PNNL-13826

Pacific Northwest National Laboratory
Operated by Battelle for the U.S. Department of Energy

Borehole Data Package for Calendar Year 2001 RCRA Wells at Single-Shell Tank Waste Management Area TX-TY

D. G. Horton

March 2002

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RL01830

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

This document is a compilation of the information on well drilling and construction, well development, pump installation, and sediment sampling at two new RCRA wells (299-W14-18 and 299-W15-765) at Waste Management Area TX-TY in August through October 2001. These wells were constructed to the specifications and requirements described in Washington Administrative Codes 173-160 and 173-303.

In well 299-W14-18, groundwater samples were collected during drilling, and borehole and drill cuttings were monitored regularly for organic vapors and radionuclide contaminants. Radiological contamination was found between 47 and 65 ft below ground surface (bgs). The borehole was geophysically logged with spectral gamma-ray and neutron moisture tools on September 25, 2001. Cesium-137 was found between 35 and 40 ft bgs at a maximum concentration of 0.50 pCi/g. Cobalt-60 was identified between 35 and 40 ft bgs. Europium-152/154 was found between 36 and 65 ft bgs and 85 and 95 ft bgs.

In well 299-W15-765, groundwater samples were collected during drilling and borehole and drill cuttings were monitored regularly for organic vapors and radionuclide contaminants. The borehole was geophysically logged with spectral gamma-ray and neutron moisture tools on September 28 and 29, 2001. Cesium-137 was detected near the surface at 1.1 to 0.4 pCi/g. No other manmade radionuclide was detected.

Contents

Figure

Table

1.0 Introduction

Two new Resource Conservation and Recovery Act (RCRA) groundwater monitoring wells were installed at the single-shell tank farm Waste Management Area (WMA) TX-TY in August 2001 through October 2001 in partial fulfillment of Tri-Party Agreement (Ecology 1996) milestone M-24-00M. The well names are 299-W14-18 and 299-W15-765; the corresponding well numbers are C3396 and C3397, respectively. Well 299-W14-18 is located east of the northern part of 241-TX tank farm and is a down-gradient well replacing well 299-W14-2, which is dry. Well 299-W15-765 is an upgradient well, located west of 241-TY tank farm, and replaces well 299-W15-12, which is dry. The locations of all wells in the WMA TX-TY monitoring network are shown on Figure 1.

The original assessment monitoring plan for WMA TX-TY was issued in 1993 (Caggiano and Chou 1993). That plan was updated for the continued assessment at WMA TX-TY in 2001 (Hodges and Chou 2001). The updated plan provides justification for the new wells. The new wells were constructed to the specifications and requirements described in Washington Administrative Code (WAC) 173-160 and WAC 173-303, the updated assessment plan for WMA TX-TY (Hodges and Chou 2001), and the description of work for well drilling and construction.[1]

This document compiles information on the drilling and construction, well development, pump installation, and sediment sampling applicable to the installation of the two new wells. Appendix A contains the Well Summary Sheets (as-built diagrams), the Well Construction Summary Reports, and the geologist's logs; Appendix B contains results of physical properties testing; and Appendix C contains borehole geophysical logs. Additional documentation concerning well construction is on file with Bechtel Hanford, Inc., Richland, Washington.

English units are used in this report because that is the system of units used by drillers to measure and report depths and well construction details. To convert to metric units, multiply feet by 0.3048 to obtain meters; multiply inches by 2.54 to obtain centimeters.

2.0 Well 299-W14-18

2.1 Drilling and Sampling

Well 299-W14-18 was drilled during August to October 2001 with a cable tool rig and core barrel from the surface to 95 ft below ground surface (bgs) and cable tool rig and hard tool from 95 ft bgs to

[1] Letter from J. S. Fruchter (Pacific Northwest National Laboratory) to G. B. Mitchem (Bechtel Hanford Inc.) *Description of Work for Drilling of CY 2001 RCRA Groundwater Monitoring Wells*, dated April 16, 2001.

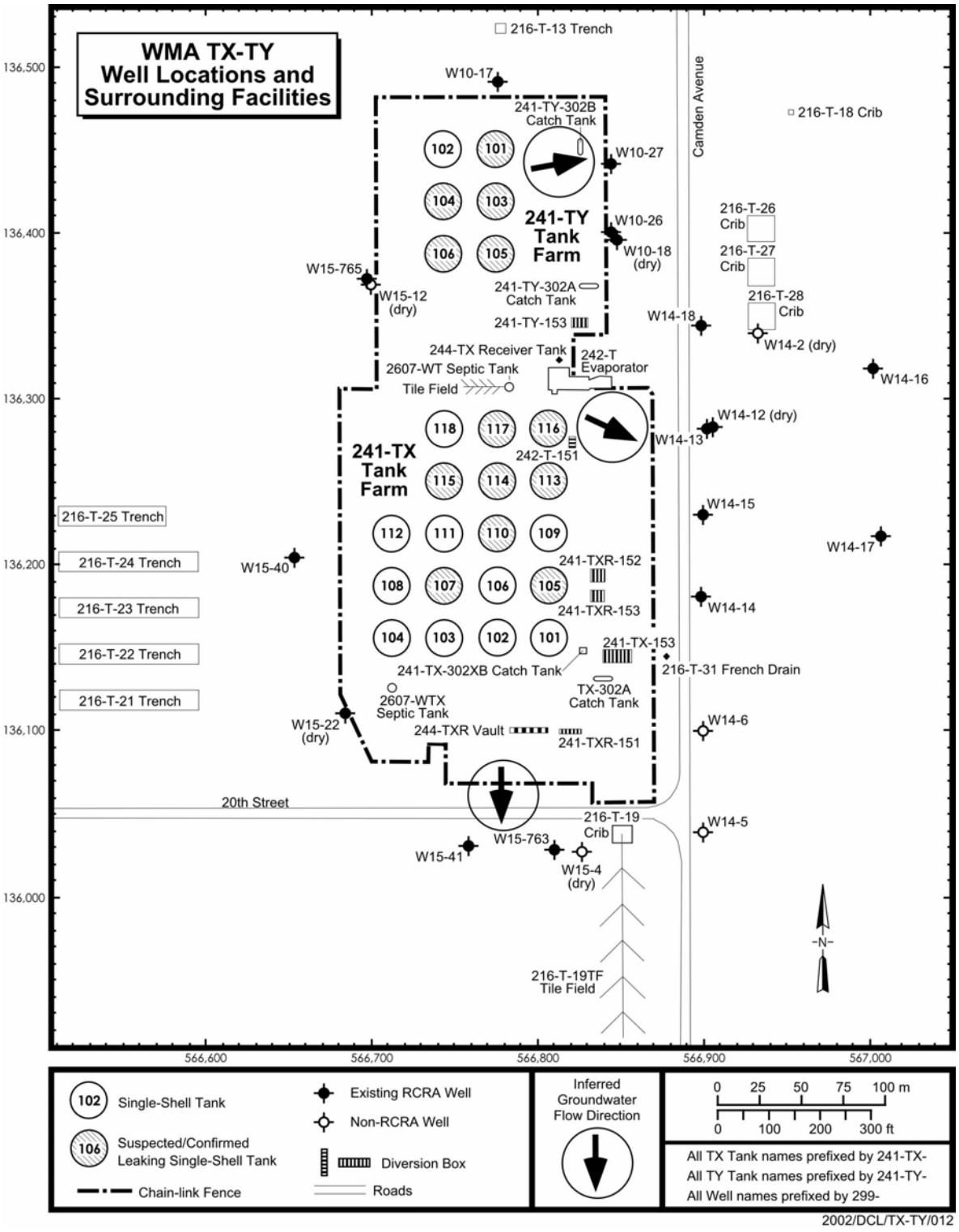


Figure 1. Map of Waste Management Area TX-TY and Locations of Wells in the Groundwater Monitoring Network

total depth of 261.5 ft bgs. Temporary 10-¾ in.-outside-diameter, carbon steel casing was used from the surface to 68.6 ft bgs and 8 ⅝ in. temporary casing was used from the surface to total depth. Five feet of bentonite and 30 gal of water were added to the borehole at 69 ft bgs (where casing was downsized) to prevent spreading of contamination. An unknown amount of water was added to the borehole during hard tool drilling.

The sediments encountered during drilling were predominantly sand, silty sand, and sandy gravel of the Hanford formation from the surface to about 88 ft bgs; Plio-Pliestocene silty sand from about 88 to 112 ft bgs; and Ringold Formation sand, sandy silt, gravelly silt, silty gravel and sandy gravel from about 112 ft to total depth (261.5 ft bgs). The geologist's log is included in Appendix A.

Grab samples for geologic description and archive were collected every 5 ft throughout the borehole. Also, two split spoon samples were taken from 222.0 to 224.0 ft and from 255.0 to 257.0 ft bgs for analysis of particle size distribution. Particle size distribution data are in Appendix B.

Two groundwater samples were collected during drilling. The samples were collected from the top of the uppermost aquifer and at total depth. The samples were analyzed in the Pacific Northwest National Laboratory at 3720 building using standard operating procedures. The samples were tested for anions, specific conductivity, metals, pH, technetium-99, and uranium-238. All available analytical data are given in Appendix B.

The borehole and drill cuttings were monitored regularly for organic vapors and radionuclide contaminants. Radiological contamination was found between 47 and 65 ft bgs.

The borehole was geophysically logged with spectral gamma-ray and neutron moisture tools on September 25, 2001. Cesium-137 was identified at the surface and at 35 to 40 ft bgs with a maximum concentration of 50 pCi/g. Cobalt-60 was also identified between 35 and 40 ft depth. Europium-152/154 was identified between a depth of 35 and 65 ft and 85 and 95 ft, with the maximum concentration of about 100 pCi/g in both zones.

2.2 Well Completion

The permanent casing and screen were installed in well 299-W14-18 in November 2001. A 4-in.-inner-diameter, stainless steel, wire wrap, 20 slot screen was set from 253.05 to 218.06 ft bgs. The permanent casing is 4-in.-inner-diameter, stainless steel from 218.06 bgs to 2.0 ft above ground surface. A 2-ft-long stainless steel sump is below the screen from a depth of 255.05 to 253.05 ft.

The filter pack is 10 to 20 mesh silica sand from 261.5 to 208.4 ft bgs. The annular seal is bentonite pellets from 208.4 ft to 203.3 ft, granular bentonite from 203.3 ft to 10.5, and Portland cement grout from 10.5 ft bgs to the surface. A 4 ft by 4 ft by 6 in. concrete pad was placed around the well at the surface. A protective casing with locking cap, four protective steel posts, and a brass marker stamped with the well number were set into the concrete. The protective casing extends 2.48 ft above the concrete pad. The Well Summary Sheet (as-built) and Well Construction Summary Report are included in Appendix A.

The vertical and horizontal coordinates of the well were surveyed in December 2001. The horizontal position of the well was determined by Global Positioning System observations referenced to horizontal control stations established by Rogers Surveying, Inc., Richland, Washington and the U.S. Army Corps of Engineers. The coordinates are Washington Coordinate System, South Zone, NAD83(91) datum. Vertical datum is NAVD 1988 and is based on existing benchmarks established by the U.S. Army Corps of Engineers. Survey data are included in Table 1 and the survey data sheet is included in Appendix A.

Table 1. Survey Data for New Wells at Waste Management Area TX-TY

Well Name	Easting (m)	Northing (m)	Elevation (m)	Reference Point
299-W14-18	566897.47	136344.15		Center of casing
			205.019	"X" on rim of casing
	566897.44	136344.43	204.263	Brass cap
299-W15-765	566697.02	136373.06		Center of casing
			205.299	Top of casing
	566697.00	136373.39	204.505	Brass cap

2.3 Well Development and Pump Installation

Well 299-W14-18 was developed in November 2001. A temporary, 3 hp, submersible pump was used to remove approximately 910 gal of formation water at 10 gpm with a drawdown of 20.3 ft and 600 gal at 5 gpm with drawdown of 19 ft. The pump intake was at 248 ft bgs and final turbidity was 1.23 NTU.

A dedicated submersible sampling pump was installed in well 299-W14-18 in November 2001. The sampling pump intake is at 240.35 ft below top of casing (the casing extends 2.48 ft above the concrete pad) or about 17.7 ft below the water table. Static water level was 220.17 bgs on November 8, 2001.

3.0 Well 299-W15-765

3.1 Drilling and Sampling

Well 299-W15-765 was drilled in September 2001 with an air rotary drill rig from the surface to a total depth of 267 ft bgs. Temporary 10-in.-outside-diameter, carbon steel casing was used for the entire depth. Unknown amounts of water were added to the borehole at 140 ft and 220 ft bgs to unplug the drill bit.

The sediments encountered during drilling were dominantly sand, gravel, sandy gravel, and gravely sand of the Hanford formation from the surface to about 93 ft bgs; Plio-Pliestocene silt and sandy silt

from 93 ft to about 115 ft bgs; and Ringold Formation sand, sandy gravel, gravelly sand, and gravel from 115 ft to total depth (267 ft bgs). The geologist's log is included in Appendix A.

Grab samples for geologic description and archive were collected every 5 ft throughout the borehole. Also, two groundwater samples were collected during drilling. The samples were collected from the top of the uppermost aquifer and at total depth. The samples were analyzed by the Pacific Northwest National Laboratory using standard operating procedures. The samples were tested for anions, specific conductivity, metals, pH, technetium-99, and uranium-238. All available analytical data are given in Appendix B.

The borehole and drill cuttings were monitored regularly for organic vapors and radionuclide contaminants. No contamination was found by field screening methods. The borehole was geophysically logged with spectral gamma-ray and neutron moisture tools on September 28 and September 29, 2001. Cesium-137 was identified from the surface to a depth of 6 ft. Cesium-137 concentrations ranged from about 1.1 pCi/g at the surface to 0.4 pCi/g at 6 ft bgs.

3.2 Well Completion

The permanent casing and screen were installed in well 299-W15-765 in October 2001. A 4-in.-inner-diameter, stainless steel, wire wrap, 20 slot screen was set from 255 ft to 220 ft bgs. The permanent casing is 4-in.-inner-diameter, stainless steel from 220 ft bgs to 2.3 ft above ground surface.

The filter pack is 10 to 20 mesh silica sand from 265 ft to 209.5 ft bgs. The annular seal is bentonite pellets from 209.5 to 204.8 ft, bentonite crumbles from 204.8 ft to 10.2 ft, and Portland cement from 10.2 ft bgs to the surface. A 4 ft by 4 ft by 6 in. concrete pad was placed around the well at the surface. A 6-in. stainless steel protective casing with locking cap, four protective steel posts, and a brass marker stamped with the well number were set into the concrete. The protective casing extends 2.61 ft above the concrete pad. The Well Summary Sheet (as-built) and Well Construction Summary Report are included in Appendix A.

The vertical and horizontal coordinates of the well were surveyed in December 2001. The horizontal position of the well was determined by Global Positioning System observations referenced to horizontal control stations established by Rogers Surveying, Inc., Richland, Washington and the U.S. Army Corps of Engineers. The coordinates are Washington Coordinate System, South Zone, NAD83(91) datum. Vertical datum is NAVD 1988 and is based on existing benchmarks established by the U.S. Army Corps of Engineers. Survey data are included in Table 1 and the survey data sheet is included in Appendix A.

3.3 Well Development and Pump Installation

Well 299-W15-765 was developed in October 2001. A temporary, 3 hp, submersible pump was used to remove ~2,250 gal of formation water. First, about 1,470 gal of water were removed from the well at 30 gal/min with a drawdown of about 4.7 ft. The pump intake was at 252.8 ft bgs. Second, about 780 gal of water were removed at 30 gal/min with the pump intake at 237.8 ft bgs resulting in 4.3 ft of drawdown. The final turbidity was 4.69 NTU.

A dedicated, Redi Flo-2 submersible sampling pump was installed in well 299-W15-765 in October 2001. The sampling pump intake is at 228.38 ft bgs (or about 7.9 ft below the water table). Static water level was 220.51 ft bgs on October 31, 2001.

4.0 References

Caggiano, J. A. and C. J. Chou. 1993. *Interim-Status Groundwater Quality Assessment Plan for the Single-Shell Tank Waste Management Areas T and TX-TY.* WHC-SD-EN-AP-132, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Ecology - Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy. 1998. *Hanford Federal Facility Agreement and Consent Order.* Document No. 89-10, Rev. 5 (The Tri-Party Agreement), Ecology, Olympia, Washington.

Hodges, F. N. and C. J. Chou. 2001. *RCRA Assessment Plan for Single-Shell Tank Waste Management Area TX-TY at the Hanford Site.* PNNL-12072, Pacific Northwest National Laboratory, Richland, Washington.

NAVD88. 1988. North American Vertical Datum of 1988.

RCRA - *Resource Conservation and Recovery Act*. 1976. Public Law 94-580, as amended, 90 Stat. 2795, 42 USC 6901 et seq.

WAC 173-160, Washington Administrative Code. *Minimum Standards for Construction and Maintenance of Wells.* Olympia, Washington.

WAC 173-303, Washington Administrative Code. *Dangerous Waste Regulations*. Olympia, Washington.

