual Fill Material	Annual Fill Interval (ft bgs)	Sensor	Depth of Sensor (ft bgs)
2-in. Schedule 40, PVC Blank Casing	0.17 - 82.50	Cement grout	0.0 - 20.22	Electrode	27.0
		3/8-in. bentonite crumbles	20.22 - 26.03		
		200 mesh sand	26.03 - 27.86		
		100 mesh sand	27.86 - 29.14		
		200 mesh sand	29.14 - 30.71	Electrode	30.0
		100 mesh sand	30.71 - 32.28	Thermistor	31.5
		200 mesh sand	32.28 - 33.61	Electrode	33.0
		100 mesh sand	33.61 - 35.24		
		200 mesh sand	35.24 - 36.70	Electrode	36.0
		100 mesh sand	36.70 - 38.20	Thermistor / Gas Sampler	37.5
		200 mesh sand	38.20 - 39.85	Electrode	39.0

Table 2-6. C9518 Well Construction and Sensor-Array Placement Information

Permanent Casing	Permanent Casing Interval (ft bgs)	Annual Fill Material	Annual Fill Interval (ft bgs)	Sensor	Depth of Sensor (ft bgs)
1/4-in. Schedule 40, PVC Blank Sediment Coupon	0.17 – 46.5	100 mesh sand	39.85 - 41.20	Electrode	39.0
		200 mesh sand	41.20 - 42.82	Electrode	42.0
		100 mesh sand	42.82 - 44.27	Thermistor / Gas Sampler	43.5
		200 mesh sand	44.27 - 45.61	Electrode	45.0
1/4-in. Schedule 40, PVC Blank Sediment Coupon	0.17 – 52.5	100 mesh sand	45.61 - 47.18	Thermistor	46.5
		200 mesh sand	47.18 - 48.69	Electrode	48.0
		100 mesh sand	48.69 - 50.22	Thermistor / Gas Sampler	49.5
		200 mesh sand	50.22 - 51.76	Electrode	51.0
		100 mesh sand	51.76 - 53.17	Thermistor	52.5
2-in. Schedule 40, PVC Blank Casing	0.17 - 82.50	200 mesh sand	53.17 - 54.63	Electrode	54.0
		100 mesh sand	54.63 - 56.28	Thermistor / Gas Sampler	55.5
		200 mesh sand	56.28 - 57.80	Electrode	57.0
		100 mesh sand	57.80 - 59.35		
		200 mesh sand	59.35 - 60.65	Electrode	60.0
		100 mesh sand	60.65 - 62.25	Thermistor / Gas Sampler	61.5
		200 mesh sand	62.25 - 63.79	Electrode	63.0
		100 mesh sand	63.79 - 65.21		
		200 mesh sand	65.21 - 66.54	Electrode	66.0
		100 mesh sand	66.54 - 68.31	Thermistor	67.5

Table 2-6. C9518 Well Construction and Sensor-Array Placement Information

Permanent Casing	Permanent Casing Interval (ft bgs)	Annual Fill Material	Annual Fill Interval (ft bgs)	Sensor	Depth of Sensor (ft bgs)
2-in. Schedule 40, PVC Blank Casing	0.17 - 82.50	200 mesh sand	68.31 - 69.71	Electrode	69.0
		100 mesh sand	69.71 - 71.25		
		200 mesh sand	71.25 - 82.50	Electrode	72.0

ft bgs = feet below ground surface.
PVC = polyvinyl chloride

2.2.4 Well 299-W22-121 (C9519)

Borehole C9519 was drilled from March 3, 2017 through March 21, 2017 to a TD of 81.5 ft bgs. The borehole was drilled using threaded carbon-steel casing of 8-in.-nominal-diameter to a depth of 80.9 ft bgs and a 6-in. core barrel to a TD of 81.5 ft bgs. Ninety-one core samples were collected from 30.4 to 81.5 ft bgs using 4-in. nominal diameter LEXAN™ liners. Sample date, depth interval, recovery, sample temperatures, and HEIS numbers are summarized in Appendix D. No water was added to the borehole during drilling. Radiological contamination encountered during drilling is summarized in Table 2-7.

Following placement of the 8-in. temporary casing, the borehole was logged on March 22, 2017 and March 23, 2017 using SGLS from ground surface to a depth of 80.00 ft bgs and NMLS to a depth of 81.01 ft bgs.

Well construction took place May 8, 2017 through May 18, 2017. Well construction information is summarized in Table 2-8 and in documentation contained in Appendix D. The well was constructed as a 4-in. nominal diameter injection well with a 9.79 ft 20-slot screened interval and a 49.23 ft sump with end cap. Sixteen individual resistivity electrodes were installed on the well at 3-ft intervals from 25.0 to 70.0 ft bgs. Nine individual thermistors were installed on the well every 3-ft from 29.8 to 38.5 ft bgs and from 59.5 to 71.5 ft bgs. A temperature sensing cable was installed on the well from 0.43 to 78.10 ft bgs. From TD, the annulus was filled with 22.9 ft of cement grout, 3.2 ft of 3/8-in. bentonite pellets, 11.9 ft of 10-20 mesh silica sand, 3.3 ft of 3/8-in. bentonite pellets, 16.9 ft of cement grout, 5.4 ft of 3/8-in. bentonite pellets, and a 17.6 ft of cement grout. During well construction, 8.4 ft of grout was measured in the sump. The integrity of the well was not compromised and the well can function as designed. The project decided to take no action and the cement remains in the sump. All temporary casing was removed during well construction. The flush mount monument, and surface seal, were installed on May 18, 2017.

Table 2-7. Radiological Contamination at Borehole C9519

Date	Depth (ft bgs)	Media	Radiological Contamination (dpm, beta/gamma)
3/14/2017	32.9 - 35.9	LEXAN™ liner	Direct, $600x10^3$
	35.9	Solid shoe	Direct, $600x10^3$ Removable, $3x10^3$
	35.3 – 38.3	LEXAN™ liner	Direct, $23x10^3$
3/15/2017	38.3 – 41.3		Direct, $460x10^3$
	41.3 – 44.3		Direct, $400x10^3$
	44.0 – 46.5		Direct, $200x10^3$
3/16/2017	46.0 – 49.0		Direct, $280x10^3$
	50.9 – 53.9		Direct, $8x10^3$
3/20/2017	56.2 – 56.7		Direct, $10x10^3$
3/20/2017	59.9 – 62.9		Direct, $6x10^3$

dpm = disintegrations per minute.
ft bgs = feet below ground surface.

Table 2-8. C9519 Well Construction and Sensor-Array Placement Information

Permanent Casing	Permanent Casing Interval (ft bgs)	Annual Fill Material	Annual Fill Interval (ft bgs)	Sensor	Depth of Sensor (ft bgs)
4-in. Schedule 80, PVC Blank Casing	0.43 - 44.11	Cement grout	0.00 - 17.60	Temperature Senor Cable	0.43 – 78.10
		3/8-in. bentonite pellets	17.60 - 23.00		
		Cement grout	23.00 - 39.90	Electrode	25.00
				Electrode	28.00
				Thermistor	29.50
				Electrode	31.00
				Thermistor	32.50
				Electrode	34.00
				Thermistor	35.50
				Electrode	37.00
				Thermistor	38.50
		3/8-in. bentonite pellets	39.90 - 43.20	Electrode	40.00
				Electrode	43.00
4-in. Schedule 80, 20-slot (0.020-in.), PVC Screen	44.11 - 53.90	10-20 mesh sand	43.2 - 55.1	Electrode	46.0
				Electrode	49.0
				Electrode	52.0
4-in. Schedule 80, PVC Sump/End Cap	53.90 - 81.20			Electrode	55.0

Table 2-8. C9519 Well Construction and Sensor-Array Placement Information

Permanent Casing	Permanent Casing Interval (ft bgs)	Annual Fill Material	Annual Fill Interval (ft bgs)	Sensor	Depth of Sensor (ft bgs)
4-in. Schedule 80, PVC Sump/End Cap	53.90 - 81.20	3/8-in. bentonite pellets	55.1 - 58.3	Electrode	58.0
		Cement grout	58.3 - 81.2	Thermistor	59.5
				Electrode	61.0
				Thermistor	62.5
				Electrode	64.0
				Thermistor	65.5
				Electrode	67.0
				Thermistor	68.5
				Electrode	70.0
				Thermistor	71.5
		Natural fill	81.2 - 81.5		

ft bgs = feet below ground surface.
PVC = polyvinyl chloride

2.2.5 Well 299-W22-124 (C9583)

Borehole C9583 was drilled from May 1, 2017 through May 3, 2017 to a TD of 80.2 ft bgs. The borehole was drilled with using 6-in. nominal diameter threaded carbon-steel casing to a depth of 80.5 ft bgs and a 4-in. core barrel to TD. No samples were collected from C9583. No water was added to the borehole during drilling, however eight ounces of water was added at 50.6 ft prior to well construction. Radiological contamination encountered during drilling is summarized in Table 2-9

Following placement of the 6-in. temporary casing, the borehole was logged on May 4, 2017 and May 04, 2017 using SGLS from ground surface to a depth of 79.02 ft bgs and NMLS from ground surface to a depth of 80.00 ft bgs.

Well construction took place May 22, 2017 through May 30, 2017. Well construction information is summarized in Table 2-10 and in documentation contained in Appendix E. The well was constructed as a 2-in. nominal diameter monitoring well with 80.39 ft of Schedule 40 PVC, including an end cap. Fifteen individual resistivity electrodes were installed on the well at 3-ft intervals from 29.90 to 71.90 ft bgs. Six individual thermistors were installed on the well every 6 ft from 31.5 to 43.5 ft bgs and 55.50 to 67.50 ft bgs. Three additional thermistors were installed at 3-ft intervals from 43.50 to 55.50 ft bgs. Five

gas samplers were installed on the well at 6-ft intervals from 37.50 to 61.50 ft bgs. A temperature sensing cable was installed on the well from 0.17 to 78.00 ft bgs. From TD to surface, the annulus was filled with 54.15 ft of alternating 1.50-ft intervals of 200 mesh and 100 mesh filter pack sand, 6.20 ft of 3/8-in. bentonite crumbles, and a 20.05 ft of cement grout. All temporary casing was removed during well construction. The flush mount monument, and surface seal, were installed on May 30, 2017.

Table 2-9. Radiological Monitoring Measurements Exceeding Background at Well C9583

Date	Depth (ft bgs)	Media	Radiological Contamination (dpm, beta/gamma)
5/1/2017	22.0 – 27.0	Sediment	Direct, $5x10^3$
5/1/2017	27.0 – 32.0	Sediment	Direct, $80x10^3$
5/1/2017	32.0 – 37.0	Sediment	Direct, $200x10^3$
5/1/2017	37.0 – 42.0	Sediment	Direct, $120x10^3$
5/1/2017	42.0 – 47.0	Sediment	Direct, $120x10^3$
5/2/2017	47.0 – 52.0	Sediment	Direct, $50x10^3$
5/2/2017	53.5 – 60.1	Sediment	Direct, $14x10^3$
5/2/2017	60.1 – 67.0	Sediment	Direct, $8x10^3$
5/3/2017	67.0 – 69.5	Sediment	Direct, $6.5x10^3$

dpm = disintegrations per minute.
ft bgs = feet below ground surface.
ppmv = part per million by volume.
VOC = volatile organic compound.

Table 2-10. C9583 Well Construction and Sensor-Array Placement Information

Permanent Casing	Permanent Casing Interval (ft bgs)	Annual Fill Material	Annual Fill Interval (ft bgs)	Sensor	Depth of Sensor (ft bgs)
2-in. Schedule 40, PVC Blank Casing	0.17 – 80.40	Cement grout	0.00 – 20.05	Temperature Sensor Cable	0.17 – 78.00
		3/8-in. bentonite crumbles	20.05 – 26.25		
		200 mesh sand	26.25 – 27.75		
		100 mesh sand	27.75 – 29.27		
		200 mesh sand	29.27 – 30.70	Electrode	30.00
		100 mesh sand	30.70 – 32.10	Thermistor	31.50
		200 mesh sand	32.10 – 33.82	Electrode	33.00
		100 mesh sand	33.82 – 35.22		
		200 mesh sand	35.22 – 36.80	Electrode	36.00
		100 mesh sand	36.80 – 38.25	Thermistor / Gas Sampler	37.50
		200 mesh sand	38.25 – 39.79	Electrode	39.00
		100 mesh sand	39.79 – 41.22		
		200 mesh sand	41.22 – 42.80	Electrode	42.00
		100 mesh sand	42.80 – 44.20	Thermistor / Gas Sampler	43.50
		200 mesh sand	44.20 – 45.80	Electrode	45.00
		100 mesh sand	45.80 – 47.20	Thermistor	46.50
		200 mesh sand	47.20 – 48.75	Electrode	48.00
		100 mesh sand	48.75 – 50.15	Thermistor / Gas Sampler	49.50

Table 2-10. C9583 Well Construction and Sensor-Array Placement Information

Permanent Casing	Permanent Casing Interval (ft bgs)	Annual Fill Material	Annual Fill Interval (ft bgs)	Sensor	Depth of Sensor (ft bgs)
2-in. Schedule 40, PVC Blank Casing	0.17 – 80.40	200 mesh sand	50.15 – 51.85	Electrode	51.00
		100 mesh sand	51.85 – 53.22	Thermistor	52.50
		200 mesh sand	53.22 – 54.65	Electrode	54.00
		100 mesh sand	54.65 – 56.12	Thermistor / Gas Sampler	55.50
		200 mesh sand	56.12 – 57.70	Electrode	57.00
		100 mesh sand	57.70 – 59.15		
		200 mesh sand	59.15 – 60.64	Electrode	60.00
		100 mesh sand	60.64 – 62.25	Thermistor / Gas Sampler	61.50
		200 mesh sand	62.25 – 63.77	Electrode	63.00
		100 mesh sand	63.77 – 65.25		
		200 mesh sand	65.25 – 66.65	Electrode	66.00
		100 mesh sand	66.65 – 68.25	Thermistor	67.50
		200 mesh sand	68.25 – 69.72	Electrode	69.00
		100 mesh sand	69.72 – 71.22		
		200 mesh sand	71.22 – 80.40	Electrode	72.00
		Natural fill	80.40 – 80.50		

ft bgs = feet below ground surface.
PVC = polyvinyl chloride

3 Geologic Observations

This section summarizes the general geology in 200-WA-1 OU and present the stratigraphy encountered during the drilling of each well. Due to radiological contamination, no sieve analyses were performed on sediment samples. Drill cuttings containment requirements resulted in very limited visual observations of geologic properties such as, grain size distribution, lithology, and mineralogy. As such, all reported geologic observations are estimated.

3.1 Geology of the 200-WA-1 Operable Unit

The 200-WA-1 OU is located on the 200 West Area of the Hanford site and includes most waste sites located in the 200 West Area. The Columbia River Basalt Group and a sequence of overlying sediments comprise the local geology. The overlying sediments are approximately 564 ft thick and primarily consist of the Ringold Formation, Cold Creek unit, and Hanford formation. The boreholes drilled to support this project did not extend into the Cold Creek unit and the only major stratigraphic unit encountered was the Hanford formation.

Depending on proximity to former facilities and remediation sites, the ground surface of the 200 Areas has been disturbed by grading, construction, and demolition work. Anthropogenically-disturbed sediments can extend more deeply, but in general range from 1 to 15 ft bgs.

The Hanford formation underlies any anthropogenically-disturbed sediment and largely consists of cataclysmic flood deposits related to episodic ice dam failures at glacial Lake Missoula that resulted in varying grain size from high-energy gravel rich deposits to low-energy silts and sands. Floodwaters scoured hundreds of miles of the Columbia River Flood basalts, resulting in sediments predominately composed of sandy gravel or gravelly sand lithology, and occasionally finer lithology formed from slackwater facies. The sand fraction consists of loose, fine-to-course-grained sand, composed of, on average, 50% mafic-rich minerals and 50% silicates. This gives many of the Hanford formation sediments a “salt and pepper” appearance (DOE/RL-2002-39, *Standardized Stratigraphic Nomenclature for Post-Ringold Formation Sediments Within the Central Pasco Basin*).

3.2 Borehole Geology

The following section summarizes the lithology encountered during the drilling of each well.

3.2.1 Borehole Geology for C9515 (299-W22-117)

Sediments encountered during drilling of C9515 were predominately sandy gravel, sand, or silty sand. The upper 29.3 ft of the borehole was characterized as sandy gravel composed of 45% gravel and 55% sand with gravel-size varying from very fine to very coarse pebble and poorly sorted sand. Sand, composed of 95% very fine to coarse sand and 5% silt was encountered from 29.3 ft to 81.2 ft bgs. Within the sand interval, a distinctive silty sand layer was evident from 49.0 to 50.0 ft bgs, comprised of 80% sand and 20% silt.

From 81.2 to 87.3 ft bgs (TD), no sediment identification occurred due to re-drilling the borehole. During re-drilling, annular material was mixed in with native formation and no representative samples could be recovered.

3.2.2 Borehole Geology for C9517 (299-W22-119)

Sediments encountered in the upper 27 ft of the C9517 borehole, consist of between gravelly sand composed of 25% gravel and 75% sand with clast-sizes varying from very fine to very coarse pebble and grain-sizes varying from very fine to coarse sand.

Between 27.0 and 81.5 ft bgs (TD), sediments were sleeved in yellow plastic for radiological control; therefore, visual observation was not possible.

3.2.3 Borehole Geology for C9518 (299-W22-120)

The sediments encountered during the drilling of borehole C9518 predominately consist of sandy gravel and sand, with interbedded silty sand intervals. The upper 10 ft of the borehole was characterized as sand consisting of 5% gravel, 90% sand, and 5% silt. Underlying the upper sand interval to a depth of 30.8 ft bgs, sediments coarsen to sandy gravel composed of 35% gravel, 60% sand, 5% silt, with fine to medium pebbles and very fine to very coarse sand. An approximately 0.5 ft thick sand-to silty sand was noted at 30.8 ft bgs consisting of 95% sand and 5% silt. At 31.3 ft bgs, sediments change from sand to silty sand, which is present until 41.4 ft bgs, corresponding to an increase in silt content from 5 to 25%.

The interval from 41.4 to 79.7 ft bgs predominately consists of sand composed of 95% sand and 5% silt with very fine to very coarse sand grain-size. Within this sand, intervals of slightly silty sand (47.9 to 51.4 ft bgs), gravelly sand (53.4 to 54.4 ft bgs), and silty sand (66.1 to 68.1 ft bgs) were noted.

Below 79.7 ft to a TD of 82.5 ft bgs, sediments coarsen to gravelly sand composed of 20% gravel and 80% sand. Gravel varies from very fine to very coarse pebbles and the sand fraction ranges from very fine to very coarse sand.

3.2.4 Borehole Geology for C9519 (299-W22-121)

Sediments encountered during the drilling of borehole C9519 were predominately sandy gravel, gravelly sand, or sand. The upper 41.3 ft of the borehole consists of sandy gravel with 65% gravel and 35% sand. The gravel fraction varies in size from very fine to medium pebble and the sand fraction varies from very fine to medium sand. A distinct sandy interbed consisting of 5% gravel, 90% sand and 5% silt was noted from 35.8 to 38.3 ft bgs.

At 41.3 ft to a depth of 66.0 ft bgs, grain size gradually increases with sediments transitioning from a sand, to a gravelly sand, and finally to a sandy gravel. The sand interval from 41.3 to 49.0 ft bgs consists of 5% gravel, 90% sand, and 5% silt. Gravel ranges in size from very fine to fine pebbles and sand ranges in grain-size from very fine to very coarse. Gravelly sand occurs from 49.0 to 55.7 ft bgs. Gravel content increases from 5% to 29%, sand content decreases from 90% to 80% and silt content decreases to 0%. Gravel ranges in size from very fine to medium pebbles and sand ranges in grain-size from very fine to very coarse grains. At 55.7 ft bgs, gravel content increases to 45% and sand content decreases to 55% to form a sandy gravel. Gravel ranges in size from very fine to coarse pebbles and sand ranges in grain-size from very fine to very coarse.

Sand is present from 66.0 to 81.5 ft bgs (TD) and consists of 5% gravel and 95% sand. Sand ranges in grain-size from very fine to very coarse sand.

3.2.5 Borehole Geology for C9583 (299-W22-124)

Sediments encountered in the upper 22 ft of borehole C9583, consist of gravelly sand, composed of 25% gravel and 75% sand with gravel content ranging in size from very fine to very coarse pebble and sand ranging in size from very fine to coarse sand.

Between 22.0 and 69.5 ft bgs, sediments were sleeved in yellow plastic for radiological control; therefore, no sediment description occurred over this interval.

Sand was encountered from 69.5 ft to the TD of 80.5 ft bgs. This lower interval consists of 5% gravel ranging in size from very fine to medium pebble, and 95% sand, ranging in size from very fine to very coarse sand.

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4 Waste Management

Waste generated during the activities described in this document were managed in accordance with DOE/RL-2015-46, *Waste Control Plan for the 200-WA-1 Operable Unit Waste Sites Uranium Sequestration Pilot Test*. Waste generated throughout the performance of this project included vadose zone drill cuttings and miscellaneous solid waste such as sampling equipment, plastic, paper, and personal protective equipment. All waste was managed as Investigation-Derived Waste and surveyed by Radiological Control Technicians and Industrial Hygiene personnel prior to transfer and disposal at Environmental Restoration Disposal Facility (ERDF).

All vadose zone drill cuttings were managed near the borehole in tip dumpsters, and then placed in designated waste roll off boxes. Miscellaneous solid waste associated with drill cuttings, including nitrile gloves, plastic bags used to collect drill cuttings, and other waste associated with sampling activities, were contained in plastic bags and placed in the designated roll off box. Following surveys, roll off boxes were transported to the ERDF for disposal.

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 *North American Vertical Datum of 1988* (NAVD88) and the horizontal coordinates were recorded using the Washington State Plane (South Zone) *North American Datum of 1983* (NAD83), with the 1991 adjustment for horizontal coordinates. Surveyed coordinates and elevation for each well are presented in Table 1-1 and survey data reports are included in Appendix F.

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 CHPRC and Cascade (drilling contractor) participated in the acceptance inspection for C9515, C9517, C9518, C9519, and C9583 on July 3, 2017. 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.

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

GW-068, 2017, REV. 1, *The Installation of One Injection Well and Four Vapor Monitoring Wells in the 200-WA-1 Operable Unit, FY 2017*

Other References:

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq., Pub. L. 107-377, December 31, 2002. Available at: https://elr.info/sites/default/files/docs/statutes/full/cercla.pdf

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NAD83, 1991, *North American Datum of 1983*, as revised, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland, as revised. Available at: http://www.ngs.noaa.gov/.

NAVD88, 1988, *North American Vertical Datum of 1988*, as revised, National Geodetic Survey, Federal Geodetic Control Committee, Silver Spring, Maryland. Available at: http://www.ngs.noaa.gov/.

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq. Available at: http://www.epa.gov/rcraonline/.

SGW-58715, 2017, *Description of Work for the Installation of One Vapor Injection Well, Five Instrumented Monitoring Vapor Wells and Two Characterization Boreholes in the 200-WA-1 Operable Unit in Support of the Uranium Sequestration Pilot Test*, 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 C9515 (299-W22-117)

Contents

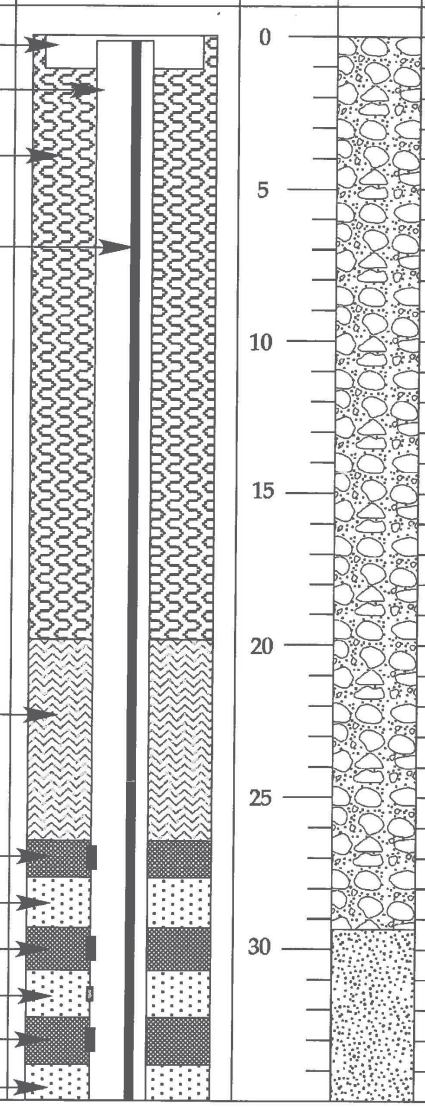
Well Summary Sheet …….….....A-1
Borehole Log …….…..A-4
Continuous Core Sediment Sample Collection Summary for C9515.…….…….....A-7
Log Data Report……A-11

WELL SUMMARY SHEET

Well ID : C9515	Well Name: 299-W22-117	Start Date: 4/24/2017
Project: Installation of 5 wells in 200-WA-1 OU	Location: ~12m South of 216-U-8 Crib	Finish Date: 6/19/2017

CONSTRUCTION DATA

Description	Diagram
Flush Mount Monument	
2-in I.D. Schedule 40, PVC Blank Casing: 0.17 - 72.89 ft bgs	
Type I/II Portland Cement Grout: 0.0 - 19.85 ft bgs	
Temperature Sensor Cable: 0.17 - 78.0 ft bgs	
Resistivity Electrode Array: Individual sensors installed every 3 ft between: 27 - 72 ft bgs.	
Thermistor: Individual thermistors installed every 6 ft between: 31.5 - 43.5 and 55.5 - 67.5 ft bgs. Individual thermistors installed every 3 ft between: 43.5 - 55.5 ft bgs.	
Gas Sampler: Individual samplers installed every 6 ft between: 37.5 - 61.5 ft bgs.	
3/8-in Bentonite Crumbles: 19.85 - 26.23 ft bgs	
200 mesh Premier Silica Filter Pack Sand: 26.23 - 27.80 ft bgs	
100 mesh Premier Colorado Silica Filter Pack Sand: 27.80 - 29.30 ft bgs	
200 mesh 29.30 - 30.61 ft bgs	
100 mesh 30.61 - 32.14 ft bgs	
200 mesh 32.14 - 33.80 ft bgs	
100 mesh 33.80 - 35.15 ft bgs	



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
0		0.0 - 29.3 sandy Gravel (sG)
5		
10		
15		
20		
25		
30		29.3 - 49.0 Sand (S)

Reported By:

Tracy Mallgren	Geologist	[signature]	8-8-17
Print Name	*Title*	*Signature*	*Date*

Reviewed By:

Kelly Whitley	Well Coordinator	Kelly Whitley	8/21/17
Print Name	*Title*	*Signature*	*Date*

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OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

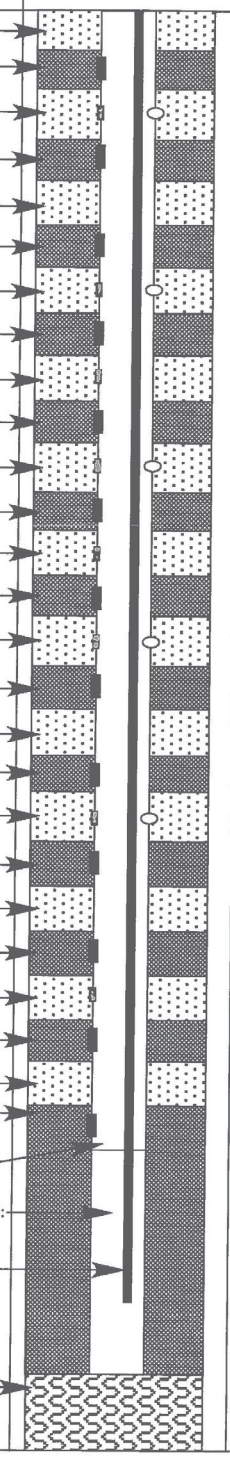
WELL SUMMARY CONTINUATION SHEET

Page 2 of 3

Well ID: C9515	Well Name: 299-W22-117	Project	Installation of 5 wells in 200-WA-1 OU

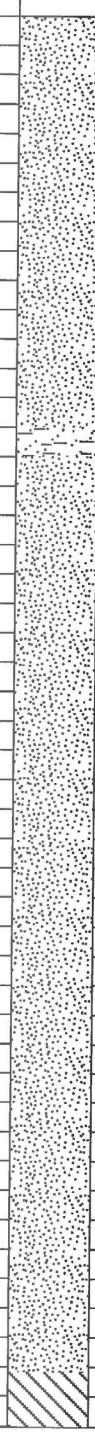
CONSTRUCTION DATA

Description	Diagram
100 mesh 33.80 - 35.15 ft bgs	
200 mesh 35.15 - 36.77 ft bgs	
100 mesh 36.77 - 38.39 ft bgs	
200 mesh 38.39 - 39.89 ft bgs	
100 mesh 39.89 - 41.36 ft bgs	
200 mesh 41.36 - 42.75 ft bgs	
100 mesh 42.75 - 44.24 ft bgs	
200 mesh 44.24 - 45.85 ft bgs	
100 mesh 45.85 - 47.22 ft bgs	
200 mesh 47.22 - 48.78 ft bgs	
100 mesh 48.78 - 50.35 ft bgs	
200 mesh 50.35 - 51.76 ft bgs	
100 mesh 51.76 - 53.31 ft bgs	
200 mesh 53.31 - 54.83 ft bgs	
100 mesh 54.83 - 56.26 ft bgs	
200 mesh 56.26 - 57.77 ft bgs	
100 mesh 57.77 - 59.25 ft bgs	
200 mesh 59.25 - 60.87 ft bgs	
100 mesh 60.87 - 62.29 ft bgs	
200 mesh 62.29 - 63.86 ft bgs	
100 mesh 63.86 - 65.27 ft bgs	
200 mesh 65.27 - 66.79 ft bgs	
100 mesh 66.79 - 68.38 ft bgs	
200 mesh 68.38 - 69.73 ft bgs	
100 mesh 69.73 - 71.13 ft bgs	
200 mesh 71.13 - 80.40 ft bgs	
2-in I.D. Schedule 40, PVC Blank Casing: 0.17 - 72.89 ft bgs	
2-in I.D. Schedule 40, PVC Blank Casing Sump: 72.89 - 80.40 ft bgs	
Temperature Sensor Cable: 0.17 - 78 ft bgs	
Type I/II Portland Cement Grout: 80.40 - 83.20 ft bgs	



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
35		29.3 - 49.0 Sand (S)
40		
45		
50		49.0 - 50.0 silty Sand (mS) 50.0 - 81.2 Sand (S)
55		
60		
65		
70		
75		
80		81.2 - 87.3 No sediment identification



A-6006-992 (Rev 2)

WELL SUMMARY CONTINUATION SHEET

Well ID: C9515	Well Name: 299-W22-117	Project	Installation of 5 wells in 200-WA-1 OU

CONSTRUCTION DATA			GEOLOGIC/HYDROLOGIC DATA	
Description	Diagram	Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
Natural fill: 83.20 - 87.30 ft bgs		85		81.2 - 87.3 No sediment identification
				Total Depth: 87.3 (6/8/2017)
		90		
		95		
		100		
		105		
		110		
		115		
		120		
		125		
Depths are in feet below ground surface. Borehole drilled with 6-in O.D. casing from 0.0 - 85.5 ft bgs. All temporary drill casing was removed from the ground.		130		

A-6006-992 (Rev 2)

BOREHOLE LOG

Page 1 of 3

Date: 6/29/17

Well ID: C9515 | Well Name: 299-W22-117 | Location: ~12m South of 216-U-8 Crib

Project: 5 wells in 200-WA-1 OU | Reference Measure Point: Ground Surface

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
0			0-29.3: Sandy Gravel (sG) 45%g, 55%s	Sonic drilling with 6-in OD
			Sand: vf-vc grained, m=avg, sub-ang	Temp. casing 0-80.5' bgs
			Gravel: 2-40mm, vf-vc pebble, sub ang	Continuous core sampling
			to sub rounded	with 3 3/4" LEXAN Liners
				from 29.3-81.2' bgs.
5				Soil classifications are
				estimated based on
				visual inspection through
				LEXAN Liners.
10				
15				
20				
25				
				RAD contamination (beta/gamma)
				29.3-32.3: 15,000 dpm direct
30			29.3-49: Sand (S): 95% Sand, 5% m	31.0-34.0: 440,000 dpm direct
			Sand vf-c grained m=avg,	33.6-36.6: 360,000 dpm direct
				36.7-37.7: 360,000 dpm direct

Reported By:

Print Name	Title	Signature	Date
Tracy Mallgren	Geologist		6/29/17

Reviewed By:

Print Name	Title	Signature	Date
Sarah Springer	geologist (LG)		09-05-17

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Page 2 of 3

Date: 6/29/17

Well ID: C9515 | Well Name: 299-W22-117 | Location: ~12 m South of 216-U-8 Crib

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
35			29.3-49: Sand (S) 95% sand, 5% m Sand vf-c grained m= avg.	Sonic drilling with 6-in OD Temp. casing 0-80.5' bgs Continuous core sampling with LEXAN Liners 29.3-81.2' bgs. Soil classifications based on visual inspection through lexan liners.
40				
				RAD contamination (beta/gamma)
45				39.3-42.3: 249,000 dpm direct
				42.0-45.0: 160,000 dpm direct
				46.7-49.7: 120,000 dpm direct
				49.6-52.6: 50,000 dpm direct
			49-50': silty Sand (mS) 21% silt, 79% sand	
50			Sand vf-f grained	
				52.8-57.9: 8,000 dpm direct
			50-81.2: Sand (S) 95% sand 5% silt Sand: vf-vc grained, sub ang, mod sorted	
55				
				58.3-61.3: 10,000 dpm direct
60				60.7-63.7: 15,000 dpm direct
65				65.9-68.9: 6,000 dpm direct
				68.2-75.1: 3,000 dpm direct
70				

Reported By:

Print Name	Title	Signature	Date
Tracy Mallgren	Geologist		6/29/17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Page 3 of 3

Date: 6/29/17

Well ID: C9515 | Well Name: 299-W22-117 | Location: ~12m South of 216-W-8 crib

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
75			50-81.2: Sand (SS) 95% sand 5% silt	Sonic drilling with 6-in OD
			Sand vf-vc grained, sub ang - mod sorted	Temp. casing 0-85.5' bgs
				Continuous core sampling
				w/ LEXAN Liners 29.3-
				81.2' bgs. Soil classification
80			81.2-87.3 No sediment identification	estimated based on visual
			TD=87.3 (6/8/17)	observation through
			6-in casing to 85.5'	LEXAN liners.
85				

Reported By:

Tracy Mallgren — Print Name | Geologist — Title | Signature | 6/29/17 — Date

A-6006-993 (REV 0)

Continuous Core Sediment Sample Collection Summary for C9515

Date	Interval Depth (ft bgs)	Recovery (%)	HEIS #	Rad Screen HEIS #
4/25/2017	29.3 – 29.8	100%	B38XB5	B38X94
	29.8 – 30.3		B38XB6	
	30.3 – 30.8		B38XB7	
	30.8 – 31.3		B38XB8	
	31.3 – 31.8		B38XB9	
	31.8 – 32.3		B38XC0	
4/25/2017	31.0 – 31.5	100%	B38XC5	B38X95
	31.5 – 32.0		B38XC6	
	32.0 – 32.5		B38XC7	
	32.5 – 33.0		B38XC8	
	33.0 – 33.5		B38XC9	
	33.5 – 34.0		B38XD0	
4/25/2017	33.6 – 34.1	100%	B38XD5	B38X96
	34.1 – 34.6		B38XD6	
	34.6 – 35.1		B38XD7	
	35.1 – 35.6		B38XD8	
	35.6 – 36.1		B38XD9	
	36.1 – 36.6		B38XF0	
4/25/2017	35.7 – 36.2	100%	B38XF5	B38X97
	36.2 – 36.7		B38XF6	
	36.7 – 37.2		B38XF7	
	37.2 – 37.7		B38XF8	
4/25/2017	39.3 – 39.8	100%	B38XH5	B38X98
	39.8 – 40.3		B38XH6	
	40.3 – 40.8		B38XH7	
	40.8 – 41.3		B38XH8	
	41.3 – 41.8		B38XH9	
	41.8 – 42.3		B38XJ0	

Continuous Core Sediment Sample Collection Summary for C9515

Date	Interval Depth (ft bgs)	Recovery (%)	HEIS #	Rad Screen HEIS #
4/25/2017	42.0 – 42.5	100%	B38XJ5	B38X99
	42.5 – 43.0		B38XJ6	
	43.0 – 43.5		B38XJ7	
	43.5 – 44.0		B38XJ8	
	44.0 – 44.5		B38XJ9	
	44.5 – 45.0		B38XK0	
4/26/2017	46.7 – 47.2	100%	B38XK5	B38XB0
	47.2 – 47.7		B38XK6	
	47.7 – 48.2		B38XK7	
	48.2 – 48.7		B38XK8	
	48.7 – 49.2		B38XK9	
	49.2 – 49.7		B38XL0	
4/26/2017	49.6 – 50.1	100%	B38XL5	B38XB1
	50.1 – 50.6		B38XL6	
	50.6 – 51.1		B38XL7	
	51.1 – 51.6		B38XL8	
	51.6 – 52.1		B38XL9	
	52.1 – 52.6		B38XM0	
4/26/2017	52.8 – 53.3	50%	B38XM5	B38XB2
	53.3 – 53.8		B38XM6	
	53.8 – 54.3		B38XM7	
4/26/2017	54.9 – 55.4	100	B38XN5	B38XB3
	55.4 – 55.9		B38XN6	
	55.9 – 56.4		B38XN7	
	56.4 – 56.9		B38XN8	
	56.9 – 57.4		B38XN9	
	57.4 – 57.9		B38XP0	

Continuous Core Sediment Sample Collection Summary for C9515

Date	Interval Depth (ft bgs)	Recovery (%)	HEIS #	Rad Screen HEIS #
4/26/2017	58.3 – 58.8	100	B38XP5	B38XB4
	58.8 – 59.3		B38XP6	
	59.3 – 59.8		B38XP7	
	59.8 – 60.3		B38XP8	
	60.3 – 60.8		B38XP9	
	60.8 – 61.3		B38XR0	
4/26/2017	60.7 – 61.2	100	B396B0	B39697
	61.2 – 61.7		B396B1	
	61.7 – 62.2		B396B2	
	62.2 – 62.7		B396B3	
	62.7 – 63.2		B396B4	
	63.2 – 63.7		B396B5	
4/27/2017	65.9 – 66.4	100	B396C0	B39698
	66.4 – 66.9		B396C1	
	66.9 – 67.4		B396C2	
	67.4 – 67.9		B396C3	
	67.9 – 68.4		B396C4	
	68.4 – 68.9		B396C5	
4/27/2017	68.2 – 68.7	100	B396D0	B39699
	68.7 – 69.2		B396D1	
	69.2 – 69.7		B396D2	
	69.7 – 70.2		B396D3	
	70.2 – 70.7		B396D4	
	70.7 – 71.2		B396D5	

Continuous Core Sediment Sample Collection Summary for C9515

Date	Interval Depth (ft bgs)	Recovery (%)	HEIS #	Rad Screen HEIS #
4/27/2017	72.1 – 72.6	100	B397X3	B397W8
	72.6 – 73.1		B397X4	
	73.1 – 73.6		B397X5	
	73.6 – 74.1		B397X6	
	74.1 – 74.6		B397X7	
	74.6 – 75.1		B397X8	
	72.1 – 75.1 (excess sediment)		B397X9	
	72.1 – 75.1 (excess sediment)		B397Y0	
	72.1 – 75.1 (excess sediment)		B397Y1	
	72.1 – 75.1 (excess sediment)		B397Y2	
4/27/2017	74.3 – 74.8	65	B397Y3	-
	74.8 – 75.3		B397Y4	
	75.3 – 75.8		B397Y5	
	75.8 – 76.3		B397Y6	
4/27/2017	78.7 – 79.2	100	B39803	-
	79.2 – 79.7		B39804	
	79.7 – 80.2		B39805	
	80.2 – 80.7		B39806	
	80.7 – 81.2		B39807	

ft bgs = feet below ground surface.
HEIS = Hanford Environmental Information System.