Appendix A

Well Construction and Completion Documentation

WELL CONSTRUCTION SUMMARY REPORT

Start Card # RO37816

Start Date: 8/30/01
Finish Date: 11-1-01
Page 1 of 1

Specification No.: 0200X-SP-V0004 Rev. No.: 0	Well Name: 299-W14-18 Well No.: C3396
ECNs: NA	Approximate Location: SE corner of 241-TY
Project: CY01 RCRA Drilling	Other Companies: BHI, CHI
Drilling Company: Resonant Sonic Inc.	Geologist(s): LDWalker, JHocking, RFRaidl, JMFaurote, CTrice, JMWimett, DCWeekes
Driller: M Wraspir #1909	

TEMPORARY CASING AND DRILL DEPTH

*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.
Carbon Steel, FJ	0' - 68.6'	11" / 9 7/8"
10 3/4" / 9 3/8"	- 2nd	
8 5/8" / 7 3/4" FJ CS	0' - 261.4'	9" / 7 3/4"
	-	
	-	

*Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design

DRILLING METHOD/HOLE DIAMETER

Auger:	Diameter From ___ to ___
Cable Tool: ✓ 10" / 8"	Diameter From 0 to 261.5
Air Rotary:	Diameter From ___ to ___
A.R. w/Sonic:	Diameter From ___ to ___
	Diameter From ___ to ___
	Diameter From ___ to ___
	Diameter From ___ to ___

Drilling Fluid: NA

Total Drilled Depth: 261.5' Hole Dia @ TD: 9"

Total Amt. Of Water Added During Drilling:

Well Straightness Test Results: Passed, 10-22-01

Static Water Level: 220.45' Date: 11/7/01

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date	Sondes (type)	Interval	Date
Spectral Gamma	0' - 70'	9/25/01	RLS Moisture Log	68' - 218.5'	10/25/01
Spectral Gamma	68' - 256'	9/24 & 9/25/01		-	
RLS Moisture log	0' - 69.25'	10/3/01		-	

COMPLETED WELL

Size/Wt./Material	Depth	Thread	Slot Size	Type	Interval Annular Seal/Filter Pack	Volume	Mesh Size
4 1/2" OD sch.5 SS304L	+2.0' - 218.06'	F480	NA	Portland Cement Grout	0' - 10.5'	8 bags	NA
Casing	- 253.05			Granular Bentonite	10.5' - 203.3'	126 bag	#8
4 1/2" OD SS304L Screen	218.06' - 255.05	F480	0.020"	Bentonite Pellets	203.3' - 208.4	4 buck.	1/4"
4 1/2" OD SS304L tailpipe	255.05 - 257.0	F480	NA	Silica Sand	208.4 - 261.5	56 bag	10-20
	253.05 - 255.05 EW				-		

OTHER ACTIVITIES

Aquifer Test: Well Development	Date: 11/7/01 11/8/01	Well Abandoned:	Yes:	No:	Date:
Description: Pumped 10 gpm for 91 min with 20.33' drawdown on 11/7/01. Resumed 11/8/01 at the same depth and pumped 5 gpm for 120 minutes with 19.1' drawdown.		Description:			

WELL SURVEY DATA

Date:	Protective Casing Elevation:
Washington State Plane Coordinates:	Brass Cap Elevation:

COMMENTS/REMARKS

Vol. Calcs: Portland Cement: 8 x 1.285 = 10.28 Ft³; Gran Bentonite: 126 x 0.71 = 89.46 Ft³; Bent. Pellets: 4 x 0.62 = 2.48 Ft³; Silica Sand: 56 x 0.535 = 29.96 Ft³

Reported By: L. D. Walker		Reviewed By: Jess Hocking	
Title: Geologist	Date: 11-2-01	Title: Geologist	Date: 11/5/01
Signature: LD Walker		Signature: Jess Hocking	

BHI-EE-181 (12/97)

WELL SUMMARY SHEET

Page 1 of 2

Date: 11-1-01

Well ID: C 3396

Well Name: Z99-W14-18

Location: SE Corner of 241-TxTy Tank Farm.

Project: RCRA DRILLING CY-01

Prepared By: Jess Hocking / L.D. Walker Date: 10/19/01

Reviewed By: D.C. Weekes Date: 11/6/01 (dcw 11/12/01)

Signature: Jess Hocking / L.D. Walker

Signature: D.C. Weekes

CONSTRUCTION DATA

Description	Diagram
Portland Cement 0' → 10.5'	
6" SS protective casing set 1.0' above 4" well casing.	
10 3/4" OD Temporary casing 0' → 68.6'	
Stainless Steel well casing Sch. 5, 304L, 4½" OD, 4" ID +2.0' → 218.06'	
Granular Bentonite 10.5' → 203.3'	
8" Temporary casing 0' ~~68.6'~~ (dcw 11/8/01) → 260'	
Bentonite Pellets, 1/4" 203.3' → 208.4'	
All depths in feet below ~~the~~ (dcw 11/8/01) ground surface	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
0		0-0.5' Drill Pad Surface
		0.5'-8' Silty Sand (mS)
		8'-13' Sand (S)
		13'-34' Sandy Gravel (sG)
		34'-88.5' Sand (S)
40		88.5'-114' Sandy Silt (sM)
		114'-120' Silty Sand (mS)
		120'-125' Sandy Silt (sM)
		125'-145' Gravelly Silt (gM)
		145'-155' Silty Gravel (mG)
80		155'-160' Gravelly Silt (gM)
		160'-165' Silty Gravel (mG)
		165'-190' Gravelly Silt (gM)
		190'-200' Sandy Silt (sM)
		200'-205' Gravelly Sandy Silt (gsM)
120		205'-210' Silty Gravel (mG)
		210'-215' Sandy Silt (sM)
		215'-220' Gravelly Silt (gM)
		220'-235' Gravelly Sandy Silt (gsM)
		235'-240' Gravelly Silt (gM)
160		
200		
▼		GWL = 219.95' bgs (10/18/01)
▼		GWL = 220.45' bgs (11/7/01)
		Continued on Page 2.

BHI-EE-189 (12/97)

Page 2 of 2

WELL SUMMARY SHEET

Date: 10/19/01

Well ID: C3396	Well Name: Z99-W14-18
Location: SE Corner of Z41-TxTy Tank Farm.	Project: RCRA DRILLING CY-01
Prepared By: Jess Hocking/C.Trice Date: 10/19/01	Reviewed By: DC Weekes Date: 11/6/01
Signature: Jess Hocking/C. Trice	Signature: DC Weekes

CONSTRUCTION DATA

Description	Diagram
Silica Sand, 10-20 mesh 208.4' → 261.5'	
Stainless Steel Wellscreen 0.020-in slot cont. wire-wrap type 304L 4½" OD/4" ID 218.06' → 253.05'	
SS304L Tailpipe with welded endcap 4½" OD/4" ID 253.05' → 255.05'	
Total SS well from top of casing is 257.05'	
All depths in feet below ground surface All temporary casing removed from ground	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
240		240' - TD Gravelly Sandy Silt (gsM)
		TD = 261.5'
280		

BHI-EE-189 (12/97)

WELL SURVEY DATA REPORT

ERC Project: 22192	**Prepared By:** Gary B. Wagner, P.L.S. **Company:** Rogers Surveying, Inc.
Date Requested: 11/19/01	**Requestor:**
Date of Survey: 12/05/01	**Surveyor:** Rogers Surveying, Inc.
ERC Point of Contact: Mr. Robert Bone	**Survey Co. Point of Contact:** Gary B. Wagner, P.L.S.
Description of Work: Civil surveying for eleven groundwater wells in 200W & 200E Areas.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Metric **Hanford Area Designation:** 200W

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
HSWB-037 & GPS 31

Vertical Control Monuments:
HSWB-037

Well Name	Well ID	Easting	Northing	Elevation	
299-W14-18	C3396	566897.47	136344.15		**Center of Casing**
				205.019	**"X" on Rim**
		566897.44	136344.43	204.263	**Brass Cap**

Notes:

Surveyor Statement:	**Certification Seal**
I, Gary B. Wagner, a professional land surveyor registered in the state of Washington (Registration No. 30440), hereby certify that this report is based on a field survey performed in December, 2001 under my direct supervision and that the data contained here is true and correct.	

BHI-EE-202 (09/98)

BOREHOLE LOG

Page 1 of 9
Date: 8-30-01

Well ID: C3396 | Well Name: 299-W14-18 | Location: SE corner of 241-TY
Project: C401 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0	Drive barrel	NA		0' → 0.5': Crushed rock drill pad surface.	Cable tool, 10¾"/9⅞" casing
				0.5' → 8': Silty SAND (mS) 75% Sand, 25% Silt. 20% v.cse - cse sand, 40% med, 40% fn - v. fn. 2.5Y 4/2 (dk grayish brown) moist; mod sorted, SA-SR; 40% basalt/mafic, 60% qtz/feld. Strong rxn HCl - gradual silt decrease -	α,β,γ: background
5	Archive - grab				5': Collect grab sample for archive
				8' → 13': SAND (S) 95% Sand, 5% Silt	
10	Archive - grab			20% v.cse, 20% cse, 30% med, 30% fn - v. fn 10YR5/2 (grayish brown), moist, mod sort; SA - Angular; 55-60% qtz/Feld, 40-45% basalt/other mafic; max size ~ 2mm no rxn HCl.	10': Archive sample α,β,γ: at background levels
					15': Archive sample
15	Archive - grab			13' → 34': Sandy GRAVEL (sG) 70% Gravel, 30% Sand, tr silt: tr large cobble, 20% sm. cob, 50% v.cse - cse peb, 30% med - v. fn peb. Sand predom cse - med. 10YR 6/2 (lt. brownish gray) sl moist; poorly sorted; Gravel R-SR 25% basalt, 75% granitic/qtzite; max size > 20 cm; tr caliche coating on some gravel (tr strong rxn)	α,β,γ: background OVM/LEL < detect.
20	Archive - grab				20': Archive sample α,β,γ: background
25	Archive - grab			sl increase in silt: tr - 5% gravel ~ 60%	25': Archive sample α,β,γ: background
				Silt decrease to tr Sand predom. cse ⇒ 40% basalt	

Reported By: L. D. Walker | Reviewed By: DC Weekes
Title: Geologist | Title: Geologist
Signature: LD Walker | Date: 8-30-01 | Signature: DC Weekes | Date: 10/23/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 2 of 9
Date: 8-30-01

Well ID: C3396 | Well Name: 299-W14-18 | Location: SE corner 241-TY / 200W
Project: CY01 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
30	Archive - grab	NA			Cable tool, CS
				Sandy GRAVEL (sG) similar to above. 60% gravel, 40% sand, tr silt. Tr boulder (33'→34') 20% cobble, 40% v.cse-cse peb, 30% med, 10% v.fn peb - fn. Sand predom cse.	casing 10¾"/9⅝"
	Drive barrel				30': Archive sample
35	Archive - grab			- sharp contact -	35': Archive sample α,β,γ: background
				34'→ : SAND (S) 100% Sand, tr silt. Sand predom med-cse. 10YR 5/3 (brown), sl moist; mod-well sorted, SA; 75% qtz/Feld, 25% basalt/other mafic, tr mica; no rxn HCl	OVM/LEL < detect.
40	Archive - grab			36': silt ~5%	40': Archive sample rad: background
				40': Sand cse-v.cse, tr v.fn peb basalt up to ~40%	45': Archive & grab sample
45	Archive - grab				*47-48' - RAD @ or near action level -
		6989 dpm		SAND (S) as above	6989 dpm
50		~6000 dpm		51': ~0.2' thick layer of silty sand, then back to Sand	⊗No archive samples will be collected while α,β,γ readings remain elevated. - no alpha, only beta/gamma
55		6000 dpm		SAND (S) similar to above 100% sand, tr silt. predom med, dry, mod-well sorted	

Reported By:	L.D. Walker / JM Faucrote	Reviewed By:	Jess Hocking
Title:	Geologist	Title:	Geologist
Signature:	D Walker / JM Faucrote	Date: 9-21-01	Signature: Jess Hocking	Date: 11/5/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 3 of 9
Date: 9-21-01

Well ID: C 3396 | Well Name: 299-W14-18 | Location: SE corner of 241-TY / 200 W
Project: CY '01 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
60		~6000 dpm		SAND (S) similar to above.	Cable tool, threaded
				100% Sand, tr silt. Predom cse-med	CS casing
		~5500 dpm		10YR5/2 (grayish brn), sl moist; mod-	10 3/4" OD / 9 7/8" ID
				well sorted, SA; 60-70% qtz/feld,	no alpha-low
				30-40% basalt/other mafic, no rxn	63': α,β,γ beginning
65		<5000 dpm		HCl	to decrease
				64': tr gravel (fn peb)	
				68': tr gravel (v.fn-fn peb)	69': α,β,γ at
		α,β,γ = background			background levels
70	archive sample				70 ft archive sample
					α, β, γ @ backgr
75	archive sample	α,β,γ @ backgr.			75 ft archive sample
					α, β, γ @ backgr.
80	Archive Sample	α, β, γ backgr.			80 ft archive sample
					α, β, γ @ backgr.
				Small cut & fill structures 85-87', of vf grnd	
85	Archive Sample	α, β, γ @ backgr		sand and silt. Do not exceed 2" thickness	85' Archive sample
				Sand continues as med & crse grained material. Bkgd α, β, γ	
				Approx 88.5 - Sandy Silt or Silty Sand. ~25%	
				silt, 75% sand, SA-SR, Sand is f-med grnd	

Reported By: L.D. Walker / R.F. Raidl | Reviewed By: Jess Hocking
Title: Geologist | Title: Geologist
Signature: LD Walker / RF Raidl | Date: 5 OCT 01 | Signature: Jess Hocking | Date: 11/5/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 4 of 9
Date: 10/5/01

Well ID: C3396 | Well Name: 299-W14-18 | Location: SE Corner 241-TY Tankfarm 200W
Project: CY01 RCRA Drilling | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
90	Archive			Contd from 88.5 - 114' Sandy Silt, 35% sand (vf-f grnd), 65% silt. Unit is gray-yellow-brown and appears pseudobedded, it is malleable and rx's med to HCl. Becomes tighter and locally pure silt - milk chocolate brown.	bkgd γ β∝ Archive & grab sample. SG EP/PP @ 88.5'(?)
95	Archive	1520 hrs			bkg γ β∝ Archive & grab sample. end shift 10/05/01
100	ARCHIVE	1230 hrs.			Begin "Hard Tooling" bkg γ β∝ Archive + grab sample
105	ARCHIVE	1255 hrs.		@ 105' Trace Gravels; max size = md. granule, still classified as Sandy Silt.	bkg γ β∝ Archive + grab sample
110	ARCHIVE	1352 hrs.		@ 110' Trace gravel continues - though not enough present to change lithology classification.	bkg γ β∝ Archive + grab sample
115	ARCHIVE	1430 hrs.		114 - 120' Silty Sand: 70% S, 30% M, Sand fine - v. fine, sub. rnd - sub. ang., well sort., wet from "hard tooling"; Silt% decreases. color (wet): 7.5 YR 4/3 light brown color (dry): 7.5 YR 8/3 pink	bkg γ β∝ Archive + grab sample

Reported By: JM Faurote / Jess Hocking		Reviewed By: L.D. Walker	
Title: Geologist / Geologist		Title: Geologist	
Signature: JM Faurote for Hocking	Date: 10/8/01	Signature: LD Walker	Date: 11-2-01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 5 of 9
Date: 10-8-01

Well ID: C3396 | Well Name: 299-W14-18 | Location: SE Corner 241-TxTy Tank Farm.
Project: CY-01 RCRA DRILLING | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120	ARCHIVE	1519hrs.		120 - 125' Sandy Silt : See above description; (65% M, 35% S).	bkg γ β α Archive + grab sample
125	ARCHIVE	0939 hrs.		125 - 145' Gravelly Silt : 75% M, 20% G, 5% S; Silt % increases ; Gravel crushed due to "hard tooling" , max size = sm. granule , mod. sorf, mineralogy of gravel unknown ; Sand % decreases greatly. Color (wet) : 7.5 YR 3/2 dark brown.	bkg γ β α Archive + grab sample.
130	ARCHIVE	1318hrs.			bkg. γ β α Archive + grab sample
135	ARCHIVE	1610 hrs		@ 135' Gravelly Silt : 75% M, 25% G ; same as above % sand.	bkg. γ β α Archive + grab sample
140	ARCHIVE			@ 140' Gravelly Silt: 75% M, 25% G; same as above.	bkg $\gamma\beta\alpha$ Archive + grab sample
145	ARCHIVE	1417 hrs.		145 - 155' Silty Gravel : 50% M, 50% G ; silt % decreases slightly ; Gravel % increases ; Descriptions for both are the same as above.	bkg γ β α Archive + grab sample.

Reported By: Jess Hocking | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Jess Hocking | Date: 10/11/01 | Signature: L.D. Walker | Date: 11-2-01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 6 of 9
Date: 10-11-01

Well ID: C3396 | Well Name: 299-W14-18 | Location: SE Corner of 241-TxTy Farm
Project: RCRA DRILLING CY-01 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
150	ARCHIVE	0852 hrs.		@ 150' Silty Gravel: 60% M, 40% G;	bkg. $\gamma\beta\alpha$
				Silt % increases; Gravel ang., poor sort.,	Archive + grab sample
				max size = md. granule, mineralogy: basalt,	
				quartzite, trace unknown.; Color: 7.5 YR 3/	
				very dark gray.	
155	ARCHIVE	1057 hrs.			bkg. $\gamma\beta\alpha$
				155 - 160' Gravelly Silt: 75% M, 25% G;	Archive + grab sample
				similar to last given description (pg. 5);	
				color: 7.5 YR 3/ very dark gray.; mineralogy:	
				same as above.	
160	ARCHIVE	1408 hrs.			bkg. $\gamma\beta\alpha$
				160' - 165' Silty Gravel: 70% M, 30% G;	Archive + grab sample
				similar to above description; mineralogy:	
				basalt + quartzite; color: 10 YR 5/2 grayish brown.	
165	ARCHIVE	0813 hrs.		165 - 190' Gravelly Silt: 70% M, 20% G max,	bkg. $\gamma\beta\alpha$
				10% S; similar to last given description (pg. 5);	Archive + grab sample.
				Sand % increases, v. fine, well sort; color:	
				7.5 YR 3/ very dark gray; mineralogy: same as	
				above.	
170	ARCHIVE	1111 hrs.			bkg. $\gamma\beta\alpha$
				@ 170' Gravelly Silt: 70% M, 15% G, 15% S;	Archive + grab samples.
				Gravel % decreases, Sand % increases,	
				description + mineralogy the same; color: 5 YR 5/1	
				gray.	
175	ARCHIVE	1352 hrs.			bkg. $\gamma\beta\alpha$
				@ 175' Gravelly Silt: (70% M, 15% G, 15% S);	Archive + grab sample
				same as above; color: 7.5 YR 6/2 pinkish gray.	

Reported By: Jess Hocking		Reviewed By: L. D. Walker	
Title: Geologist		Title: Geologist	
Signature: Jess Hocking	Date: 10/15/01	Signature: L D Walker	Date: 11-2-01

BHI-EE-183 (12/97)

BOREHOLE LOG

Date: 10-15-01

Well ID: C3396 | Well Name: Z99-W14-18 | Location: SE Corner of Z41-TxTy Farm.

Project: RCRA DRILLING CY-01 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
180	ARCHIVE	0932 hrs.		@ 180' Gravelly Silt: 70% M, 20% G, 10% S; color: 10 YR 5/2 grayish brown.	bkg. χ β α; Archive + grab samples
185	ARCHIVE	1239 hrs.		@ 185' Gravelly Silt: 70% M, 20% S, 10% G; color: same as above; Gravel max size = sm. cobble.; mineralogy: same as before.	bkg. χ β α; Archive + grab samples.
190	ARCHIVE	1424 hrs.		190 - 200' Sandy Silt: 55% M, 40% S, 5% G; Silt % decreases; Sand v. fine - fine, v. well sort., sub. ang.; Gravel % decreases, max size = lg. granule, mod. sort., mineralogy: same as above; color: 10 YR 5/3 brown.	bkg. χ β α; Archive + grab samples.
195	ARCHIVE	0755 hrs.			bkg. χ β α; Archive + grab samples.
200	ARCHIVE	1008 hrs.		200 - 205' Gravelly Sandy Silt: 55% M, 35% S, 10% G; Silt the same; Sand % decreases, otherwise the same; Gravel % increases, mineralogy: basalt, quartzite, and quartz (jasper and serpentine trace), max	bkg. χ β α; Archive + grab samples
205	ARCHIVE	1150 hrs.		size = lg. granule, ang. - sub. ang.; color same as above.	bkg. χ β α; Archive + grab samples

Reported By: Jess Hocking | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: Jess Hocking | Date: 10/16/01 | Signature: L.D. Walker | Date: 11-5-01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 8 of 9
Date: 10-16-01

Well ID: C3396 | Well Name: 299-W14-18 | Location: SE Corner of 241-TxTy Tank Farm.
Project: RCRA DRILLING CY-01 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
210	ARCHIVE	1441 hrs.		205-210' Silty Gravel: 60% M, 35% G, 5% S; Silt% increases.; Gravel % increases, same as above, mineralogy: basalt, quartzite, quartz, granite (trace jasper); Sand % decreases, same as above; color: same as above.	bkg. X β α Archive + grab sample.
215	ARCHIVE	1047 hrs.			bkg. X β α Archive + grab sample.
				210-215' Sandy Silt: 60% M, 35% S, 5% G; Silt% the same; Gravel and Sand %'s flip-flop; Gravel same as before; Sand same as before; same color.	GWL = 219.95' bgs bkg. X β α Archive + grab sample.
220	ARCHIVE	1427 hrs.			
	SS #1	1503 hrs.		215-220' Gravelly Silt: 65% M, 25% S, 10% G; Silt% increases; Sand % decreases, same as before; Gravel % increases,	bkg. X β α splitspoon sample #1
	100%	1530 hrs.			
225	ARCHIVE	1621 hrs.		ang. - sub. ang., max size = sm. pebble, mineralogy: quartzite, quartz, granite, very low % basalt. Color: same as above.	bkg. X β α Archive + grab sample.
				220-235' Gravelly Sandy Silt: 60% M, 30% S, 10% G; Silt% decreases; Sand % increases, same as before; Gravel the same, mineralogy: quartzite, basalt, quartz, granite, ~~serpentine~~ MSN serpentine.	
230	ARCHIVE	1047 hrs.			bkg. X β α Archive + grab sample.
235	ARCHIVE	1312 hrs.		@ 230' mineralogy: quartzite, quartz, basalt	bkg. X β α Archive + grab sample.
				235-240' Gravelly Silt: 60% M, 20% S, 20% G; Silt% stays the same; Sand% decreases, fine - v. fine, v. well srt.; Gravel % increases,	

Reported By: Jess Hocking | Reviewed By: L.D. Walker
Title: Geologist | Title: Geologist
Signature: Jess Hocking | Date: 10/18/01 | Signature: L.D. Walker | Date: 11-5-01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 9 of 9
Date: 10-18-01

Well ID: C3396 | Well Name: 299-W14-18 | Location: SE Corner of 241-TxTy Tank Farm.
Project: RCRA DRILLING CY-01 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
240	ARCHIVE	1600 hrs.		235' (cont'd.) gravel max size = lg. granule, mineralogy: quartzite, quartz, basalt, jasper, and serpentine, ang. - sub. ang.; color: 7.5 YR 6/2 pinkish gray.	bkg. δ B α Archive + grab sample
245	ARCHIVE	0848 hrs.		240-261.5' Gravelly Sandy Silt: 60% M, 30% S, 10% G; similar to above description; max gravel size = sm. cobble; color: same as above.	bkg. δ B α Archive + grab sample
250	Archive	1150 hrs		@ 245' Gravelly Sandy Silt: 50% M, 25% S, 25% G; gravel size = md. granule, mineralogy: quartzite, quartz, basalt; color: 7.5 YR 5/2 brown.	Archive - grab SS
255	Archive	1328			Archive, grab + SS
260	Archive	1512		TD = 261.5'	Archive + grab SS GW slurry
265					

Reported By: Jess Hocking / C. Trice | Title: Geologist | Signature: Jess Hocking / C. Trice | Date: 10/19/01

Reviewed By: L. D. Walker | Title: Geologist | Signature: LD Walker | Date: 11-5-01

BHI-EE-183 (12/97)

WELL CONSTRUCTION SUMMARY REPORT

Start Date: ~~10-1-01~~ 09/19/01
Finish Date: 10-4-01
Page 1 of 1

Specification No.: 0200X-SP-V0004 Rev. No.: 0	Well Name: 299-W15-765 Temp. Well No.: C3397
ECNs: N/A / Start card # R037816	Approximate Location: west side of TX-TY
Project: CY01 RCRA Drilling	Other Companies: MACTEC, CHI
Drilling Company: Resonant Sonic Inc.	Geologist(s): J. Hocking, J.M. Faurote, C. Trice
Driller: Mike Gomez, no licence #	

TEMPORARY CASING AND DRILL DEPTH

*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.
10" Threaded Carbon Steel	0 - 265'	10¾" / 10"
	-	
	-	
	-	
	-	

*Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design

DRILLING METHOD/HOLE DIAMETER

Auger:	Diameter From ___ to ___
Cable Tool:	Diameter From ___ to ___
Air Rotary: X 10"	Diameter From 0' to 265'
A.R. w/Sonic:	Diameter From ___ to ___
	Diameter From ___ to ___
	Diameter From ___ to ___
	Diameter From ___ to ___

Total Drilled Depth: ~~264'~~ 267' bgs	Hole Dia @ TD: 8" 10¾"	Drilling Fluid: ~~WATER~~ Air	
Well Straightness Test Results: PASSED using a 20.4' long, 3.5" OD Straightness tool.		Total Amt. Of Water Added During Drilling: ~~UNKNOWN~~ N/A	
		Static Water Level: 219.8' bgs	Date: 9/27/01

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date	Sondes (type)	Interval	Date
	-			-	
	-			-	
	-			-	

COMPLETED WELL

Size/Wt./Material	Depth	Thread	Slot Size	Type	Interval Annual Seal/Filter Pack	Volume	Mesh Size
4" ID SS 304L Riser	+2.30' - 220'	FJ80 Yes	-	Colorado 10-20 mesh silica sand	265 - 209.5	49.75ft³	10-20
4" ID Screen SS304L 0.020" Cont. Wire Wrap	220' - 255'	FJ80 Yes	0.020"	¼" Bentonite pellets	209.5 - 204.8	2.48ft³	¼
4" ID SS 304 Sump	255' - 257.1'	FJ80 Yes	-	Bentonite crumbles	204.8 - 10.2	106.5ft³	8-20
	-			Portland cement	10.2 - 0	6.425ft³	-
	-				-		

OTHER ACTIVITIES

Aquifer Test: well development	Date: 10/31/01 10/30/01	Well Abandoned:	Yes:	No:	Date:
Description: using 3 Hp submersible pump w/intake set @ 252.8' bgs withdrew H2O for 49 minutes @ 30gpm. drawdown 4.48': 2nd intake @ 237.8', 30gpm, 24 min. drawdown of 4.29'		Description:			

WELL SURVEY DATA

Date:	Protective Casing Elevation:
Washington State Plane Coordinates:	Brass Cap Elevation:

COMMENTS/REMARKS

~~93~~ 93 50# bags silica sand used: 4 50# buckets bent. pellets used. 150 50# bags bent. crumbles used: 5 94# bags portland cement used.

Reported By: Jess Hocking		Reviewed By: Charlene Martinez	
Title: Geologist	Date: 10/4/01	Title: Geologist	Date: 11/07/01
Signature: Jess Hocking		Signature: Charlene Martinez	

BHI-EE-181 (12/97)

WELL SUMMARY SHEET

Page 1 of 2

Date: 10-4-01

Well ID: C3397	Well Name: 299-W15-765
Location: West Side of TX-TY	Project: C401 RCRA Drilling
Prepared By: Jess Hocking	Date: 10/4/01
Reviewed By: D C Weekes	Date: 10/16/01
Signature: Jess Hocking	Signature: D C Weekes

CONSTRUCTION DATA

Description	Diagram
4" ID SS 304L RISER +2.30' → 220' bgs	
SS 304L 0.020" 4" ID CONT. WIRE WRAP SCREEN 220' bgs → 255' bgs	
4" ID SS 304L SUMP 255' bgs → 257.1' bgs.	
Colorado 10-20 mesh silica sand 265.0' bgs → 209.5' bgs	
1/4" Bentonite Pellets 209.5' bgs → 204.8' bgs.	
Bentonite 8-20 mesh crumbles 204.8' bgs → 10.2' bgs	
Portland Cement 10.2' bgs → 0'	
NOTE: ALL TEMP. CASING REMOVED FROM GROUND NOT TO SCALE	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
0		0-2' Drill Pad
		2-5' Gravelly Sand [gS]
		5-25' Sandy Gravel [sG]
		25-30' Gravel [G]
		30-35' Silty Gravel [mG]
40		35-40' Slightly Silt Gravelly Sand [cmgS]
		40-92' Sand [S]
80		92-93' Silty Sand [mS]
		93-105' Silt [M]
		105-110' Gravelly Silt [gM]
		110-117' Sandy Silt [sM]
120		117-120' Sand [S]
		120-125' Sandy Silt [sM]
		125-130' Silt [M]
		130-135' Sand [S]
		135-136' Silty Gravel [mG]
160		136-140' Gravel [G]
		140-150' Sandy Gravel [sG]
		150-151' Gravelly Silty Sand [gmS]
		151-155' Gravel [G]
		155-157' Gravelly Sandy Silt [gsM]
200		157-160' Gravel [G]
		160-170' Sandy Gravel [sG]
		170-175' Gravel [G]
		175-180' Silty Gravel [sG]
		180-195' Gravelly Sand [gS]

BHI-EE-189 (12/97)

Page 2 of 2

WELL SUMMARY SHEET

Date: 10-4-01

Well ID: C3397	Well Name: 299-W15-765
Location: WEST Side of 241-Tx, Ty Farm.	Project: RCRA DRILLING FY-01
Prepared By: Jess Hocking Date: 10/4/01	Reviewed By: DC Weekes Date: 10/16/01
Signature: Jess Hocking	Signature: DC Weekes

CONSTRUCTION DATA

Description	Diagram
NOTE: ALL TEMP. CASING REMOVED FROM GROUND.	
All depths from Ground surface in feet	
NOT TO SCALE	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
240		195-200' Sandy Gravel [sG]
		200-220' Silty Gravel [mG]
		220-230' Silty Sandy Gravel [msG]
		230-235' Gravel [G]
		235-240' Silty Gravel [mG]
280		240-250' Silty Sandy Gravel [msG]
		250-255' Gravel [G]
		255-265' Sandy Gravel [sG]
		TD = ~~264.6'~~ 267' bgs (Cm)
		SWL = 219.8' bgs (9/27/01)

BHI-EE-189 (12/97)

WELL SURVEY DATA REPORT

ERC Project: 22192	**Prepared By:** Gary B. Wagner, P.L.S. **Company:** Rogers Surveying, Inc.
Date Requested: 11/19/01	**Requestor:**
Date of Survey: 12/05/01	**Surveyor:** Rogers Surveying, Inc.
ERC Point of Contact: Mr. Robert Bone	**Survey Co. Point of Contact:** Gary B. Wagner, P.L.S.
Description of Work: Civil surveying for eleven groundwater wells in 200W & 200E Areas.	**Horizontal Datum:** NAD83(91) **Vertical Datum:** NAVD88 **Units:** Metric **Hanford Area Designation:** 200W
Coordinate System: Washington State Plane Coordinates (South Zone)	
Horizontal Control Monuments: HSWB-037 & GPS 31	
Vertical Control Monuments: HSWB-037	

Well Name	Well ID	Easting	Northing	Elevation	
299-W15-765	C3397	566697.02	136373.06		**Center of Casing**
				205.299	**"X" on Rim**
		566697.00	136373.39	204.505	**Brass Cap**

Notes:

Surveyor Statement:	**Certification Seal**
I, Gary B. Wagner, a professional land surveyor registered in the state of Washington (Registration No. 30440), hereby certify that this report is based on a field survey performed in December, 2001 under my direct supervision and that the data contained here is true and correct.	

BHI-EE-202 (09/98)

BOREHOLE LOG

Page 1 of 9
Date: 9-19-01

Well ID: C3397 | Well Name: 299-W15-765 | Location: WEST Side of Tx, Ty Farm
Project: RCRA DRILLING FY-01 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
0	A R	N/A		0-2' Drilling Pad	Air Rotary using tricone bit
				2-5' Gravelly Sand: 80% S., 15% G., 5% M; Sand is well sortd., sub. ang., max size = med.; Gravel is ang. - rnd., mostly crushed basalt, max size = lg. pebble - sm. cobble; silt % is low.	
5	ARCHIVE			5-25' Sandy Gravel: 60% G, 35% S, 5% M; Gravel the same; Sand med. - fine; silt the same.	
10	ARCHIVE				
15	ARCHIVE			@ 15' Gravel is 70% and Sand is 30% (med. - v. coarse), both ang. - still Sandy Gravel.	
20	ARCHIVE			@ 20' Gravel is 80% and Sand is 20%; Gravel still the same; Sand v. coarse, ang. - still Sandy Gravel.	
				@ 22' Gravel the same but smaller,	
25	ARCHIVE			max size = med. pebble; Sand the same; trace silt.	
				25-30' Gravel: 90% G, 10% S; Descriptions the same.	

Reported By: Jess Hocking | Reviewed By: Charlene Martinez
Title: Geologist | Title: Geologist
Signature: Jess Hocking | Date: 9/19/01 | Signature: Charlene Martinez | Date: 11/06/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 2 of 9
Date: 9-19-01

Well ID: C3397 | Well Name: 299-W15-765 | Location: WEST Side of 241-Tx-Ty
Project: RCRA DRILLING CFY-01 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
30	AIR ARCHIVE	N/A		30-35' Silty Gravel : 75% G, 25% M; Gravel max size = md. - sm. pebble, sub. ang. - sub. rnd., mostly crushed basalt w/ some mixed qtz.; Silt % higher - due to injected H_2O is saturated to viscous mud.	Air Rotary using tricone bit
35	ARCHIVE			35-40' Slightly Silt Gravelly Sand : 60% S, 30% G, 10% M; Sand v. fine, v. well sort., rnd. - sub. rnd.; Gravel sub. rnd. - ang., max size = sm. pebble, still mostly crushed basalt; Silt % down.	
40	ARCHIVE			@ 37' Sand coarse - v. coarse, poor sort. (55% S, 30% G, 15% M) - still Slightly Silt Gravelly Sand.	
45	ARCHIVE			40 - 92' Sand : 85% S, 10% G, 5% M; Sand v. coarse - v. fine, v. well sort.; Gravel still sm. pebble; silt % lower.	
50	ARCHIVE				
55	ARCHIVE				

Reported By: Jess Hocking
Title: Geologist
Signature: Jess Hocking Date: 9/19/01

Reviewed By: Charlene Martinez
Title: Geologist
Signature: Charlene Martinez Date: 11/06/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 3 of 9
Date: 9-19-01

Well ID: C3397 | Well Name: 299-W15-765 | Location: WEST Side of 241-Tx, Ty
Project: RCRA DRILLING CY-01 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
60	A R ARCHIVE	N/A		@ 60' Sand v. well sort., rnd., fine - v.fine (100% S)	Air Rotary using tricone bit
65	ARCHIVE			@ 65' Sand fine - med., v. well sort, sub. rnd. - sub. ang. (100% S)	
70	ARCHIVE				
75	ARCHIVE			@ 75' Trace granules (95% S, 5% G)	
80	ARCHIVE				
85	ARCHIVE			@ 85' Sand fine - v.fine (100% S)	

Reported By: Jess Hocking | Reviewed By: Charlene Martinez
Title: Geologist | Title: Geologist
Signature: Jess Hocking | Date: 9/21/01 | Signature: Charlene Martinez | Date: 11/06/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 4 of 9
Date: 9-21-01

Well ID: C3397 | Well Name: Z99-W15-765 | Location: WEST Side of Z41-Tx, Ty
Project: RCRA DRILLING FY-01 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
90	AIR ARCHIVE	N/A		@ 90' Sand is fine-v.fine, some mica chips present (95% S, 5% M) - still Sand.	AIR ROTARY using tricone bit
				92-93' Silty Sand: 70% S, 25% M, 5% G; Sand v.fine, v.well sort., rnd.; silt % higher; Trace Gravel granules.	
95	ARCHIVE			93-105' Silt: 100% M; Silt % very high - NO SAND, NO GRAVEL PRESENT	
100	ARCHIVE			@ 102' lg. granules appear (95% M, 5% G)	
105	ARCHIVE			105-110' Gravelly Silt: 85% M, 15% G; Silt % still v.high; Gravel max size = sm. pebble, rnd., well sort. NO SAND PRESENT	
110	ARCHIVE			110-117' Sandy Silt: 70% M, 25% S, 5% G; Silt % dropping but still high; Sand v.fine grained, well sorted, rnd.; Gravel max size sm. granule, rnd., well sort.	
115	ARCHIVE			117'-120' Sand: ~~85%~~ 90 MSH S, ~~15%~~ 10 MSH M; Sand fine-v.fine, rnd., v.well sort.; silt % low. NO GRAVEL PRESENT	

Reported By: Jess Hocking | Reviewed By: Charlene Martinez
Title: Geologist | Title: Geologist
Signature: Jess Hocking | Date: 9/21/01 | Signature: Charlene Martinez | Date: 11/06/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 5 of 9
Date: 9-20-01

Well ID: C3397 | Well Name: 299-W15-765 | Location: WEST Side of 241-Tx, Ty
Project: RCRA DRILLING CY-01 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
120	AIR ARCHIVE	N/A		120 - 125' Sandy Silt: 70% M, 30% S	AIR ROTARY
				Similar to above description.	using tricone bit
				125' - 130' Silt: 95% M, 5% S;	
125	ARCHIVE			Similar to above description; sand v. fine,	
				v. well sort, some mica present.	
130	ARCHIVE			130 - 135' Sand: 95% S, 5% M;	
				Sand med. - coarse, mod. sort., sub. rnd. -	
				sub. ang, mica + flakes of pyrite present;	
				Silt % v. low.	
135	ARCHIVE			135 - 136' Silty Gravel: 75% G, 25% M;	
				Gravel max size = lg. granule - sm. pebble,	
				sub. rnd. - sub. ang., mod. sort.; Silt %	
				increasing.	
140	ARCHIVE			136 - 140' Gravel: 100% G; Gravel	
				max size = med. pebble, sub. ang. - ang.,	
				poorly sort. - mostly crushed basalt w/	
				intermixed qtz. and feldspars.	
145	ARCHIVE			140 - 150' Sandy Gravel: 75% G, 25% S;	
				Gravel max size = lg. granule, sub. ang. -	
				ang., poor sort. - crushed basalt;	
				Sand v. coarse, poor sort, sub ang. -	
				sub. rnd. Black in color.	