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299-W22-117 (C9515)
Log Data Report

Borehole Information

Log Date	2017-04-28	Filename	C9515_HG-NM_2017-04-28	Site	200-WA-1

DTW[1] (ft)	DTW Date	DTW Source	Drill Date	Total Depth (ft)	Depth Datum
None	N/A	SN3	04/27/17	80.5	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	Sonic	3.0	6.0	5 1/4	3/8	-3.0	80.5

Borehole Notes

The logging engineer measured casing thickness. Drill depth and casing depth were provided by the wellsite geologist. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma 5Tb	Type	60% HPGe SGLS[2]
Effective Calibration Date	02/16/17	Serial No.	54-TP13441B
Calibration Reference	HGLP-CC-152, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 5Cb	Type	Planar HPGe HRLS[3]
Effective Calibration Date	08/04/16	Serial No.	39A314
Calibration Reference	HGLP-CC-142, Rev. 0	Logging Procedure	SGRP-PRO-OP-53050, Rev. 0

Logging System	Gamma 5Pb	Type	NMLS[4] He-3 (CPN 503)
Effective Calibration Date	02/27/17	Serial No.	H34055445
Calibration Reference	HGLP-CC-153, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0

SGLS Log Run Information

Log Run	1	2	3	4	5 Repeat
HEIS Number	1019858	1019859	1019860	1019861	1019862
Date	04/27/17	04/27/17	04/27/17	04/27/17	04/27/17
Logging Engineer	Felt	Felt	Felt	Felt	Felt
Start Depth (ft)	0.0	34.0	39.0	43.0	47.0
Finish Depth (ft)	35.0	44.0	40.0	80.01	54.0
Count Time (sec)	100	15	100	100	300
Live/Real	R	R	R	R	R

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

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Log Run	1	2	3	4	5 Repeat
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	C9515FTB2017 0427AV00CAB 1	C9515FTB2017 0427AV00CAB 1	C9515FTB2017 0427AV00CAB 1	C9515FTB2017 0427AV00CAB 1	C9515FTB2017 0427AV00CAB 1
Start File	AD000000	BD003400	CD003900	DD004300	ED004700
Finish File	AD003500	BD004400	CD004000	DD008001	ED005400
Post-Verification	C9515FTB2017 0427EV00CAA1	C9515FTB2017 0427EV00CAA1	C9515FTB2017 0427EV00CAA1	C9515FTB2017 0427EV00CAA1	C9515FTB2017 0427EV00CAA1
Depth Return Error (in.)	N/A	N/A	N/A	N/A	1.0 high
Comments	No fine gain adjustments made	High rate dead time >70%	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made

HRLS Log Run Information

Log Run	6	7 Repeat			
HEIS Number	1019863	1019864			
Date	04/28/17	04/28/17			
Logging Engineer	Felt	Felt			
Start Depth (ft)	33.0	37.0			
Finish Depth (ft)	43.0	38.0			
Count Time (sec)	300	300			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C9515FCB2017 0428AV00CAB 1	C9515FCB2017 0428AV00CAB 1			
Start File	AD003300	BD003700			
Finish File	AD004300	BD003800			
Post-Verification	C9515FCB2017 0428BV00CAA 1	C9515FCB2017 0428BV00CAA 1			
Depth Return Error (in.)	N/A	0.0			
Comments	No fine gain adjustments made	No fine gain adjustments made			

NMLS Log Run Information

Log Run	8	9 Repeat			
HEIS Number	1019865	1019866			
Date	04/28/17	04/28/17			
Logging Engineer	Felt/Meisner	Meisner			
Start Depth (ft)	0.0	72.0			

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Log Run	8	9 Repeat			
Finish Depth (ft)	80.01	80.01			
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	C9515FPB20170 428AV00CAB1	C9515FPB20170 428AV00CAB1			
Start File	AD000000	BD007200			
Finish File	AD008001	BD008001			
Post-Verification	C9515FPB20170 428BV00CAA1	C9515FPB20170 428BV00CAA1			
Depth Return Error (in.)	N/A	0.0			
Comments	None	None			

Logging Operation Notes

A centralizer was not installed on the SGLS, HRLS, and NMLS sondes. The logging sonde and cable were sleeved in plastic to prevent potentially contaminating the equipment.

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

Analysis Notes

Analyst	P.D. Henwood	Date	05/15/17
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as FTB20170216_CC-152 for the SGLS, using an efficiency function and corrections for casing and dead time as determined during annual response checks.

Results and Interpretations

Cs-137 was detected intermittently from ground surface to 15 ft and from 30 ft to the bottom of the borehole at 80 ft. A high activity interval exists from 33 to 43 ft in depth where a maximum Cs-137 concentration was measured at approximately 21,650 pCi/g at 37 ft.

Pa-234m (manmade U-238) was detected at the margins of the high activity interval at 32 ft and from 46 to 49 ft. The maximum concentration was measured at 855 pCi/g at 32 ft. Although not measured, Pa-234m likely exists in the high activity interval at higher concentrations.

U-235 was detected at 48 ft at a maximum concentration of 62 pCi/g. U-235 likely exists with Pa-234m but is below the minimum detection limit.

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 manmade, KUT, and moisture repeat plots indicate that the respective systems were working properly. The repeat data were acquired at 300 second counting times rather than the standard 100 seconds, resulting in additional detections of Pa-234m and U-235 and improved accuracy where concentrations are near the MDL[5].

[5] minimum detection level

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List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-80 ft)
Natural Gamma Logs (0-80 ft)
Combination Plot (0-80 ft)
Total Gamma & Moisture (0-80 ft)
Manmade Radionuclides Repeat Data (47-54 ft)
Repeat Section of Natural Gamma Logs (47-54 ft)
Moisture Repeat Section (72-80 ft)

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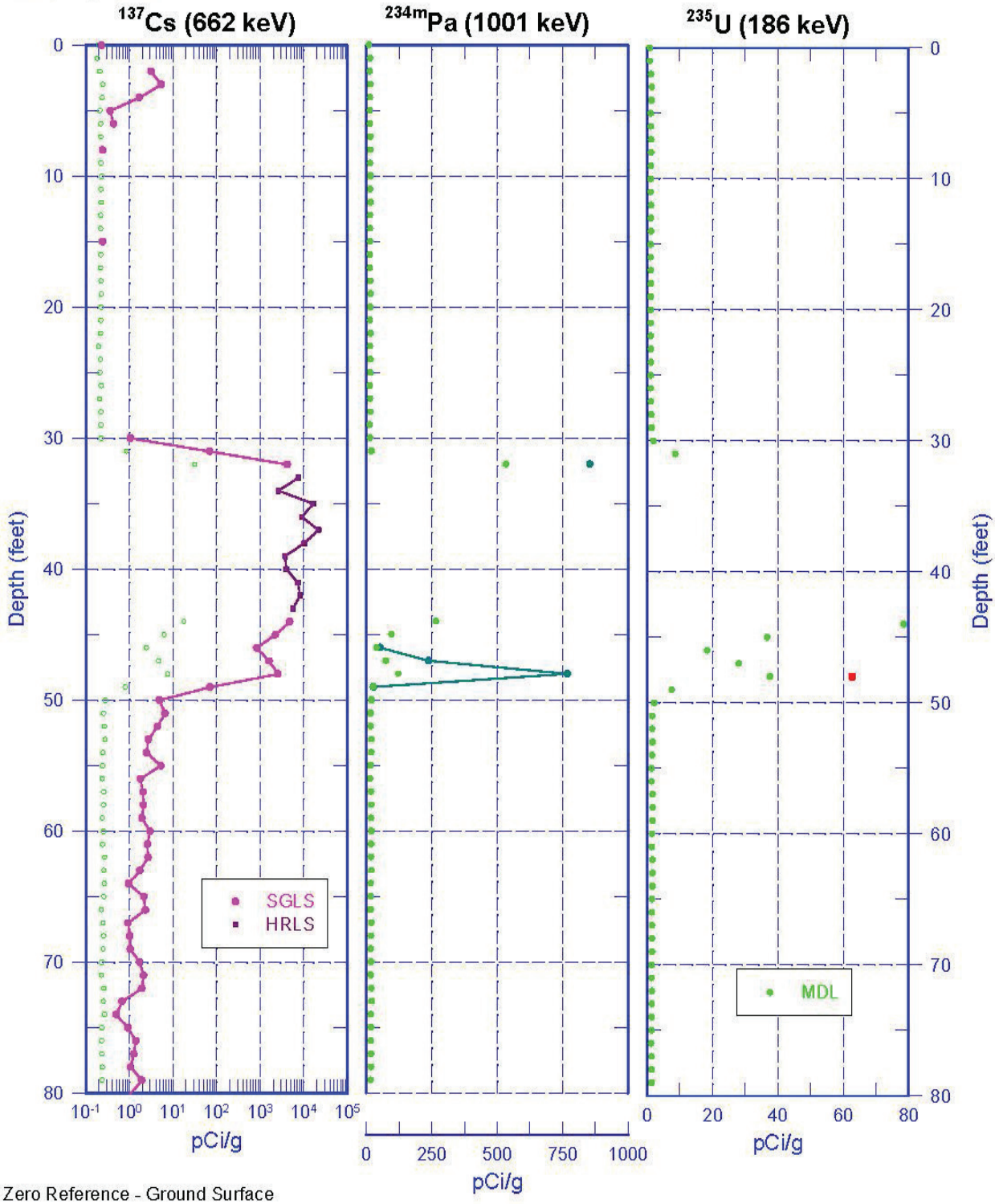
299-W22-117(C9515)
Manmade Radionuclides



Zero Reference - Ground Surface

Stoller Newport News Nuclear
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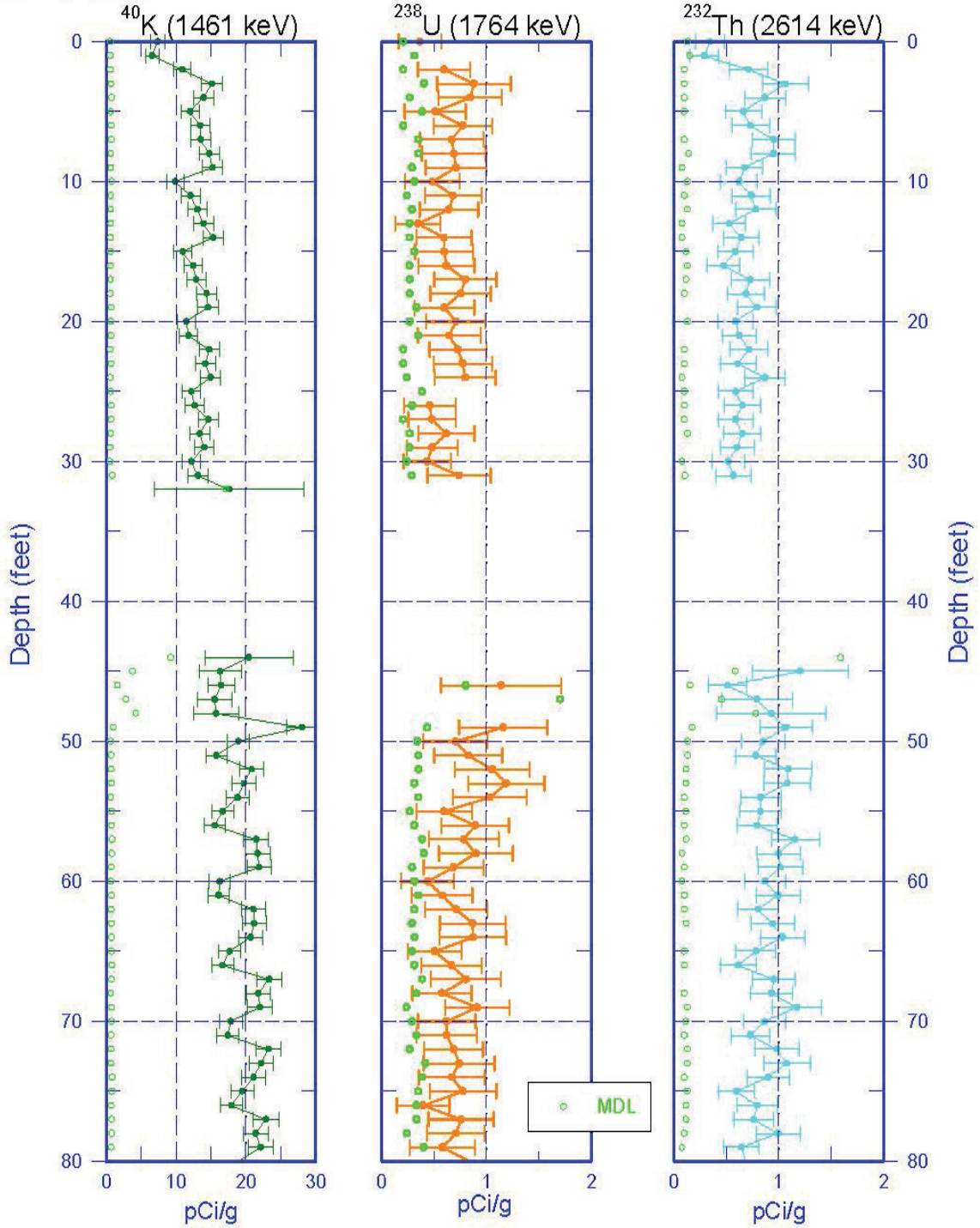
299-W22-117 (C9515)
Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
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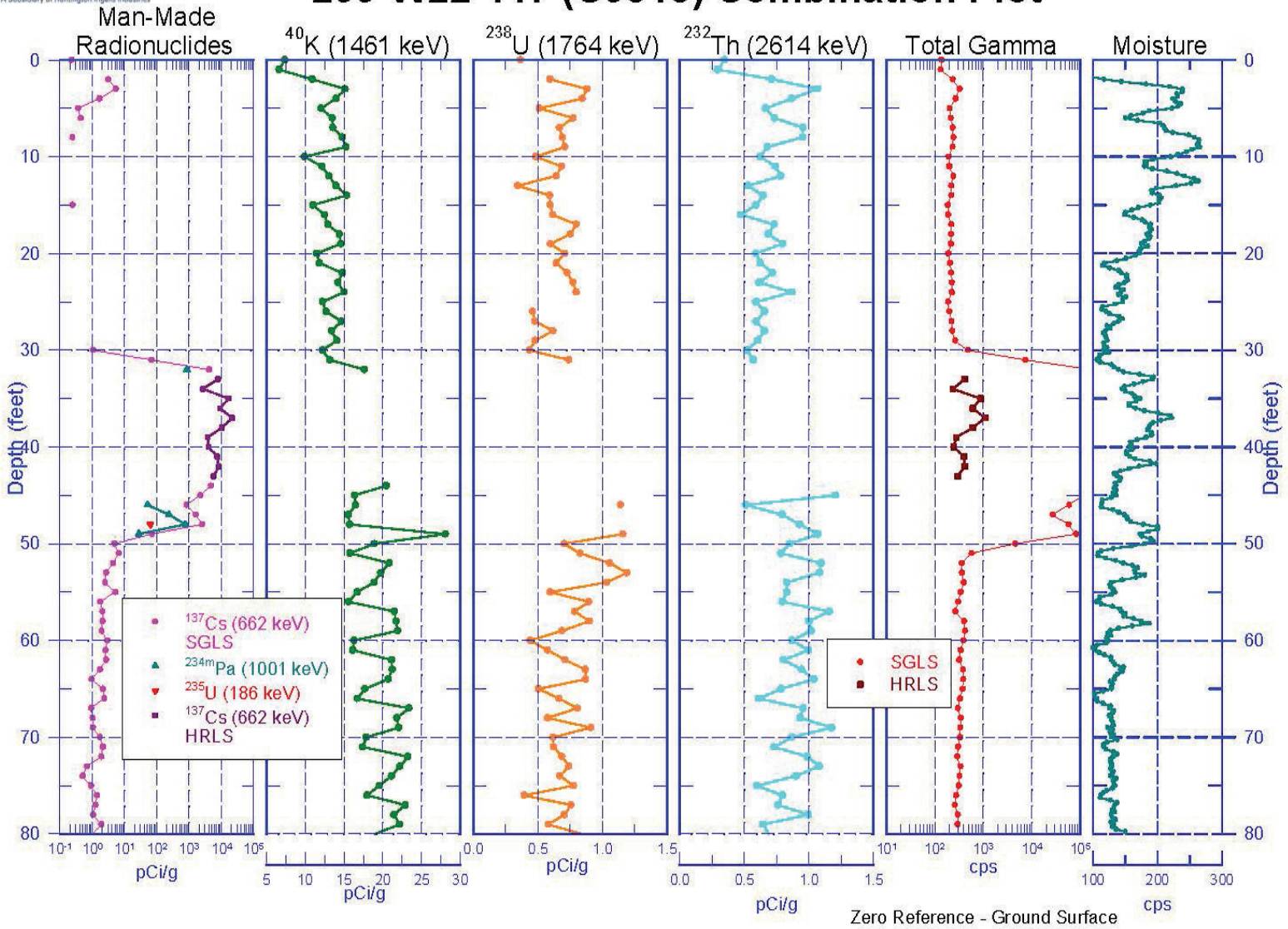
299-W22-117 (C9515) Combination Plot



Stoller Newport News Nuclear
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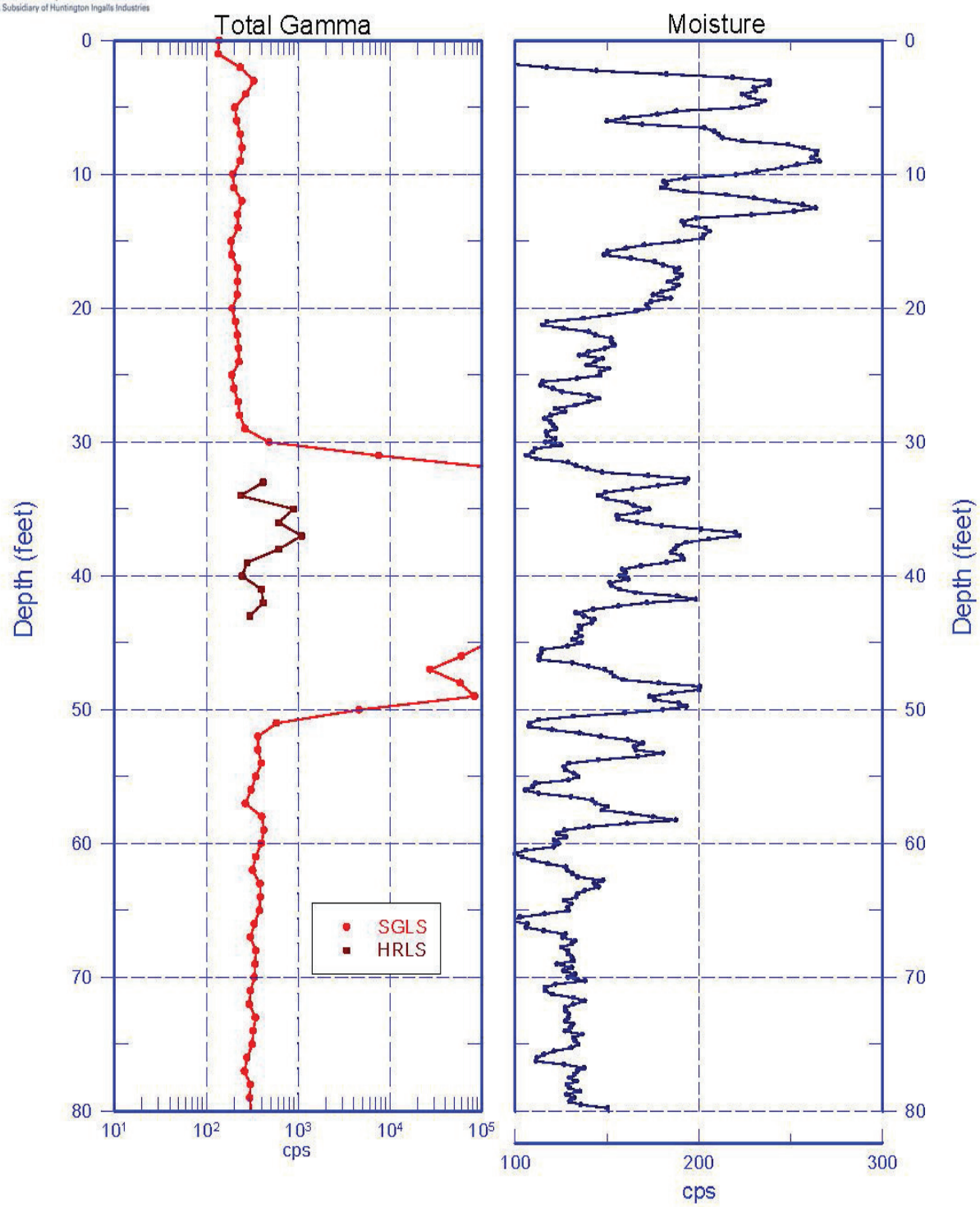
299-W22-117 (C9515)
Total Gamma & Moisture



Zero Reference - Ground Surface

Stoller Newport News Nuclear
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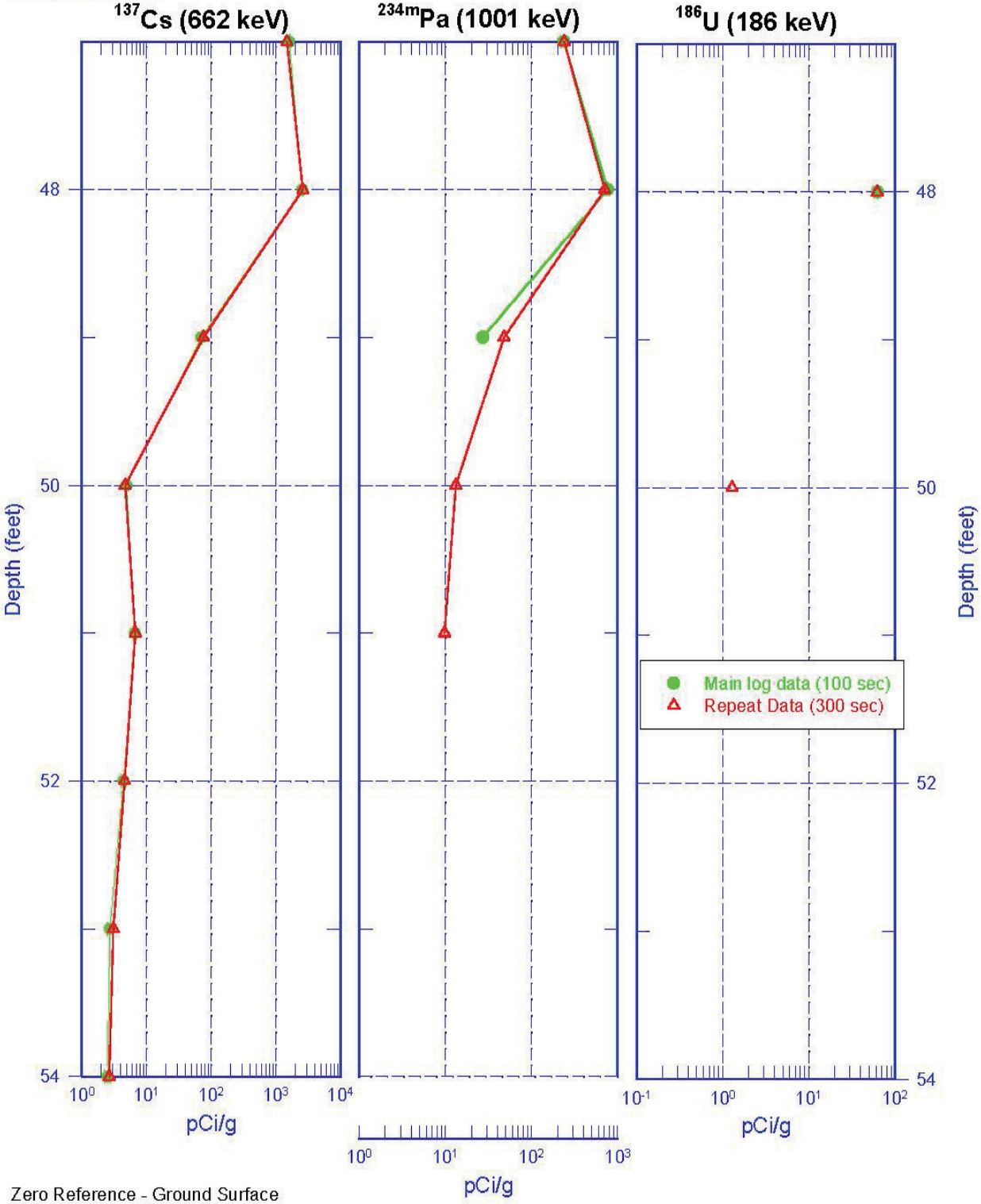
299-W22-117 (C9515)
Manmade Radionuclides Repeat Data



Zero Reference - Ground Surface

Stoller Newport News Nuclear
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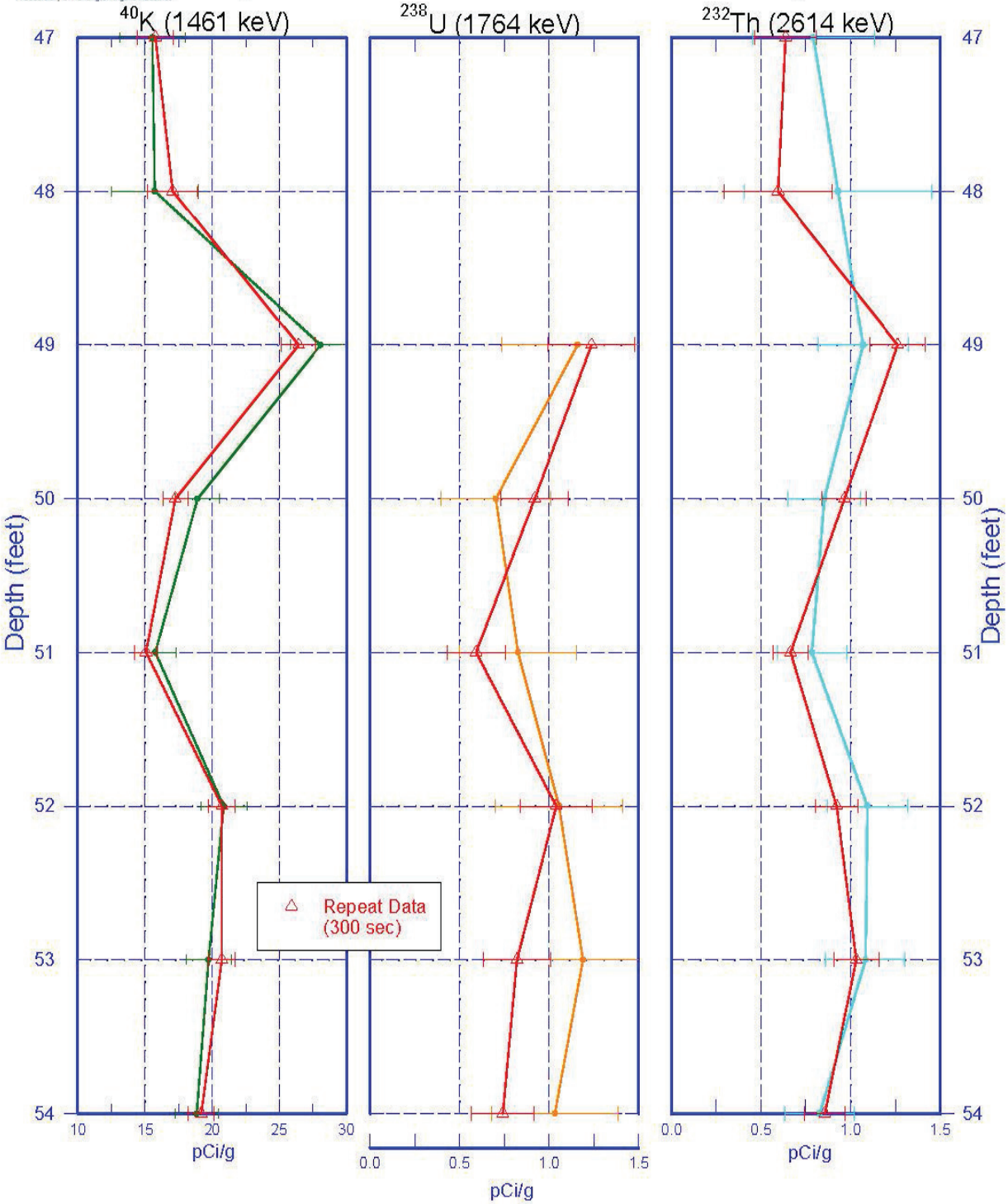
299-W22-117 (C9515)

Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
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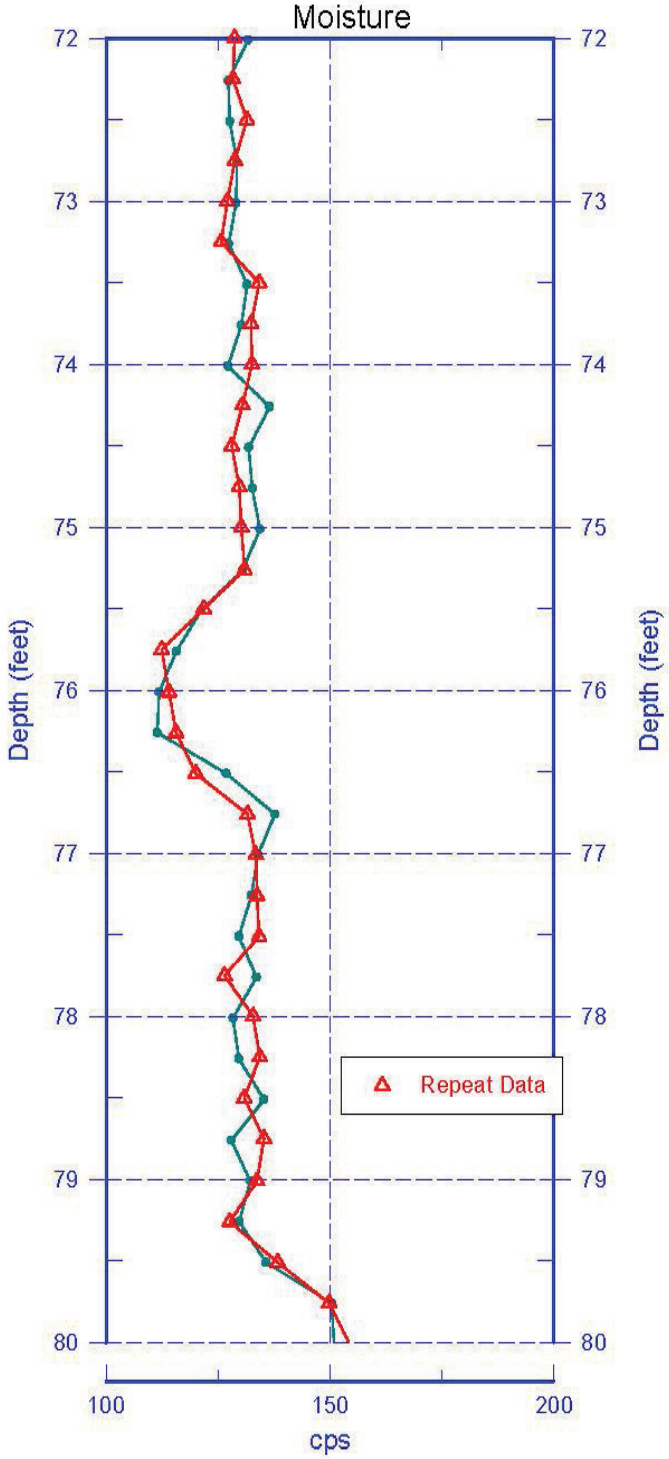
299-W22-117 (C9515)
Moisture Repeat Section



Zero Reference - Ground Surface

Appendix B

Well Documentation for C9517 (299-W22-119)

Contents

Well Summary Sheet …….……....B-1
Borehole Log …….…….....B-3
Log Data Report…….....……B-6

WELL SUMMARY SHEET

Well ID : C9517	Well Name: 299-W22-119	Start Date: 3/29/2017
Project: Installation of 5 wells in 200-WA-1 OU	Location: ~10m South of 216-U-8 Crib	Finish Date: 6/21/2017

CONSTRUCTION DATA

Description

Flush Mount Monument

2-in I.D. Schedule 40, PVC Blank Casing: 0.17 - 72.90 ft bgs

Type I/II Portland Cement Grout: 0.0 - 20.05 ft bgs

Temperature Sensor Cable: 0.17 - 78 ft bgs

Resistivity Electrode Array: Individual sensors installed every 3 ft between: 27 - 72 ft bgs.