Reported By: Jess Hocking | Reviewed By: Charlene Martinez
Title: Geologist | Title: Geologist
Signature: Jess Hocking | Date: 9/21/01 | Signature: Charlene Martinez | Date: 11/06/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 5 of 9
Date: 9-21-01

Well ID: C3397 | Well Name: 299-W15-765 | Location: WEST Side of Z41 - Tx, Ty
Project: RCRA DRILLING CFY-01 | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
150	A 18 ARCHIVE	N/A		150 - 151' Gravelly Silty Sand: 55% S, 25% M, 20% G; Sand v.fine, v. well sort, sub. ang. - sub. rnd.; Silt% increasing; Gravel sub. ang. - sub rnd., black basalt, max size = sm. pebble, mod. sort.	· Air Rotary using tri cone bit
155	ARCHIVE			151 - 155' Gravel: 100% G; Similar to last given description.	
				155 - 157' Gravelly Sandy Silt: 50% M, 30% S, 20% G; Silt% increases, moisture clumping present; Sand med., mod. sort, rnd.; Gravel the same.	
160	ARCHIVE			157 - 160' Gravel: 100% G; Similar to last given description.	
165	ARCHIVE			160 - 170' Sandy Gravel: 50% G, 50% S; Gravel ang., max size = sm. pebble, basalt, qtz., feldspars - crushed; Sand fine - med., mod sort, sub. ang. - sub - rnd.	
170	ARCHIVE			170 - 175' Gravel: 100% G; Similar to last given description, max size = sm. pebble.	
175	ARCHIVE			175 - 180' Silty Gravel: 75% G, 20% M, 5% S; Similar to last given description; moisture clumping.	
				@ 177' (70% G, 20% M, 10% S)	

Reported By: Jess Hocking | Reviewed By: Charlene Martinez
Title: Geologist | Title: Geologist
Signature: Jess Hocking | Date: 9/21/01 | Signature: Charlene Martinez | Date: 11/6/10

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 6 of 9 (7)
Date: 9-24-01

Well ID: C3397 | Well Name: 299-W15-765 | Location: WEST SIDE 241-TX, TY Farm
Project: RCRA DRILLING CAY-01 (2) | Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
180	AIR ARCHIVE	N/A		180 - 195' Gravelly Sand: 80% S, 20% G; Sand fine - v. fine, v. well sort, sub. rnd. - sub. ang., color = 2.5YR 3/3 dark reddish brwn.; Gravel max size = md. - lg. granule, mostly crushed basalt w/some unknowns mixed in., sub. ang - rnd.	Continue Air Rotary Drilling using tricone bit
185	ARCHIVE				
190	ARCHIVE				@ 191' cuttings put in barrels.
195	ARCHIVE			195 - 200' Sandy Gravel: 70% G, 25% S, 5% M; Gravel max size = sm. pebble, sub. rnd. - sub. ang., poor sort., mostly crushed basalt w/some qtz. mixed in.; Sand fine - med., mod. sort, rnd. color = 10YR 2/2 very dark brwn.; Silt% low.	
200	ARCHIVE			200 - 220' Silty Gravel: 75% G, 20% M, 5% S; Gravel same as above; Silt% increasing; Sand v. fine, color = 7.5YR 6/3 light brwn., v. well sort.	
205	ARCHIVE			@ 205' NO SAND PRESENT (80% G, 20% M)	

Reported By: Jess Hocking | Reviewed By: Charlene Martinez
Title: Geologist | Title: Geologist
Signature: Jess Hocking | Date: 9/24/01 | Signature: Charlene Martinez | Date: 11/06/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 8 of 7
Date: 9-26-01

Well ID: C3397	Well Name: 299-W15-765	Location: WEST SIDE OF 241-TX, TY Farm.
Project: RCRA DRILLING CFY-01		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
210	AIR ARCHIVE	N/A		@ 210' SAND BECOMES PRESENT AGAIN - (75% G, 20% M, 5% S); Gravel ang.-sub. ang.; basalt, qtz., feldspars, granite; Sand fine, well sort.	Continue Air Rotary Drilling using tricone bit
215	ARCHIVE			@ 215' (70% G, 20% M, 10% S) Sand increases; Gravel decreases but its description stays the same.	
					Cable tool w/
220	ARCHIVE	SS #1		220 - 230' Silty Sandy Gravel: 75% G, 15% S, 10% M; Gravel max size = lg. pebble, ang., poor sort.; basalt, qtz., feldspar, granite; Sand fine-med., poor sort, sub. ang.-sub. rnd.; Silt% decreasing.	Splitspoon sample taken [220'-222'] 50% recovery.
	Cable Tool for SS	50%			
	AIR				Continue Air Rotary Drilling
225	ARCHIVE				EST. WT = 225' bgs
					ACT. WT = 219.8' bgs
230	ARCHIVE			230 - 235' Gravel: 90% G, 10% M; Gravel the same; Silt the same; NO SAND PRESENT	
235	ARCHIVE			235 - 240' Silty Gravel: 70% G, 30% M; Similar to last given description, Gravel the same, silt % increases.	

Reported By: Jess Hocking		Reviewed By: Charlene Martinez	
Title: Geologist		Title: Geologist	
Signature: Jess Hocking	Date: 9/26/01	Signature: Charlene Martinez	Date: 11/06/01

BHI-EE-183 (12/97)

BOREHOLE LOG

Page 5 of 7
Date:

Well ID: C3397	Well Name: 299-W15-765	Location: WEST Side of 241-Tx, Ty Farm
Project: RCRA DRILLING CY-01		Reference Measuring Point: Ground Surface

Depth (Ft.)	Sample Type No.	Sample Blows Recovery	Graphic Log	Sample Description: Group Name, Grain Size Distribution, Soil Classification, Color, Moisture Content, Sorting, Angularity, Mineralogy, Max Particle Size, Reaction to HCl	Comments: Depth of Casing, Drilling Method, Method of Driving Sampling Tool, Sampler Size, Water Level
240	AIR ARCHIVE			240 - 250' Silty Sandy Gravel: 65% G, 20% M, 15% S; Similar to last given description; Gravel the same; Silt% decreases; Sand fine - med., well sort.	Continue Air Rotary Drilling using tricone bit
245	ARCHIVE				
250	ARCHIVE			250 - 255' Gravel: 100% G; Gravel max size = lg. pebble, sub. ang. - rnd., mod. sort; basalt, qtz., feldspar, granite, trace unknowns.	
255	ARCHIVE	SS #2 95% rec.		255 - TD (264.6') Sandy Gravel: 80% G, 20% S; Gravel the same; Sand med. - coarse, sub. ang - sub. rnd., poor sort.	255 - 257' Splitspoon sample taken w/cable tool
	Cable Tool for SS				
	AIR	N/A			Resume Air Rotary
				@ 257' TRACE SILT PRESENT	Drilling @ 257'
260	ARCHIVE			@ 260' LENS OF GRAVEL APPEARS	
				@ 261' RETURNS TO SANDY GRAVEL.	
265	ARCHIVE	TD		@ 265' Gravel max size = md. cobble, made up of: basalt, granite, qtz., quartzite, and sandstone.; Sand med., well sort.	EST. TD = 265' bgs ACTUAL TD = ~~264.6~~ 267' bgs

Reported By: Jess Hocking		Reviewed By: Charlene Martinez	
Title: Geologist		Title: Geologist	
Signature: Jess Hocking	Date: 9/27/01	Signature: Charlene Martinez	Date: 11/06/01

BHI-EE-183 (12/97)

Appendix B

Physical and Chemical Properties Data

Appendix B

Physical and Chemical Properties Data

This appendix includes the results of testing for particle size distribution on split spoon samples from the wells 299-W14-18 and 299-W15-765. The particle size analyses were done by CH2M HILL Hanford, Inc. using standard sieve techniques. Also in this appendix are the results of laboratory testing for metals, anions, electrical conductivity, technetium, and uranium-238. Laboratory analyses were done at Pacific Northwest National Laboratory using standard laboratory procedures.

Table B.1. Electrical Conductivity and pH in Wells 299-W14-18 and 299-W15-765

Well Name and Depth (ft)	pH	EC (mS/cm)
299-W14-18		
220	7.65	0.543
262	7.61	0.269
299-W15-765		
238	7.39	0.352
265	7.46	0.674

Table B.2. Metals in Samples from Wells 299-W14-18 and 299-W15-765

Well Name and Depth (ft)	Al 394.4[(a)] <125[(b)]	As 193.7 <125	B 249.7 <125	Ba 455.4 <25	Ca Rad 393.7 <50	Cd 228.8 <25	Co 228.6 <25	Cr 267.7 <30	Cu 324.8 <50	Fe 274.0 <50
299-W14-18										
220	<125	(25)	(41)	87	40281	<25	<25	<30	<50	(10)
262	<125	(12)	(29)	53	19041	<25	(2)	(3)	(4)	67
299-W15-765										
238	<125	<125	(66)	41	29789	<25	(2)	<30	<50	<50
265	<125	(41)	(19)	78	68144	<25	(3)	(3)	<50	109

Well Name and Depth (ft)	K Rad 766 <12500	Mg Rad 279.6 <50	Mn 294.9 <113	Mo 204.6 <25	Ni 231.6 <50	Sr Rad 407.8 <50	Zn 213.9 <25	Na Rad 589.6 <2500	S 182.6 <2500	Ti 334.9 <2500	Zr 343.8 <125
299-W14-18											
220	7589	14926	559	174	(4)	198	<25	36356	18402	<125	<125
262	5175	6652	141	96	(3)	91	(4)	16576	10155	<125	<125
299-W15-765											
238	4282	10115	164	244	(3)	133	<25	18486	13805	<125	<125
265	5120	23041	538	105	(3)	286	<25	19334	16720	<125	<125

All concentrations are reported in µg/L (ppb).
(a) Wavelength.
(b) Lower limit of quantification.
(c) Indicates analyte below lower limit of quantification or suspect value.

Table B.3. Technetium-99 and Uranium-238 in Samples from Wells 299-W14-18 and 299-W15-765

Well Name and Depth (ft)	Tc-99[(a)] <0.05[(b)] µg/L	U-238 <0.025 µg/L
299-W14-18		
220	(0.006)	0.564
262	(0.005)	0.143
299-W15-765		
238	(0.004)	0.270
265	(0.009)	0.913
All concentrations reported in µg/L (ppb). (a) Isotope of choice. (b) Lower limit of quantification. (c) Signifies value is below limit of quantification.		

Table B.4. Anions in Samples from Wells 299-W14-18 and 299-W15-765

Well Name and Depth (ft)	Fluoride	Chloride	Nitrite	Bromide	Nitrate	Sulfate	Phosphate	Carbonate
299-W14-18								
220	0.87	31.71	4.27	<1.00	56.85	55.58	<1.50	64.24
262	0.70	7.59	<1.00	<1.00	3.26	32.22	<1.50	73.01
299-W15-765								
238	0.95	14.10	2.05	<1.00	24.27	42.93	<1.50	77.59
265	0.42	19.39	2.77	<1.00	174.11	52.11	<1.50	95.97
Note: All concentrations reported in parts per million (ppm).								

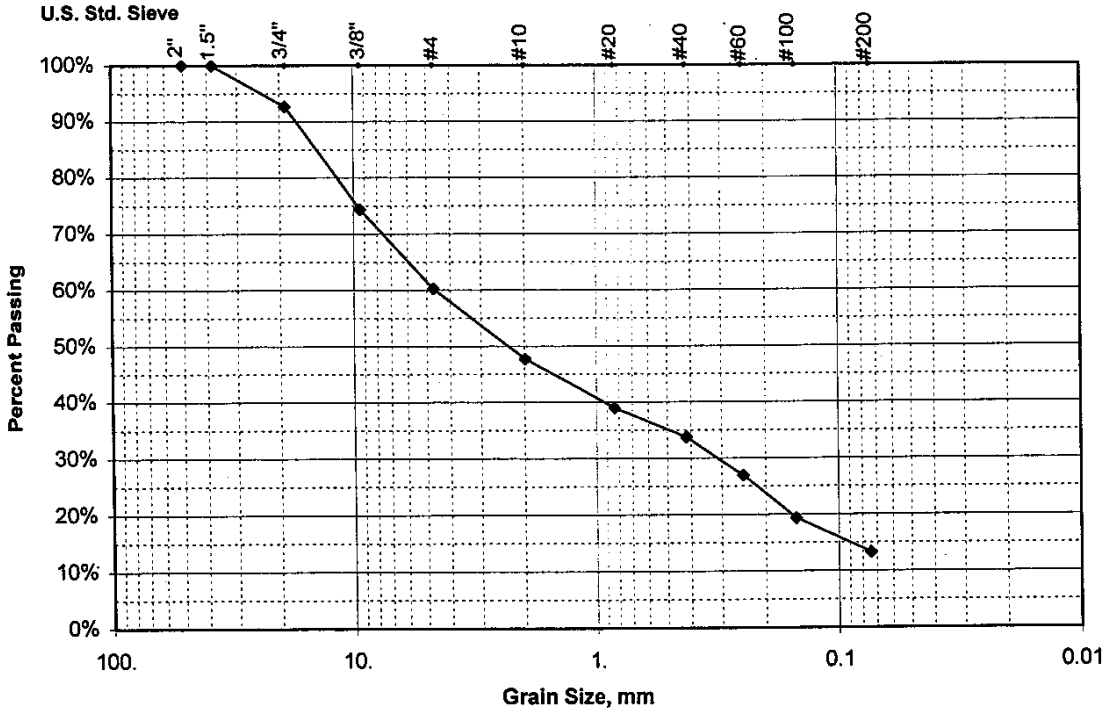
CH2M Hill Hanford, Inc.

SIEVE ANALYSIS

WELL NAME	299-W14-18	DEPTH	222.0'-224.0'	SAMPLE#	W14-18-222.0	WELL ID#	C3396
TESTED BY	J.M.Wimett	CONTACT	Dave Weekes	PHONE	372-9601	DATE	11/02/2001

SAMPLE WT (g)	SIEVE SIZE IN.	CUMULATIVE WEIGHT(g)	% WEIGHT RETAINED	% PASSING	Grain Size (mm)	COMMENTS
985.80	2"	0.0	0.0	100.0	50.80	
	1.5"	0.0	0.0	100.0	38.10	
	3/4"	71.9	7.3	92.7	19.05	
	3/8"	252.5	25.6	74.4	9.42	
	#4	392.3	39.8	60.2	4.70	
	#10	516.0	52.3	47.7	1.98	
	#20	601.6	61.0	39.0	0.83	
	#40	652.7	66.2	33.8	0.42	
	#60	720.8	73.1	26.9	0.25	
	#100	795.2	80.7	19.3	0.150	
	#200	854.6	86.7	13.3	0.074	

Sieve Analysis Data for Sample W14-18-222.0



Comments: Silty Sandy Gravel

All data are accurately and completely recorded.

Checked By: JMWimett DCWeekes Date: 11/2/01

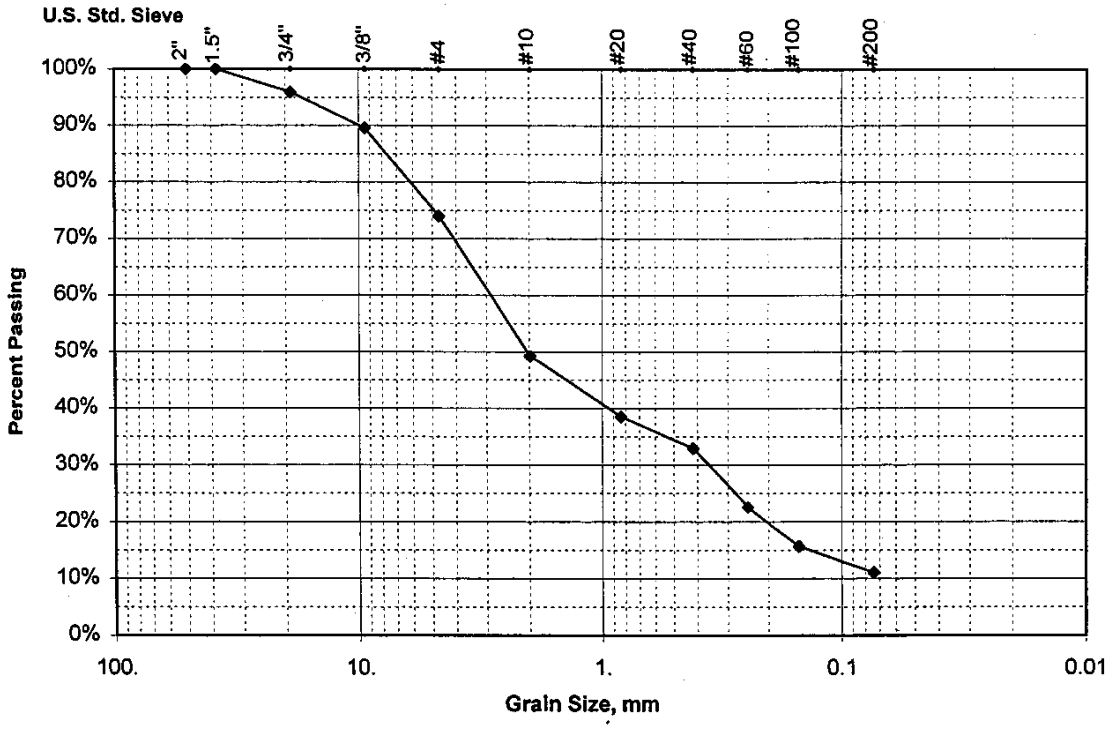
CH2M Hill Hanford, Inc.