Thermistor: Individual thermistors installed every 6 ft between: 31.5 - 43.5 and 55.5 - 67.5 ft bgs. Individual thermistors installed every 3 ft between: 43.5 - 55.5 ft bgs.

Gas Sampler: Individual samplers installed every 6 ft between: 37.5 - 61.5 ft bgs.

3/8-in Bentonite Crumbles: 20.05 - 26.29 ft bgs

200 mesh Premier Silica Filter Pack Sand: 26.29 - 27.65 ft bgs

100 mesh Premier Colorado Silica Filter Pack Sand: 27.65 - 29.30 ft bgs

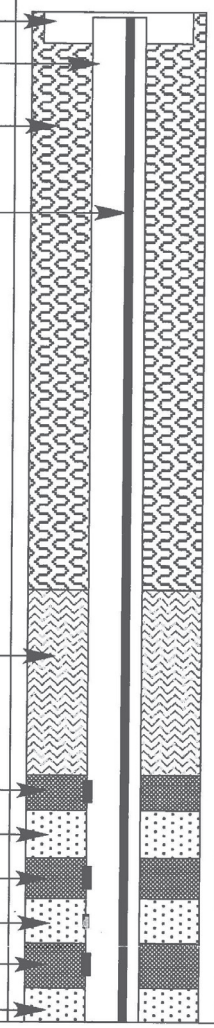
200 mesh 29.30 - 30.72 ft bgs

100 mesh 30.72 - 32.18 ft bgs

200 mesh 32.18 - 33.86 ft bgs

100 mesh 33.86 - 35.28 ft bgs

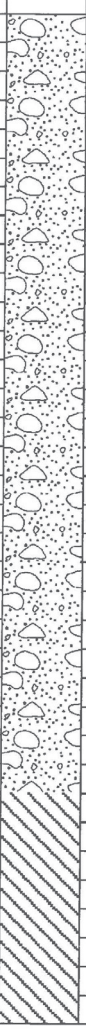
Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 5, 10, 15, 20, 25, 30

Graphic Log



Lithologic Description (ft bgs)

0.0 - 27.0 gravelly Sand (gS)

27.0 - 81.5 No sediment identification

Reported By:				
Tracy Mallgren	Geologist	[signature]	8-8-17
Print Name	*Title*	*Signature*	*Date*

Reviewed By:			
Kelly Whitley	Well Coordinator	Kelly Whitley	8/21/17
Print Name	*Title*	*Signature*	*Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

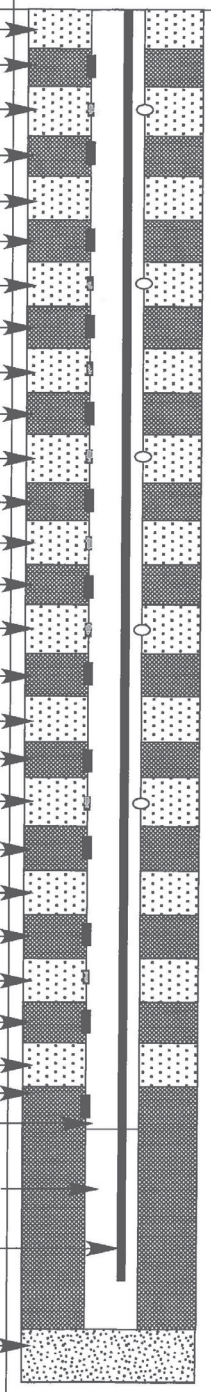
WELL SUMMARY CONTINUATION SHEET

Page 2 of 2

Well ID: C9517	Well Name: 299-W22-119	Project	Installation of 5 wells in 200-WA-1 OU

CONSTRUCTION DATA

Description	Diagram
100 mesh 33.86 - 35.28 ft bgs	
200 mesh 35.28 - 36.67 ft bgs	
100 mesh 36.67 - 38.38 ft bgs	
200 mesh 38.38 - 39.88 ft bgs	
100 mesh 39.88 - 41.28 ft bgs	
200 mesh 41.28 - 42.82 ft bgs	
100 mesh 42.82 - 44.36 ft bgs	
200 mesh 44.36 - 45.87 ft bgs	
100 mesh 45.87 - 47.32 ft bgs	
200 mesh 47.32 - 48.75 ft bgs	
100 mesh 48.75 - 50.38 ft bgs	
200 mesh 50.38 - 51.75 ft bgs	
100 mesh 51.75 - 53.16 ft bgs	
200 mesh 53.16 - 54.73 ft bgs	
100 mesh 54.73 - 56.32 ft bgs	
200 mesh 56.36 - 57.90 ft bgs	
100 mesh 57.90 - 59.30 ft bgs	
200 mesh 59.30 - 60.61 ft bgs	
100 mesh 60.61 - 62.25 ft bgs	
200 mesh 62.25 - 63.89 ft bgs	
100 mesh 63.89 - 65.30 ft bgs	
200 mesh 65.30 - 66.89 ft bgs	
100 mesh 66.89 - 68.37 ft bgs	
200 mesh 68.37 - 69.80 ft bgs	
100 mesh 69.80 - 71.26 ft bgs	
200 mesh 71.26 - 79.75 ft bgs	
2-in I.D. Schedule 40, PVC Blank Casing: 0.17 - 72.90 ft bgs	
2-in I.D. Schedule 40, PVC Blank Casing Sump: 72.90 - 79.75 ft bgs	
Temperature Sensor Cable: 0.17 - 78 ft bgs	
Natural fill 79.75 - 81.5 ft bgs	



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
35		27.0 - 81.5 No sediment identification
40		
45		
50		
55		
60		
65		
70		
75		
80		

Total Depth: 81.5 (4/19/2017)
Depths are in feet below ground surface.
Borehole drilled with 6-in O.D. casing from 0.0 - 80.5 ft bgs.
All temporary drill casing was removed from the ground.

A-6006-992 (Rev 2)

BOREHOLE LOG

Page 1 of 3

Date: 6/29/17

Well ID: C9517 | Well Name: 299-W22-119 | Location: ~10m South of 216-U-8 Crib

Project: 5 wells in 200-WA-1 OU | Reference Measure Point:

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
0			0-27' bgs gravelly Sand (gS) 25% g, 75% s	Sonic drilling with 6-inch
			Sand: vf-c grained, ~35% fel, ang.	Temp. casing from
			Gravel: 2-40mm, poorly sorted, sub ang	0-80.5' bgs. No sediment
			to sub round. Moist.	samples collected from
				borehole.
5				
10				
15				
20				
25				RAD contamination
			27-81.5' bgs: All sediment sleeved in	(beta/gamma)
			yellow plastic for radiological control	27-37: 480,000 dpm direct
		Not used	-no sediment identification-	37-47: 100,000 dpm direct
30		BS 9/13/17		

Reported By: Tracy Mallgren (Print Name) | Geologist (Title) | [signature] (Signature) | 6/29/17 (Date)

Reviewed By: Sarah Springer (Print Name) | geologist (LG) (Title) | [signature] (Signature) | 09-05-17 (Date)

For Office Use Only

OR Doc Type: | WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Page 2 of 3

Date: 6/29/17

Well ID: C9517 | Well Name: 299-W22-119 | Location: ~10m South of 216-U-8 Crib

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
35		Not used by 8/3/17	27-81.5': All sediment sleeved in yellow plastic for radiological control - no sediment identification -	Sonic drilling with 6-in OD temp. casing 0-80.5' bgs. No sediment collected from the borehole.
40				RAD Contamination (beta/gamma) 37-47: 100,000 dpm direct 47-57: 20,000 dpm direct 52-57: 50,000 dpm direct 57-62: 20,000 dpm direct 62-67: 16,000 dpm direct 67-72: 8,000 dpm direct
45				
50				
55				
60				
65				
70				

Reported By:

Print Name	Title	Signature	Date
Tracy Mallgren	Geologist	[signature]	6/29/17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Page 3 of 3

Date: 6/29/17

Well ID: C9517 | Well Name: 299-W22-119 | Location: ~10m South 216-U-8 Crib

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
75			27-81.5: All sediment sleeved in yellow plastic for radiological control	Sonic drilling with 6-inOD Temp. casing 0-80.5'bgs
			— no sediment identification —	No sediment collected from borehole.
			TD = 81.5 (4-19-17)	
80				@ 76.0'bgs 1 gallon H_2O added to aid in sediment recovery.
			NOT USED KT 8/3/17	

Reported By:

Print Name	Title	Signature	Date
Tracy Mallgren	Geologist		6/29/17

A-6006-993 (REV 0)

Stoller Newport News Nuclear

299-W22-119 (C9517)
Log Data Report

Borehole Information

Log Date	2017-04-20	Filename	C9517_HG-NM_2017-04-20	Site	200-WA-1

DTW[1] (ft)	DTW Date	DTW Source	Drill Date	Total Depth (ft)	Depth Datum
None	N/A	SN3	04/19/17	81.5	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	Sonic	0.25	6.0	5 1/4	3/8	-0.25	80.5

Borehole Notes

The logging engineer measured casing thickness. Drill depth and casing depth were provided by the wellsite geologist. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma ALd	Type	60% HPGe SGLS[2]
Effective Calibration Date	01/26/17	Serial No.	47-TP-32211A
Calibration Reference	HGLP-CC-150, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 5Cb	Type	Planar HPGe HRLS[3]
Effective Calibration Date	08/04/16	Serial No.	39A314
Calibration Reference	HGLP-CC-142, Rev. 0	Logging Procedure	SGRP-PRO-OP-53050, Rev. 0

Logging System	Gamma AHd	Type	NMLS[4] He-3 (CPN 503)
Effective Calibration Date	02/23/17	Serial No.	H310700352
Calibration Reference	HGLP-CC-151, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0

SGLS Log Run Information

Log Run	1	2	3	4	5 Repeat
HEIS Number	1019871	1019872	1019873	1019874	1019875
Date	04/20/17	04/20/17	04/20/17	04/20/17	04/20/17
Logging Engineer	Spatz	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	0.0	26.03	33.0	35.98	72.0
Finish Depth (ft)	25.02	34.0	39.0	80.0	80.0
Count Time (sec)	100	100	20	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

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

Stoller Newport News Nuclear

Log Run	1	2	3	4	5 Repeat
Log Speed (ft/min)	N/A	N/A	N/A	N/A	N/A
Pre-Verification	C9517ALD2017 0420AV00CAB 1	C9517ALD2017 0420AV00CAB 1	C9517ALD2017 0420AV00CAB 1	C9517ALD2017 0420AV00CAB 1	C9517ALD2017 0420AV00CAB 1
Start File	AD000000	BD002603	CD003300	DD003598	ED007200
Finish File	AD002502	BD003402	CD003900	DD008000	ED008000
Post-Verification	C9517ALD2017 0420EV00CAA1	C9517ALD2017 0420EV00CAA1	C9517ALD2017 0420EV00CAA1	C9517ALD2017 0420EV00CAA1	C9517ALD2017 0420EV00CAA1
Depth Return Error (in.)	N/A	N/A	N/A	N/A	0.5 high
Comments	No fine gain adjustments made	No fine gain adjustments made	High rate interval at 20 sec count time	No fine gain adjustments made	No fine gain adjustments made

HRLS Log Run Information

Log Run	8	9 Repeat			
HEIS Number	1019876	1019877			
Date	04/20/17	04/20/17			
Logging Engineer	Spatz/Felt	Spatz/Felt			
Start Depth (ft)	32.0	34.0			
Finish Depth (ft)	37.0	34.0			
Count Time (sec)	300	300			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C9517FCB2017 0420AV00CAB 1	C9517FCB2017 0420AV00CAB 1			
Start File	AD003200	BD003400			
Finish File	AD003700	BD003400			
Post-Verification	C9517FCB2017 0420BV00CAA 1	C9517FCB2017 0420BV00CAA 1			
Depth Return Error (in.)	N/A	1.0 high			
Comments	No fine gain adjustments made	No fine gain adjustments made			

NMLS Log Run Information

Log Run	6	7 Repeat			
HEIS Number	1019878	1019879			
Date	04/20/17	04/20/17			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0.0	37.0			
Finish Depth (ft)	80.0	45.0			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	N	N			

Stoller Newport News Nuclear

Log Run	6	7 Repeat			
MSA Interval (ft)	0.25	0.25			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C9517AHD2017 0420AV00CAB 1	C9517AHD2017 0420AV00CAB 1			
Start File	AD000000	BD003700			
Finish File	AD008000	BD004500			
Post-Verification	C9517AHD2017 0420BV00CAA 1	C9517AHD2017 0420BV00CAA 1			
Depth Return Error (in.)	N/A	0.0			
Comments	None	None			

Logging Operation Notes

A centralizer was not installed on the SGLS and NMLS sondes. The logging sonde and cable were sleeved in plastic to prevent potentially contaminating the equipment.

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

Analysis Notes

Analyst	P.D. Henwood	Date	05/24/17
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as ALD20170126_CC-150 for the SGLS, using an efficiency function and corrections for casing and dead time as determined during annual response checks.

Results and Interpretations

Cs-137 was detected almost throughout the borehole. A high activity interval exists from 33 to 35 ft in depth where a maximum Cs-137 concentration was measured at approximately 14,600 pCi/g at 34 ft.

Pa-234m (manmade U-238) was detected at the margins of the high activity interval at 32 and 36 ft and at intermittent depth locations to 80 ft. Even though detections were intermittent, it is possible the manmade uranium exists continuously but at concentrations below the MDL[5] of approximately 16 pCi/g at some depths. The maximum concentration was measured at 1,556 pCi/g at 36 ft. Although not measured, Pa-234m likely exists in the high activity interval at higher concentrations.

U-235 was detected at 75 ft and from 77 to 79 ft at a maximum concentration of 17 pCi/g at 78 ft. U-235 likely exists with Pa-234m but is below the MDL in some cases.

Note: The KUT log plots represent naturally occurring radionuclides (potassium, uranium, and thorium) present in the surrounding formation and are not manmade contaminants.

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

[5] minimum detection limit

List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-80 ft)
Natural Gamma Logs (0-80 ft)
Combination Plot (0-80 ft)
Total Gamma & Moisture (0-80 ft)
Manmade Radionuclides Repeat Data (72-80 ft)
Repeat Section of Natural Gamma Logs (72-80 ft)
Moisture Repeat Section (37-45 ft)

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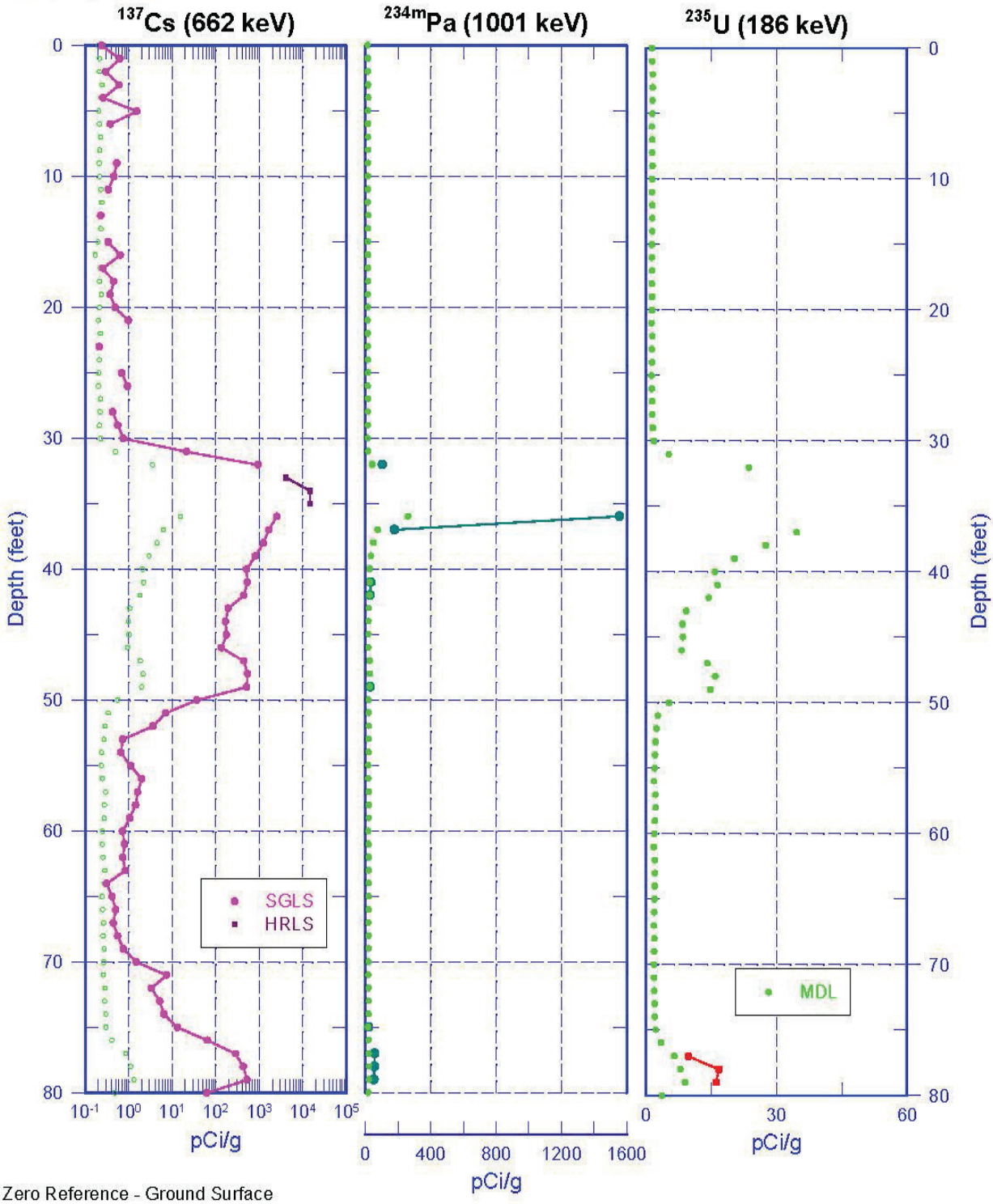
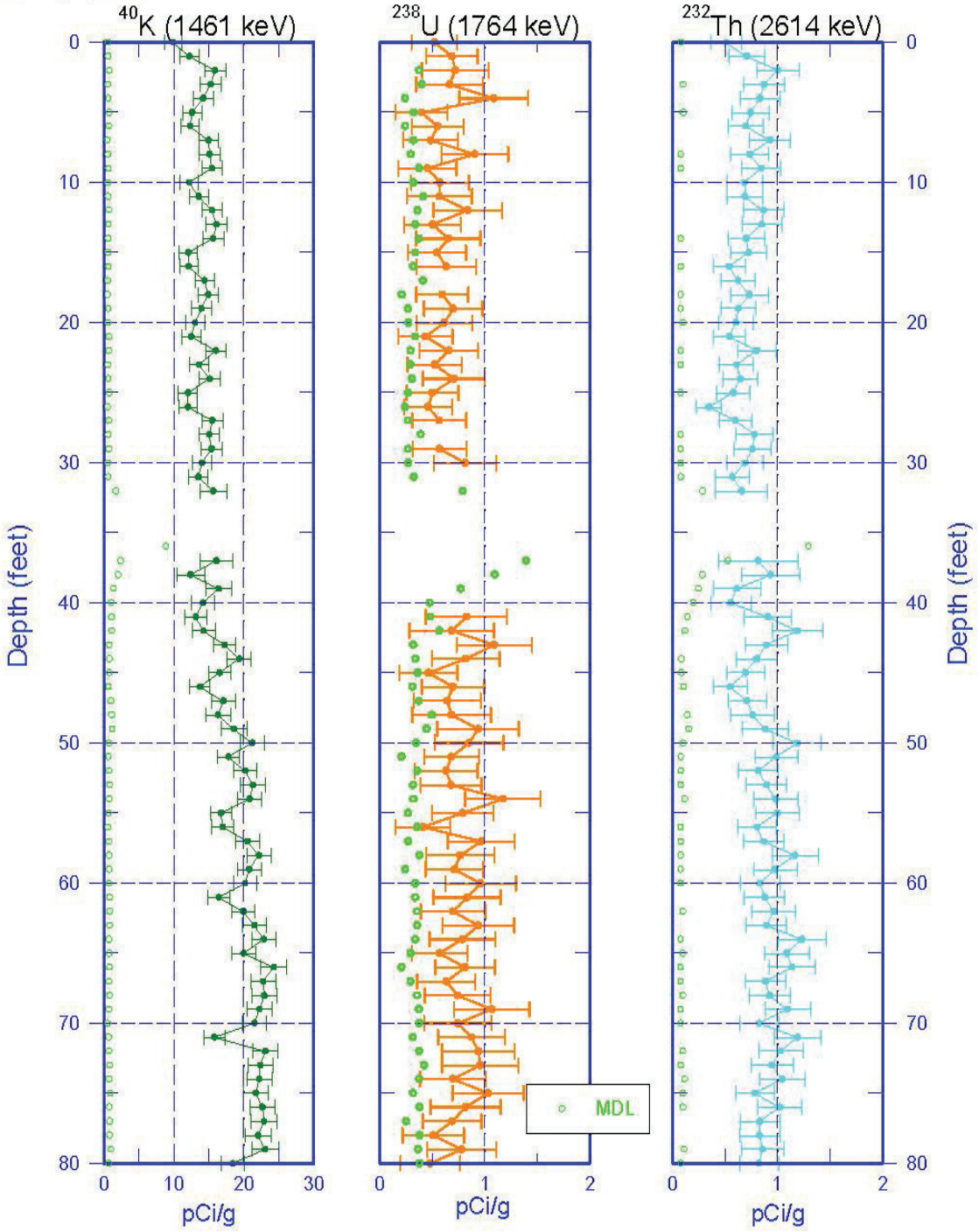
299-W22-119 (C9517)
Manmade Radionuclides



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

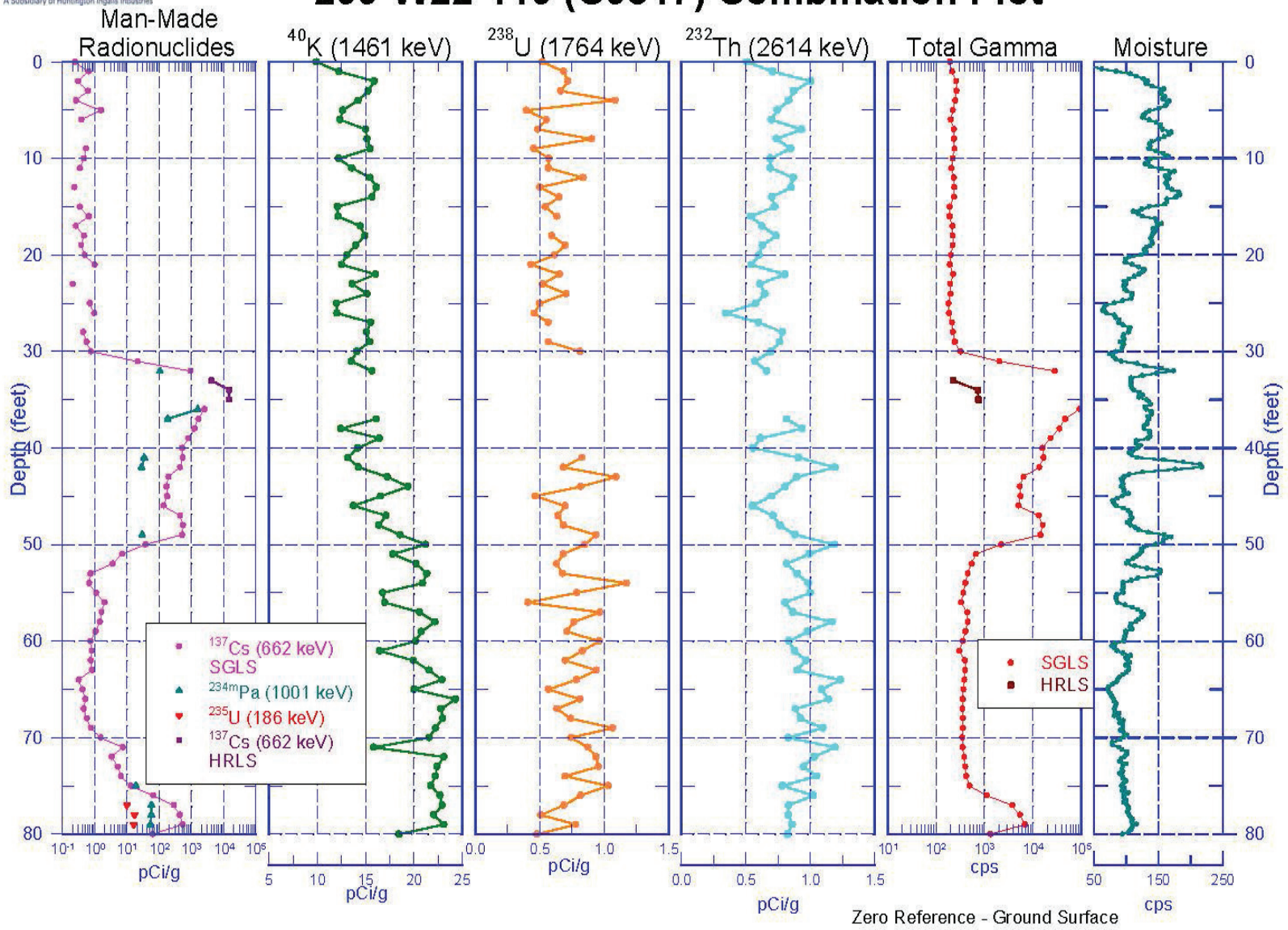
299-W22-119 (C9517)
Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

299-W22-119 (C9517) Combination Plot



Stoller Newport News Nuclear
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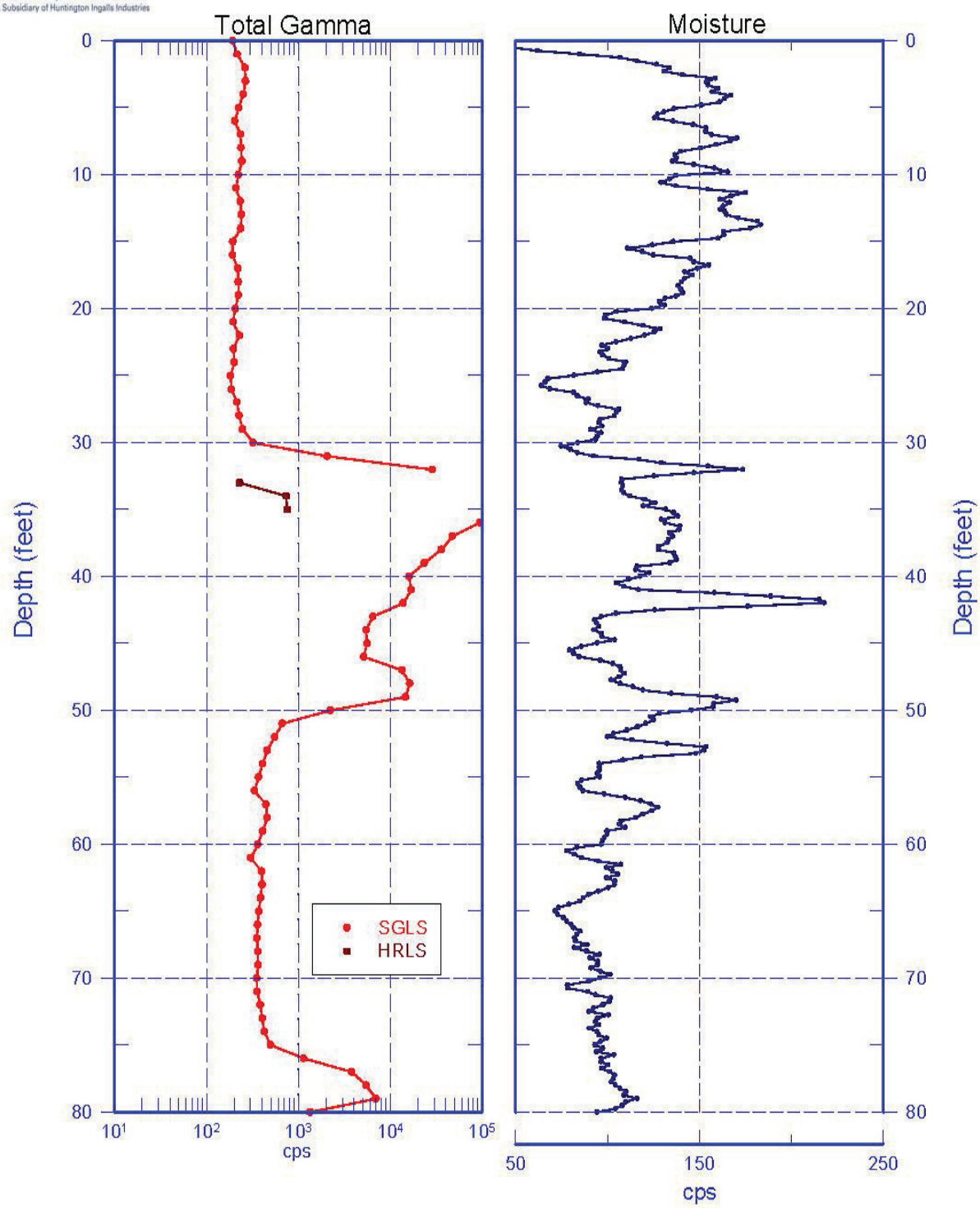
299-W22-119 (C9517)
Total Gamma & Moisture



Zero Reference - Ground Surface

Stoller Newport News Nuclear
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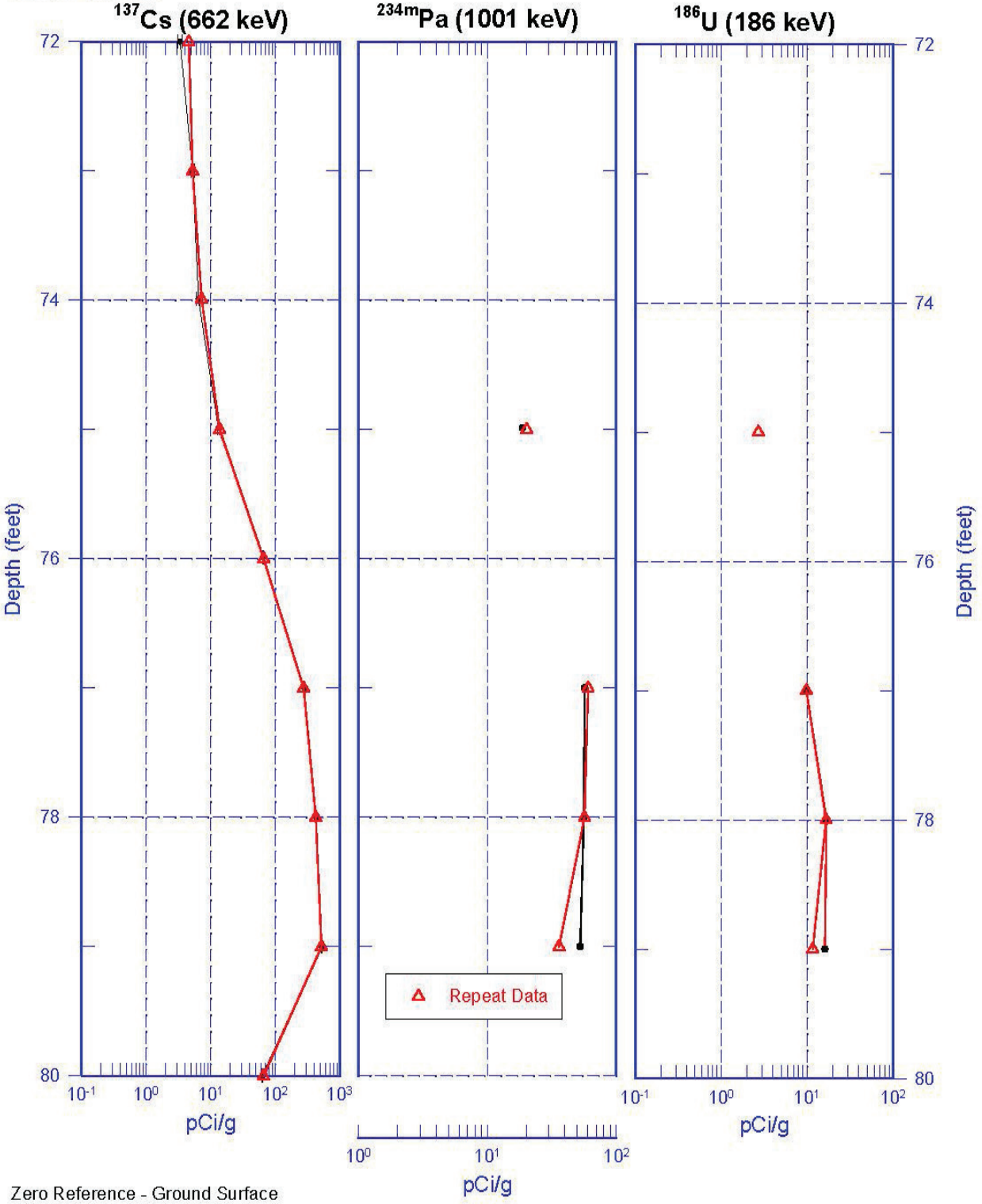
299-W22-119 (C9517)
Manmade Radionuclides Repeat Data



Stoller Newport News Nuclear
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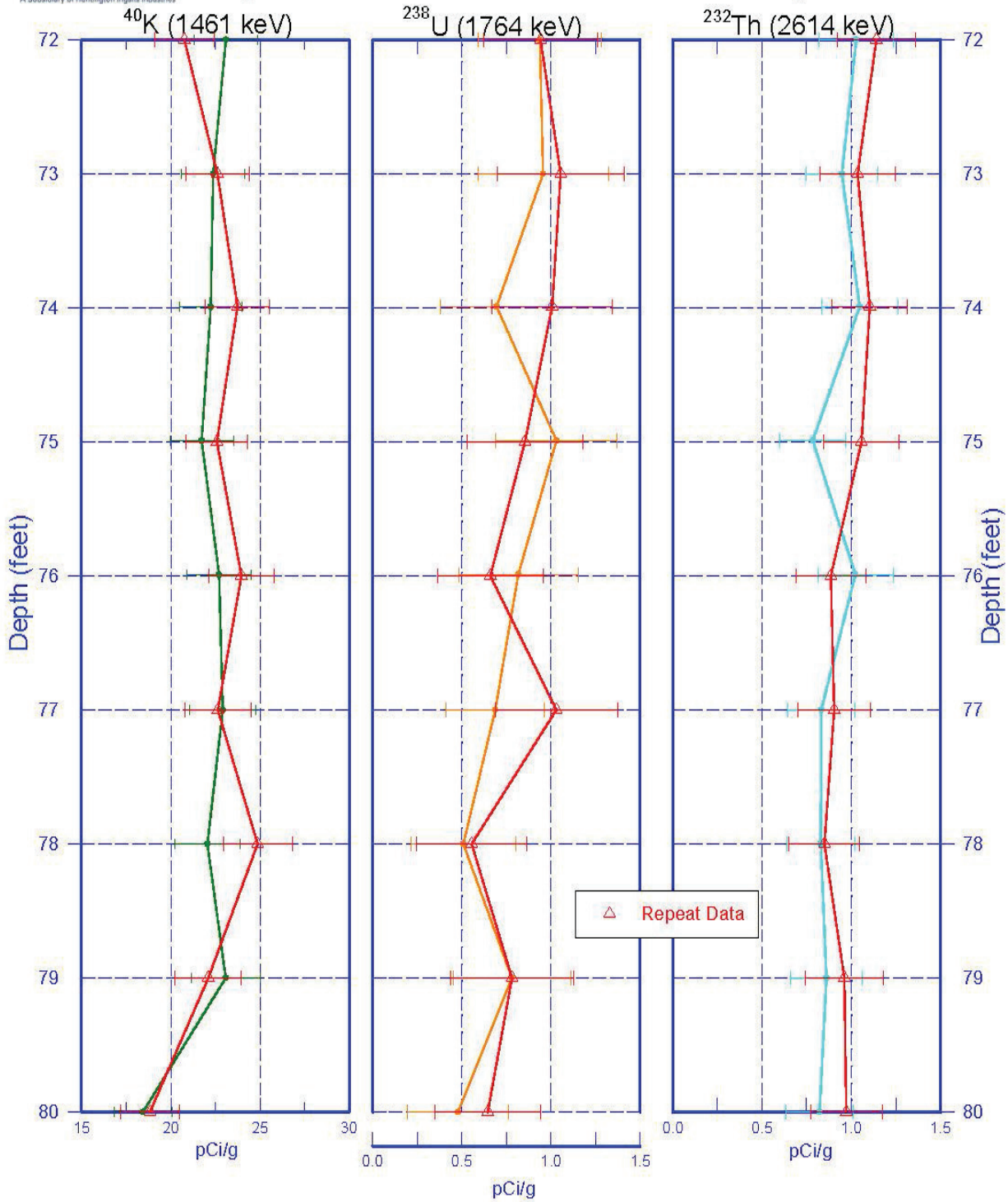
299-W22-119 (C9517)

Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
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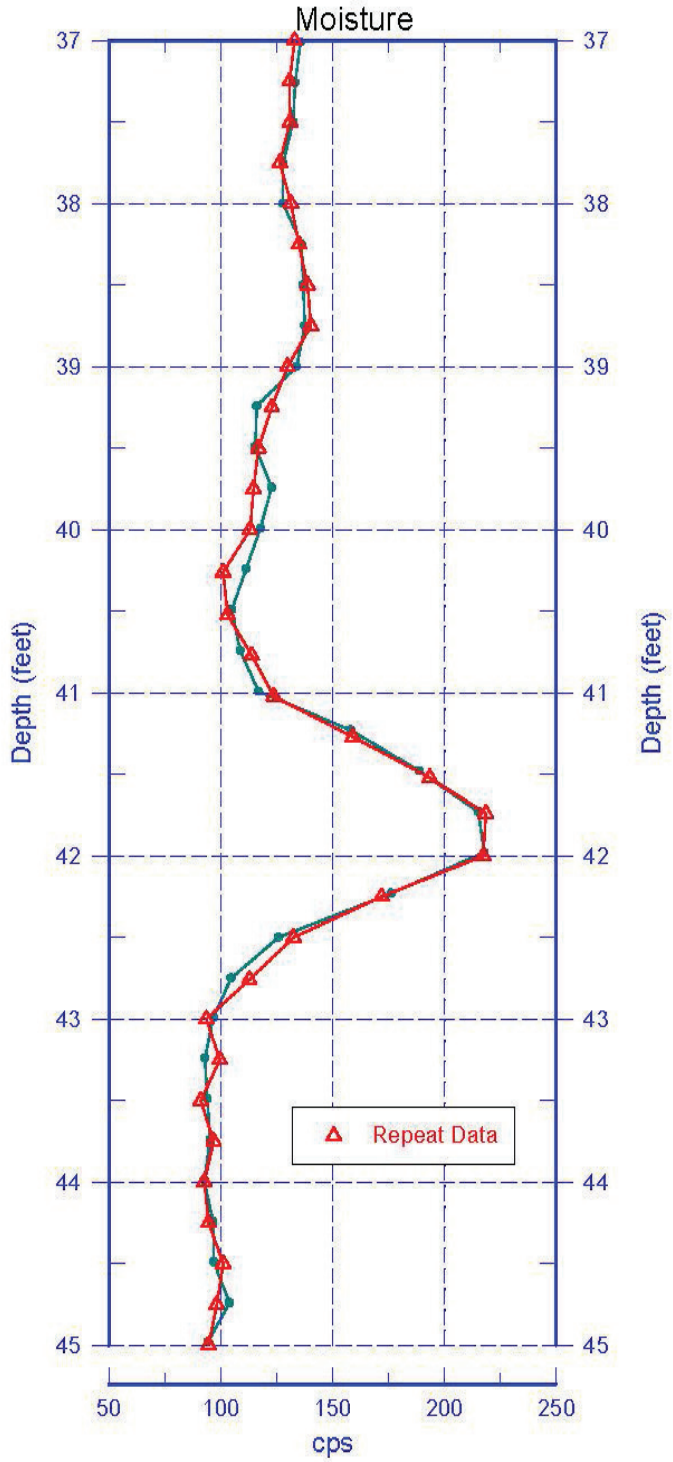
299-W22-119 (C9517)
Moisture Repeat Section



Zero Reference - Ground Surface

Appendix C

Well Documentation for C9518 (299-W22-120)

Contents

Well Summary Sheet …….....C-1
Borehole Log ……..C-3
LEXAN Liner photographs.……..C-6
Continuous Core Sediment Sample Collection Summary for C9518…….....C-16
Log Data Report……C-20

WELL SUMMARY SHEET

Well ID : C9518	Well Name: 299-W22-120	Start Date: 3/22/2017
Project: Installation of 5 wells in 200-WA-1 OU	Location: ~10m South of 216-U-8 Crib	Finish Date: 6/28/2017

CONSTRUCTION DATA

Description

Flush Mount Monument

2-in I.D. Schedule 40, PVC Blank Casing:
0.17 - 72.85 ft bgs

Type I/II Portland Cement Grout:
0.0 - 20.22 ft bgs

1/4-in I.D. Schedule 40,
PVC Blank Casing (sediment coupon):
0.17 - 46.5 ft bgs
0.17 - 52.5 ft bgs

Resistivity Electrode Array:
Individual sensors installed every
3 ft between: 27 - 72 ft bgs.

Thermistor:
Individual thermistors installed every
6 ft between: 31.5 - 43.5 and 55.5 - 67.5 ft bgs.
Individual thermistors installed every
3 ft between: 43.5 - 55.5 ft bgs.

Gas Sampler:
Individual samplers installed every
6 ft between: 37.5 - 61.5 ft bgs.

3/8-in Bentonite Crumbles:
20.22 - 26.03 ft bgs

200 mesh Premier Silica
Filter Pack Sand: 26.03 - 27.86 ft bgs

100 mesh Premier Colorado Silica
Filter Pack Sand: 27.86 - 29.14 ft bgs

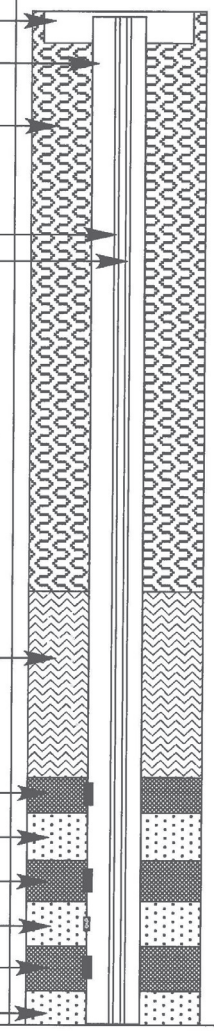
200 mesh 29.14 - 30.71 ft bgs

100 mesh 30.71 - 32.28 ft bgs

200 mesh 32.28 - 33.61 ft bgs

100 mesh 33.61 - 35.24 ft bgs

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 5, 10, 15, 20, 25, 30

Graphic Log

Lithologic Description (ft bgs)

0.0 - 10.0 Sand (S)

10.0 - 30.8 sandy Gravel (sG)

30.8 - 31.3 Sand (S)

31.3 - 41.4 silty Sand (mS)

Reported By:

Tracy Mallgren	Geologist	[signature]	8/8/17
Print Name	*Title*	*Signature*	*Date*

Reviewed By:

Kelly Whitley	Well Coordinator	Kelly Whitley	8/21/17
Print Name	*Title*	*Signature*	*Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

WELL SUMMARY CONTINUATION SHEET

Page 2 of 2

Well ID: C9518 | Well Name: 299-W22-120 | Project: Installation of 5 wells in 200-WA-1 OU

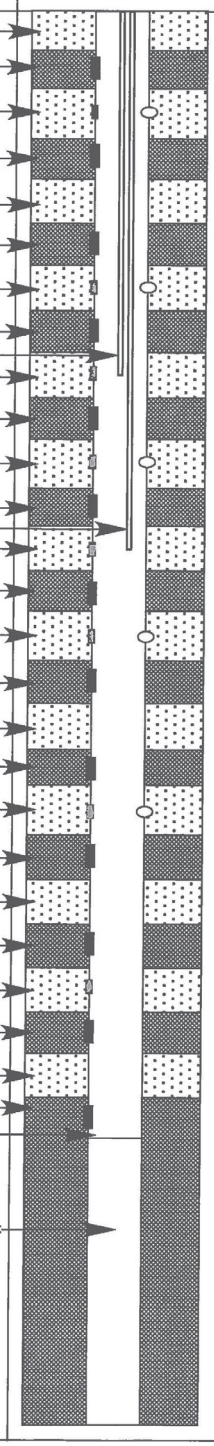
CONSTRUCTION DATA

Description

100 mesh 33.61 - 35.24 ft bgs
200 mesh 35.24 - 36.70 ft bgs
100 mesh 36.70 - 38.20 ft bgs
200 mesh 38.20 - 39.85 ft bgs
100 mesh 39.85 - 41.20 ft bgs
200 mesh 41.20 - 42.82 ft bgs
100 mesh 42.82 - 44.27 ft bgs
200 mesh 44.27 - 45.61 ft bgs
Sediment Coupon 0.17 - 46.5 ft bgs
100 mesh 45.61 - 47.18 ft bgs
200 mesh 47.18 - 48.69 ft bgs
100 mesh 48.69 - 50.22 ft bgs
200 mesh 50.22 - 51.76 ft bgs
Sediment Coupon 0.17 - 46.5 ft bgs
100 mesh 51.76 - 53.17 ft bgs
200 mesh 53.17 - 54.63 ft bgs
100 mesh 54.63 - 56.28 ft bgs
200 mesh 56.28 - 57.80 ft bgs
100 mesh 57.80 - 59.35 ft bgs
200 mesh 59.35 - 60.65 ft bgs
100 mesh 60.65 - 62.25 ft bgs
200 mesh 62.25 - 63.79 ft bgs
100 mesh 63.79 - 65.21 ft bgs
200 mesh 65.21 - 66.54 ft bgs
100 mesh 66.54 - 68.31 ft bgs
200 mesh 68.31 - 69.71 ft bgs
100 mesh 69.71 - 71.25 ft bgs
200 mesh 71.25 - 82.50 ft bgs
2-in I.D. Schedule 40, PVC Blank Casing: 0.17 - 72.85 ft bgs
2-in I.D. Schedule 40, PVC Blank Casing Sump: 72.85 - 82.50 ft bgs

Depths are in feet below ground surface.
Borehole drilled with 6-in O.D. casing from 0.0 - 80.5 ft bgs.
All temporary drill casing was removed from the ground.

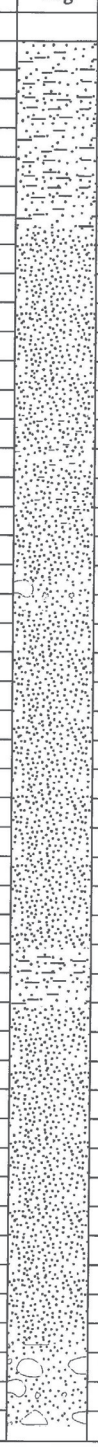
Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 35, 40, 45, 50, 55, 60, 65, 70, 75, 80

Graphic Log



Lithologic Description (ft bgs)

31.3 - 41.4 silty Sand (mS)
41.4 - 47.9 Sand (S)
47.9 - 51.4 slightly silty Sand ((m)S)
51.4 - 53.4 Sand (S)
53.4 - 54.4 gravelly Sand (gS)
54.4 - 66.1 Sand (S)
66.1 - 68.1 silty Sand (mS)
68.1 - 79.7 Sand (S)
79.7 - 82.5 gravelly Sand (gS)
Total Depth: 82.5 (6/26/2017)

A-6006-992 (Rev 2)

BOREHOLE LOG

Page 1 of 3

Date: 6/29/17

Well ID: C9518 | Well Name: 299-W22-120 | Location: ~10m South of 216-U-8 Crib

Project: 5 wells in 200-WA-1 OU | Reference Measure Point: Ground Surface

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
0			0-10: Sand (S): m=5%, g=5%, s=90%. Sand: very fine to medium sand, moderately sorted. Gravel: very fine to medium pebble avg size 8mm, max 40mm, moderately sorted, sub-angular to sub rounded. Moist	Sonic drilling with 6" OD Temporary casing from 0-80.5' bgs. Continuous core with 3 3/4" LEXAN liners from 30.8-80.7' bgs. Soil classifications are estimated based on visual inspection through LEXAN Liners
5				
10			10-30.8: ~~Sand~~ Sandy Gravel (sG) TMS 5/4/17 m=5%, s=60%, g=35%. Sand: very fine to very coarse, mod. sorted, 80% maf, 20% fel, subangular, Gravel: very fine to med. pebble, avg size 8mm, max 40mm 95% mafic, 5% fel sub ang to sub rounded.	
15				
20				
25				
30			30.8-31.3: Sand (S) 95% s, ~5% m well sorted, fine to coarse, avg is coarse	Rad contamination (beta/gamma) 30.8-33.8: 500,000 dpm direct 32.9-35.9: 400,000 dpm direct
			31.3-41.4: Silty Sand (mS) 75% s, 25% m Sand is mod to well sorted, v. fine to v. coarse, Avg is med.	

Reported By:

Print Name	Title	Signature	Date
Tracy Mallgren	Geologist	[signature]	6/29/17

Reviewed By:

Print Name	Title	Signature	Date
Sarah Springer	geologist (LG)	[signature]	09-05-17

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Page 2 of 3

Date: 6/29/17

Well ID: C9518 | Well Name: 299-W22-120 | Location: ~10m South of 216-U-8

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
35			31.3-41.4: silty Sand (mS), 75% s, 25% m Sand is mod to well sorted, v. fine to v. coarse average is med.	Sonic drilling with 6" OD Temp. casing: 0-80.5' bgs Continuous core sampling with LEXAN Liners 30.8'-80.7' bgs. Soil classification estimated based on visual inspection through LEXAN Liners.
40			41.4-47.9: Sand (S) 95% s, 5% m Sand is v. fine to v. coarse, avg med, moderately sorted.	RAD contamination (beta/gamma)
45			47.9-~~56.9~~ 51.4: slightly silty Sand (mS) 85% s, 15% m Sand is v. fine to med. avg fine. well sorted	36.0-39.0: 225,000 dpm direct 38.9-39.4: 60,000 dpm direct 42.9-45.9: 22,000 dpm direct 44.9-47.9: 65,000 dpm direct 48.4-51.4: 32,000 dpm direct
50			51.4-53.4: Sand (S) 95% s, 5% m Sand is v. fine to v. coarse, avg med, mod sorted	51.4-57.2: 10,000 dpm direct
55			53.4-54.4: gravelly Sand (gS) 20% g, 75% s, 5% m Gravel: v. fine to coarse pebble, mod. sorted Sand: v fine to coarse, mod sorted	
60			54.4-66.1: Sand (S) 95% s, 5% m, T. gravel Sand is v. fine to v. coarse, avg is med. moderately sorted	57.2-63.1: 8,000 dpm direct 62.6-65.6: <5,000 dpm direct
65			66.1-68.1: silty Sand (mS) 75% s, 25% m Sand is v. fine to v. coarse, avg fine, Mod to well sorted.	66.1-80.7: 5,000 dpm direct
70			68.1-79.7: Sand (S) 95% s, 5% m, T. gravel Sand is v. fine to v. coarse, avg med, mod to well sorted	

Reported By:

Tracy Mallgren	Geologist	[signature]	6/29/17
Print Name	Title	Signature	Date

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Page 3 of 3

Date: 6/29/17

Well ID: C9518 | Well Name: 299-W22-120 | Location: ~10m South of 216-U-8

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
75			68.1-79.7: Sand (S) 95% s, 5% m, T. gravel Sand is v. fine to v. coarse, avg med, mod to well sorted.	Sonic drilling with 6" OD Temp casing: 0-80.5' bgs Continuous core sampling with LEXAN liners
			79.7-~~80.2~~ 82.5': gravelly Sand (gS) 20% g, 80% s Gravel is poorly sorted, v fine to v coarse pebble. Sand is mod. sorted, v. fine to v. coarse, avg. med.	30.8-80.7' bgs. Soil classification estimated based on visual inspection through LEXAN liners
80			TD = 82.5' (6-26-17) casing to 80.5'	

Reported By:

Tracy Mallgren (Print Name) | Geologist (Title) | [signature] (Signature) | 6/29/17 (Date)

A-6006-993 (REV 0)

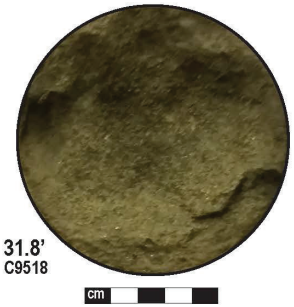
Depth: 30.8 - 35.4
(feet below ground surface)

Sand (S)

Sand:
- well sorted
- fine to coarse sand (average is coarse)

Silty Sand (mS)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)



Silty Sand (mS)

Sand:
- moderately sorted
- very fine to medium sand (average is medium)

Silty Sand (mS)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Silty Sand (mS)

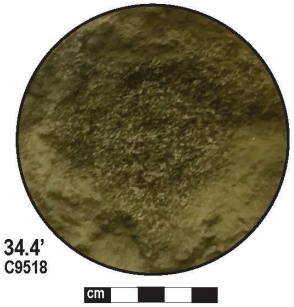
Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Sand (S)

Sand:
- well sorted
- very fine to medium sand (average is medium)

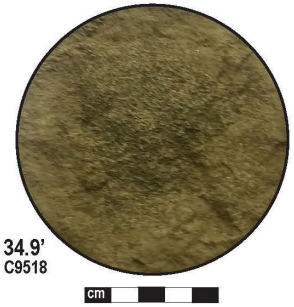
Silty Sand (mS)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)



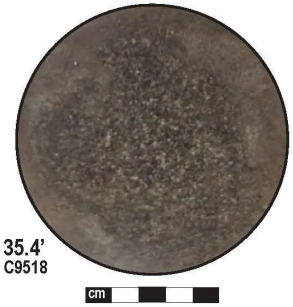
Silty Sand (mS)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)



Silty Sand (mS)

Sand:
- moderately sorted
- very fine to medium sand (average is medium)



Silty Sand (mS)

Sand:
- moderately sorted
- very fine to very coarse sand (average is coarse)

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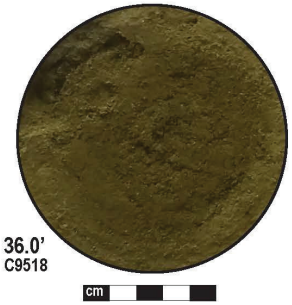
LEXAN Liner Photographs - C9518 (299-W22-120)

Depth: 35.9 - 39.9
(feet below ground surface)

Silty Sand (mS)
Sand:
- moderately sorted
- fine to very coarse sand (average is coarse)



Silty Sand (mS)
Sand:
- moderately sorted
- very fine to coarse sand (average is fine)

Silty Sand (mS)
Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Silty Sand (mS)
Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Silty Sand (mS)
Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Silty Sand (mS)
Sand:
- moderately sorted
- very fine to medium sand (average is medium)

Silty Sand (mS)
Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Silty Sand (mS)
Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Silty Sand (mS)
Sand:
- moderately sorted
- very fine to medium sand (average is fine)

Silty Sand (mS)
Sand:
- well sorted
- very fine to fine sand (average is fine)

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LEXAN Liner Photographs - C9518 (299-W22-120)

Depth: 40.4 - 45.4
(feet below ground surface)

Silty Sand (mS)

Sand:
- well sorted
- very fine to medium sand (average is fine)

Sand (S)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Silty Sand (mS)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is coarse)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is coarse)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is coarse)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

Sand (S)

Sand:
- well sorted
- very fine to fine sand (average is medium)

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LEXAN Liner Photographs - C9518 (299-W22-120)

Depth: 45.9 - 50.4
(feet below ground surface)

Sand (S)

Sand:
- well sorted
- fine to coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

Silty Sand (mS)

Sand:
- well sorted
- very fine to medium sand (average is fine)

Silty Sand (mS)

Sand:
- well sorted
- very fine to medium sand (average is fine)

Silty Sand (mS)

Sand:
- well sorted
- very fine to medium sand (average is fine)

Silty Sand (mS)

Sand:
- well sorted
- very fine to medium sand (average is fine)

Silty Sand (mS)

Sand:
- well sorted
- very fine to medium sand (average is fine)

FREESTONE ENVIRONMENTAL SERVICES, INC.

LEXAN Liner Photographs - C9518 (299-W22-120)

Depth: 50.9 - 55.2
(feet below ground surface)

silty Sand (mS)
Sand:
- moderately sorted
- very fine to coarse sand (average is fine)

Sand (S)
Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Sand (S)
Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Sand (S)
Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Sand (S)
Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

gravelly Sand (gS)
Gravel:
- moderately sorted
- very fine to coarse pebble

Sand:
- moderatly sorted
- very fine to coarse sand (average is medium)

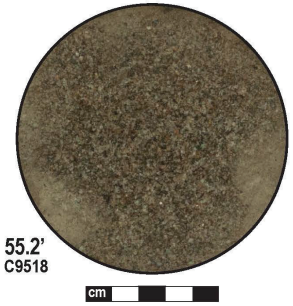
gravelly Sand (gS)
Gravel:
- moderately sorted
- very fine to coarse pebble

Sand:
- moderatly sorted
- very fine to coarse sand (average is medium)

gravelly Sand (gS)
Gravel:
- moderately sorted
- very fine to coarse pebble

Sand:
- moderatly sorted
- very fine to coarse sand (average is medium)

Sand (S)
Sand:
- moderately sorted
- very fine to very coarse sand (average is coarse)



Sand (S)
Sand:
- moderately sorted
- very fine to very coarse sand (average is coarse)

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LEXAN Liner Photographs - C9518 (299-W22-120)

Depth: 55.7 - 60.2
(feet below ground surface)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

Sand (S)

Sand:
- well sorted
- very fine to coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is coarse)

gravelly Sand (gS)

Gravel:
- well sorted
- very fine pebble

Sand:
- moderately sorted
- very fine to very coarse sand (average is coarse)

gravelly Sand (gS)

Gravel:
- well sorted
- very fine pebble

Sand:
- moderately sorted
- very fine to very coarse sand (average is coarse)

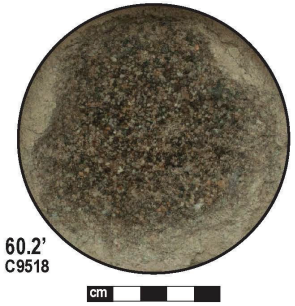
gravelly Sand (gS)

Gravel:
- moderately sorted
- very fine to coarse pebble

Sand:
- moderately sorted
- very fine to very coarse sand (average is coarse)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is coarse)



Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is coarse)

FREESTONE
ENVIRONMENTAL SERVICES, INC.

LEXAN Liner Photographs - C9518 (299-W22-120)

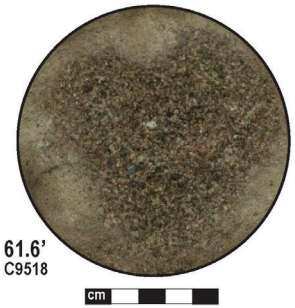
Depth: 60.7 - 65.1
(feet below ground surface)

Sand (S)

Sand:
- moderately sorted
- fine to very coarse sand (average is coarse)

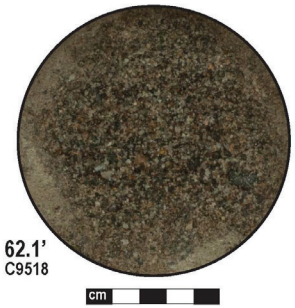
Sand (S)

Sand:
- moderately sorted
- fine to coarse sand (average is coarse)



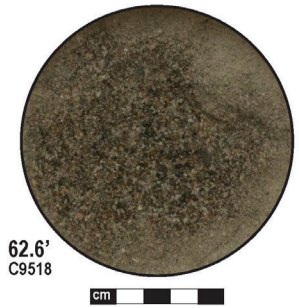
Sand (S)

Sand:
- moderately sorted
- fine to very coarse sand (average is coarse)



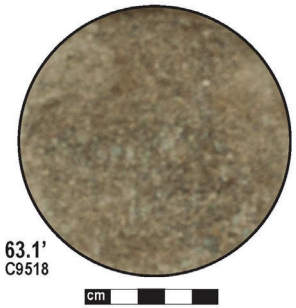
Sand (S)

Sand:
- moderately sorted
- fine to very coarse sand (average is medium)



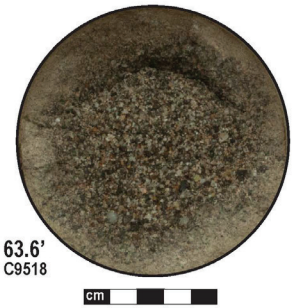
Sand (S)

Sand:
- moderately sorted
- fine to very coarse sand (average is coarse)



Sand (S)

Sand:
- moderately sorted
- fine to very coarse sand (average is coarse)

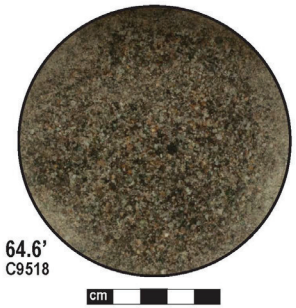


Sand (S)

Sand:
- moderately sorted
- fine to very coarse sand (average is coarse)

Sand (S)

Sand:
- moderately sorted
- fine to very coarse sand (average is coarse)



Sand (S)

Sand:
- moderately sorted
- fine to very coarse sand (average is coarse)

Sand (S)

Sand:
- moderately sorted
- fine to very coarse sand (average is medium)

FREESTONE ENVIRONMENTAL SERVICES, INC.

LEXAN Liner Photographs - C9518 (299-W22-120)

Depth: 65.6 - 70.1
(feet below ground surface)

Sand (S)

Sand:
- moderately sorted
- fine to very coarse sand (average is coarse)

Silty Sand (mS)

Sand:
- well sorted
- very fine to fine sand (average is fine)

Silty Sand (mS)

Sand:
- well sorted
- very fine to medium sand (average is fine)

Silty Sand (mS)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Silty Sand (mS)

Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is coarse)

Sand (S)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

FREESTONE ENVIRONMENTAL SERVICES, INC.

LEXAN Liner Photographs - C9518 (299-W22-120)

Depth: 70.6 - 75.0
(feet below ground surface)

Sand (S)

Sand:
- well sorted
- fine to medium sand (average is medium)

Silty Sand (mS)

Sand:
- well sorted
- very fine to fine sand (average is fine)

Sand (S)

Sand:
- well sorted
- very fine to medium sand (average is medium)

Sand (S)

Sand:
- well sorted
- very fine to medium sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Sand (S)

Sand:
- well sorted
- very fine to medium sand (average is medium)

Sand (S)

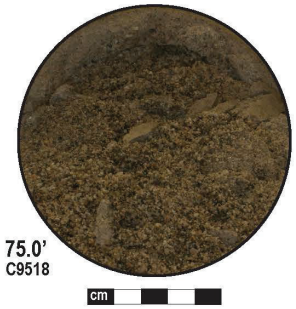
Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

Sand (S)

Sand:
- well sorted
- very fine to very coarse sand (average is medium)



Sand (S)

Sand:
- well sorted
- very fine to coarse sand (average is medium)

FREESTONE ENVIRONMENTAL SERVICES, INC.

LEXAN Liner Photographs - C9518 (299-W22-120)

Depth: 75.5 - 80.2
(feet below ground surface)

Sand (S)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Silty Sand (mS)

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

Silty Sand (mS)

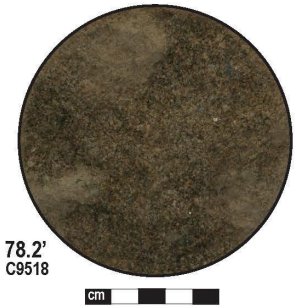
Sand:
- well sorted
- very fine to medium sand (average is fine)

Sand (S)

Sand:
- well sorted
- very fine to medium sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)



Sand (S)

Sand:
- well sorted
- very fine to medium sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

Sand (S)

Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

gravelly Sand (gS)

Gravel:
- poorly sorted
- very fine to very coarse pebble

Sand:
- moderately sorted
- very fine to very coarse sand (average is medium)

gravelly Sand (gS)

Gravel:
- poorly sorted
- very fine to very coarse pebble

Sand:
- moderately sorted
- very fine to coarse sand (average is medium)

FREESTONE ENVIRONMENTAL SERVICES, INC.

LEXAN Liner Photographs - C9518 (299-W22-120)

Continuous Core Sediment Sample Collection Summary for C9518

Date	Interval Depth (ft bgs)	Recovery (%)	HEIS #	Radiological Screen HEIS #
3/27/2017	30.8 – 31.3	100	B38XT6	B38XR5
	31.3 – 31.8		B38XT7	
	31.8 – 32.3		B38XT8	
	32.3 – 32.8		B38XT9	
	32.8 – 33.3		B38XV0	
	33.3 – 33.8		B38XV1	
3/27/2017	32.9 – 33.4	100	B38XV6	B38XR6
	33.4 – 33.9		B38XV7	
	33.9 – 34.4		B38XV8	
	34.4 – 34.9		B38XV9	
	34.9 – 35.4		B38XW0	
	35.4 – 35.9		B38XW1	
3/27/2017	36.0 – 36.5	100	B38XW6	B38XR7
	36.5 – 37.0		B38XW7	
	37.0 – 37.5		B383XW8	
	37.5 – 38.0		B38XW9	
	38.0 – 38.5		B38XX0	
	38.5 – 39.0		B38XX1	
3/27/2017	38.9 – 39.4	100	B38XX6	B38XR8
	39.4 – 39.9		B38XX7	
	39.9 – 40.4		B38XX8	
	40.4 – 40.9		B38XX9	
	40.9 – 41.4		B38XY0	
	41.4 – 41.9		B38XY1	
3/28/2017	42.9 – 43.4	100%	B38XY6	B38XR9
	43.4 – 43.9		B38XY7	
	43.9 – 44.4		B38XY8	
	44.4 – 44.9		B38XY9	
	44.9 – 45.4		B38Y00	

Continuous Core Sediment Sample Collection Summary for C9518

Date	Interval Depth (ft bgs)	Recovery (%)	HEIS #	Radiological Screen HEIS #
3/28/2017	44.9 – 45.4	100	B38Y06	B38XT0
	45.4 – 45.9		B38Y07	
	45.9 – 46.4		B38Y08	
	46.4 – 46.9		B38Y09	
	46.9 – 47.4		B38Y10	
	47.4 – 47.9		B38Y11	
3/28/2018	48.4 – 48.9	100	B38Y16	B38XT1
	48.9 – 49.4		B38Y17	
	49.4 – 49.9		B38Y18	
	49.9 – 50.4		B38Y19	
	50.4 – 50.9		B38Y20	
	50.9 – 51.4		B38Y21	
3/28/2017	51.4 – 51.9	100	B38Y26	B38XT2
	51.9 – 52.4		B38Y27	
	52.4 – 52.9		B38Y28	
	52.9 – 53.4		B38Y29	
	53.4 – 53.9		B38Y30	
	53.9 – 54.4		B38Y31	
3/28/2017	54.2 – 54.7	100	B38Y36	-
	54.7 – 55.2		B38Y37	
	55.2 – 55.7		B38Y38	
	55.7 – 56.2		B38Y39	
	56.2 – 56.7		B38Y40	
	56.7 – 57.2		B38Y41	
3/28/2017	57.7 – 58.2	100	B38Y46	-
	58.2 – 58.7		B38Y47	
	58.7 – 59.2		B38Y48	
	59.2 – 59.7		B38Y49	
	59.7 – 60.2		B38Y50	
	60.2 – 60.7		B38Y51	

Continuous Core Sediment Sample Collection Summary for C9518

Date	Interval Depth (ft bgs)	Recovery (%)	HEIS #	Radiological Screen HEIS #
3/28/2017	60.1 – 60.6	100	B38Y56	-
	60.6 – 61.1		B38Y57	
	61.1 – 61.6		B38Y58	
	61.6 – 62.1		B38Y59	
	62.1 – 62.6		B38Y60	
	62.6 – 63.1		B38Y61	
3/28/2017	62.6 – 63.1	100	B396F4	-
	63.1 – 63.6		B396F5	
	63.6 – 64.1		B396F6	
	64.1 – 64.6		B396F7	
	64.6 – 65.1		B396F8	
	65.1 – 65.6		B396F9	
3/29/2017	66.1 – 66.6	100	B396H4	-
	66.6 – 67.1		B396H5	
	67.1 – 67.6		B396H6	
	67.6 – 68.1		B396H7	
	68.1 – 68.6		B396H8	
	68.6 – 69.1		B396H9	
	69.1 – 69.6		B396J0	
	69.6 – 70.1		B396J1	
	70.1 – 70.6		B396J2	
	70.6 – 71.1		B396J3	
3/29/2017	71.0 – 71.5	90	B396J4	-
	71.5 – 72.0		B396J5	
	72.0 – 72.5		B396J6	
	72.5 – 73.0		B396J7	
	73.0 – 73.5		B396J8	
	73.5 – 74.0		B396J9	
	74.0 – 74.5		B396K0	
	74.5 – 75.0		B396K1	
	75.0 – 75.5		B396K2	

Continuous Core Sediment Sample Collection Summary for C9518

Date	Interval Depth (ft bgs)	Recovery (%)	HEIS #	Radiological Screen HEIS #
3/29/2017	75.7 – 76.2	100	B39838	-
	76.2 – 76.7		B39839	
	76.7 – 77.2		B39840	
	77.2 – 77.7		B39841	
	77.7 – 78.2		B39842	
	78.2 – 78.7		B39843	
	78.7 – 79.2		B39844	
	79.2 – 79.7		B39845	
	79.7 – 80.2		B39846	
	80.2 – 80.7		B39847	

ft bgs = feet below ground surface.
HEIS = Hanford Environmental Information System.