SIEVE ANALYSIS

WELL NAME	299-W14-18	DEPTH	255.0'-257.0'	SAMPLE#	W14-18-255.0	WELL ID#	C3396
TESTED BY	J.M.Wimett	CONTACT	Dave Weekes	PHONE	372-9601	DATE	11/02/2001

SAMPLE WT (g)	SIEVE SIZE IN.	CUMULATIVE WEIGHT(g)	% WEIGHT RETAINED	% PASSING	Grain Size (mm)	COMMENTS
974.70	2"	0.0	0.0	100.0	50.80	
	1.5"	0.0	0.0	100.0	38.10	
	3/4"	39.7	4.1	95.9	19.05	
	3/8"	102.1	10.5	89.5	9.42	
	#4	253.6	26.0	74.0	4.70	
	#10	494.5	50.7	49.3	1.98	
	#20	599.2	61.5	38.5	0.83	
	#40	653.1	67.0	33.0	0.42	
	#60	754.9	77.4	22.6	0.25	
	#100	821.6	84.3	15.7	0.150	
	#200	867.2	89.0	11.0	0.074	

Sieve Analysis Data for Sample W14-18-255.0



Comments: Silty Sandy Gravel

All data are accurately and completely recorded.

Checked By: JMWimett DCWeekes Date: 11/2/01

Appendix C

Borehole Geophysical Logs

Appendix C

Borehole Geophysical Logs

This appendix contains the borehole geophysical logs obtained from boreholes 299-W14-18 and 299-W15-765. The logs were run and analyzed by MACTEC-ERS. Analyses of the results are included with the logs.

299-W14-18 (C3396)

Log Data Report

Borehole Information:

Borehole: 299-W14-18			Site:	Between TX/TY and T-28 Crib	
Coordinates (Plant)		GWL[1] (ft):	218.5	GWL Date:	10/25/01
North	East	Drill Date	TOC[2] Elevation	Total Depth (ft)	Type
not available	not available	10/01	not available	218.5	cable tool

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Steel (threaded)	1.73	10.75	9.375	0.6875	0	69.0
Steel (threaded)	4.1	8.625	7.625	0.5	0	260.0

Borehole Notes:

The casing depth information provided above is derived from personal communication with the Bechtel Hanford Incorporated site representative. The casing size information is confirmed fromtape and caliper measurements collected in the field by MACTEC-ERS personnel. Logging measurements are referenced to ground surface. The groundwater depth is determined from moisture logging measurements.

Logging Equipment Information:

Logging System:	Gamma 2B		Type: SGLS (35%)
Calibration Date:	09/00	Calibration Reference:	GJO-2001-245-TAR
		Logging Procedure:	MAC-HGLP 1.6.5

Logging System:	RLS-1		Type: RLS (70%)
Calibration Date:	10/00	Calibration Reference:	RLSG07000S00.0
		Logging Procedure:	MAC-HGLP 1.6.5

Logging System:	RLS-1		Type: Moisture
Calibration Date:	07/01	Calibration Reference:	RLSM00.0 (Randall 2001)
		Logging Procedure:	MAC-HGLP 1.6.5

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1				
Date	09/25/01				
Logging Engineer	Spatz				
Start Depth	0.0				
Finish Depth	70.0				
Count Time (sec)	200				
Live/Real	R				
Shield (Y/N)	N				

Log Run	1				
MSA Interval (ft)	1.0				
ft/min	n/a[3]				
Pre-Verification	B0058CAB				
Start File	B0058000				
Finish File	B0058070				
Post-Verification	None				

Radionuclide Logging System (RLS) Spectral Gamma Log Run Information:

Log Run	4	5	6 (Repeat)		
Date	10/24/01	10/25/01	10/25/01		
Logging Engineer	Spatz	Spatz	Spatz		
Start Depth	256.0	68.0	119.0		
Finish Depth	119.0	119.0	83.0		
Count Time (sec)	100	100	100		
Live/Real	R	R	R		
Shield (Y/N)	N	N	N		
MSA Interval (ft)	1.0	1.0	1.0		
ft/min	n/a	n/a	n/a		
Pre-Verification	B0611CAB	B0621CAB	B0621CAB		
Start File	B0611000	B0621000	B0621052		
Finish File	B0611137	B0621051	B0621088		
Post-Verification	B0611CAA	B0621CAA	B0621CAA		

Radionuclide Logging System (RLS) Moisture Log Run Information:

Log Run	2	3 (Repeat)	7	8 (Repeat)	
Date	10/03/01	10/03/01	10/25/01	10/25/01	
Logging Engineer	Spatz	Spatz	Spatz	Spatz	
Start Depth	0.0	69.25	68.0	100.25	
Finish Depth	69.25	60.0	218.5	83.0	
Count Time (sec)	n/a	n/a	n/a	n/a	
Live/Real	n/a	n/a	n/a	n/a	
Shield (Y/N)	N	N	N	N	
Data Interval (ft)	0.25	0.25	0.25	0.25	
ft/min	1.0	1.0	1.0	1.0	
Pre-Verification	C0222CAB	C0222CAB	C0252CAB	C0252CAB	
Start File	C0222000	C0222278	C0252000	CR252000	
Finish File	C0222277	C0222315	C0252602	C0252069	
Post-Verification	C0222CAA	C0222CAA	CR252CAA	CR252CAA	

Logging Operation Notes:

Spectral gamma logging using the SGLS and RLS and moisture logging using the RLS were performed in this borehole during September and October 2001 on four separate days. The logging occurred inside two different casing configurations as the borehole was drilled. A longer count time (200 sec) than usual (100 sec) was required with the SGLS because of the relatively thick casing. Because the RLS employs a detector with greater efficiency than the SGLS (70% versus 35%), logging with the RLS was conducted at 100 sec. Data repeat sections for each logging system were collected to measure their performance.

Analysis Notes:

Analyst:	Henwood	Date:	11/06/01	Reference:	MAC-VZCP 1.7.9 Rev. 2

Only a pre-run verification of the SGLS was performed for log run 1 on 09/25/01. A mechanical problem, unrelated to tool performance, disabled the logging system and precluded collection of a post-run verification spectrum. Acceptance criteria for the pre-run verification spectrum were met and this spectrum was used for the energy and resolution calibration for the data processing.

No verification criteria have been established for the RLS spectral gamma measurements. RLS pre- and post-run measurements generally indicate consistent performance of the system during log run 4 on October 24. A significant difference is apparent for peak resolution between the pre- and post-run measurements for log runs 5 and 6 on October 25. The poor resolution in the post-run spectrum appears to be caused by significant gain drift during spectrum collection where peak broadening is exhibited. Gain drift is usually gradual, occurring throughout a log run, and does not change rapidly enough to affect an individual spectrum using normal counting times. This gradual drift can be corrected during data processing by performing peak energy calibrations on individual spectra. Review of spectral data in this borehole indicates the gain drift is unpredictable and can occur within a time period of 100 sec. Radionuclide concentrations in a spectrum where significant drift occurs during the 100-sec collection time cannot be properly quantified using routine processing and the reported concentrations may be low.

Verification measurements were also collected for the RLS moisture system. Acceptance criteria have not yet been established for this logging system. However, the pre- and post-run total count rate measurements agree within about 5%, suggesting the logging system was operating properly during data collection.

Each spectrum collected during a log run was processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with EXCEL using an efficiency function and corrections for casing and water as appropriate. Calibration data used to calculate radionuclide concentrations are available for the RLS spectral gamma measurements. However, no dead time, casing, or water corrections are available. Therefore, corrections derived for the SGLS were applied to the RLS data. The ^{214}Bi peak at 1764 keV was used to determine the naturally occurring ^{238}U concentrations rather than the ^{214}Bi peak at 609 keV. The higher energy 1764-keV energy peak exhibits slightly better count rates than the 609-keV peak because of less gamma attenuation caused by the relatively thick casing in this borehole.

For the neutron moisture logs, calibration functions are available for 6-in. and 8-in.-diameter boreholes with conventional ASTM schedule-40 steel casing. The calibration function converts total neutron count rate to volume percent moisture content. Neutron moisture data from the interval between 0 and 69 ft (10-in. casing) were collected. Borehole size has a significant influence on the neutron count rates and the calibration. Calculations for percent moisture are therefore not accurate for this interval. For this reason and because the moisture profile for the interval is featureless, the data were not presented in log plots. Neutron moisture data from the interval between about 68 and 218.5 ft (8-in. casing) were analyzed using the calibration function for an 8-in. borehole. A correction factor developed from data provided by Meisner, Price, and Randall (WHC-SD-EN-TI-306) was applied to the data in the 8-in. interval to account for the 0.5-in. casing thickness. This factor increased the calculated moisture content by approximately 17 percent.

Repeat log plots at selected depth intervals for spectral gamma concentrations and neutron moisture measurements were evaluated. The spectral gamma plots generally indicate good agreement between successive log runs, demonstrating repeatability in both depth and concentration measurement. Gain drift in individual spectra may have caused peak broadening resulting in an under-estimation of concentrations. In the repeat interval from83 to 119 ft, it is apparent that this occurs, particularly in the interval from 83 to 95 ft where the repeat data indicate higher concentrations than in the previous log run. The total gamma data collected from the same log runs indicate excellent repeatability, suggesting the tool is functioning

properly but that the counts are not being attributed to the proper energy level. The moisture plots indicate good agreement.

Log Plot Notes:

Separate log plots are provided for the man-made radionuclides (^{137}Cs, ^{154}Eu, ^{152}Eu, and ^{60}Co), naturally occurring radionuclides (^{40}K, ^{232}Th, ^{238}U [KUT]), a combination of man-made, KUT, total gamma and moisture, total gamma plotted with dead time, and repeat section plots for spectral gamma and moisture measurements. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, casing corrections, or water corrections. These errors are discussed in the calibration report.

Results and Interpretations:

The man-made radionuclides detected in this borehole were ^{137}Cs, ^{152}Eu, ^{154}Eu, and ^{60}Co. ^{137}Cs is detected near the ground surface and at about 35 ft with a high concentration of about 50 pCi/g. ^{60}Co is also detected at about 35 ft in depth. $^{154/152}$Eu is detected in two distinct intervals from about 35 to 65 ft and from 85 to 98 ft; the maximum concentration of ^{154}Eu is about 100 pCi/g in both intervals. No man-made gamma-emitting radionuclides were detected below 100 ft.

The KUT logs indicate a lithology change at about 34 ft that coincides with the depth that significant man-made radionuclide contamination is observed. A second interval of man-made contamination is observed at a depth of about 87 ft that coincides with the bottom of the Hanford formation and the top of the carbonate-rich paleosols of the Pliocene-Pleistocene that are interpreted as lying between 88 and 112 ft. A caliche layer with characteristically high naturally occurring ^{238}U and ^{40}K concentrations is indicated at about 110 ft. The interval between 90 and 98 ft is interpreted, on the basis of relatively high ^{232}Th concentrations, to consist of the early Palouse soil, a silty sand to sandy silt. The combined carbonate-rich soils and the early Palouse soils separate the Ringold formation (112 ft) from the Hanford formation that ends at about 89 ft. The top of the early Palouse appears to retard the downward movement of the contamination.

The elevated naturally occurring ^{238}U concentrations measured during log run 1 from 0-69 ft relative to the ^{238}U concentrations in the remainder of the borehole are attributed to elevated radon (^{222}Rn) concentrations. ^{238}U is actually determined from the ^{214}Bi peak, which is also a short-term daughter of ^{222}Rn. The ^{222}Rn had dissipated from the borehole prior to the subsequent logging runs.

Relatively higher moisture content appears to exist in the interval from 87 to 112 ft. This depth interval coincides with the Pliocene-Pleistocene unit discussed above. The highest moisture content occurs at the top of this unit and in the two caliche layers at about 97 and 109 ft in depth. Another interval between about 188 and 195 ft exhibits slightly elevated moisture but cannot be correlated with any obvious lithologic unit. The moisture log indicates water is encountered at about 218.5 ft.

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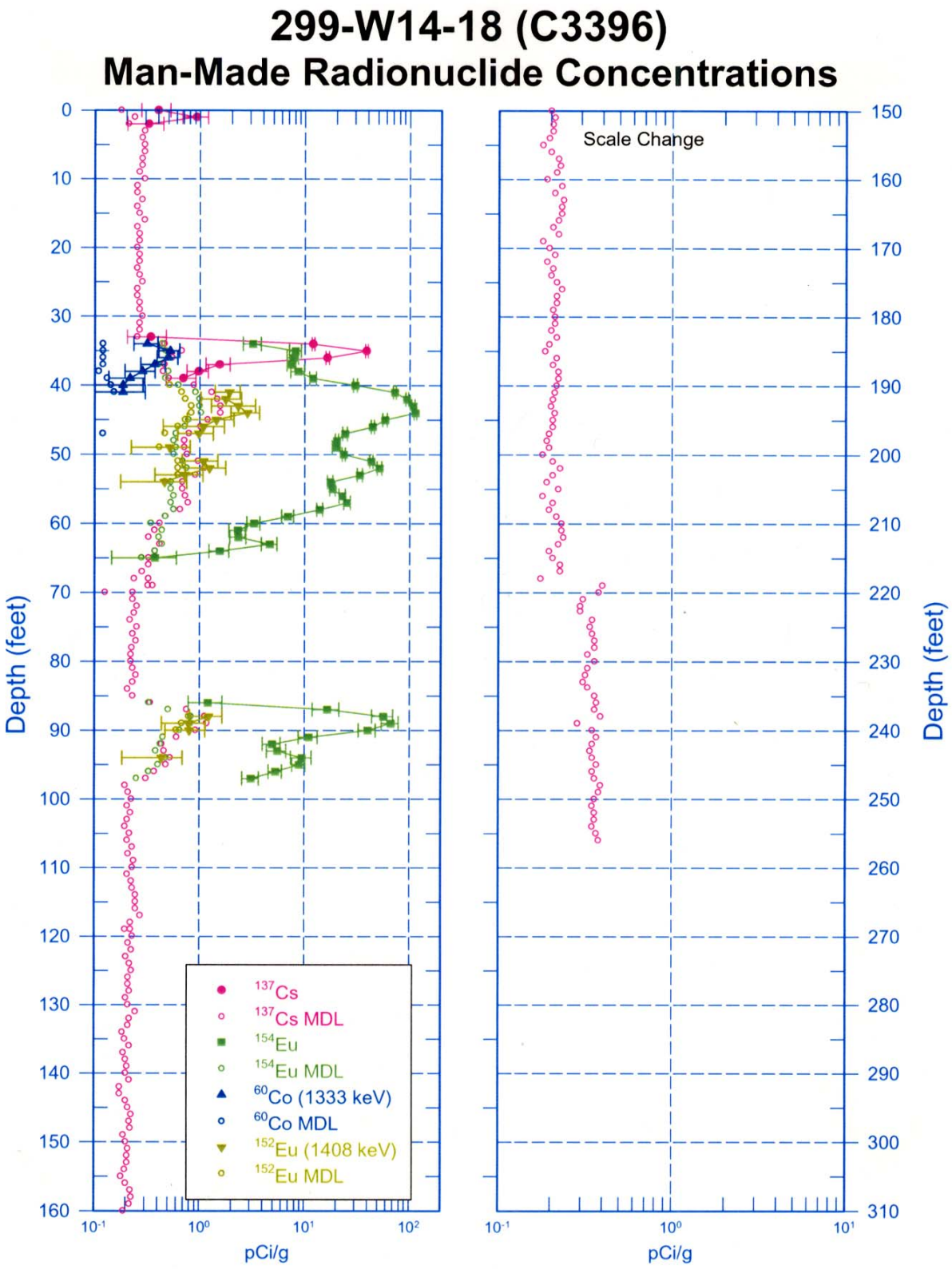
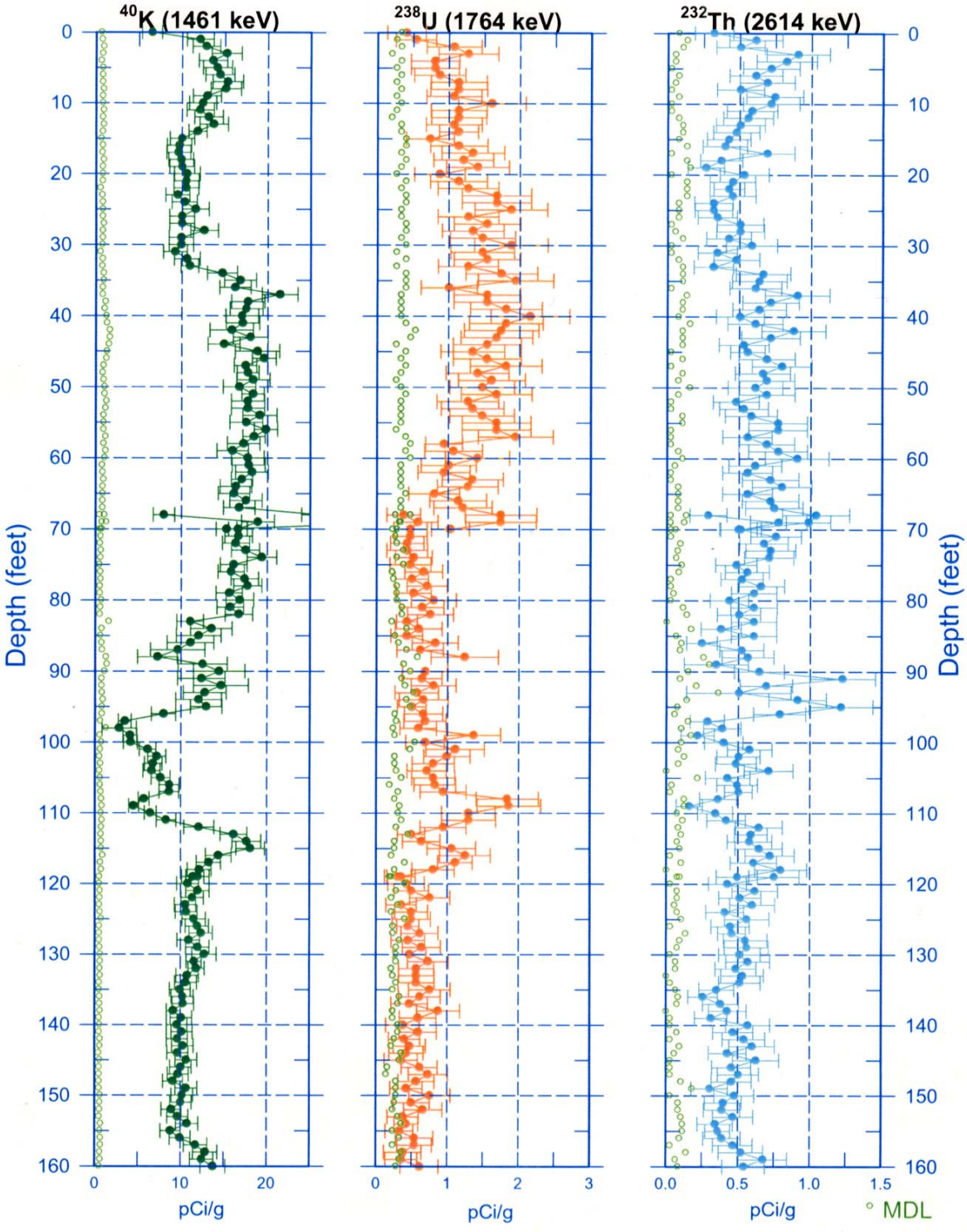
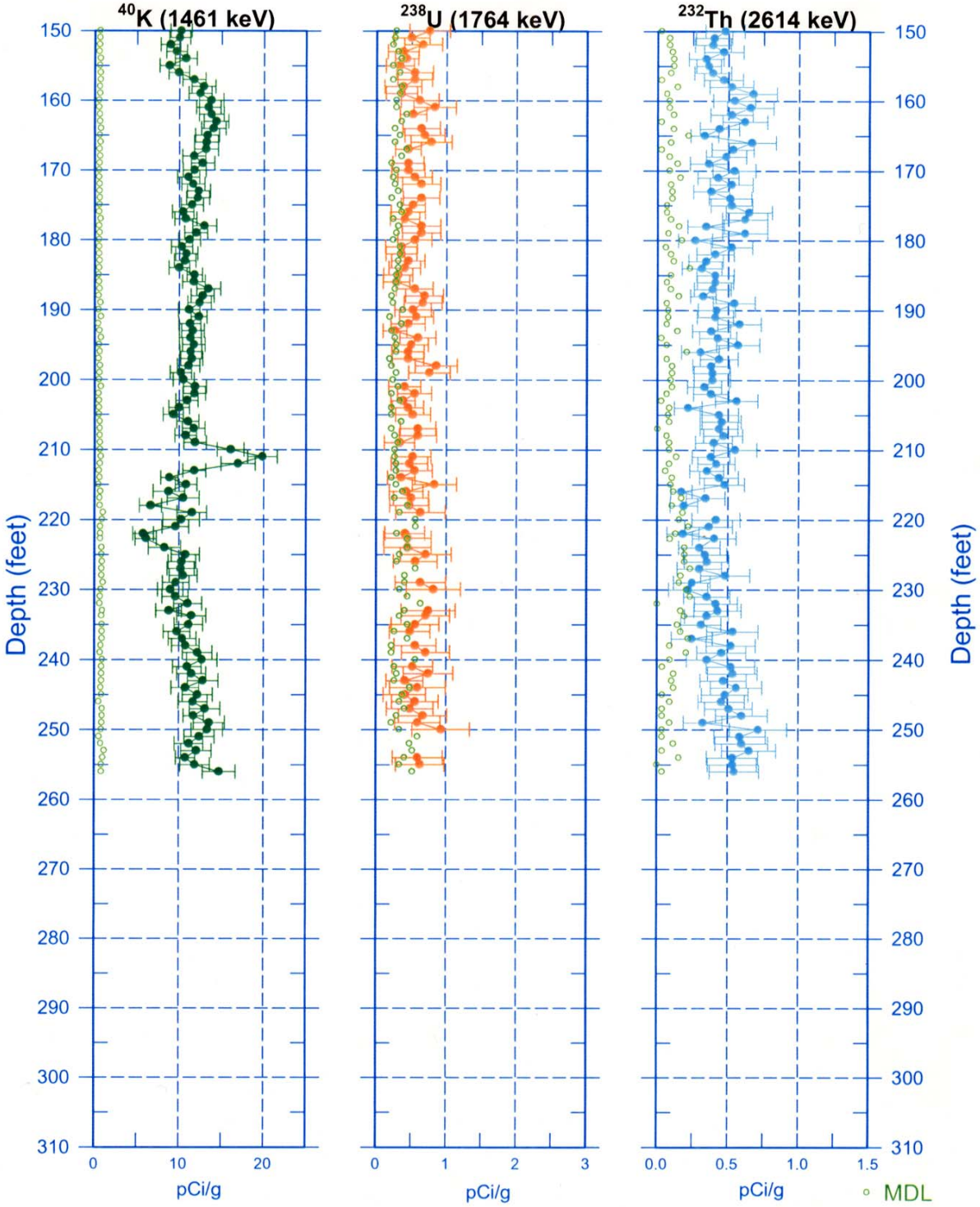
[1] GWL – groundwater level
[2] TOC – top of casing
[3] n/a – not applicable

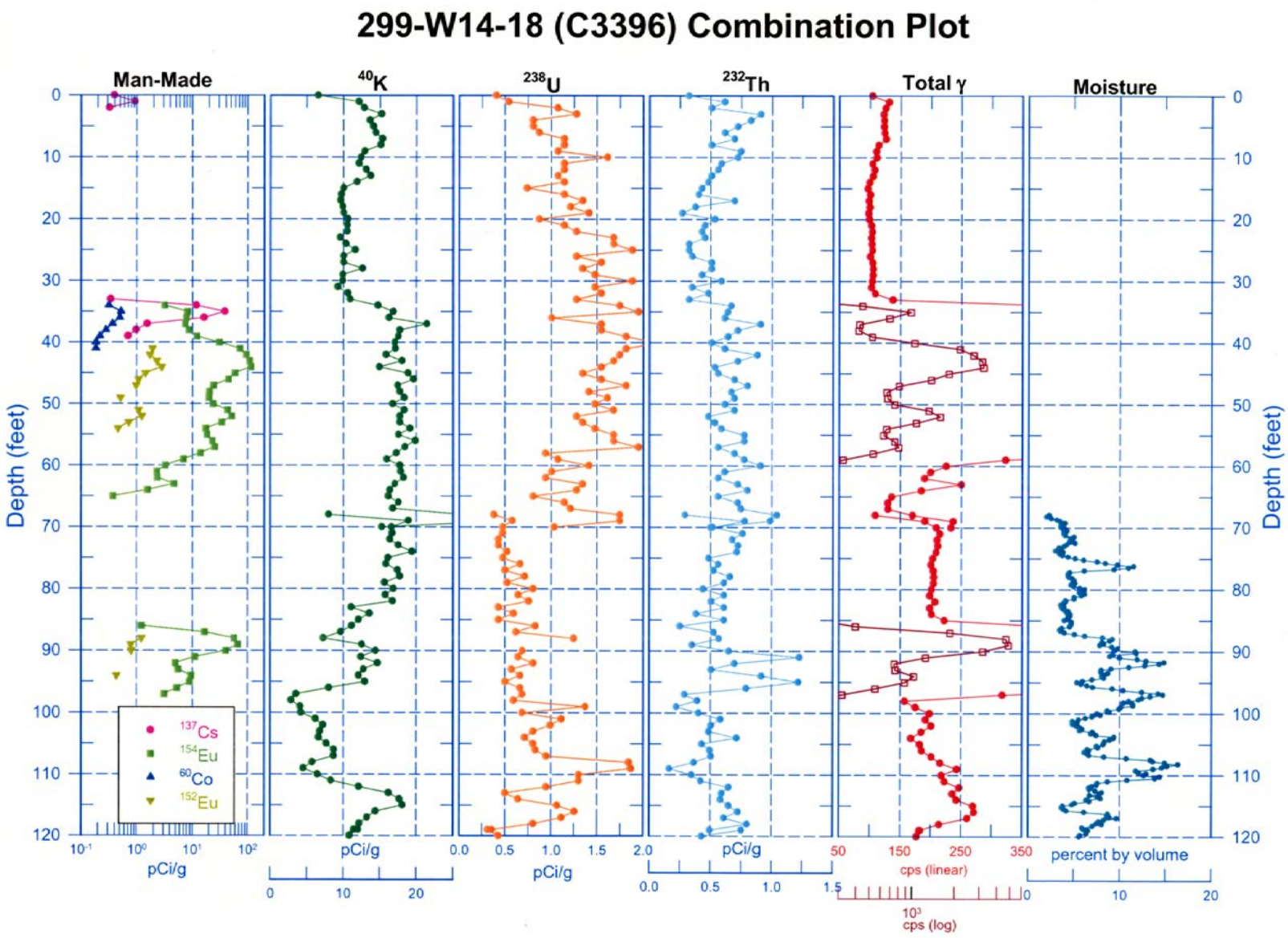

299-W14-18 (C3396)
Man-Made Radionuclide Concentrations
Scale Change
Depth (feet)
Depth (feet)
pCi/g
pCi/g
137Cs
137Cs MDL
154Eu
154Eu MDL
60Co (1333 keV)
60Co MDL
152Eu (1408 keV)
152Eu MDL