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299-W22-120 (C9518)
Log Data Report

Borehole Information

Log Date	2017-03-31	Filename	C9518_HG-NM_2017-03-31	Site	200-WA-1

DTW[1] (ft)	DTW Date	DTW Source	Drill Date	Total Depth (ft)	Depth Datum
None	N/A	SN3	03/29/17	80.5	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	Sonic	0.25	6.0	5 1/4	3/8	-0.25	79.9

Borehole Notes

The logging engineer measured casing thickness. Drill depth and casing depth were provided by the wellsite geologist. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma 5Tb	Type	60% HPGe SGLS[2]
Effective Calibration Date	02/16/17	Serial No.	54-TP13441B
Calibration Reference	HGLP-CC-152, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 5Cb	Type	Planar HPGe HRLS[3]
Effective Calibration Date	08/04/16	Serial No.	39A314
Calibration Reference	HGLP-CC-142, Rev. 0	Logging Procedure	SGRP-PRO-OP-53050, Rev. 0

Logging System	Gamma 5Pb	Type	NMLS[4] He-3 (CPN 503)
Effective Calibration Date	02/27/17	Serial No.	H34055445
Calibration Reference	HGLP-CC-153, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0

SGLS Log Run Information

Log Run	1	2	3	4 Repeat	
HEIS Number	1019829	1019830	1019831	1019832	
Date	03/30/17	03/30/17	03/30/17	03/30/17	
Logging Engineer	Felt	Felt	Felt	Felt	
Start Depth (ft)	0.0	31.0	36.0	51.0	
Finish Depth (ft)	32.0	37.0	77.01	58.0	
Count Time (sec)	100	15	100	100	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	

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

Log Run	1	2	3	4 Repeat	
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	C9518FTB2017 0330AV00CAB 1	C9518FTB2017 0330AV00CAB 1	C9518FTB2017 0330AV00CAB 1	C9518FTB2017 0330AV00CAB 1	
Start File	AD000000	BD003100	CD003600	DD005100	
Finish File	AD003200	BD003700	CD007701	DD005800	
Post-Verification	C9518FTB2017 0330DV00CAA 1	C9518FTB2017 0330DV00CAA 1	C9518FTB2017 0330DV00CAA 1	C9518FTB2017 0330DV00CAA 1	
Depth Return Error (in.)	N/A	N/A	N/A	2.0 high	
Comments	No fine gain adjustments made	High dead time interval	No fine gain adjustments made	No fine gain adjustments made	

HRLS Log Run Information

Log Run	5	6	7 Repeat		
HEIS Number	1019833	1019834	1019835		
Date	03/31/17	03/31/17	03/31/17		
Logging Engineer	Felt	Felt	Felt		
Start Depth (ft)	31.0	34.0	35.0		
Finish Depth (ft)	37.0	35.0	35.0		
Count Time (sec)	300	300	1000		
Live/Real	R	R	R		
Shield (Y/N)	N	N	N		
MSA Interval (ft)	1.0	1.0	1.0		
Log Speed (ft/min)	N/A	N/A	N/A		
Pre-Verification	C9518FCB2017 0331AV00CAB 1	C9518FCB2017 0331AV00CAB 1	C9518FCB2017 0331AV00CAB 1		
Start File	AD003100	BD003400	CD003500		
Finish File	AD003700	BD003500	CD003500		
Post-Verification	C9518FCB2017 0331CV00CAA 1	C9518FCB2017 0331CV00CAA 1	C9518FCB2017 0331CV00CAA 1		
Depth Return Error (in.)	N/A	N/A	2.0 high		
Comments	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made		

NMLS Log Run Information

Log Run	8	9 Repeat			
HEIS Number	1019836	1019837			
Date	03/31/17	03/31/17			
Logging Engineer	Felt	Felt			
Start Depth (ft)	0.0	69.0			

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Log Run	8	9 Repeat			
Finish Depth (ft)	78.01	77.0			
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	C9518FPB20170 331AV00CAB1	C9518FPB20170 331AV00CAB1			
Start File	AD000000	BD006900			
Finish File	AD007801	BD007700			
Post-Verification	C9518FPB20170 331BV00CAA1	C9518FPB20170 331BV00CAA1			
Depth Return Error (in.)	N/A	2.0 high			
Comments	None	None			

Logging Operation Notes

A centralizer was not installed on the logging sondes. The logging sonde and cable were sleeved in plastic to prevent potentially contaminating the equipment.

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

Analysis Notes

Analyst	P.D. Henwood	Date	04/18/17
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as ftB20170216_CC-152 for the SGLS, using an efficiency function and corrections for casing and dead time as determined during annual response checks.

Results and Interpretations

Cs-137 was detected almost throughout the borehole. A high activity interval exists from 31 to 37 ft in depth where a maximum Cs-137 concentration was measured at approximately 15,677 pCi/g at 35 ft.

Pa-234m (manmade U-238) was detected at the margins of the high activity interval at 31 and 37 ft and intermittently to 76 ft. Even though detections were intermittent, it is possible the manmade uranium exists continuously but at concentrations below the MDL of approximately 16 pCi/g at some depths. The maximum concentration was measured at 733 pCi/g at 41 ft. Although not measured, Pa-234m likely exists in the high activity interval at higher concentrations.

U-235 was detected at 41, 47, and 51 ft with a maximum concentration of 56 pCi/g at 41 ft. U-235 likely exists with Pa-234m but is below the minimum detection limit in some cases.

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 manmade, KUT, and moisture repeat plots indicate that the respective systems were working properly. The repeat data were acquired at 500 second counting times rather than the standard 100 seconds, resulting in additional detections and improved accuracy where concentrations are near the MDL.

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List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-80 ft)
Natural Gamma Logs (0-80 ft)
Combination Plot (0-80 ft)
Total Gamma & Moisture (0-80 ft)
Manmade Radionuclides Repeat Data (51-58 ft)
Repeat Section of Natural Gamma Logs (51-58 ft)
Moisture Repeat Section (69-77 ft)

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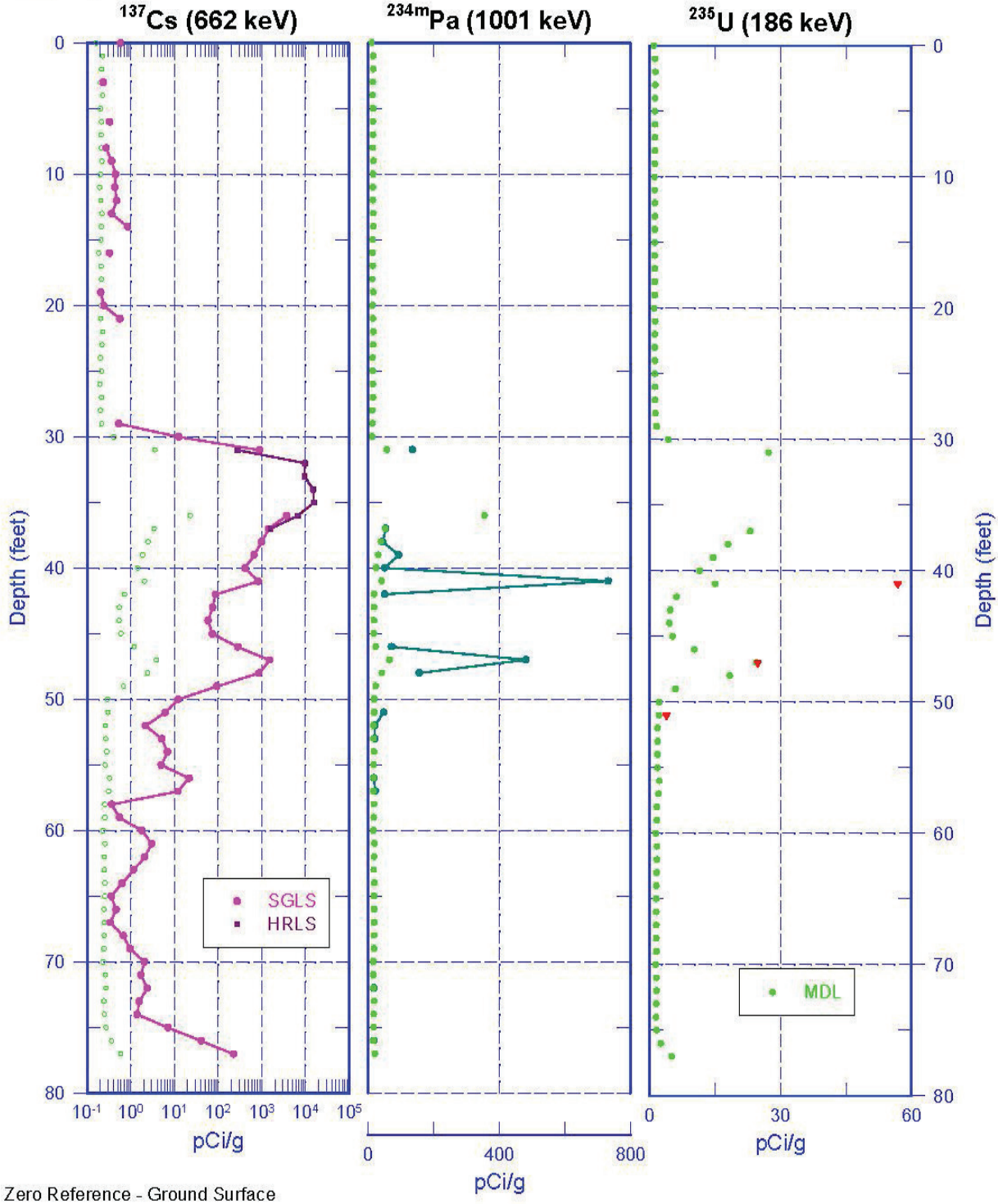
299-W22-120 (C9518)
Manmade Radionuclides



Zero Reference - Ground Surface

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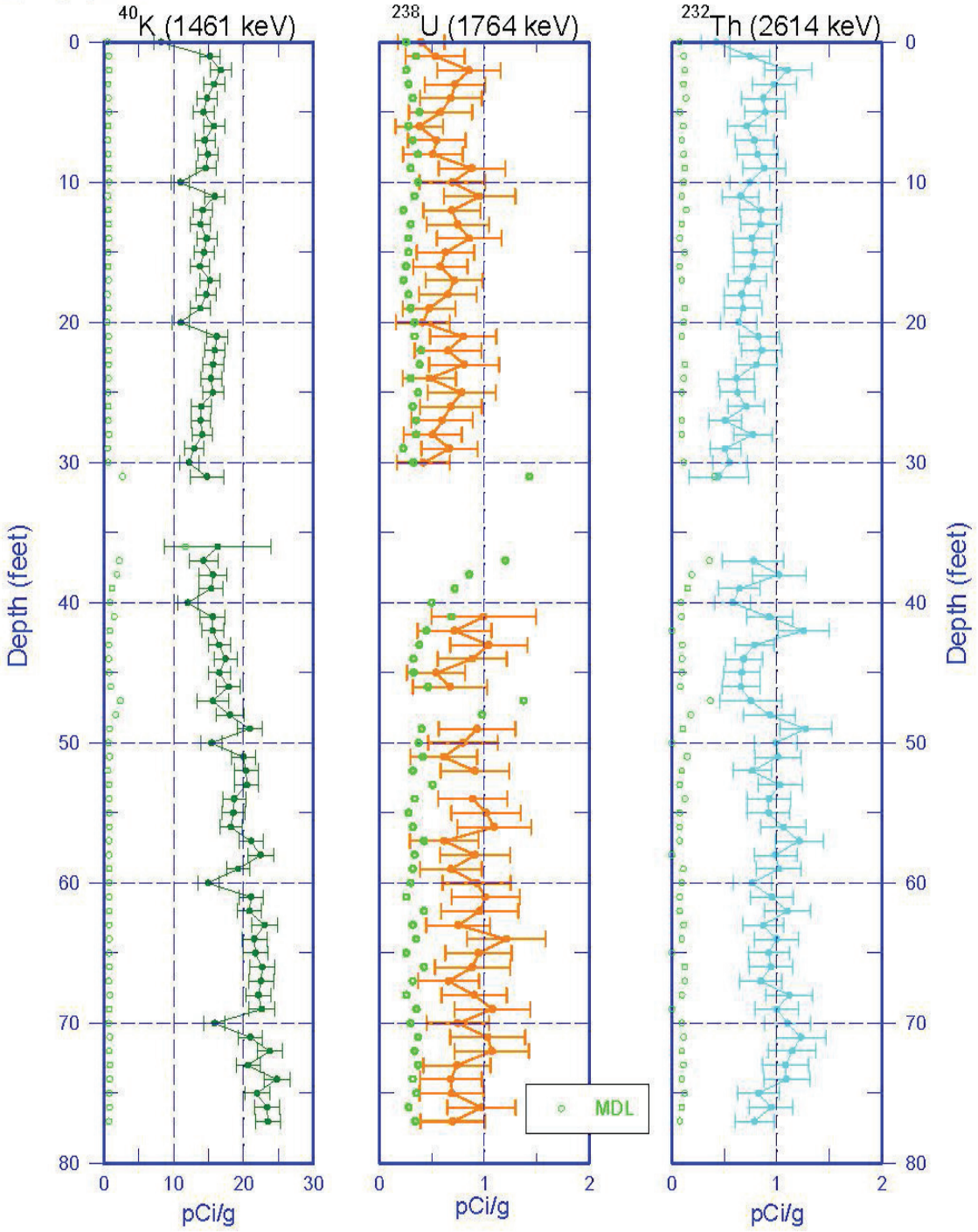
299-W22-120 (C9518)
Natural Gamma Logs



Zero Reference - Ground Surface

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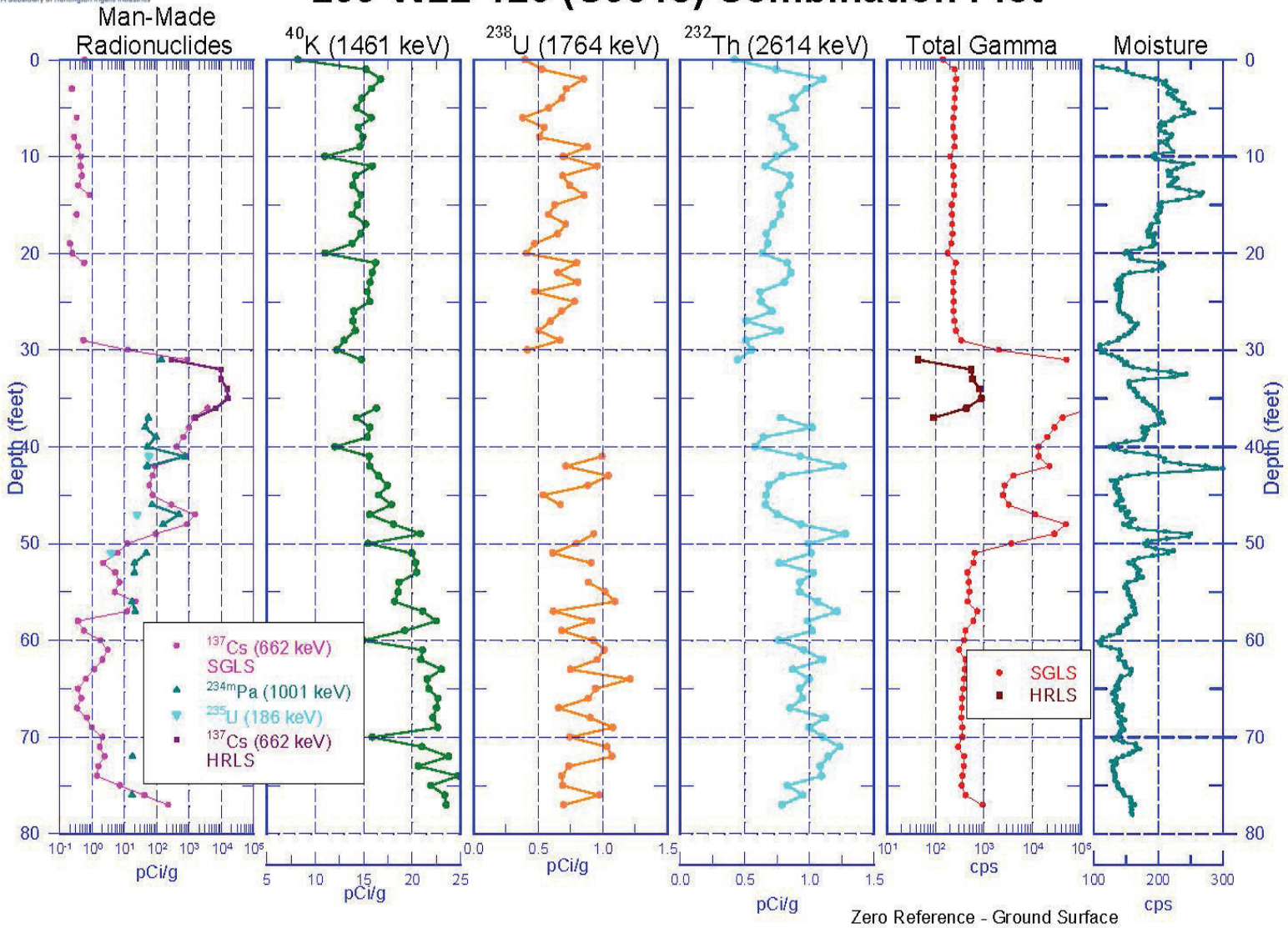
299-W22-120 (C9518) Combination Plot



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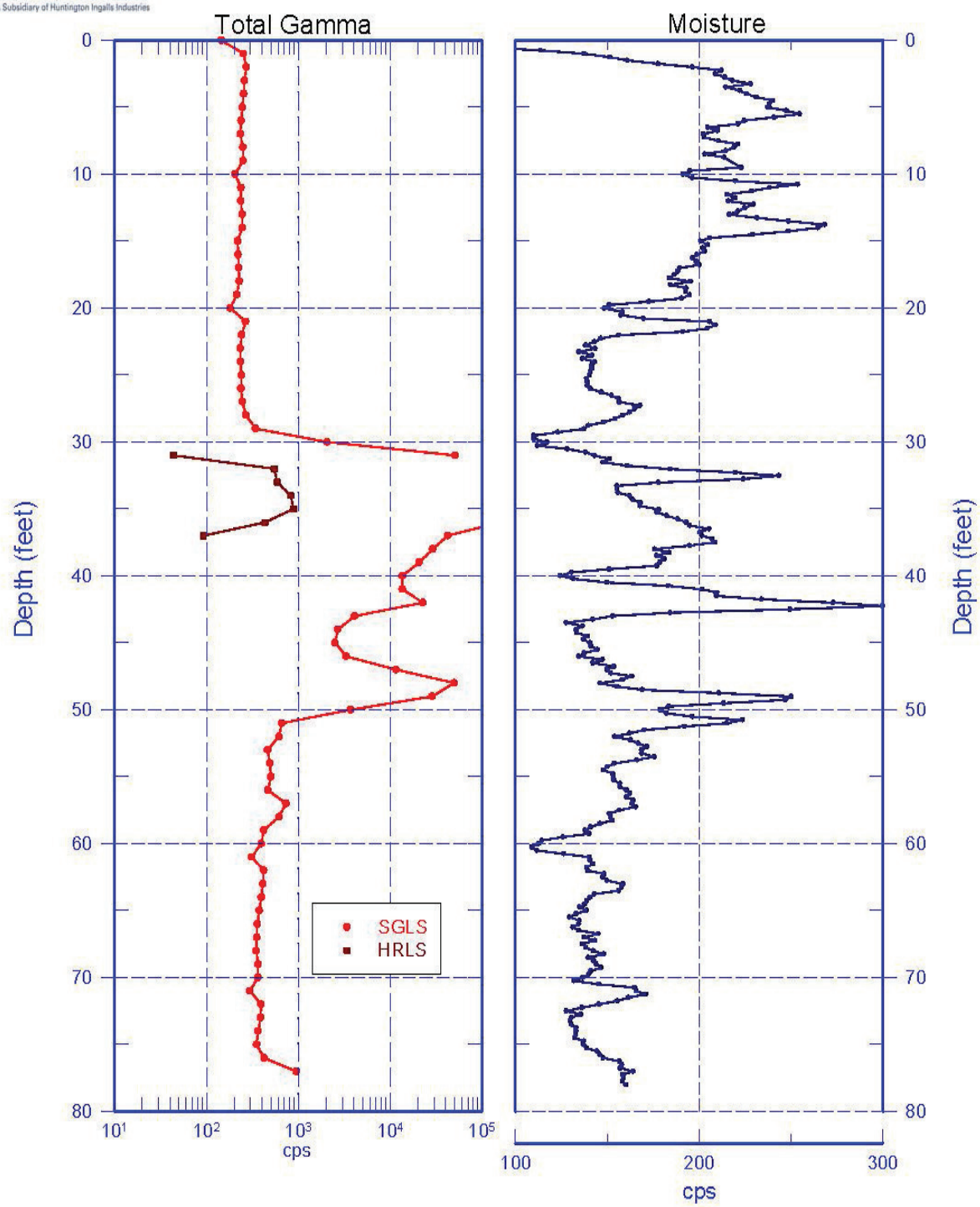
299-W22-120 (C9518)
Total Gamma & Moisture



Zero Reference - Ground Surface

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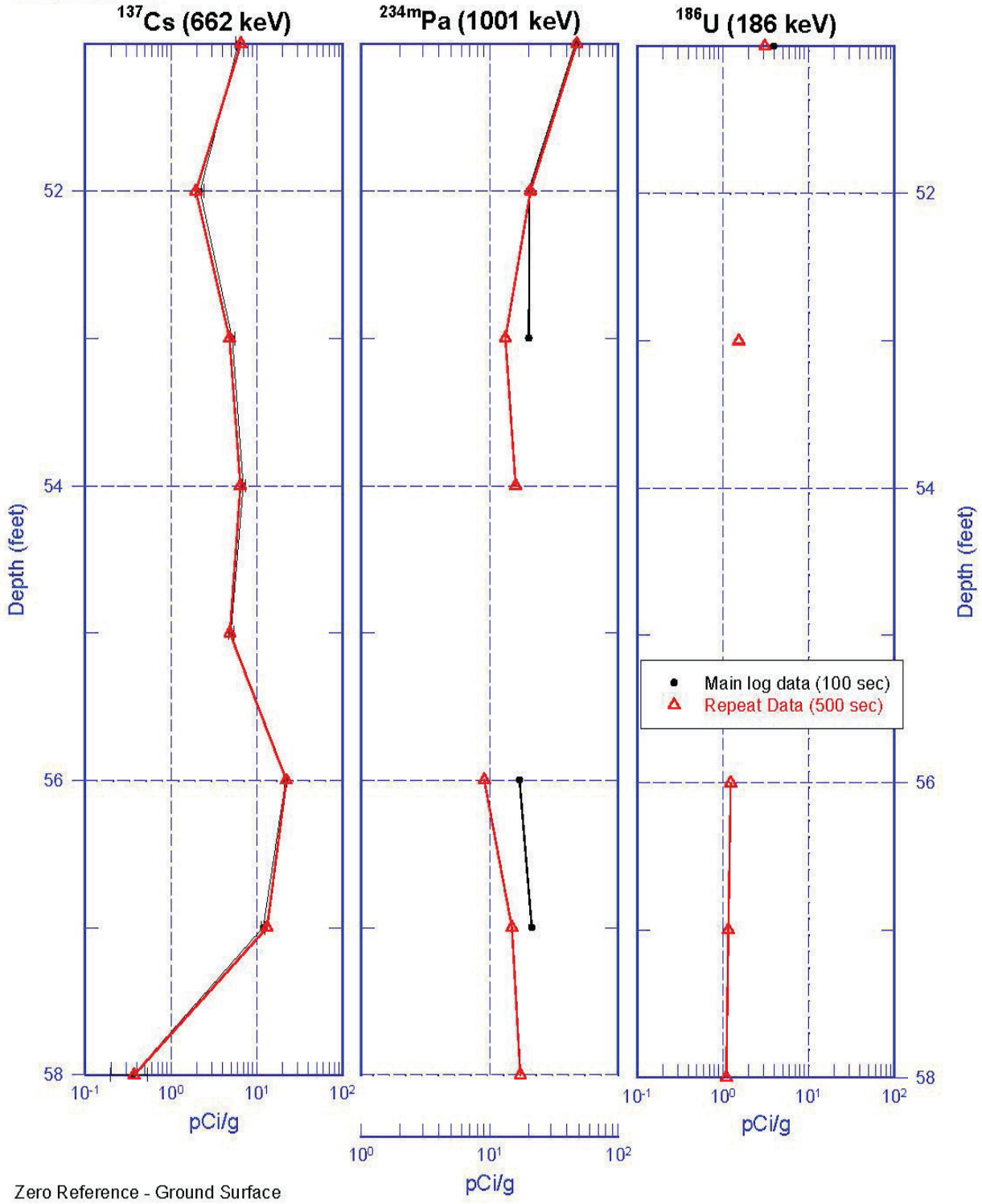
299-W22-120 (C9518)
Manmade Radionuclides Repeat Data



Zero Reference - Ground Surface

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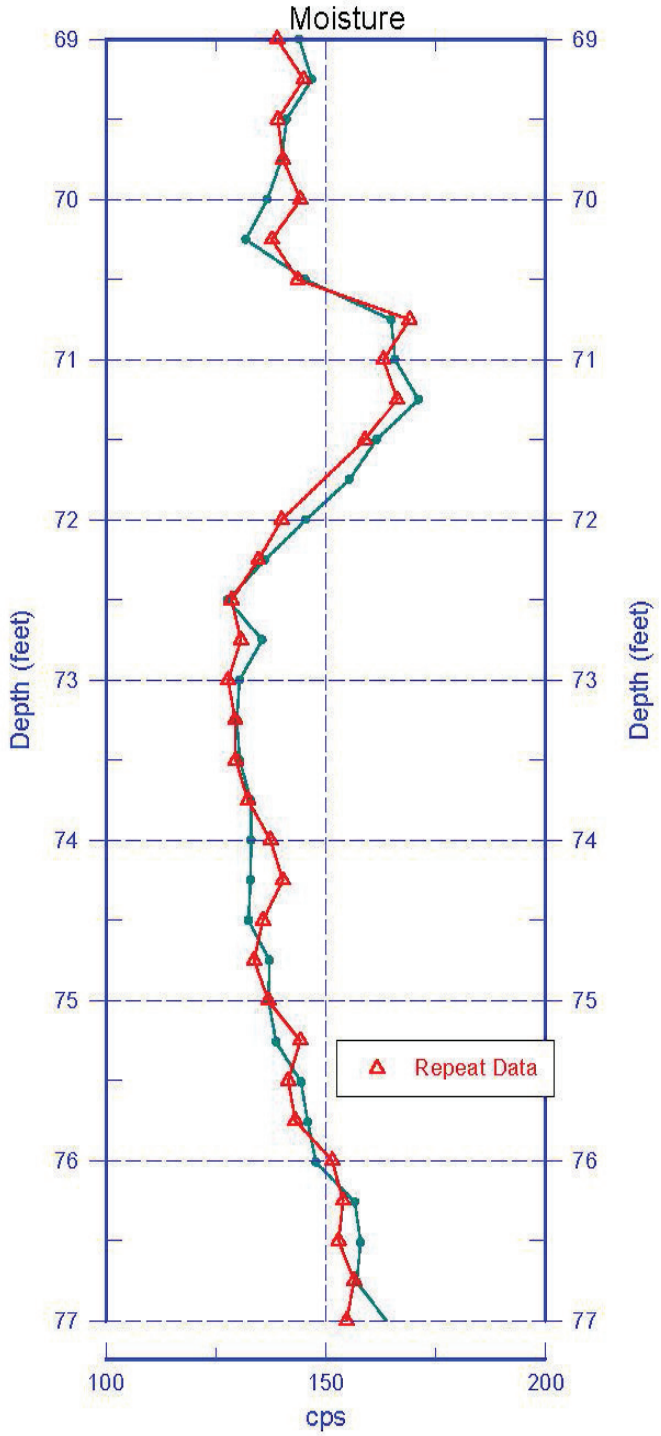
299-W22-120 (C9518)
Moisture Repeat Section



Zero Reference - Ground Surface

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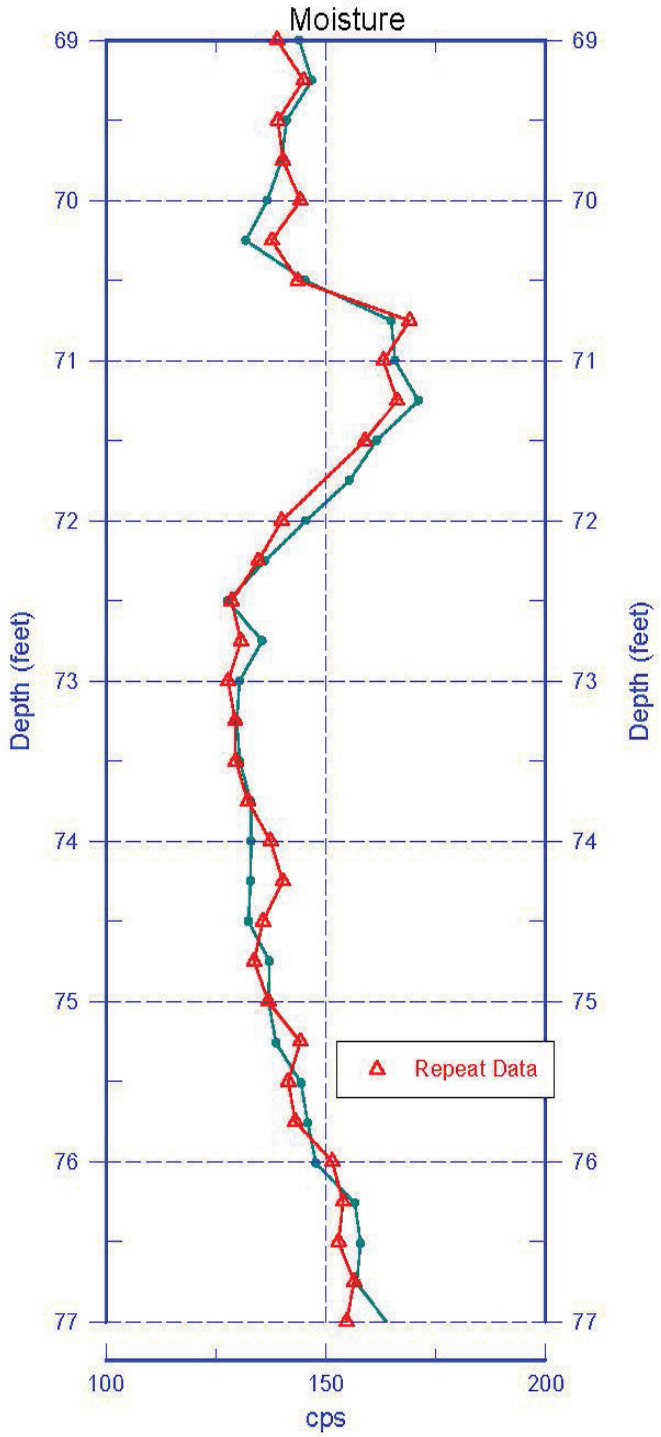
299-W22-120 (C9518)
Moisture Repeat Section



Zero Reference - Ground Surface

Appendix D

Well Documentation for C9519 (299-W22-121)

Contents

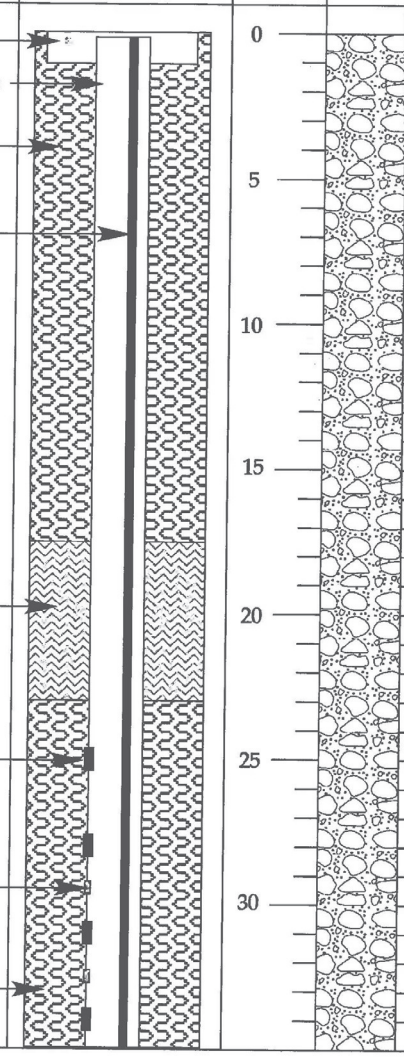
Well Summary Sheet …….…….....D-1
Borehole Log …….…..D-3
Continuous Core Sediment Sample Collection Summary for C9519 …….……D-6
Log Data Report…….....D-9

WELL SUMMARY SHEET

Well ID : C9519	Well Name: 299-W22-121	Start Date: 3/13/2017
Project: Installation of 5 wells in 200-WA-1 OU	Location: ~10m South of 216-U-8 Crib	Finish Date: 5/18/2017

CONSTRUCTION DATA

Description	Diagram
Flush Mount Monument	
3 3/4-in I.D. Schedule 80, PVC Blank Casing: 0.43 - 44.11 ft bgs	
Type I/II Portland Cement Grout: 0.0 - 17.6 ft bgs	
Temperature Sensor Cable: 0.43 - 78.1 ft bgs	
3/8-in Bentonite Pellets: 17.6 - 23.0 ft bgs	
Resistivity Electrode Array: Individual sensors installed every 3 ft between: 25 - 70 ft bgs.	
Thermistor: Individual thermistors installed every 3 ft between: 29.5 - 38.5 and 59.5 - 71.5 ft bgs.	
Type I/II Portland Cement Grout: 23.0 - 39.9 ft bgs	



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
0		0.0 - 35.3 sandy Gravel (sG)
5		
10		
15		
20		
25		
30		

Reported By:

Tracy Mallgren	Geologist		8/7/17
Print Name	*Title*	*Signature*	*Date*

Reviewed By:

Kelly Whitley	Well Coordinator	Kelly Whitley	8/21/17
Print Name	*Title*	*Signature*	*Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-643 (REV 2)

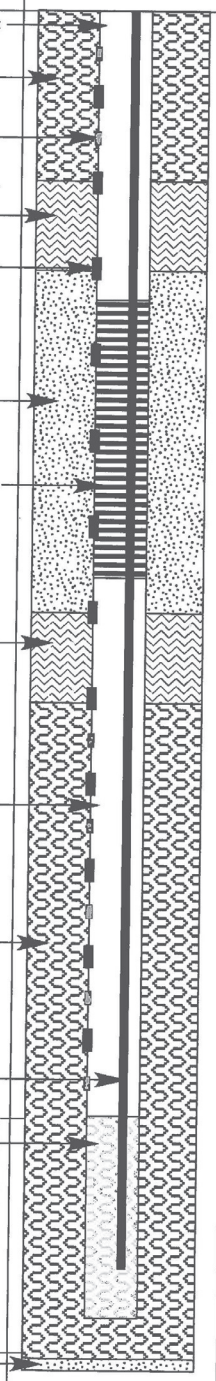
WELL SUMMARY CONTINUATION SHEET

Page 2 of 2

Well ID: C9519 | Well Name: 299-W22-121 | Project: Installation of 5 wells in 200-WA-1 OU

CONSTRUCTION DATA

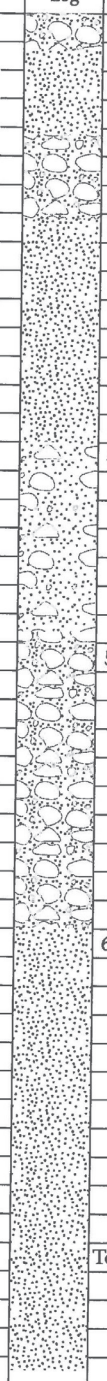
Description	Diagram
3 3/4-in I.D. Schedule 80, PVC Blank Casing: 0.43 - 44.11 ft bgs	
Type I/II Portland Cement Grout: 23.0 - 39.9 ft bgs	
Thermistor: Individual thermistors installed every 3 ft between: 29.5 - 38.5 and 59.5 - 71.5 ft bgs.	
3/8-in Bentonite Pellets: 39.9 - 43.2 ft bgs	
Resistivity Electrode Array: Individual sensors installed every 3 ft between: 25 - 70 ft bgs.	
10-20 mesh Premier Colorado Silica Filter Pack Sand: 43.2 - 55.1 ft bgs	
3 3/4-in I.D. Schedule 80, 20-slot (0.020 in.): PVC Screen: 44.11 - 53.90 ft bgs	
3/8-in Bentonite Pellets: 55.1 - 58.3 ft bgs	
3 3/4-in I.D. Schedule 80, PVC Sump: 53.90 - 81.20 ft bgs	
Type I/II Portland Cement Grout: 58.3 - 81.2 ft bgs	
Temperature Sensor Cable: 0.43 - 78.1 ft bgs	
Grout in sump: 72.78 - 81.20 ft bgs	
Possible cave-in: 72.7 - 80.9 ft bgs	
Natural fill: 81.2 - 81.5 ft bgs	



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 35, 40, 45, 50, 55, 60, 65, 70, 75, 80

Graphic Log



Lithologic Description (ft bgs)

- 0.0 - 35.3 sandy Gravel (sG)
- 35.3 - 38.3 Sand (S)
- 38.3 - 41.3 sandy Gravel (sG)
- 41.3 - 49.0 Sand (S)
- 49.0 - 55.7 gravelly Sand (gS)
- 55.7 - 66.0 sandy Gravel (sG)
- 66.0 - 81.5 Sand (S)

Total Depth: 81.5 ft bgs (3/21/2017)

Depths are in feet below ground surface.