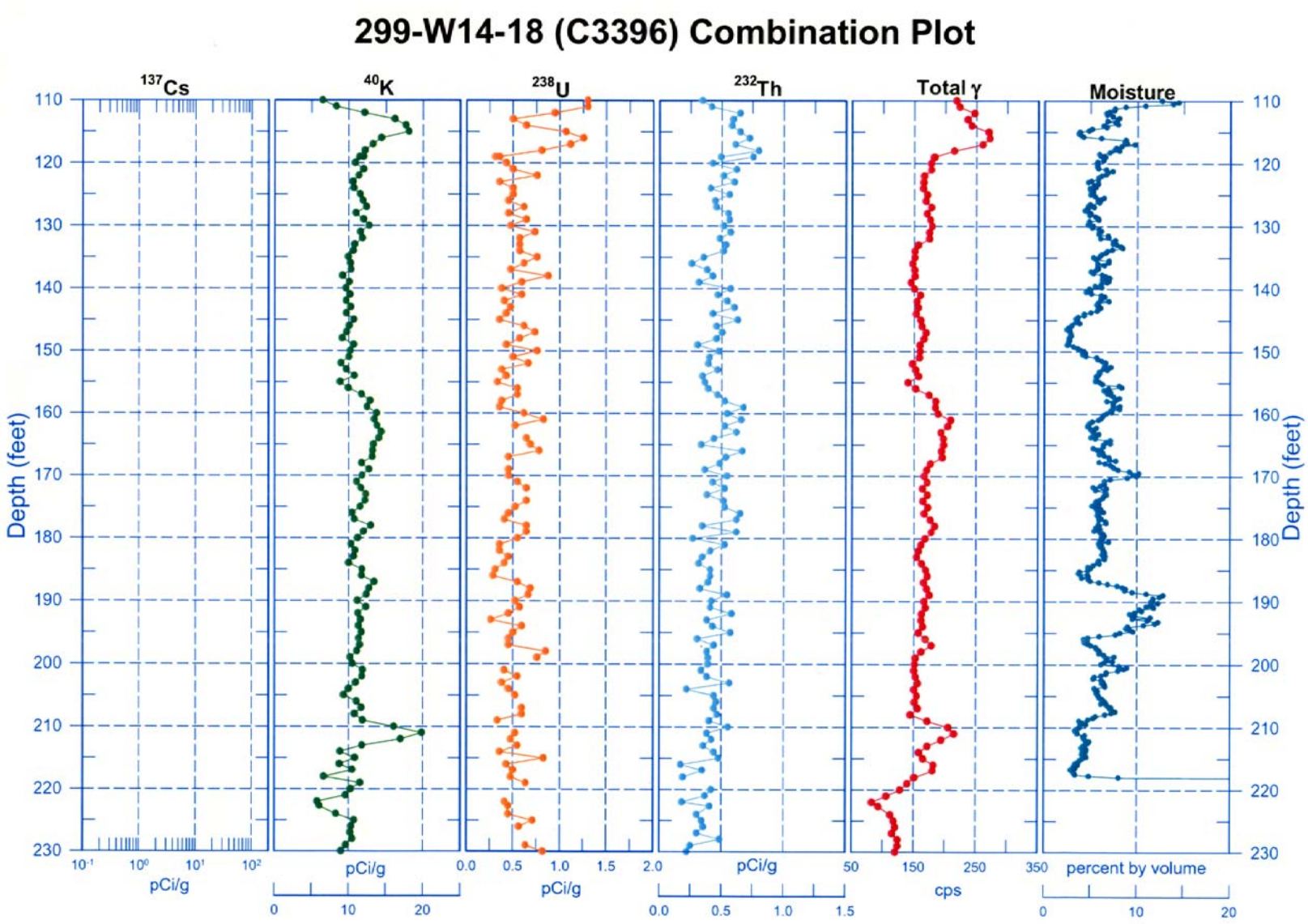
299-W14-18 (C3396)
Natural Gamma Logs

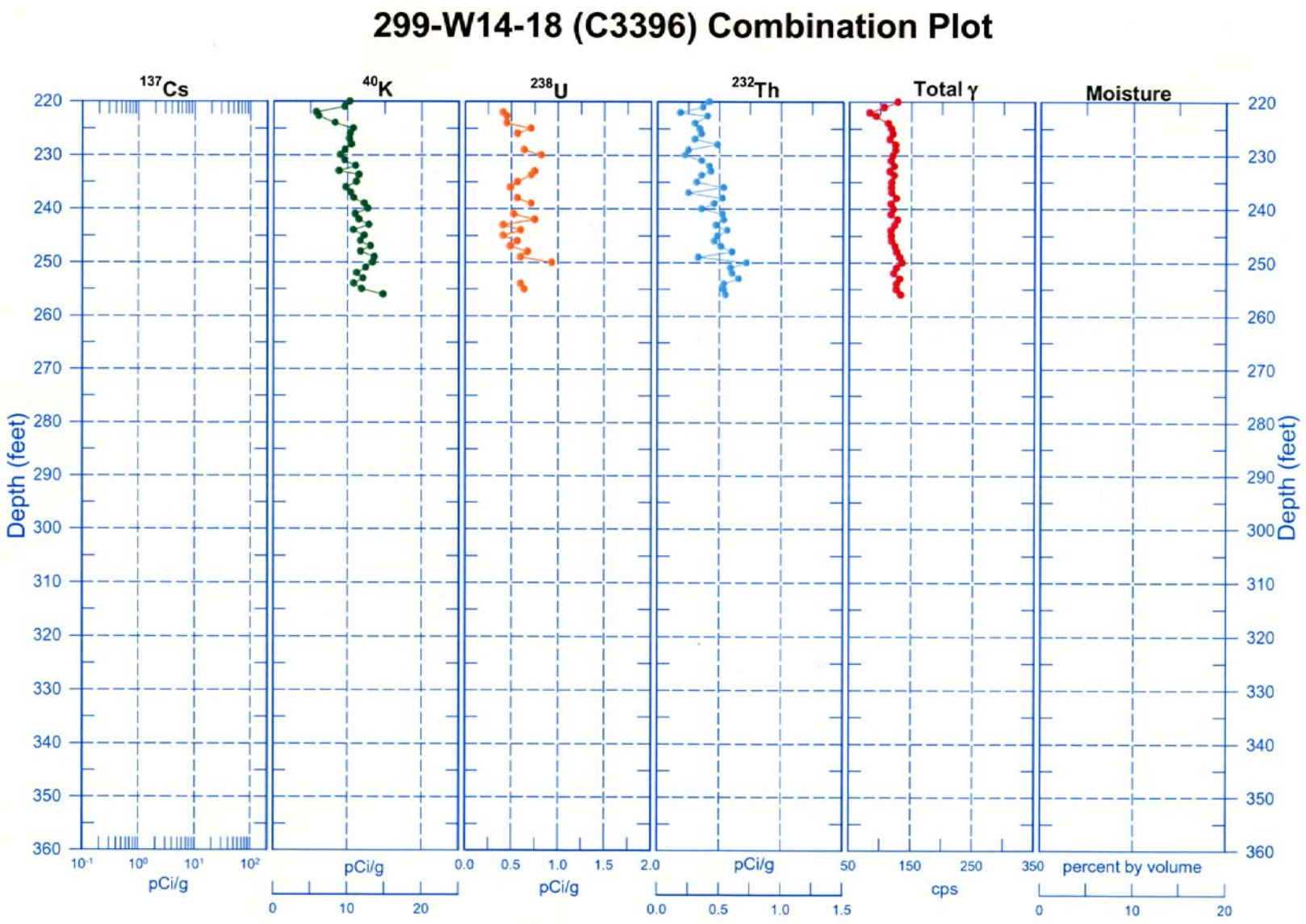


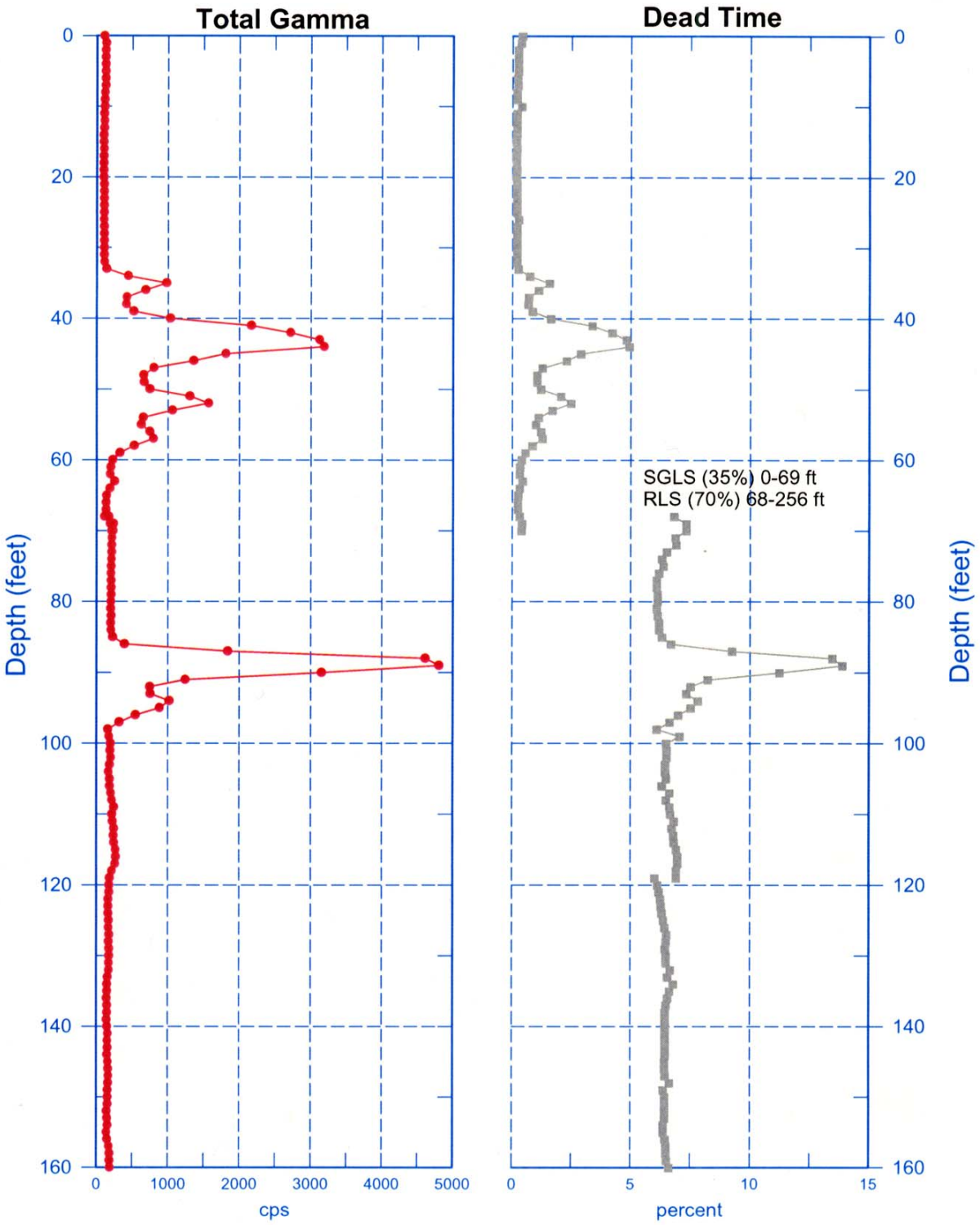
299-W14-18 (C3396)
Natural Gamma Logs

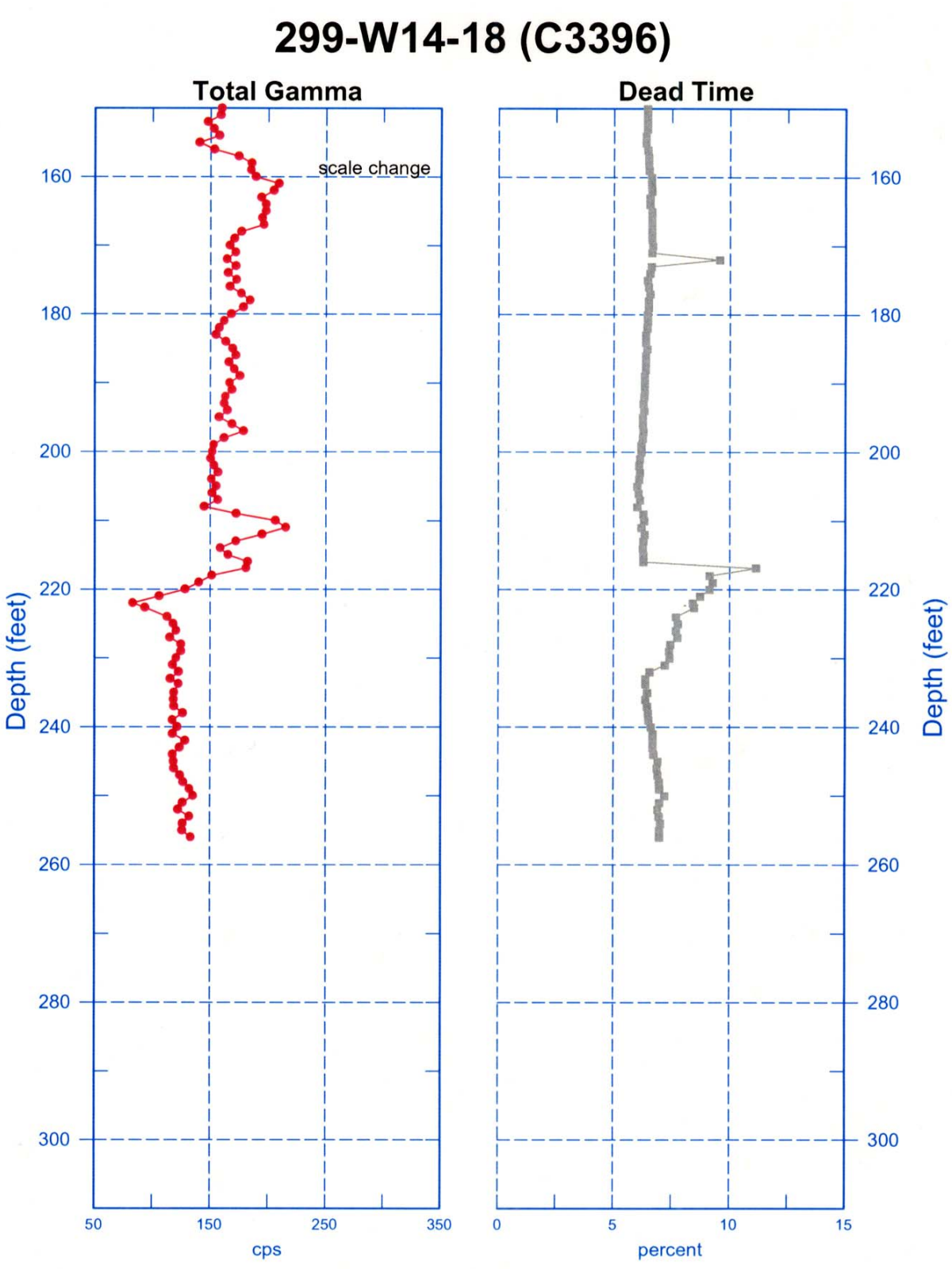



299-W14-18 (C3396) Combination Plot
Man-Made
40K
238U
232Th
Total γ
Moisture
Depth (feet)
137Cs
154Eu
60Co
152Eu
pCi/g
cps (linear)
103 cps (log)
percent by volume

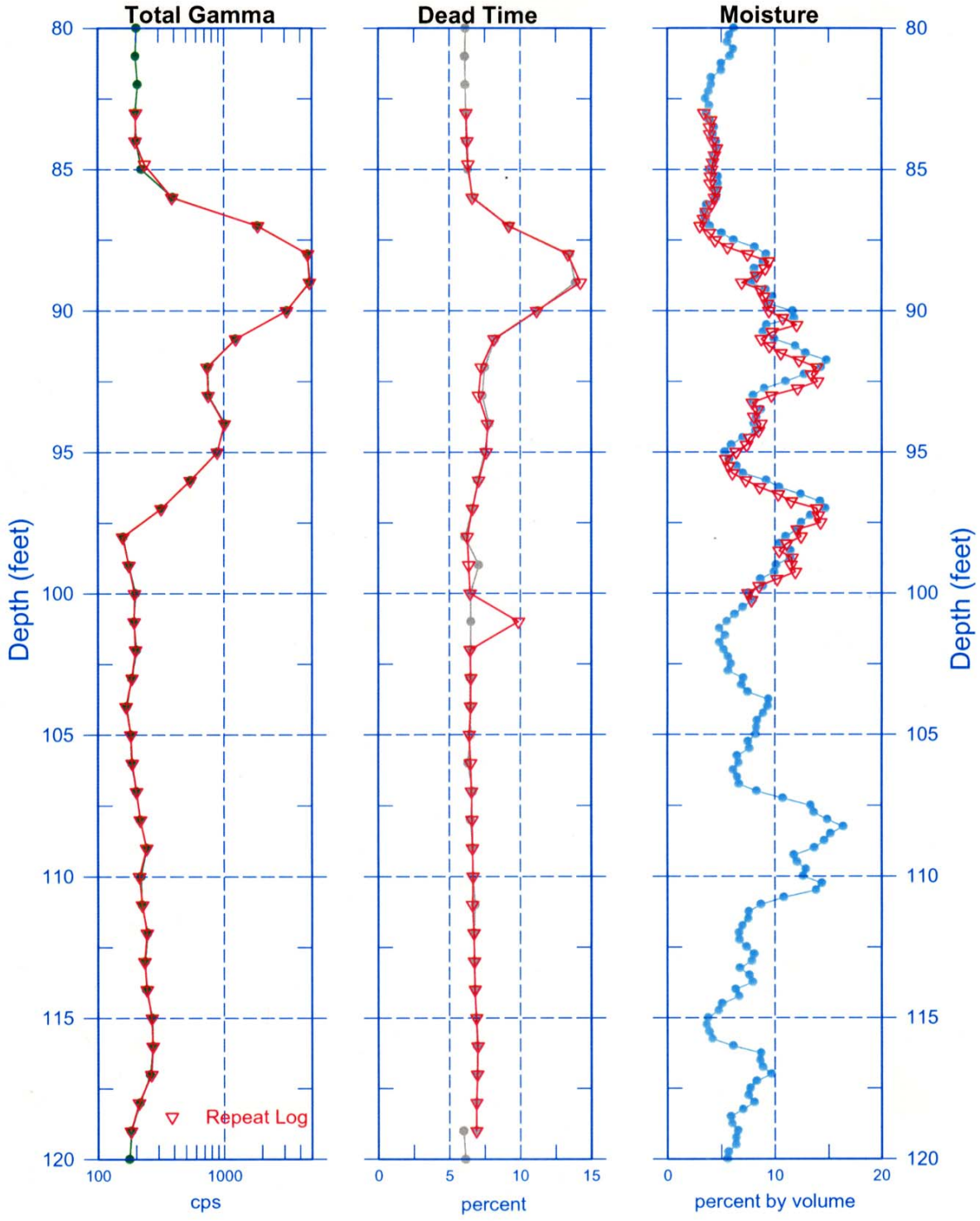

299-W14-18 (C3396) Combination Plot
137Cs
40K
238U
232Th
Total γ
Moisture
Depth (feet)
pCi/g
pCi/g
pCi/g
cps
percent by volume

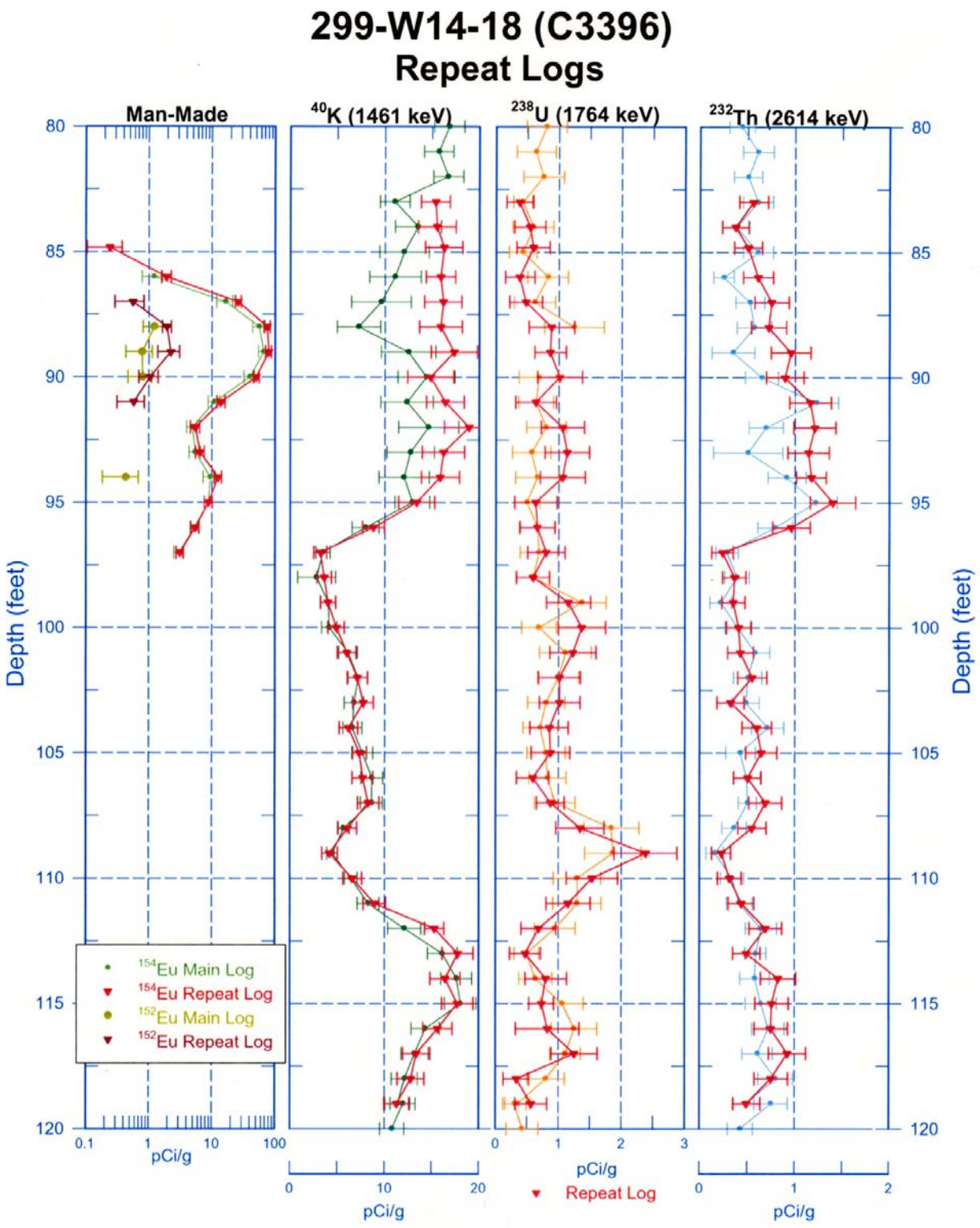

299-W14-18 (C3396) Combination Plot
137Cs
40K
238U
232Th
Total γ
Moisture
Depth (feet)
220
230
240
250
260
270
280
290
300
310
320
330
340
350
360
10-1
100
101
102
pCi/g
0
10
20
pCi/g
0.0
0.5
1.0
1.5
2.0
pCi/g
0.0
0.5
1.0
1.5
50
150
250
350
cps
percent by volume
0
10
20


299-W14-18 (C3396)
Total Gamma
Dead Time
Depth (feet)
0
20
40
60
80
100
120
140
160
0
1000
2000
3000
4000
5000
cps
0
5
10
15
percent
SGLS (35%) 0-69 ft
RLS (70%) 68-256 ft


299-W14-18 (C3396)
Total Gamma
Dead Time
scale change
160
180
200
220
240
260
280
300
Depth (feet)
50
150
250
350
cps
0
5
10
15
percent

299-W14-18 (C3396)
Repeat Logs




299-W14-18 (C3396)
Repeat Logs
Man-Made
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Depth (feet)
154Eu Main Log
154Eu Repeat Log
152Eu Main Log
152Eu Repeat Log
pCi/g
Repeat Log

299-W15-765 (C3397)

Log Data Report

Borehole Information:

Borehole: 299-W15-765 (C3397)		Site: West of TY Tank Farm		
Coordinates (Plant)	GWL (ft)[1]: 220.2		GWL Date: 9/27/01	
North East	Drill Date	TOC[2] Elevation	Total Depth (ft)	Type
	Sept. 2001	Unknown	265.5	Sonic

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Steel thread	0.2 in.	10 3/4	9 3/8	11/16	0	265.5

Borehole Notes:

The BHI site geologist reported the GWL. According to the driller, casing to 265.5 ft and 0.5 ft of fill inside of casing indicates that the depth to bottom is 265.0 ft. The logging engineer measured the pipe stickup at the borehole using a steel tape. Calipers were used to measure casing outside diameter and inside diameter only. The casing thickness is calculated.

Logging Equipment Information:

Logging System:	Gamma 1D		Type: SGLS (35%)
Calibration Date:	09/00	Calibration Reference:	GJO-2001-243-TAR
		Logging Procedure:	MAC-HGLP 1.6.5

Logging System:	RLS-1		Type: Moisture
Calibration Date:	07/01	Calibration Reference:	RLSM00.0 (Randall 2001)
		Logging Procedure:	MAC-HGLP 1.6.5

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4
Date	09/28/01	09/29/01	09/29/01	
Logging Engineer	Spatz	Spatz	Spatz	
Start Depth (ft)	0.0	266.0	137.0	
Finish Depth (ft)	137.0	138.0	110.0	
Count Time (sec)	200	200	200	
Live/Real	R	R	R	
Shield (Y/N)	N/A[3]	N/A	N/A	
MSA Interval (ft)	1.0	1.0	1.0	
ft/min	N/A	N/A	N/A	
Pre-Verification	A0004CAB	A0004CAB	A0004CAB	
Start File	A0004000	A0004138	A0004267	
Finish File	A0004137	A0004266	A0004294	
Post-Verification	A0004CAA	A0004CAA	A0004CAA	
Depth Return Error (ft)	-0.04	N/A	-0.15	
Comments			Repeat section	

Neutron Moisture Logging System (NMLS) Log Run Information:

Log Run	1	2	3	4
Date	09/28/01	09/28/01	09/28/01	09/28/01
Logging Engineer	Spatz	Spatz	Spatz	Spatz
Start Depth (ft)	0.0	98.0	196.0	122.0
Finish Depth (ft)	100.0	198.0	220.5	100.0
Count Time (sec)	N/A	N/A	N/A	N/A
Live/Real	N/A	N/A	N/A	N/A
Shield (Y/N)	N/A	N/A	N/A	N/A
MSA Interval (ft)	0.25	0.25	0.25	0.25
ft/min	1.0	1.0	1.0	1.0
Pre-Verification	C0202CAB	C0202CAB	C0202CAB	C0202CAB
Start File	C0202000	C0202400	C0202800	C0202899
Finish File	C0202399	C0202799	C0202898	C0202986
Post-Verification	C0202CAA	C0202CAA	C0202CAA	C0202CAA
Depth Return Error (ft)	N/A	N/A	N/A	+0.10
Comments	None	None	None	Repeat section

Logging Operation Notes:

Zero reference is the top of ground surface, and log depths are relative to ground level. Water was detected below 220 ft. During logging, the sonde is centralized in the borehole for both the SGLS and NMLS.

A longer count time (200 sec) was required with the SGLS because of the relatively thick casing. The borehole was logged in the drill pipe before completion as a groundwater monitoring well. In order to obtain reliable spectra while minimizing overall logging time, the depth interval was increased from 0.5 ft to 1.0 ft.

Fine gain adjustments were not necessary during the SGLS logging runs. Log run 1 was terminated to refill the sonde with liquid nitrogen. The neutron log was run on a second logging truck, RLS-1.

Analysis Notes:

Analyst:	Sobczyk	Date:	10/02/01	Reference:	MAC-VZCP 1.7.9 Rev. 2

Pre-run and post-run verification spectra for the SGLS were evaluated. The acceptance criteria for field verification of the Gamma 1D logging system are in the process of being established. Examinations of spectra indicate that the detector appears to have functioned normally during the log run, and the log data are provisionally accepted, subject to further review and analysis.