Borehole drilled with 8-in O.D. casing from 0.0 - 80.9 ft bgs.

All temporary drill casing was removed from the ground.

A-6006-992 (Rev 2)

BOREHOLE LOG

Page 1 of 3

Date: 6/29/17

Well ID: C9519 | Well Name: 299-W22-121 | Location: ~10m South of 216-U-8 crib

Project: 5 wells in 200-WA-1 OU | Reference Measure Point: Ground Surface

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
0			0-35.3': sandy Gravel (SG) S=35%. G=65%. Gravel: vf to med. pebble, avg 8mm, max 40mm. Mod sorted, sub ang - sub round. Sand: vf - m grained, mod. sorted	Sonic drilling with 8-in OD Temporary casing from 0-80.9'bgs. Continuous core sampling with 3 3/4" OD LEXAN Liners from 30.4-81.5'bgs. Soil classifications are estimated based on visual observation through LEXAN Liners.
5				
10				
15				
20				
25				
30				RAD contamination (beta/gamma) 32.9-35.9: 600,000 dpm direct

Reported By:

Print Name	Title	Signature	Date
Tracy Mallaren	Geologist		6/29/17

Reviewed By:

Print Name	Title	Signature	Date
Sarah Springer	geologist (LG)		09-05-17

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OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Page 2 of 3

Date: 6/29/17

Well ID: C95G | Well Name: 299-W22-121 | Location: ~10m South of 216-U-8 Crib

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
35			35.3-38.3: Sand (S) 90% s, 5% g, 5% m Sand: f-vc grained Gravel: 2-8mm, sub ang-sub round.	Sonic drilling with 8in OD Temp. casing: 0-80.9'bgs Continuous core sampling with LEXAN Liners 30.4-81.5'bgs. Soil classification estimated based on visual inspection through LEXAN Liners.
40			38.3-41.3: Sandy Gravel (sG) 40% g, 55% s, 5% m Gravel: vf-med pebble, sub ang-sub round Sand: vf-vc grained	
45			41.3-49.0: Sand (S) 90% s, 5% g, 5% m Sand: vf-vc grained. Gravel: vf-f pebble	RAD contamination (beta/gamma) 35.3-38.3: 23,000 dpm direct 38.3-41.3: 469,000 dpm direct 41.3-44.3: 400,000 dpm direct 44.0-46.5: 200,000 dpm direct 46.0-49.0: 280,000 dpm direct 50.9-53.9: 8,000 dpm direct
50			49.0-55.7: gravelly Sand (gS) 20% g, 80% s Gravel: vf-med pebble, sub rounded Sand: vf-vc grained, course average size	
55			55.7-66.0': sandy Gravel (sG) 45% g, 55% s Gravel: vf-coarse pebble, sub rounded Sand: f-vc grained, coarse average.	56.2-56.7: 10,000 dpm direct
60				59.9-62.9: 6,000 dpm direct
65			66.0-81.5: Sand (S) 95% s, 5% g, T-m Sand: vf-vc grained, m-c average Gravel: vf-med pebble, sub rounded.	
70				

Reported By:

Tracy Mallgren (Print Name) | Geologist (Title) | [signature] (Signature) | 6/29/17 (Date)

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Page 3 of 3

Date: 6/29/17

Well ID: C9519 | Well Name: 299-W22-121 | Location: 210m South 216-U-8 Crib

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
75			66.0-81.5: Sand (S) 95%.S, 5%.g, T. m%. Sand: vf-vc grained, m-c average Gravel: vf-med pebble, sub rounded	Sonic drilling with 8-in OD Temp. casing 0-80.9' bgs Continuous core sampling with LEXAN Liners 30.4-81.5' bgs Soil classification estimated based on visual inspection through LEXAN Liners.
80			TD = 81.5' (3/21/17) 8-in casing to 80.9'	

Reported By:

Tracy Mallgren (Print Name) | Geologist (Title) | [signature] (Signature) | 6/29/17 (Date)

A-6006-993 (REV 0)

Continuous Core Sediment Sample Collection Summary for C9519

Date	Interval Depth (ft bgs)	Recovery (%)	HEIS #	Rad Screen HEIS #
3/14/2017	30.4 – 30.9	60	B38Y77	-
	30.9 – 31.4		B38Y78	
	31.4 – 31.9		B38Y79	
3/14/2017	32.9 – 33.4	83	B38Y87	B38Y67
	33.4 – 33.9		B38Y88	
	33.9 – 34.4		B38Y89	
	34.4 – 34.9		B38Y90	
	34.9 – 35.4		B38Y91	
3/14/2107	35.3 – 35.8	100	B38Y97	B38Y68
	35.8 – 36.3		B38Y98	
	36.3 – 36.8		B38Y99	
	36.8 – 37.3		B38YB0	
	37.3 – 37.8		B38YB1	
	37.8 – 38.3		B38YB2	
3/15/2017	38.3 – 38.8	100	B38YB7	B38Y69
	38.8 – 39.3		B38YB8	
	39.3 – 39.8		B38YB9	
	39.8 – 40.3		B38YC0	
	40.3 – 40.8		B38YC1	
	40.8 – 41.3		B38YC2	
3/15/2017	41.3 – 41.8	100	B38YC7	B38Y70
	41.8 – 42.3		B38YC8	
	42.3 – 42.8		B38YC9	
	42.8 – 43.3		B38YD0	
	43.3 – 43.8		B38YD1	
	43.8 – 44.3		B38YD2	
3/15/2017	44.0 – 44.5	83	B38YD7	B38Y71
	44.5 – 45.0		B38YD8	
	45.0 – 45.5		B38YD9	
	45.5 – 46.0		B38YF0	
	46.0 – 46.5		B38YF1	

Continuous Core Sediment Sample Collection Summary for C9519

Date	Interval Depth (ft bgs)	Recovery (%)	HEIS #	Rad Screen HEIS #
3/16/2017	46.0 – 46.5	100	B38YF7	B38Y72
	46.5 – 47.0		B38YF8	
	47.0 – 47.5		B38YF9	
	47.5 – 48.0		B38YH0	
	48.0 – 48.5		B38YH1	
	48.5 – 49.0		B38YH2	
3/16/2017	50.9 – 51.4	100	B38YH7	B38Y73
	51.4 – 51.9		B38YH8	
	51.9 – 52.4		B38YH9	
	52.4 – 52.9		B38YJ0	
	52.9 – 53.4		B38YJ1	
	53.4 – 53.9		B38YJ2	
3/16/2017	53.2 – 53.7	83	B38YJ7	B38Y74
	53.7 – 54.2		B38YJ8	
	54.2 – 54.7		B38YJ9	
	54.7 – 55.2		B38YK0	
	55.2 – 55.7		B38YK1	
3/20/2017	56.2 – 56.7	100	B38YK8	-
	56.7 – 57.2		B38YK9	
	57.2 – 57.7		B38YL0	
	57.7 – 58.2		B38YL1	
	58.2 – 58.7		B38YL2	
	58.7 – 59.2		B38YL3	
3/20/2017	59.9 – 60.4	100	B38YL8	-
	60.4 – 60.9		B38YL9	
	60.9 – 61.4		B38YM0	
	61.4 – 61.9		B38YM1	
	61.9 – 62.4		B38YM2	
	62.4 – 62.9		B38YM3	

Continuous Core Sediment Sample Collection Summary for C9519

Date	Interval Depth (ft bgs)	Recovery (%)	HEIS #	Rad Screen HEIS #
3/20/2017	62.6 – 63.1	83	B396L4	-
	63.1 – 63.6		B396L5	
	63.6 – 64.1		B396L6	
	64.1 – 64.6		B396L7	
	64.6 – 65.1		B396L8	
3/21/2017	66.0 – 66.5	67	B396M4	-
	66.5 – 67.0		B396M5	
	67.0 – 67.5		B396M6	
	67.5 – 68.0		B396M7	
3/21/2017	69.9 – 70.4	93	B396N4	-
	70.4 – 70.9		B396N5	
	70.9 – 71.4		B396N6	
	71.4 – 71.9		B396N7	
	71.9 – 72.4		B396N8	
	72.4 – 72.9		B396N9	
3/21/2017	72.1 – 72.6	100	B39893	-
	72.6 – 73.1		B39894	
	73.1 – 73.6		B39895	
	73.6 – 74.1		B39896	
	74.1 – 74.6		B39897	
	74.6 – 75.1		B39898	
3/21/2017	76.5 – 77.0	100	B398B3	-
	77.0 – 77.5		B398B4	
	77.5 – 78.0		B398B5	
	78.0 – 78.5		B398B6	
	78.5 – 79.0		B398B7	
	79.0 – 79.5		B398B8	
	79.5 – 80.0		B398B9	
	80.0 -80.5		B398C0	
	80.5 – 81.0		B398C1	
	81.0 – 81.5		B398C2	

ft bgs = feet below ground surface
HEIS = Hanford Environmental Information System

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299-W22-121 (C9519)
Log Data Report

Borehole Information

Log Date	2017-03-23	Filename	C9519_HG-NM_2017-03-23	Site	200-WA-1
DTW[1] (ft)	**DTW Date**	**DTW Source**	**Drill Date**	**Total Depth (ft)**	**Depth Datum**
None	N/A	SN3	03/21/17	81.3	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	Sonic	-0.3	8.0	7 1/4	3/8	0.3	80.9

Borehole Notes

The logging engineer measured casing thickness. Drill depth and casing depth were provided by the wellsite geologist. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma 5Tb	Type	60% HPGe SGLS[2]
Effective Calibration Date	02/16/17	Serial No.	54-TP13441B
Calibration Reference	HGLP-CC-152, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 5Cb	Type	Planar HPGe HRLS[3]
Effective Calibration Date	08/04/16	Serial No.	39A314
Calibration Reference	HGLP-CC-142, Rev. 0	Logging Procedure	SGRP-PRO-OP-53050, Rev. 0

Logging System	Gamma 5Pb	Type	NMLS[4] He-3 (CPN 503)
Effective Calibration Date	02/27/17	Serial No.	H34055445
Calibration Reference	HGLP-CC-153, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0

SGLS Log Run Information

Log Run	3	4 Repeat	5	6 Repeat	7 Repeat
HEIS Number	1019816	1019817	1019818	1019819	1019820
Date	03/23/17	03/23/17	03/23/17	03/23/17	03/23/17
Logging Engineer	Spatz/McClellan	Spatz/McClellan	Spatz/McClellan	Spatz/McClellan	Spatz/McClellan
Start Depth (ft)	0.0	31.0	49.0	70.0	29.0
Finish Depth (ft)	32.0	50.0	80.0	80.0	31.0
Count Time (sec)	100	15	100	100	500
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

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

Log Run	3	4 Repeat	5	6 Repeat	7 Repeat
Log Speed (ft/min)	N/A	N/A	N/A	N/A	N/A
Pre-Verification	C9519FTB2017 0323AV00CAB 1	C9519FTB2017 0323AV00CAB 1	C9519FTB2017 0323AV00CAB 1	C9519FTB2017 0323AV00CAB 1	C9519FTB2017 0323AV00CAB 1
Start File	AD000000	BD003100	CD004900	DD007000	ED002900
Finish File	AD003207	BD005000	CD008000	DD008000	ED003100
Post-Verification	C9519FTB2017 0323EV00CAA1	C9519FTB2017 0323EV00CAA1	C9519FTB2017 0323EV00CAA1	C9519FTB2017 0323EV00CAA1	C9519FTB2017 0323EV00CAA1
Depth Return Error (in.)	N/A	N/A	N/A	N/A	1.0 high
Comments	No fine gain adjustments made	15 sec count rate through high rate interval	No fine gain adjustments made	No fine gain adjustments made	No fine gain adjustments made

HRLS Log Run Information

Log Run	8	9 Repeat			
HEIS Number	1019821	1019822			
Date	03/23/17	03/23/17			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	30.0	35.0			
Finish Depth (ft)	50.0	40.0			
Count Time (sec)	300	300			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C9519FTB2017 0323AV00CAB 1	C9519FTB2017 0323AV00CAB 1			
Start File	AD003000	BD003500			
Finish File	AD005000	BD004000			
Post-Verification	C9519FTB2017 0323BV00CAA 1	C9519FTB2017 0323BV00CAA 1			
Depth Return Error (in.)	N/A	7.0 high			
Comments	No fine gain adjustments made	No fine gain adjustments made			

NMLS Log Run Information

Log Run	1	2 Repeat			
HEIS Number	1019823	1019824			
Date	03/22/17	03/22/17			
Logging Engineer	Felt/Spatz	Felt/Spatz			
Start Depth (ft)	0.0	45.0			
Finish Depth (ft)	81.01	53.01			
Count Time (sec)	15	15			
Live/Real	R	R			
Shield (Y/N)	N	N			

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Log Run	1	2 Repeat			
MSA Interval (ft)	0.25	0.25			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C9519FPB20170 322AV00CAB1	C9519FPB20170 322AV00CAB1			
Start File	AD000000	BD004500			
Finish File	AD008101	BD005301			
Post-Verification	C9519FPB20170 322BV00CAA1	C9519FPB20170 322BV00CAA1			
Depth Return Error (in.)	N/A	0.5 high			
Comments	None	None			

Logging Operation Notes

A centralizer was not installed on the SGLS and NMLS sondes. The logging sonde and cable were sleeved in plastic to prevent potentially contaminating the equipment.

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

Analysis Notes

Analyst	P.D. Henwood	Date	04/12/17
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as FTB20170216_CC-152 for the SGLS, using an efficiency function and corrections for casing and dead time as determined during annual response checks.

Results and Interpretations

Cs-137 was detected almost throughout the borehole. A high activity interval exists from 31 to 50 ft in depth where a maximum Cs-137 concentration was measured at approximately 20,000 pCi/g at 39 ft.

Pa-234m (manmade U-238) was detected at the margins of the high activity interval at 30 and 31 ft and from 49 to 54 ft. The maximum concentration was measured at 815 pCi/g at 31 ft. Although not measured, Pa-234m likely exists in the high activity interval at higher concentrations.

U-235 was detected at 51 and 52 ft at a maximum concentration of 24 pCi/g. U-235 likely exists with Pa-234m but is below the minimum detection limit in some cases.

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

List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-80 ft)
Natural Gamma Logs (0-80 ft)
Combination Plot (0-80 ft)
Total Gamma & Moisture (0-80 ft)
Manmade Radionuclides Repeat Data (70-80 ft)
Repeat Section of Natural Gamma Logs (70-80 ft)
Moisture Repeat Section (45-54 ft)

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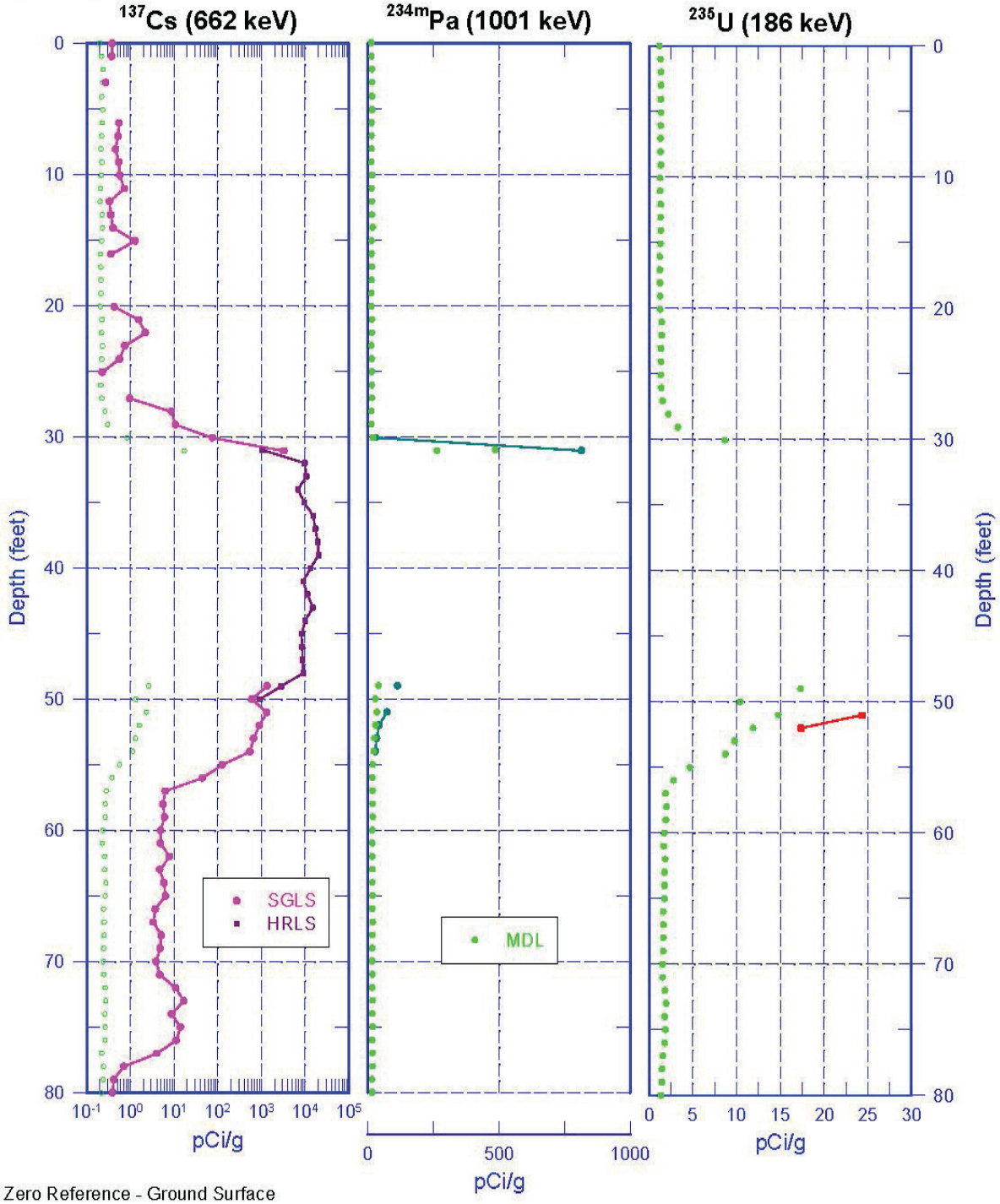
299-W22-121 (C9519)
Manmade Radionuclides



Zero Reference - Ground Surface

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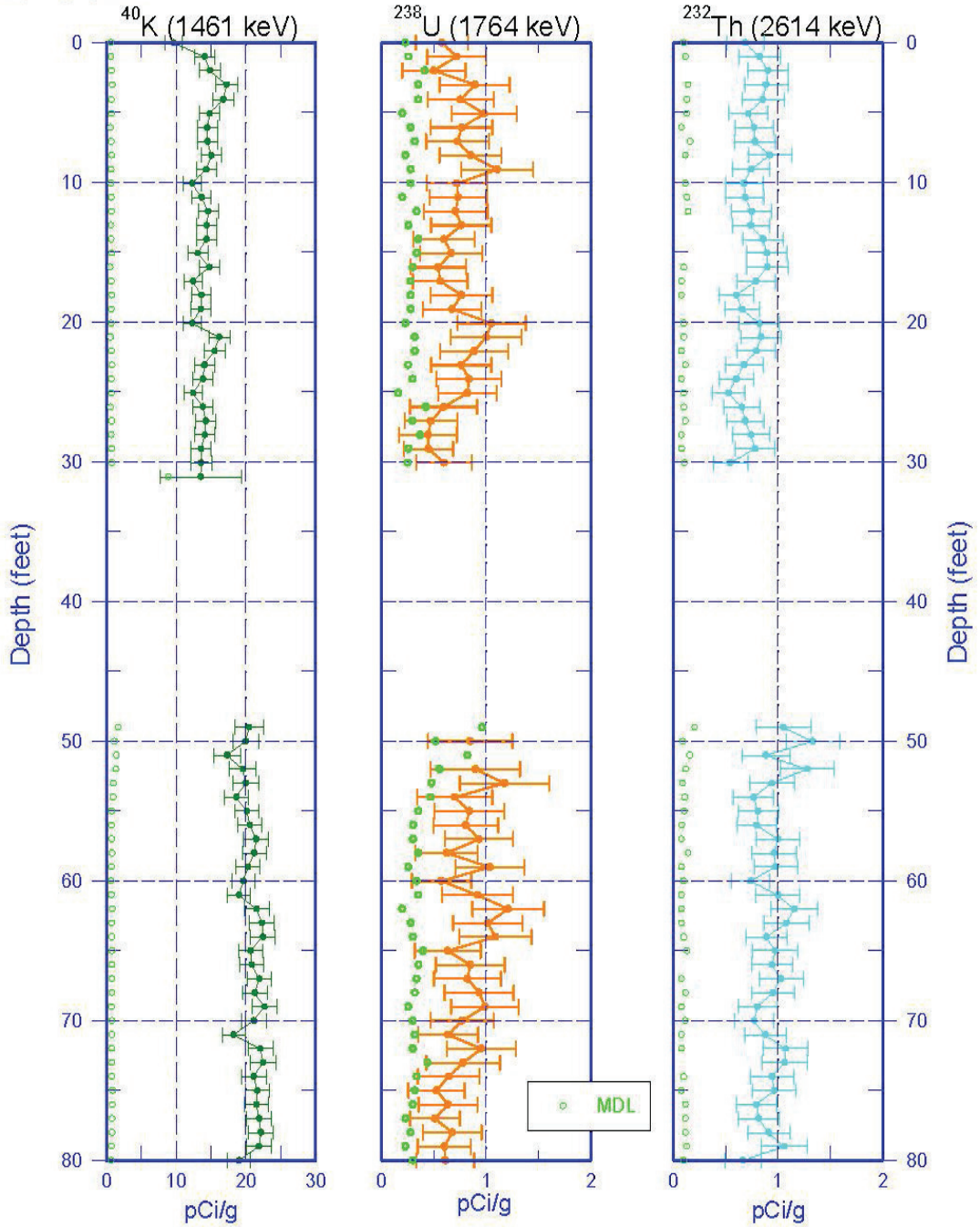
299-W22-121(C9519)
Natural Gamma Logs



Zero Reference - Ground Surface

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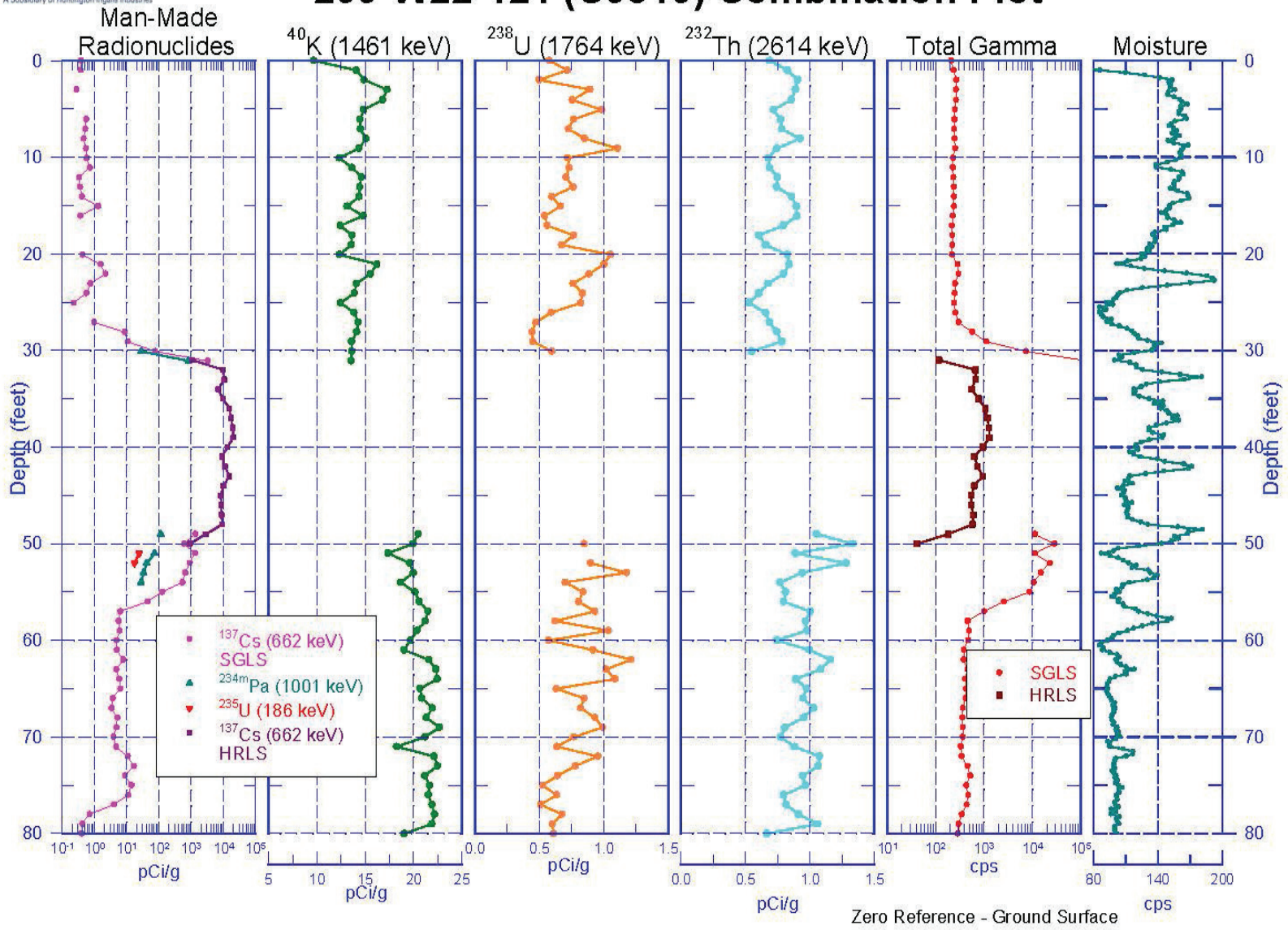
299-W22-121 (C9519) Combination Plot



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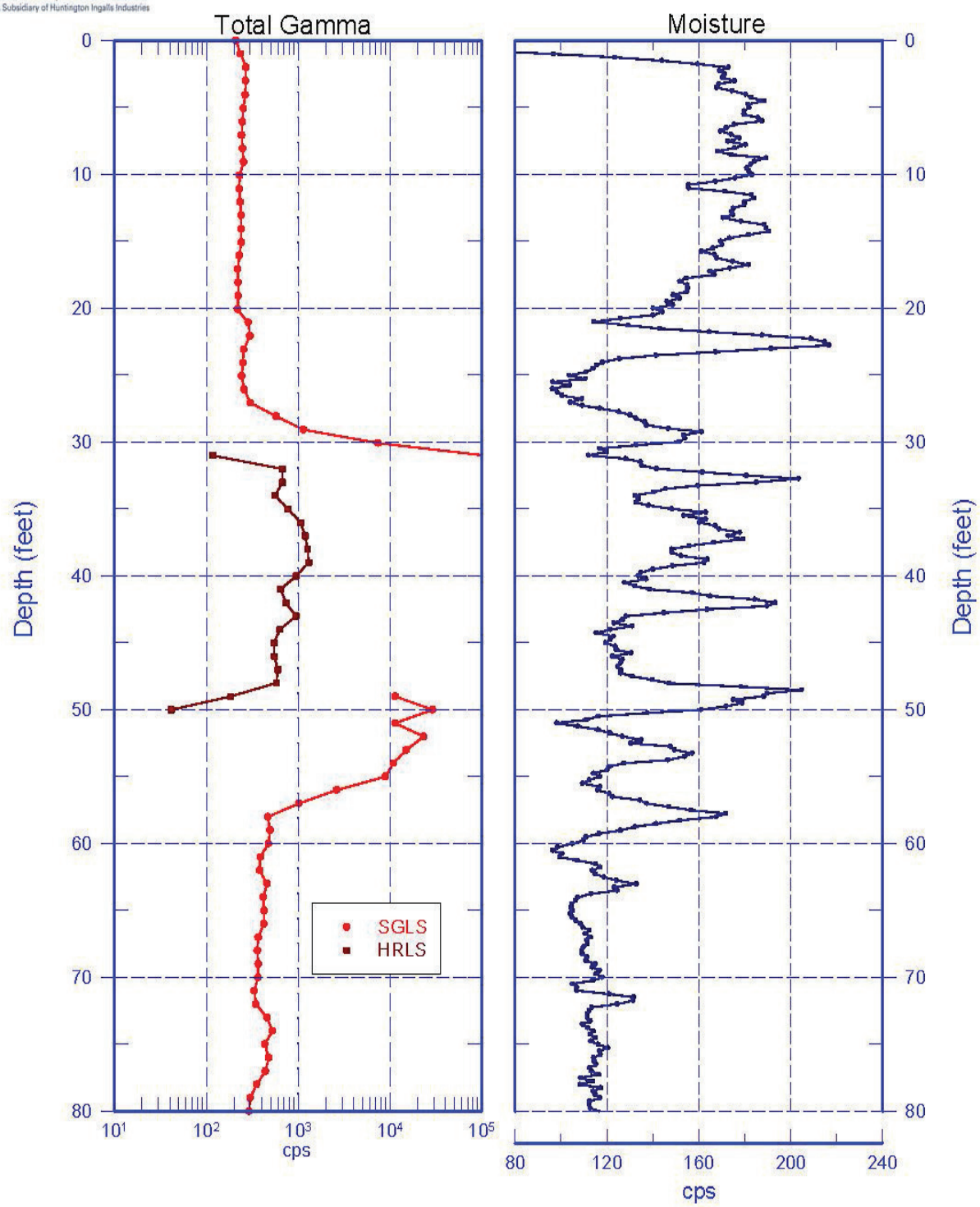
299-W22-121 (C9519)
Total Gamma & Moisture



Zero Reference - Ground Surface

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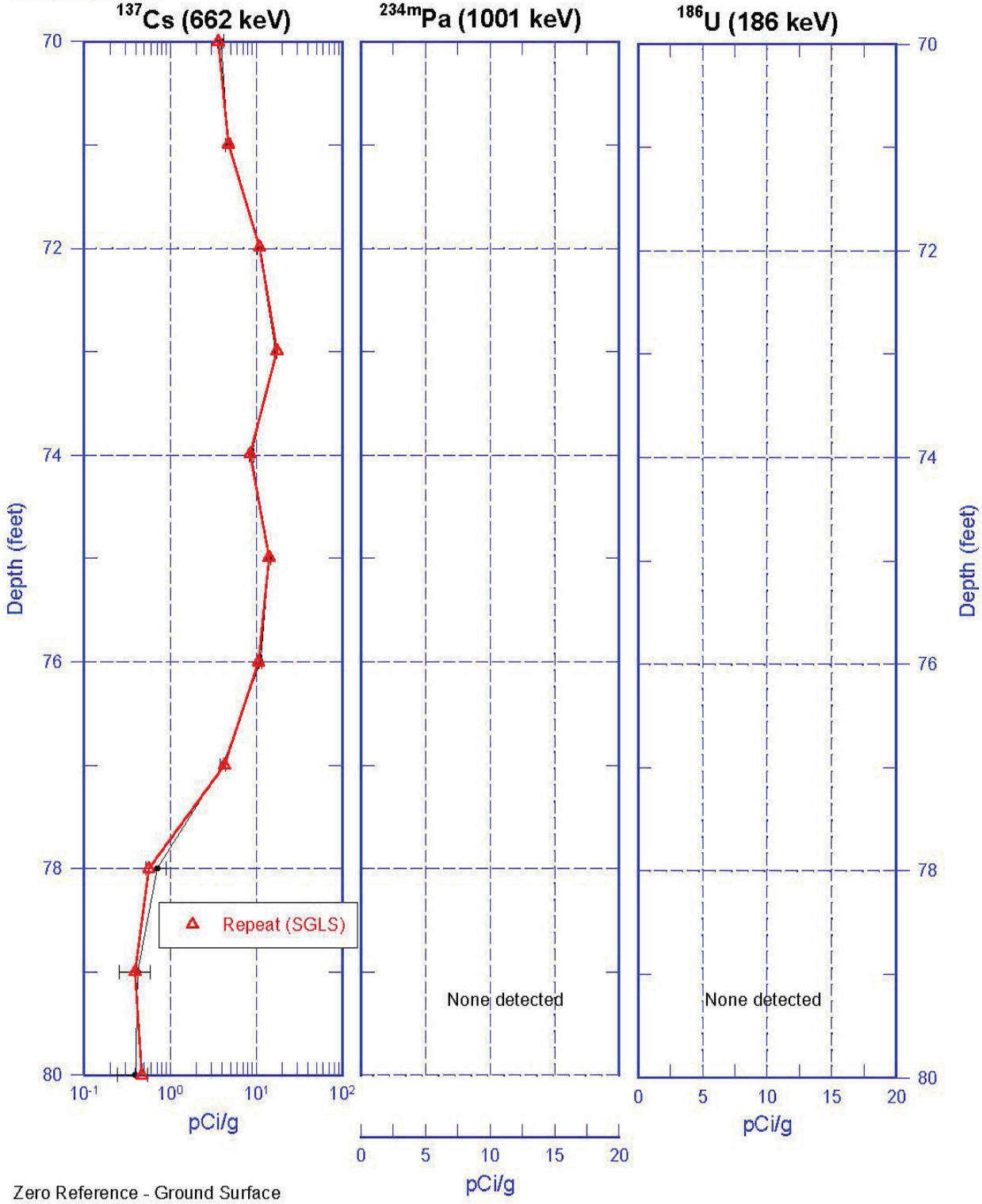
299-W22-121 (C9519)
Manmade Radionuclides Repeat Data



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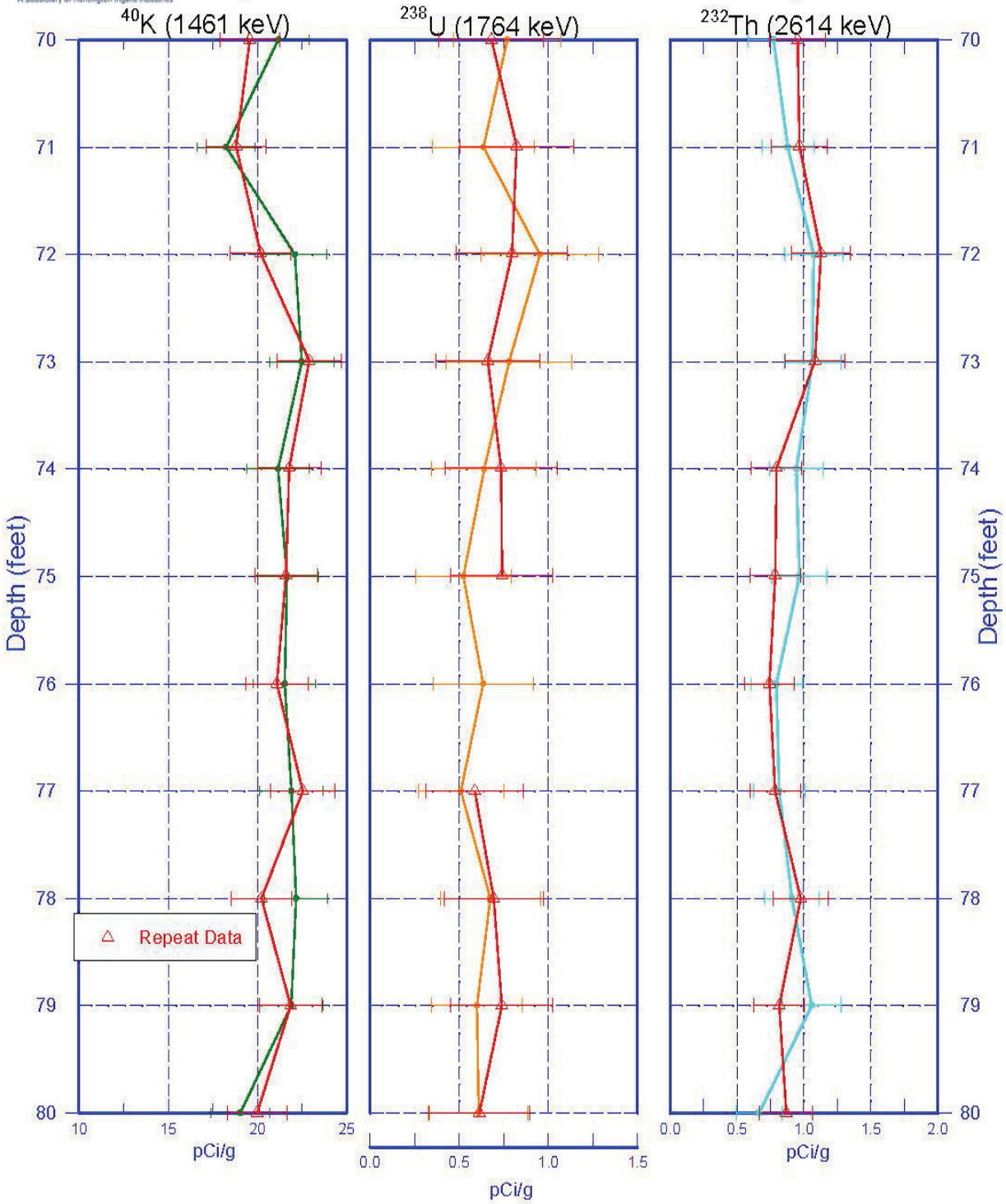
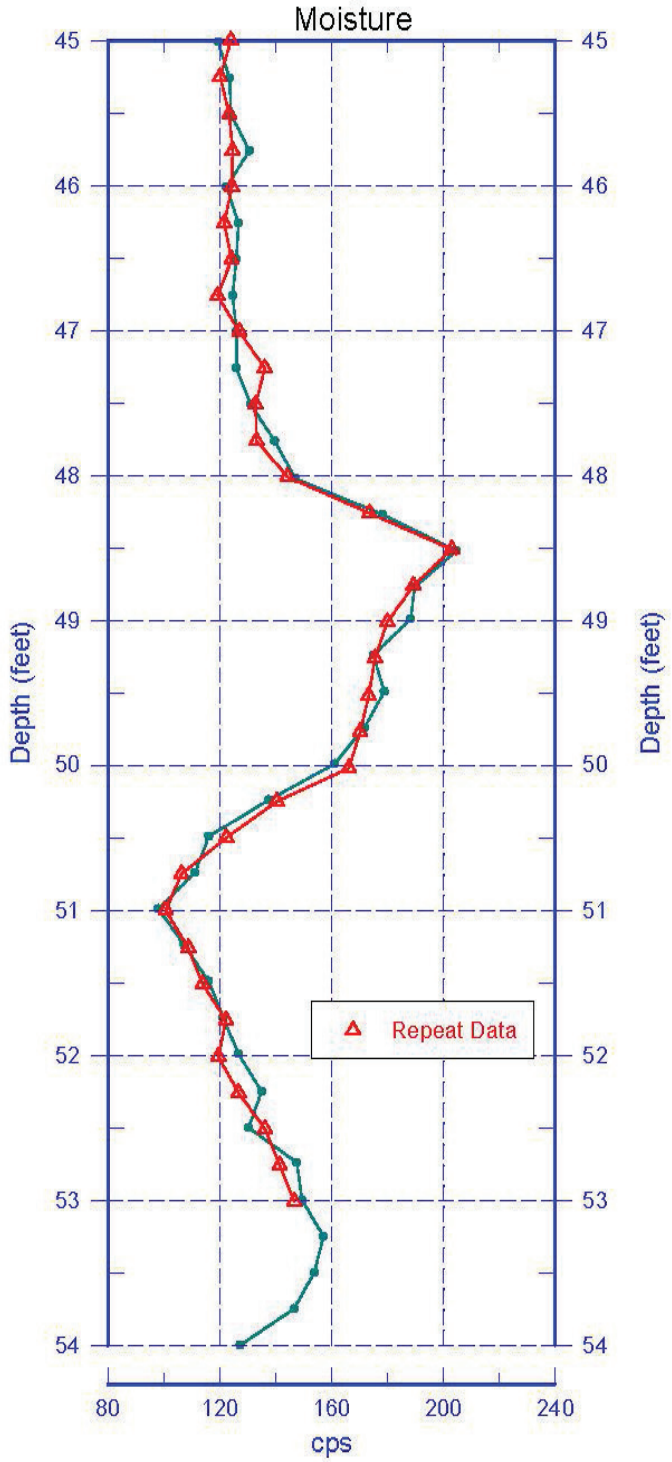
299-W22-121 (C9519)
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

299-W22-121 (C9519)
Moisture Repeat Section



Zero Reference - Ground Surface

Appendix E

Well Documentation for C9583 (299-W22-124)

Contents

Well Summary Sheet …….…….....E-1
Borehole Log …….…….....E-3
Log Data Report…….……E-6

WELL SUMMARY SHEET

Well ID : C9583	Well Name: 299-W22-124	Start Date: 5/1/2017
Project: Installation of 5 wells in 200-WA-1 OU	Location: ~14m South of 216-U-8 Crib	Finish Date: 5/30/2017

CONSTRUCTION DATA

Description

Flush Mount Monument

2-in I.D. Schedule 40, PVC Blank Casing: 0.17 - 72.65 ft bgs

Type I/II Portland Cement Grout: 0.0 - 20.05 ft bgs

Temperature Sensor Cable: 0.17 - 78 ft bgs

Resistivity Electrode Array: Individual sensors installed every 3 ft 29.9 - 71.9 ft bgs

Thermistor: Individual thermistors installed every 6 ft between: 31.5 - 43.5 and 55.5 - 67.5 ft bgs. Individual thermistors installed every 3 ft between: 43.5 - 55.5 ft bgs.

Gas Sampler: Individual samplers installed every 6 ft 37.5 - 61.5 ft bgs

3/8-in Bentonite Crumbles: 20.05 - 26.25 ft bgs

200 mesh Premier Silica Filter Pack Sand: 26.25 - 27.75 ft bgs

100 mesh Premier Colorado Silica Filter Pack Sand: 27.75 - 29.27 ft bgs

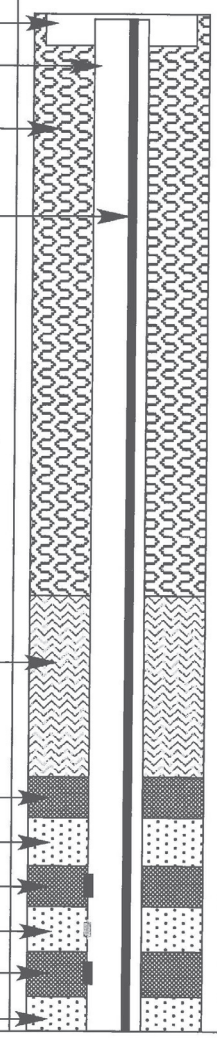
200 mesh 29.27 - 30.70 ft bgs

100 mesh 30.70 - 32.10 ft bgs

200 mesh 32.10 - 33.82 ft bgs

100 mesh 33.82 - 35.22 ft bgs

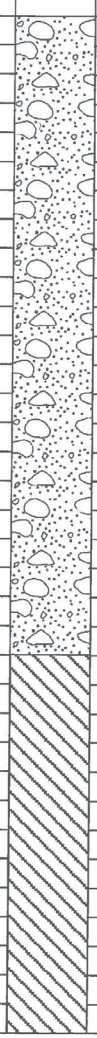
Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 5, 10, 15, 20, 25, 30

Graphic Log



Lithologic Description (ft bgs)

0.0 - 22.0 gravelly Sand (gS)

22.0 - 69.5 No sediment identification

Reported By:				
	Tracy Mallgren	Geologist		8-8-17
	Print Name	*Title*	*Signature*	*Date*

Reviewed By:				
	Kelly Whitley	Well Coordinator	Kelly Whitley	8/21/17
	Print Name	*Title*	*Signature*	*Date*

For Office Use Only

OR Doc Type:	WMU Code(s):

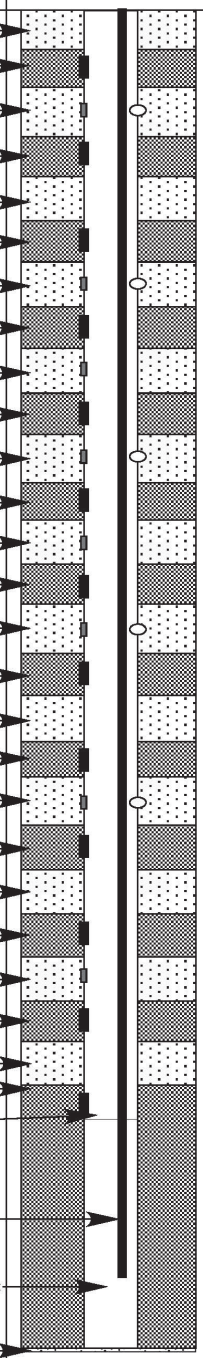
A-6003-643 (REV 2)

WELL SUMMARY CONTINUATION SHEET | Page 2 of 2

Well ID: C9583 | Well Name: 299-W22-124 | Project Installation of 5 wells in 200-WA-1 OU

CONSTRUCTION DATA

Description	Diagram
100 mesh 33.82 - 35.22 ft bgs	
200 mesh 35.22 - 36.80 ft bgs	
100 mesh 36.80 - 38.25 ft bgs	
200 mesh 38.25 - 39.79 ft bgs	
100 mesh 39.79 - 41.22 ft bgs	
200 mesh 41.22 - 42.80 ft bgs	
100 mesh 42.80 - 44.20 ft bgs	
200 mesh 44.20 - 45.80 ft bgs	
100 mesh 45.80 - 47.20 ft bgs	
200 mesh 47.20 - 48.75 ft bgs	
100 mesh 48.75 - 50.15 ft bgs	
200 mesh 50.15 - 51.85 ft bgs	
100 mesh 51.85 - 53.22 ft bgs	
200 mesh 53.22 - 54.65 ft bgs	
100 mesh 54.65 - 56.12 ft bgs	
200 mesh 56.12 - 57.70 ft bgs	
100 mesh 57.70 - 59.15 ft bgs	
200 mesh 59.15 - 60.64 ft bgs	
100 mesh 60.64 - 62.25 ft bgs	
200 mesh 62.25 - 63.77 ft bgs	
100 mesh 63.77 - 65.25 ft bgs	
200 mesh 65.25 - 66.65 ft bgs	
100 mesh 66.65 - 68.25 ft bgs	
200 mesh 68.25 - 69.72 ft bgs	
100 mesh 69.72 - 71.22 ft bgs	
200 mesh 71.22 - 80.40 ft bgs	
2-in I.D. Schedule 40, PVC Blank Casing: 0.17 - 72.65 ft bgs	
Temperature Sensor Cable: 0.17 - 78 ft bgs	
2-in I.D. Schedule 40, PVC Blank Casing Sump: 72.65 - 80.40 ft bgs	
Natural fill 80.40 - 80.50 ft bgs	



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description (ft bgs)
35		22.0 - 69.5 No sediment identification
40		
45		
50		
55		
60		
65		
70		69.5 - 80.5 Sand (S)
75		Total Depth: 80.5 (5/22/2017)
80		Depths are in feet below ground surface. Borehole drilled with 6-in O.D. casing from 0.0 - 80.5 ft bgs. All temporary drill casing was removed from the ground.

A-6006-992 (Rev 2)

BOREHOLE LOG

Page 1 of 3

Date: 6/29/17

Well ID: C9583 | Well Name: 299-W22-124 | Location: ~14m South of 216-U-8 Crib

Project: 5 wells in 200-WA-OU | Reference Measure Point: Ground Surface

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
0			0-22' bgs gravelly Sand (gS) 25% g, 75% s	Sonic drilling with 6-in
			Sand: vf-c grained, ang ~40% fel	OD Temp. casing 0-80.5' bgs
			Gravel: 2-40mm, poorly sorted, sub ang.	No sediment samples collected
			Moist.	from the borehole
5				
10				
15				
20				RAD Contamination (beta/gamma)
				22-27: 5,000 dpm direct
25		Not used ES 8/2/17	TJM 6/29/17 22- ~~27-72.6~~ 69.5' bgs; All Sediment sleeved in yellow plastic for radiological control — no sediment identification —	27-32: 80,000 dpm direct
30				
				32-37: ~~120,000~~ 200,000 dpm direct TJM 6/29/17

Reported By:

Print Name	Title	Signature	Date
Tracy Mallgren	Geologist		6/29/17

Reviewed By:

Print Name	Title	Signature	Date
Sarah Springer	geologist (LG)		09-05-17

For Office Use Only

OR Doc Type:	WMU Code(s):

A-6003-642 (REV 1)

BOREHOLE LOG (Cont.)

Page 2 of 3

Date: 6/29/17

Well ID: C9583 | Well Name: 299-W22-124 | Location: ~14 m South 216-U-8 Crib

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCl, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
35			22-69.5' bgs: All sediment sleeved in yellow plastic for radiological control — no sediment identification	Sonic drilling with 6-in OD temp. casing. 0-20.5' bgs. No sediment samples collected.
40				RAD Contamination (beta/gamma) 32-37: ~~120,000~~ 200,000 dpm direct (TM 6/29/17) 37-42: 120,000 dpm direct 42-47: 120,000 dpm direct
45				47-52: 50,000 dpm direct
50				50.6' @ ~~47'~~ bgs (TM 6/29/17) 8 oz of H_2O added to assit in core barrel recovery 53.5-60.1: 14,000 dpm direct
55		Not used ts 8/2/17		
60				60.1-67': ~~6,500~~ 81000 dpm direct (TM 6/29/17) 67-69.5: 6,500 dpm direct
65				
70			69.5-80.5' (TM 6/29/17): Sand (S) S=95% g=5%. Sand: vf-vc, avg. c, sub ang. ~50/50 fel/maf Gravel = 2-15 mm, sub. round, poor sort 60% maf	

Reported By:

Print Name	Title	Signature	Date
Tracy Mallgren	Geologist		6/29/17

A-6006-993 (REV 0)

BOREHOLE LOG (Cont.)

Page 3 of 3

Date: 6/29/17

Well ID: C9583 | Well Name: 299-W22-124 | Location: ~14m South of 216-U-8 Crib

Depth (ft)	Sample	Graphic Log	Sample Description: Sediment Classification, Grain Size Distribution, Color, Moisture Content, Sorting, Angularity, Mineralogy, Particle Size, Reaction to HCI, Other	Comments: Depth of Casing, Drilling Method, Sampling Method, Sampler Size, Water Level, Other
75			69.5-80.5' Sand (S) s=95% g=5% Sand: vf-vc, avg. c, sub. ang, ~50/50 fel/mat Gravel: 2-15mm, sub round, poor sort, 60% mat	Sonic drilling with 6-in OD Temp. Casing 0-80.5' bgs. No sediment samples collected.
80			TD = 80.5' (5/22/17)	

Not used

Reported By:

Tracy Malkiner — Print Name | Geologist — Title | Signature | 6/29/17 — Date

A-6006-993 (REV 0)

Stoller Newport News Nuclear

299-W22-124 (C9583)
Log Data Report

Borehole Information

Log Date	2017-05-04	Filename	C9583_HG-NM_2017-05-04	Site	200-WA-1
DTW[1] (ft)	**DTW Date**	**DTW Source**	**Drill Date**	**Total Depth (ft)**	**Depth Datum**
None	N/A	SN3	04/27/17	80.2	Ground Surface

Casing Information

Casing Type	Drill Type	Stickup (ft)	Diameter (in.) Outer	Diameter (in.) Inside	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	Sonic	2.7	6.0	5 1/4	3/8	-2.7	80.5

Borehole Notes

The logging engineer measured casing thickness. Drill depth and casing depth were provided by the wellsite geologist. Zero reference is ground surface.

Logging Equipment Information

Logging System	Gamma 5Tb	Type	60% HPGe SGLS[2]
Effective Calibration Date	02/16/17	Serial No.	54-TP13441B
Calibration Reference	HGLP-CC-152, Rev. 0	Logging Procedure	SGRP-PRO-OP-53023, Rev. 0

Logging System	Gamma 5Pb	Type	NMLS[3] He-3 (CPN 503)
Effective Calibration Date	02/27/17	Serial No.	H34055445
Calibration Reference	HGLP-CC-153, Rev. 0	Logging Procedure	SGRP-PRO-OP-53024, Rev. 0

SGLS Log Run Information

Log Run	1	2			
HEIS Number	1019880	1019881			
Date	05/04/17	05/04/17			
Logging Engineer	Felt/McClellan	Felt/McClellan			
Start Depth (ft)	0.0	32.0			
Finish Depth (ft)	79.02	40.0			
Count Time (sec)	100	500			
Live/Real	R	R			
Shield (Y/N)	N	N			
MSA Interval (ft)	1.0	1.0			
Log Speed (ft/min)	N/A	N/A			
Pre-Verification	C9583FTB2017 0504AV00CAB 1	C9583FTB2017 0504AV00CAB 1			

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

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Log Run	1	2			
Start File	AD000000	BD003200			
Finish File	AD007902	BD004000			
Post-Verification	C9583FTB20170504BV00CAA1	C9583FTB20170504BV00CAA1			
Depth Return Error (in.)	N/A	0.0			
Comments	No fine gain adjustments made	Repeat at 500 sec			

NMLS Log Run Information

Log Run	3	4 Repeat			
HEIS Number	1019882	1019883			
Date	05/04/17	05/04/17			
Logging Engineer	Spatz	Spatz			
Start Depth (ft)	0.0	35.0			
Finish Depth (ft)	80.0	45.0			
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	C9583FPB20170504AV00CAB1	C9583FPB20170504AV00CAB1			
Start File	AD000000	BD003500			
Finish File	AD008000	BD004500			
Post-Verification	C9583FPB20170504BV00CAA1	C9583FPB20170504BV00CAA1			
Depth Return Error (in.)	N/A	1.0 high			
Comments	None	None			

Logging Operation Notes

A centralizer was not installed on the SGLS and NMLS sondes. The logging sonde and cable were sleeved in plastic to prevent potentially contaminating the equipment.

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

Analysis Notes

Analyst	P.D. Henwood	Date	05/31/17
Reference(s)	SGRP-PRO-OP-53040, Rev. 0; SGRP-PRO-OP-53051, Rev. 0		

SGLS spectra were processed in batch mode in APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated in an EXCEL template identified as ftB20170216_CC-152 for the SGLS, using an efficiency function and corrections for casing and dead time as determined during annual response checks.

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Results and Interpretations

Cs-137 was detected from 31 to 53 ft and at intermittent depths to 76 ft. A maximum Cs-137 concentration was measured at approximately 2837 pCi/g at 48 ft.

The Manmade Radionuclides plot includes SGLS data acquired at 100 sec and repeat data acquired for 500 sec from 32 to 40 ft. The Combination plot includes only data acquired at 100 sec count times.

Pa-234m (manmade U-238) was detected from 33 to 40 ft and intermittently to 63 ft. Even though detections were intermittent, it is possible the manmade uranium exists continuously but at concentrations below the MDL[4] of approximately 16 pCi/g at some depths. The maximum concentration was measured at 205 pCi/g at 34 ft.

U-235 was detected at 58 ft using 100 sec count times at a maximum concentration of 1.9 pCi/g. Repeat data acquired at a 500 sec count time indicated U-235 at 34, 36, and 38 ft. A maximum concentration of 11 pCi/g was measured at 36 ft. U-235 likely exists with Pa-234m but is below the MDL in some cases.

Note: The KUT log plots represent naturally occurring radionuclides (potassium, uranium, and thorium) present in the surrounding formation and are not manmade contaminants.

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 manmade, KUT, and moisture repeat plots indicate that the respective systems were working properly. The repeat data were acquired at 500 sec counting times rather than the standard 100 sec, resulting in additional detections and improved accuracy where concentrations are near the MDL.

List of Log Plots

Depth Reference is ground surface.

Manmade Radionuclides (0-80 ft)
Natural Gamma Logs (0-80 ft)
Combination Plot (0-80 ft)
Total Gamma & Moisture (0-80 ft)
Total Gamma & Hanford Gamma Unit (0-80 ft)
Manmade Radionuclides Repeat Data (32-40 ft)
Repeat Section of Natural Gamma Logs (32-40 ft)
Moisture Repeat Section (35-45 ft)

[4] minimum detection limit

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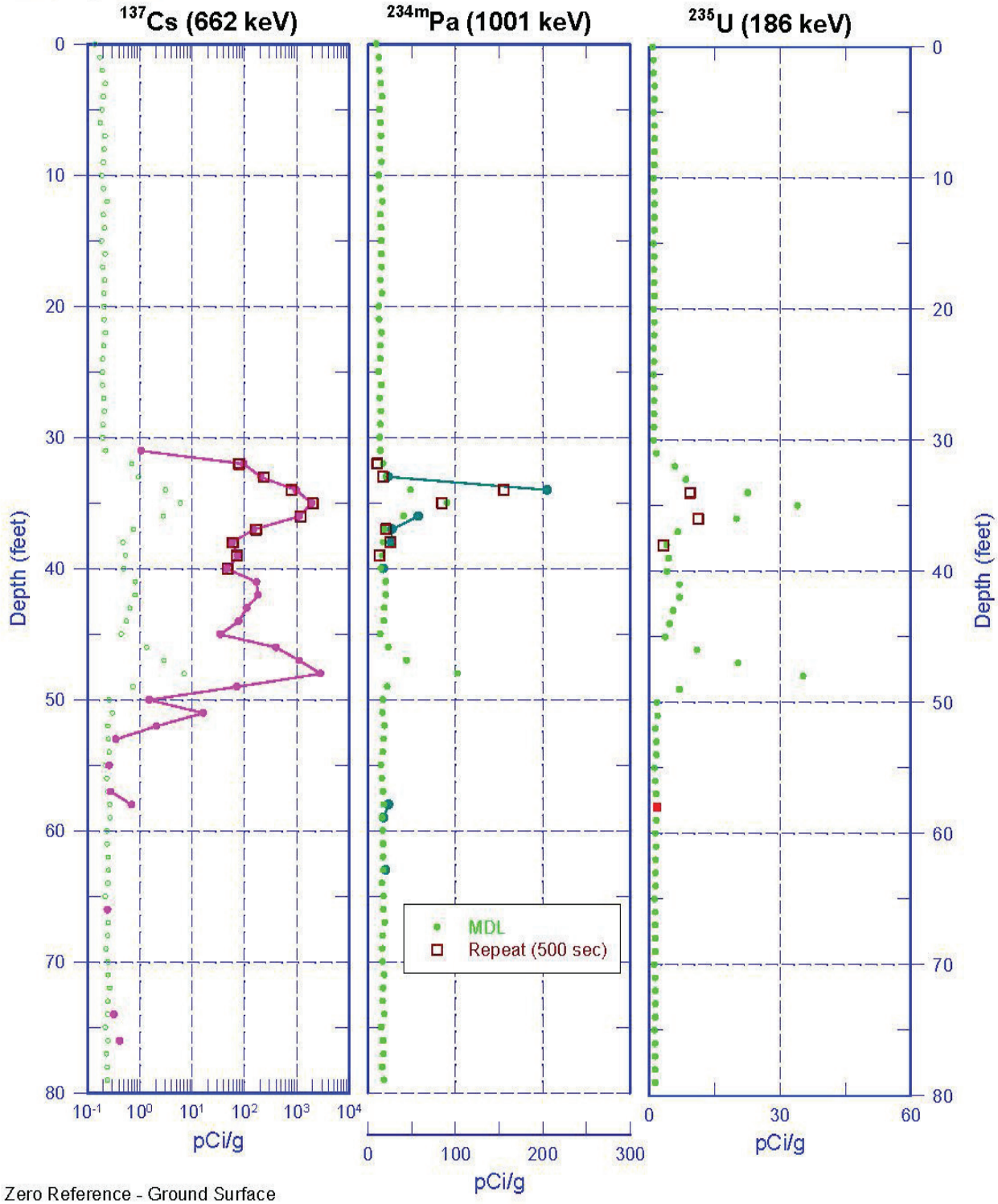
299-W22-124 (C9583)
Manmade Radionuclides



Zero Reference - Ground Surface

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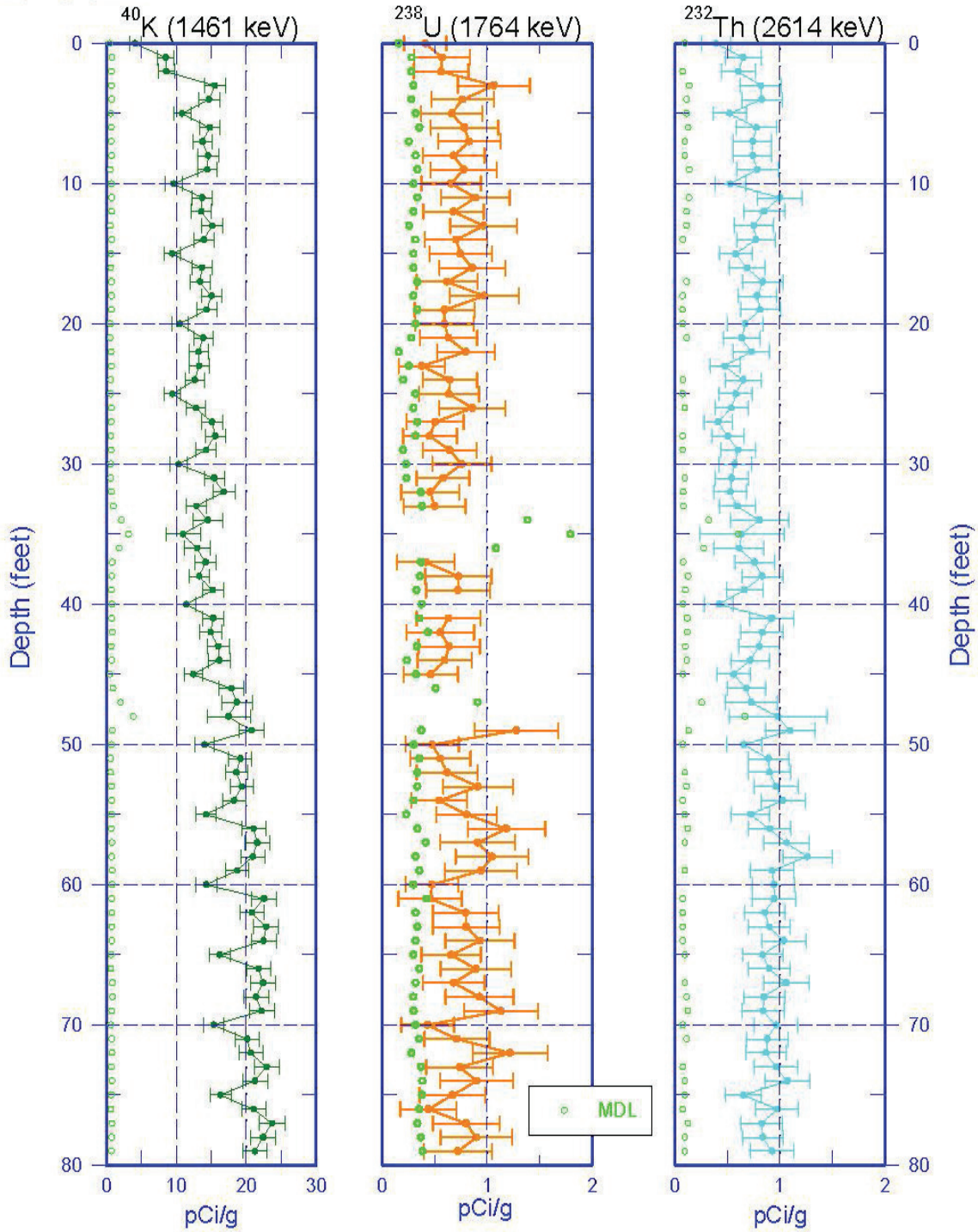
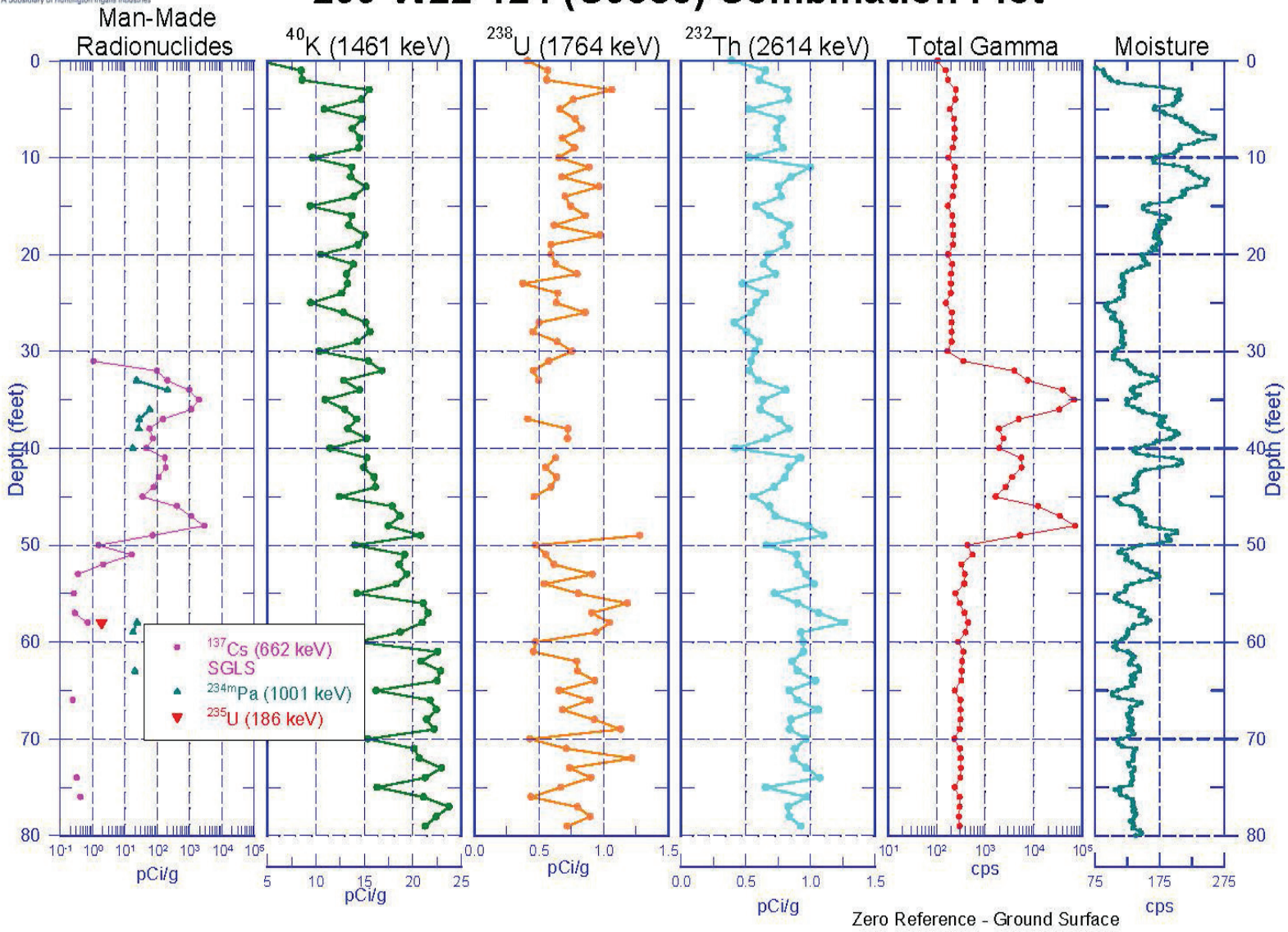
299-W22-124 (C9583)
Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

299-W22-124 (C9583) Combination Plot



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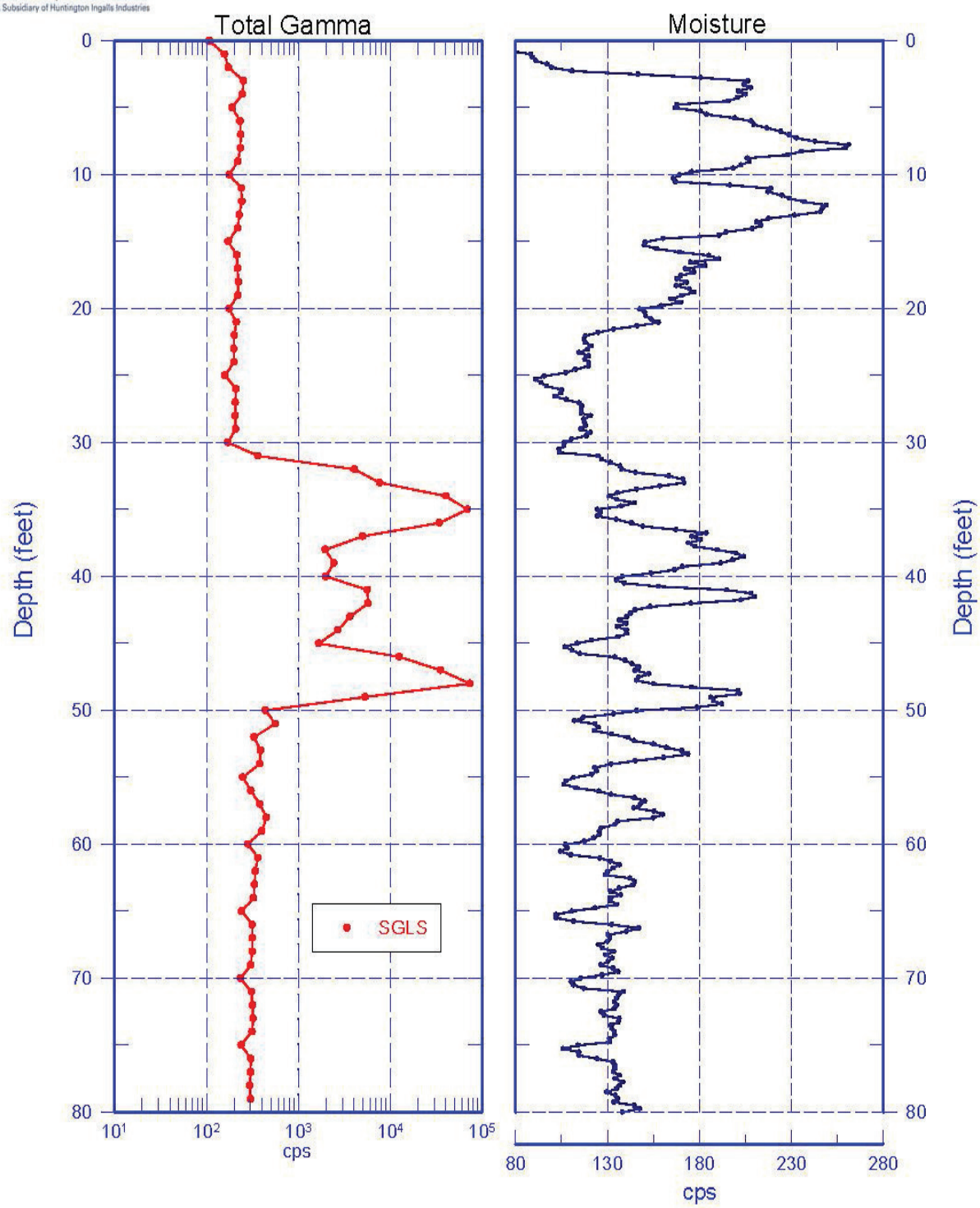
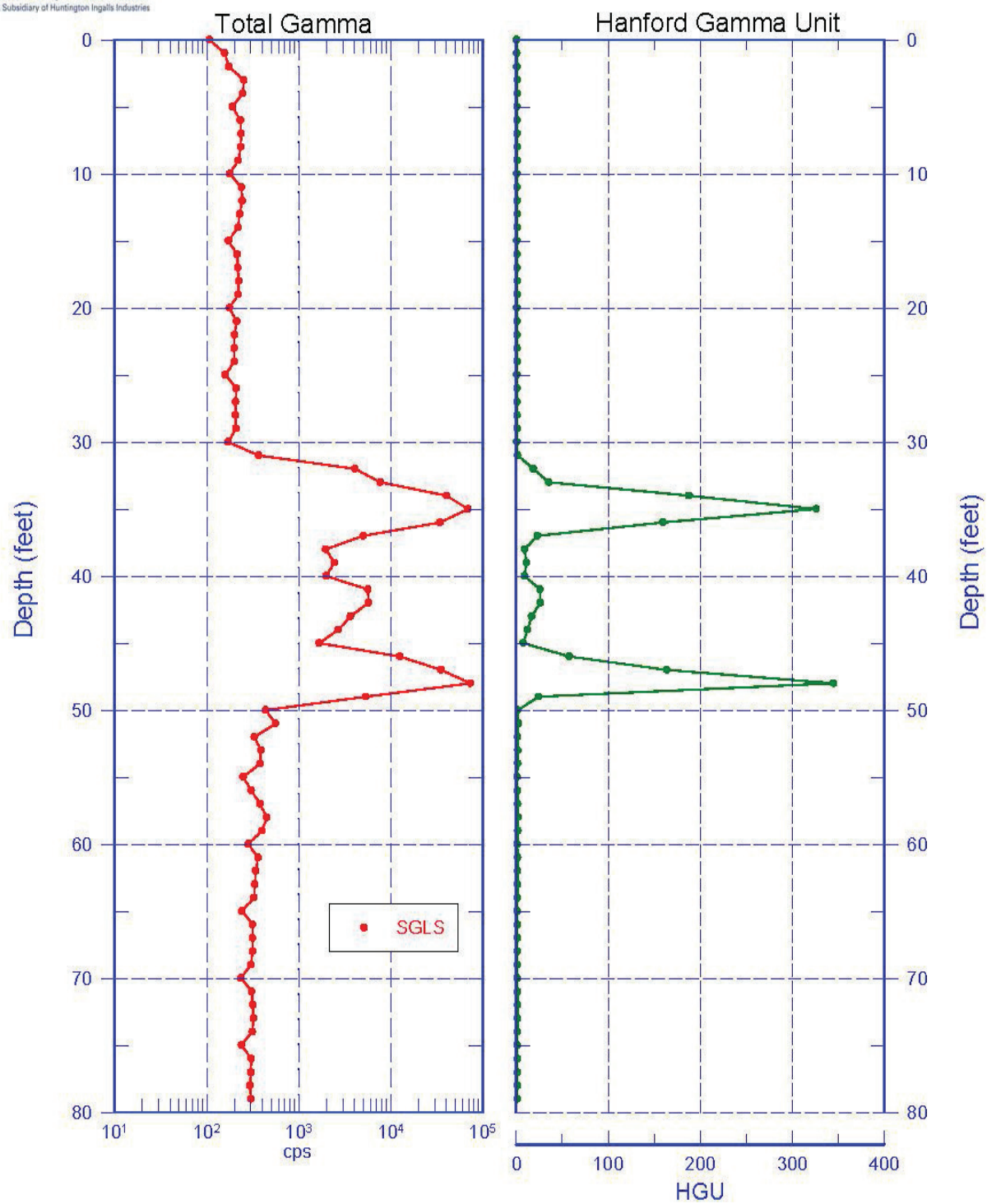
299-W22-124 (C9583)
Total Gamma & Moisture



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

299-W22-124 (C9583)
Total Gamma & Hanford Gamma Unit



Zero Reference - Ground Surface

Stoller Newport News Nuclear
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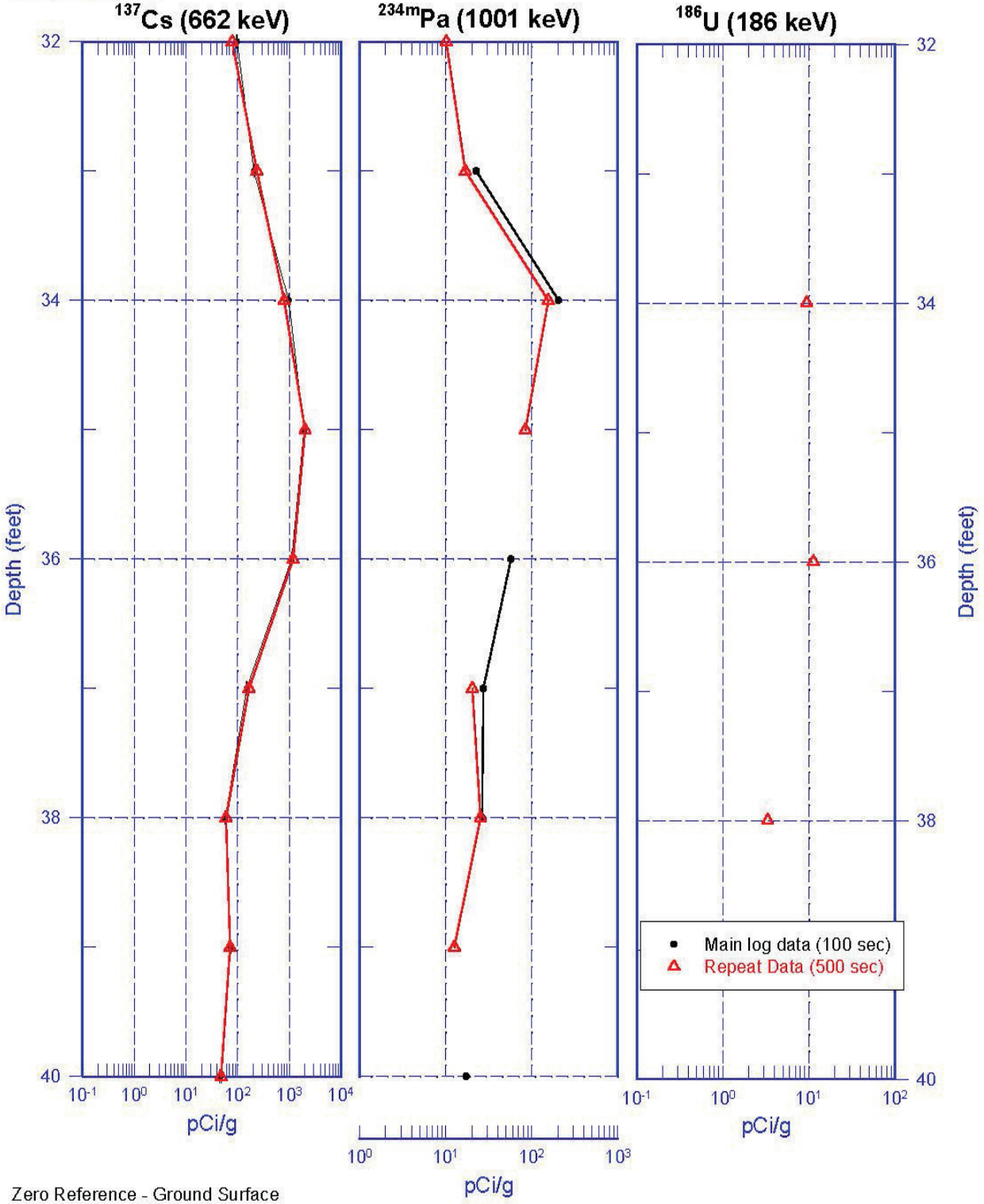
299-W22-124 (C9583)
Manmade Radionuclides Repeat Data

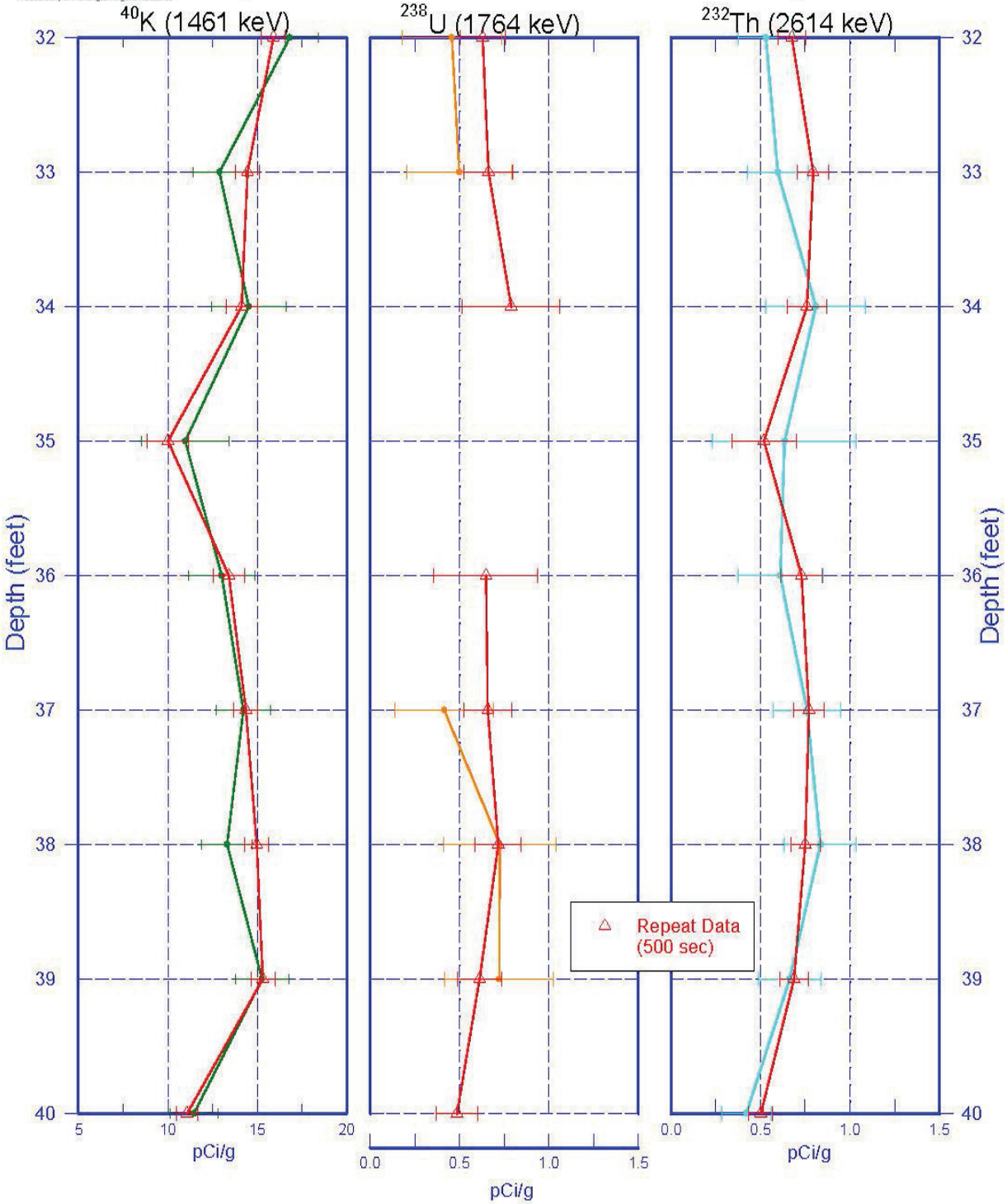


Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

299-W22-124 (C9583)

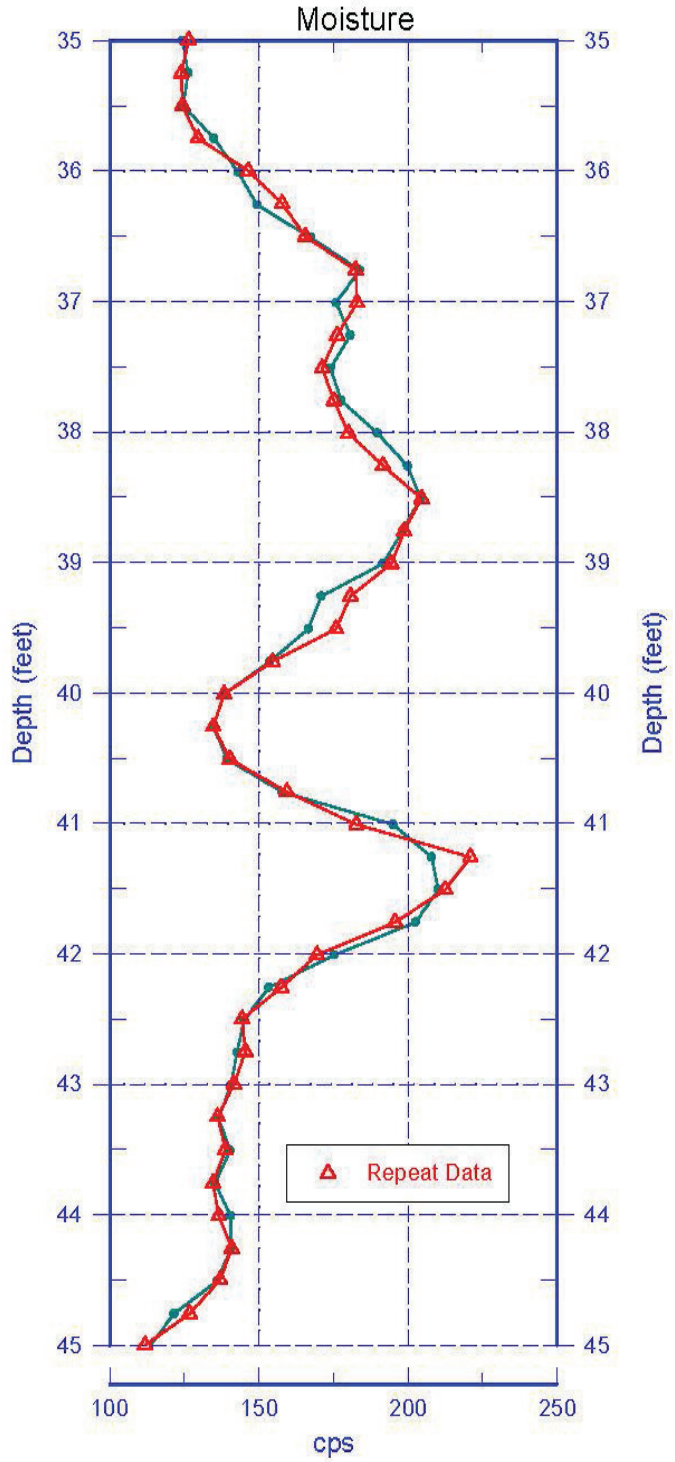
Repeat Section of Natural Gamma Logs



Zero Reference - Ground Surface

Stoller Newport News Nuclear
A Subsidiary of Huntington Ingalls Industries

299-W22-124 (C9583)
Moisture Repeat Section



Zero Reference - Ground Surface

Appendix F

Other Supporting Information for 200-WA-1 Operable Unit Wells

Contents

Variance to Drill Five Nested Monitoring Wells in Support of the Uranium Sequestration Pilot Test in 200-WA-1 Operable Unit……...F-1

Well Survey Data Report…….…….....F-3

Variance to Drill Five Nested Monitoring Wells In Support of the Uranium Sequestration Pilot Test in 200-WA-1 Operable Unit
November 30, 2016

Name, address, and telephone number of the person requesting the variance:
J.P. Sands, Department of Energy-Richland Operations, Federal Building, Richland, WA 99352, (509) 376-0057
[Provided by K. M Whitley, CHPRC, Soil & Groundwater Remediation Project, Well Coordinator, (509) 373-5869]

Address of the well sites:
Hanford Site, Richland, WA 99352

Well Name	Well ID	Well Purpose	Proposed Total Depth (ft bgs)	Easting (m)	Northing (m)
299-W22-120	C9518	Monitoring	80	134663.00	567621.00
299-W22-119	C9517	Monitoring	80	134663.00	567624.00
299-W22-117	C9515	Monitoring	80	134660.00	567619.00
299-W22-124	C9583	Monitoring	80	134657.00	567619.00
299-W22-122	C9520	Monitoring	80	134663.00	567615.93

ft bgs = feet below ground surface

The specific regulation(s) that cannot be followed; comparable alternative specification; and justification for the request:
A variance to Washington State Administrative Code (WAC) 173-160-420 is requested to allow the construction of nested wells listed above. Figures 1 displays the location of the instrumented monitoring wells.

The specific requirement found in WAC 173-160-420(3) that may not be met for the construction of this well includes the following:

> 420(3) Nested resource protection wells are prohibited.

The variance is to allow the construction of five nested instrumented monitoring wells with vertically discrete monitoring intervals to support the Uranium Sequestration Pilot Test in the 200-WA-1 Operable Unit (Figure 2). The monitoring wells will be used to help evaluate the effectiveness of injecting ammonia gas into the vadose zone to decrease the mobility of uranium. Monitoring will focus on obtaining and field analyzing gas samples, monitoring temperature at multiple depth intervals, monitoring borehole and surface electrodes for electrical resistivity tomography (ERT) surveys, collecting neutron moisture logging data, and conducting ground penetrating radar (GPR) surveys. The gas sampler, thermistor, fiber-optic DTS and resistivity electrodes will be attached to the 2" PVC permanent casing. In addition, sediment coupons will also be attached to the outside of the PVC casing at two of the five wells (C9517 and C9518). The 2" PVC will be used for moisture logging all five wells.

The wells will be considered nested wells because the sediment coupon (Figure 3) and gas samplers are cased independently from the 2" PVC permanent casing. A ½" PVC pipe provides access to deploy a sediment coupon within the well where it will be exposed to the ammonia gas. Sediment coupons will be removed at a selected time during the treatment process to evaluate reaction processes. The remaining empty ½" PVC will be filled with bentonite after the sediment coupon is removed. The gas sampler is a porous cup attached to ¼" ID tubing with a pressure monitoring system at the surface.

The completed well design does not reach the groundwater at this location. The groundwater is approximately 260 ft bgs while the monitor wells will extend 80 ft bgs.

Concurrence & date: Kelly Whitley 11/30/16 Kelly Whitley,
S&GRP Well Coordinator

Concurrence & date: 11/30/16 Jeff Ayres,
WDOE
Nuclear Waste Program
Richland, WA 99354

Concurrence & date: 11/30/16 Cheryl Whalen,
for
WDOE, Section Manager
Nuclear Waste Program
Richland, WA 99354

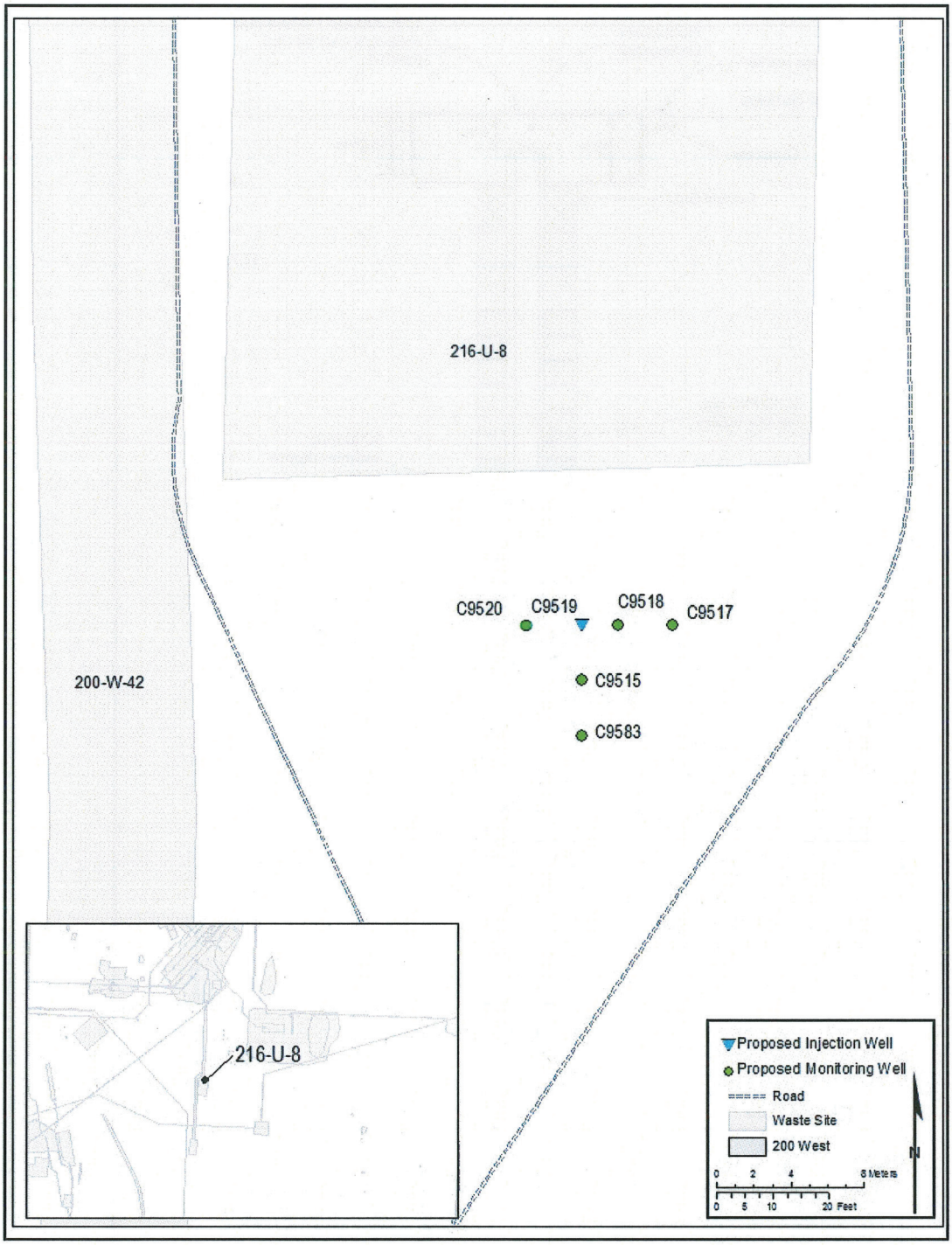


Figure 1. Map Showing Locations of 200-WA-1 Monitoring Wells, 200 East

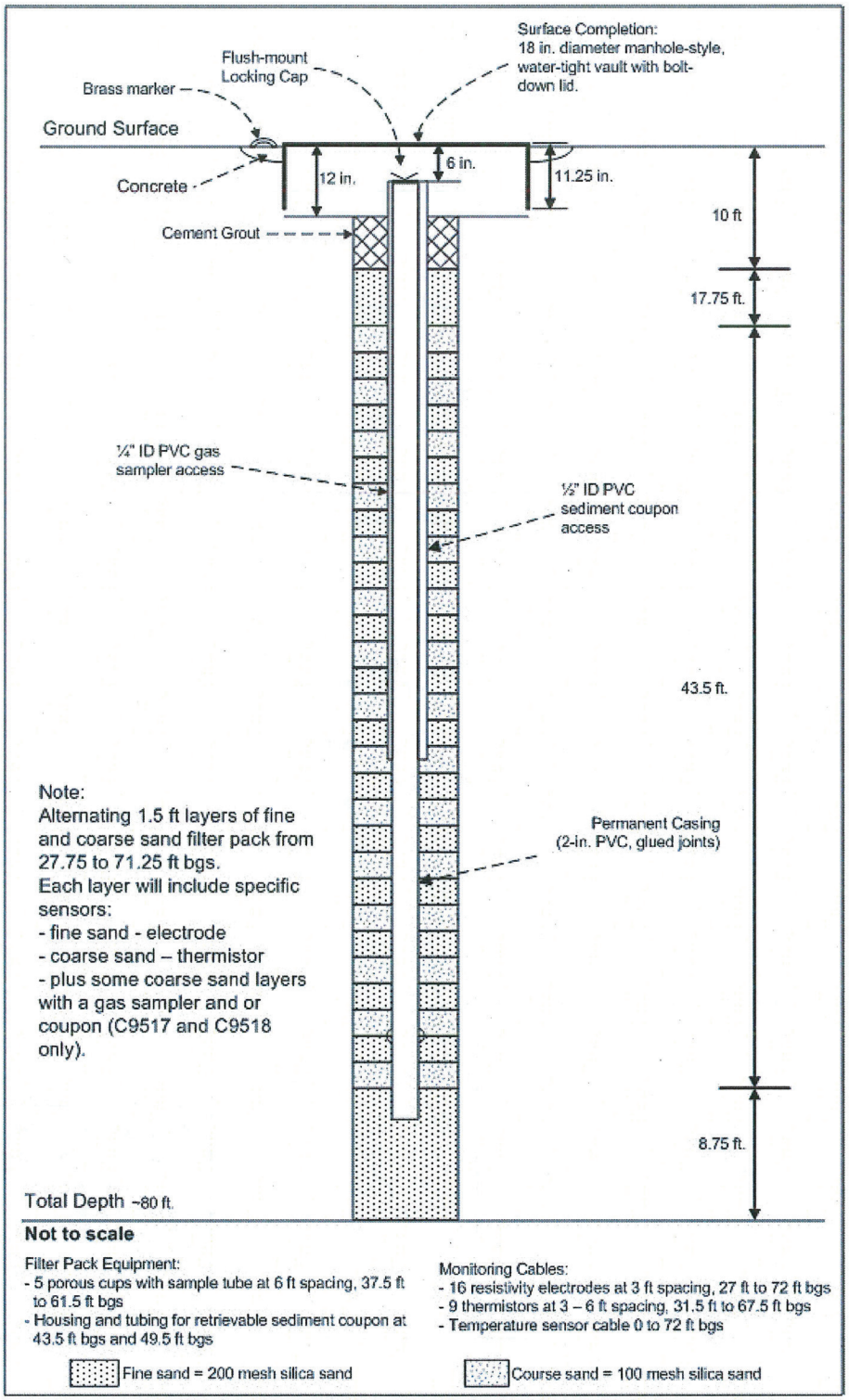


Figure 2. 200-WA-1 Monitoring Well Proposed Construction

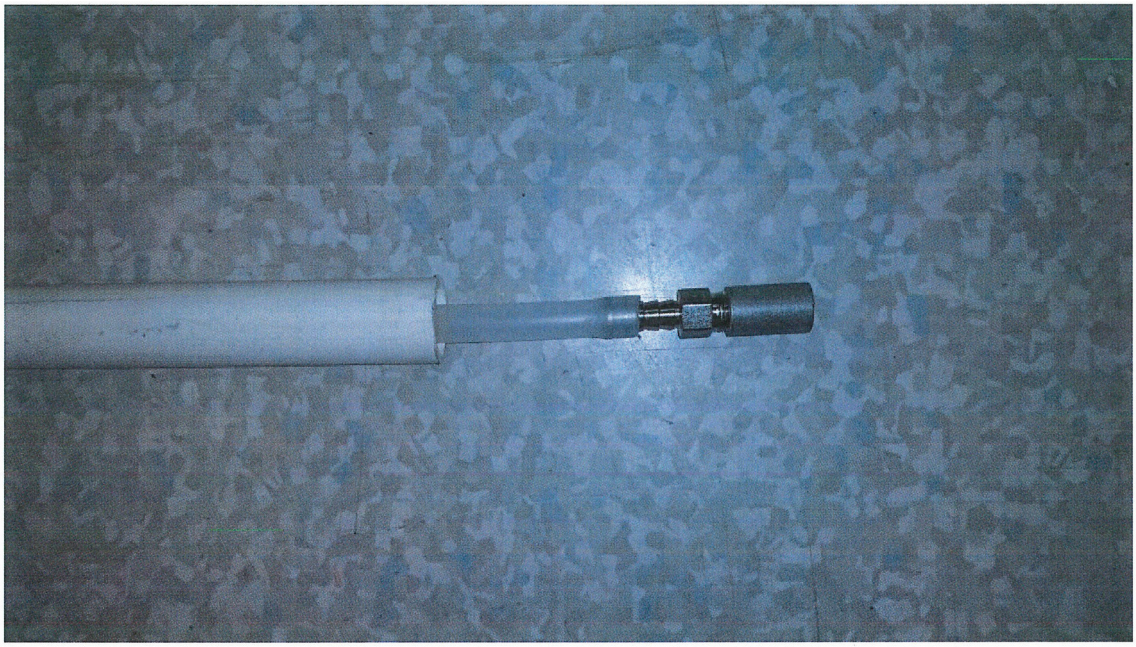


Figure 3. Sediment Coupon

SURVEY DATA REPORT				Page 1 of 6 Request No. 174-110
Project No.	Title 216-U-8/ DV-1 Wells Final Surveys			File No. 2WT12R26
Job. No. CACN: 303602-JPRC	Prepared By N.P. Fastabend	Date 7/20/17	Reviewer LEM	

DESCRIPTION OF WORK	DISTRIBUTION	SDR	PLOT	DWG
Obtained final coordinates (C/L Casing) and elevations of completed DV-1 Wells C9515(299-W22-117), C9517(299-W22-119), C9518(299-W22-120), C9519(299-W22-121) and C9583(299-W22-124) located on south side of 216-U-8 Crib in 200W Area.	Survey File	OR		
	J.D. Mehrer	1		
	K.M. Whitley	1		
	J.L. Smoot	1		
	J.B. Geiger	1		
Horizontal Datum: WCS83S/91 (Meters) Vertical Datum: NAVD88 (Meters)	B.J. Howard	1		
	A.J. Green	1		

SURVEY RESULTS AND COMMENTS

See Attached Well Survey Data Report Sheets

FOR OFFICE USE ONLY

OR Doc Type:	WMU Code(S):

A-6006-495 (REV 1)

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 06/28/17	Requestor: James D. Mehrer (CHPRC)
Date of Survey: 07/20/17	Surveyor / Company: Lawrence B. Munnell (CHPRC)
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of DV-1 Flush Mount Well C9515 (299-W22-117) located on south side of 216-U-8 Crib in 200W Area.	Horizontal Datum: NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 200W

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
2W-53 (CHPRC) and 2W-57 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C9515	299-W22-117	567619.03	134659.96		Center of Casing
				212.061	Top Outer Casing, N.Edge, Stamped X
				211.987	Top Inner 2"PVC Casing, N.Edge
				212.066	Brass Survey Marker

Notes:

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

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR
7-20-17

A-6003-659 (REV 1)

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 06/28/17	Requestor: James D. Mehrer (CHPRC)
Date of Survey: 07/20/17	Surveyor / Company: Lawrence B. Munnell (CHPRC)
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of DV-1 Flush Mount Well C9517 (299-W22-119) located on south side of 216-U-8 Crib in 200W Area.	Horizontal Datum: NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 200W

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
2W-53 (CHPRC) and 2W-57 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C9517	299-W22-119	567624.05	134662.99		Center of Casing
				212.070	Top Outer Casing, N.Edge, Stamped X
				212.016	Top Inner 2"PVC Casing, N.Edge
				212.079	Brass Survey Marker

Notes:

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

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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

LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR
7-26-17

A-6003-659 (REV 1)

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 06/28/17	Requestor: James D. Mehrer (CHPRC)
Date of Survey: 07/20/17	Surveyor / Company: Lawrence B. Munnell (CHPRC)
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of DV-1 Flush Mount Well C9518 (299-W22-120) located on south side of 216-U-8 Crib in 200W Area.	Horizontal Datum: NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 200W

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
2W-53 (CHPRC) and 2W-57 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C9518	299-W22-120	567621.01	134662.99		Center of Casing
				212.137	Top Outer Casing, N.Edge, Stamped X
				212.044	Top Inner 2"PVC Casing, N.Edge
				212.147	Brass Survey Marker

Notes:

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

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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LAWRENCE B. MUNNELL
STATE OF WASHINGTON
16216
REGISTERED
PROFESSIONAL LAND SURVEYOR
7-20-17

A-6003-659 (REV 1)

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 06/28/17	Requestor: James D. Mehrer (CHPRC)
Date of Survey: 07/20/17	Surveyor / Company: Lawrence B. Munnell (CHPRC)
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of DV-1 Flush Mount Well C9519 (299-W22-121) located on south side of 216-U-8 Crib in 200W Area.	Horizontal Datum: NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 200W

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
2W-53 (CHPRC) and 2W-57 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C9519	299-W22-121	567618.98	134662.99		Center of Casing
				212.096	Top Outer Casing, N.Edge, Stamped X
				211.960	Top Inner 2"PVC Casing, N.Edge
				212.101	Brass Survey Marker

Notes:

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

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

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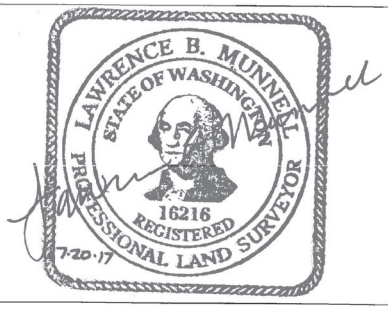

A-6003-659 (REV 1)

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend
	Company: CHPRC
Date Requested: 06/28/17	Requestor: James D. Mehrer (CHPRC)
Date of Survey: 07/20/17	Surveyor / Company: Lawrence B. Munnell (CHPRC)
Description of Work: Obtained final survey coordinates (C/L Casing) and elevations of DV-1 Flush Mount Well C9583 (299-W22-124) located on south side of 216-U-8 Crib in 200W Area.	Horizontal Datum: NAD83 (91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 200W

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
Washington State Reference Network

Vertical Control Monuments:
2W-53 (CHPRC) and 2W-57 (CHPRC)

Well ID	Well Name	Easting	Northing	Elevation	
C9583	299-W22-124	567619.00	134657.00		Center of Casing
				211.995	Top Outer Casing, N.Edge, Stamped X
				211.932	Top Inner 2"PVC Casing, N.Edge
				211.996	Brass Survey Marker

Notes:

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

Equipment Used: Trimble R8 RTK GPS
Trimble DiNi 12 Level

Surveyor Statement:

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7-20-17

A-6003-659 (REV 1)