Individual spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with EXCEL. Corrections were applied for a casing thickness of 11/16 in. from the ground surface to 266 ft. A correction for water in the borehole was applied below 220 ft, and this depth was determined from the neutron-moisture log. Dead time corrections were not necessary. The rerun of the SGLS showed good repeatability.

Pre-run and post-run verification spectra for the neutron tool were evaluated. The pre-survey verification spectrum (file C0202CAB) recorded 755 gross cps while the post-survey verification spectrum (file C0202CAA) recorded 716 gross cps.

Moisture calibration models at Hanford for 10-in. holes with 11/16-in. casing have not been established. Thus, the neutron log was not processed to estimate volumetric moisture content because the relatively large borehole diameter and casing thickness are beyond the range of conditions for which the tool was calibrated. Neutron data are presented as gross counts. In general, an increase in neutron count is indicative of an increase in moisture content, but a quantitative calculation of volumetric moisture cannot be made at

this time. The rerun of the neutron-moisture tool showed good repeatability with the exception that the two runs appear to be off-depth. This apparent discrepancy is due to acquiring data in continuous mode in different directions. During the original log, data was acquired while going deeper into the hole, and the data are shifted upward about 1.5 in. During the repeat logging, data were acquired while coming out of the hole, and the data are shifted downward about 1.5 in. In addition, the repeat log had a depth return error of 0.10 ft.

Log Plot Notes:

Separate log plots are provided for gross gamma, naturally occurring radionuclides (^{40}K, ^{232}Th, ^{238}U, and associated decay progeny), and man-made radionuclides. For each radionuclide, the energy value of the spectral peak used for quantification is indicated. Unless otherwise noted, all radionuclides are plotted in picocuries per gram (pCi/g). The open circles indicate the minimum detectable level (MDL) for each radionuclide. Error bars on each plot represent error associated with counting statistics only and do not include errors associated with the inverse efficiency function, dead time correction, or casing and water corrections. These errors are discussed in the calibration report. A combination plot is also included to facilitate correlation. A gross neutron log of neutron counts is also shown on the combination plot.

Results and Interpretations:

^{137}Cs was the only man-made radionuclide detected. ^{137}Cs activity was detected from the ground surface to a depth of 6.0 ft. The measured ^{137}Cs activity was about 1.1 pCi/g at the ground surface decreasing to about 0.4 pCi/g at a log depth of 6 ft.

The changes in gross gamma counts depend primarily upon changes in ^{40}K activities. The increase in gross gamma counts from about 75 cps to about 110 cps at a log depth of 40 ft corresponds with an increase in apparent ^{40}K activity from about 10 to 17 pCi/g. This increase in total gamma is interpreted as the Hanford H2. The increase in ^{232}Th activity from about 0.5 to 0.8 pCi/g and the increase in gross gamma counts from 110 to 135 cps at 93 ft are tentatively picked to represent the top of the Early Palouse Soil. On the basis of low K-40 activities, the carbonate-rich paleosols of the Pliocene-Pleistocene are interpreted as being between 101 and 115 ft. The caliche layer with characteristically high uranium content (greater than 2.0 pCi/g) is present between 111 and 113 ft.

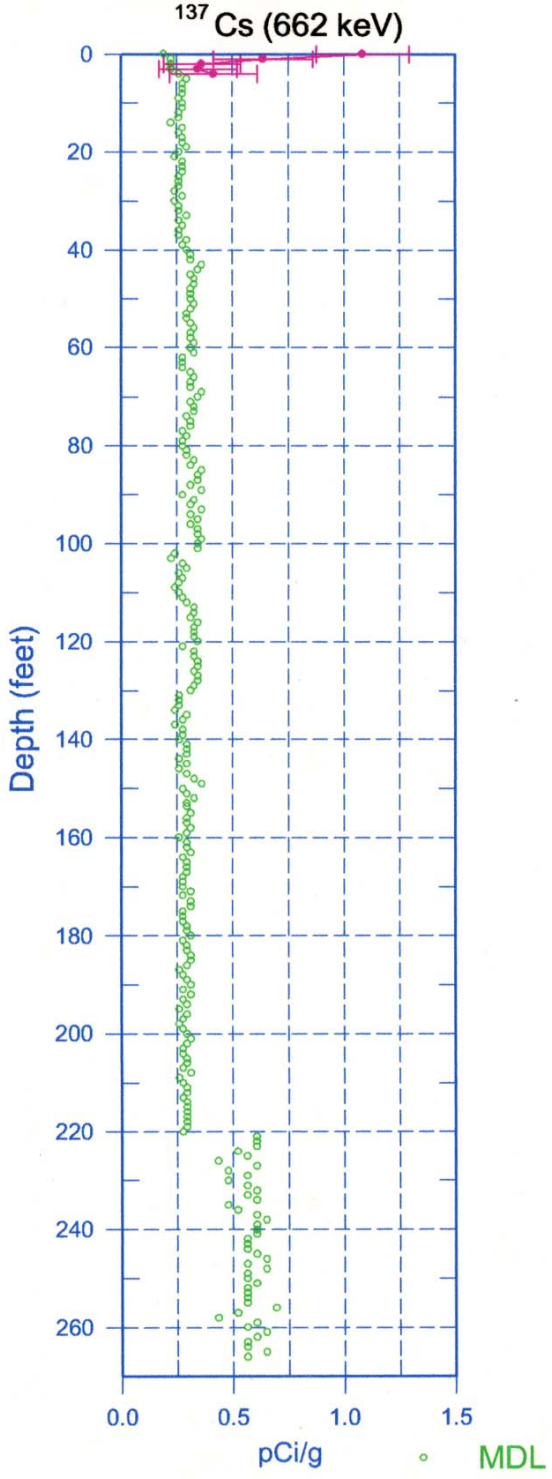
Below 220 ft, the apparent increase in ^{238}U activity based on 609-keV spectral line of about 1.0 pCi/g is greater than the apparent increase in ^{238}U activity based on 1764-keV line of about ¼ pCi/g. This apparent increase in ^{238}U at groundwater may be the result of dissolved radon (^{222}Rn) in the water, an incorrect water correction factor, or a combination of both. The apparent concentration based on the 609-keV peak appears to increase more than that based on the 1764-keV peak, because the water correction factor decreases with increasing energy level. If the source of the gamma photons is within the water, then there is less attenuation than would be expected, and the effect of the water correction is an apparent increase in the calculated concentration. Alternatively, the water correction factor may be too high, resulting in the apparent increase. At this time, the apparent increase in ^{238}U at groundwater is under review, and the water correction will be changed if necessary.

The neutron moisture tool's depressed response in this hole is due at least in part to the low-activity source, short source-to-detector spacing, and large borehole diameter. The highest neutron counts occurred in the groundwater as expected. The higher neutron counts that occurred in the 93- to 115-ft interval correspond with the Plio-Pleistocene as interpreted from the SGLS data.

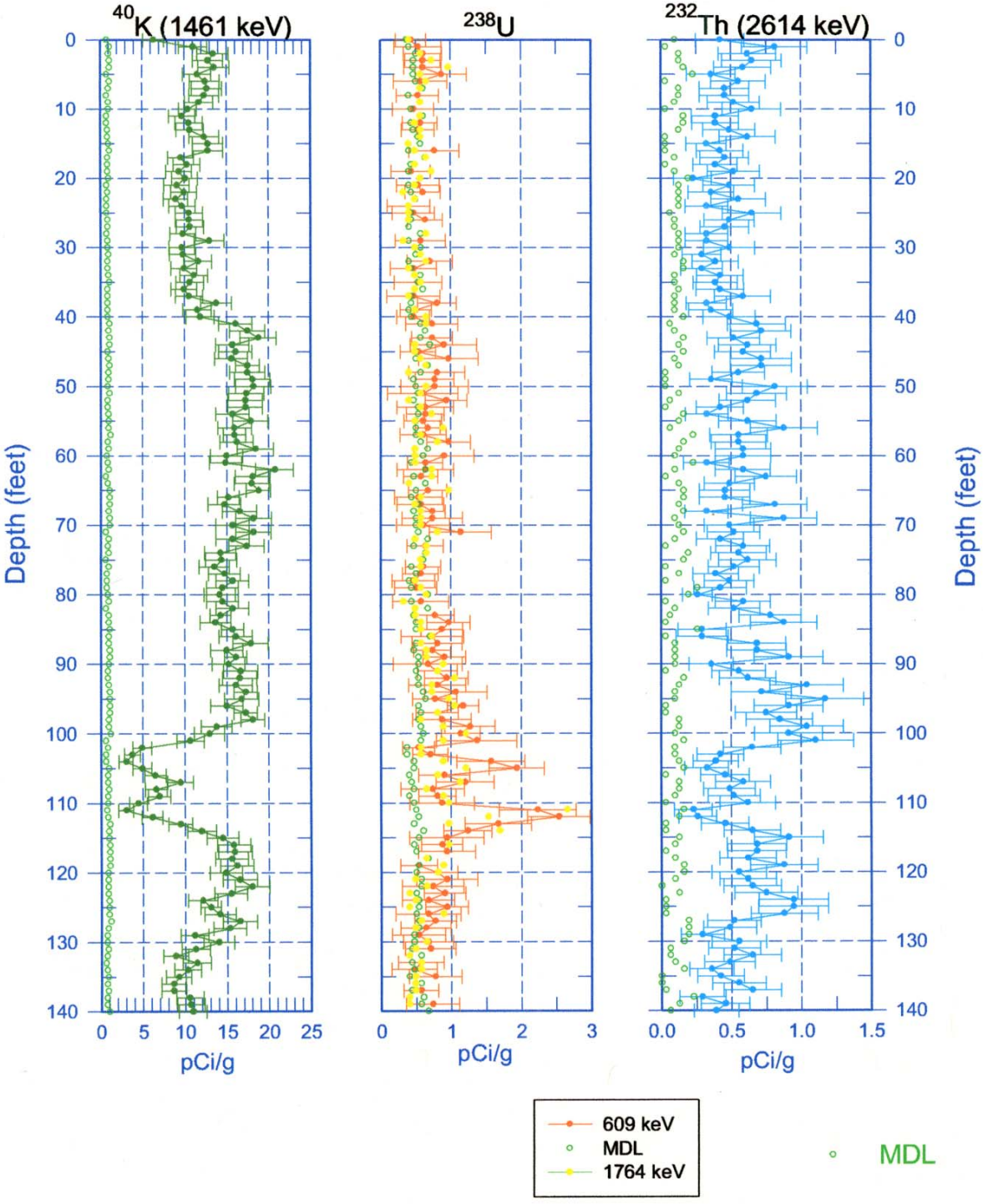
Reference: Randall, R., 2001. *Certificate of Calibration RLSM00.0*, July 11, 2001, Three Rivers Scientific, Richland, WA.

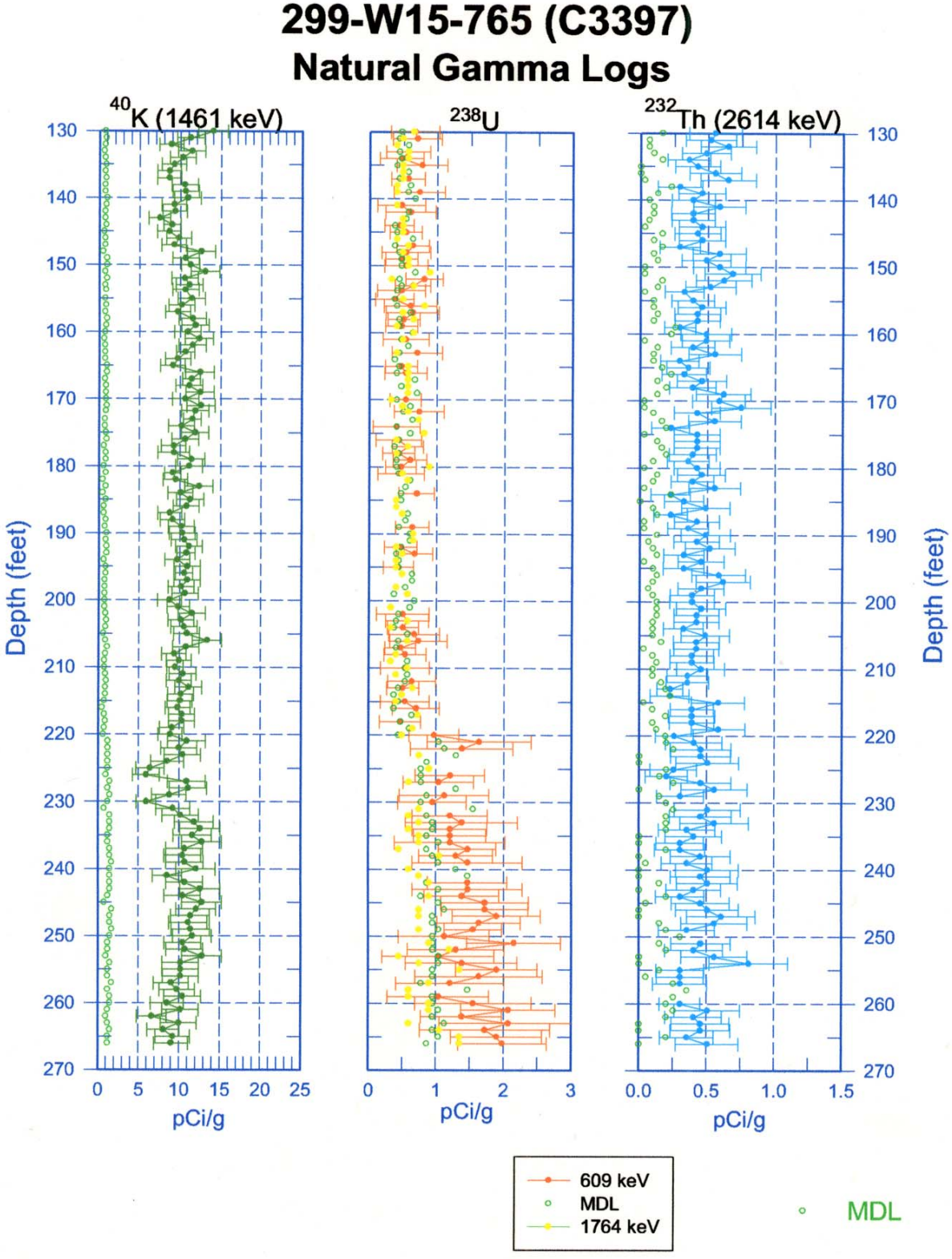
[1] GWL – groundwater level
[2] TOC – top of casing
[3] N/A – not applicable

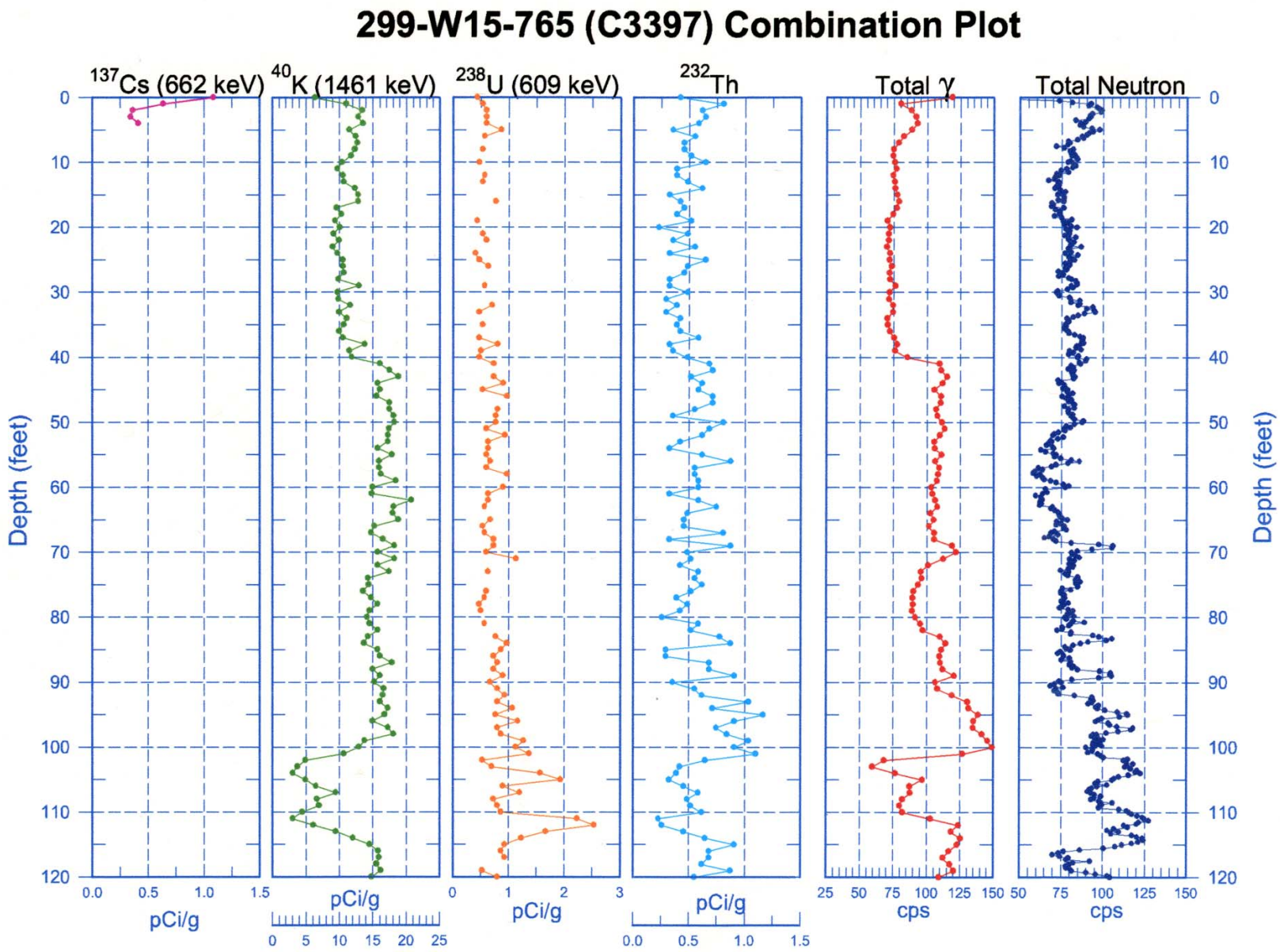
299-W15-765 (C3397)
Man-Made Radionuclide Concentrations

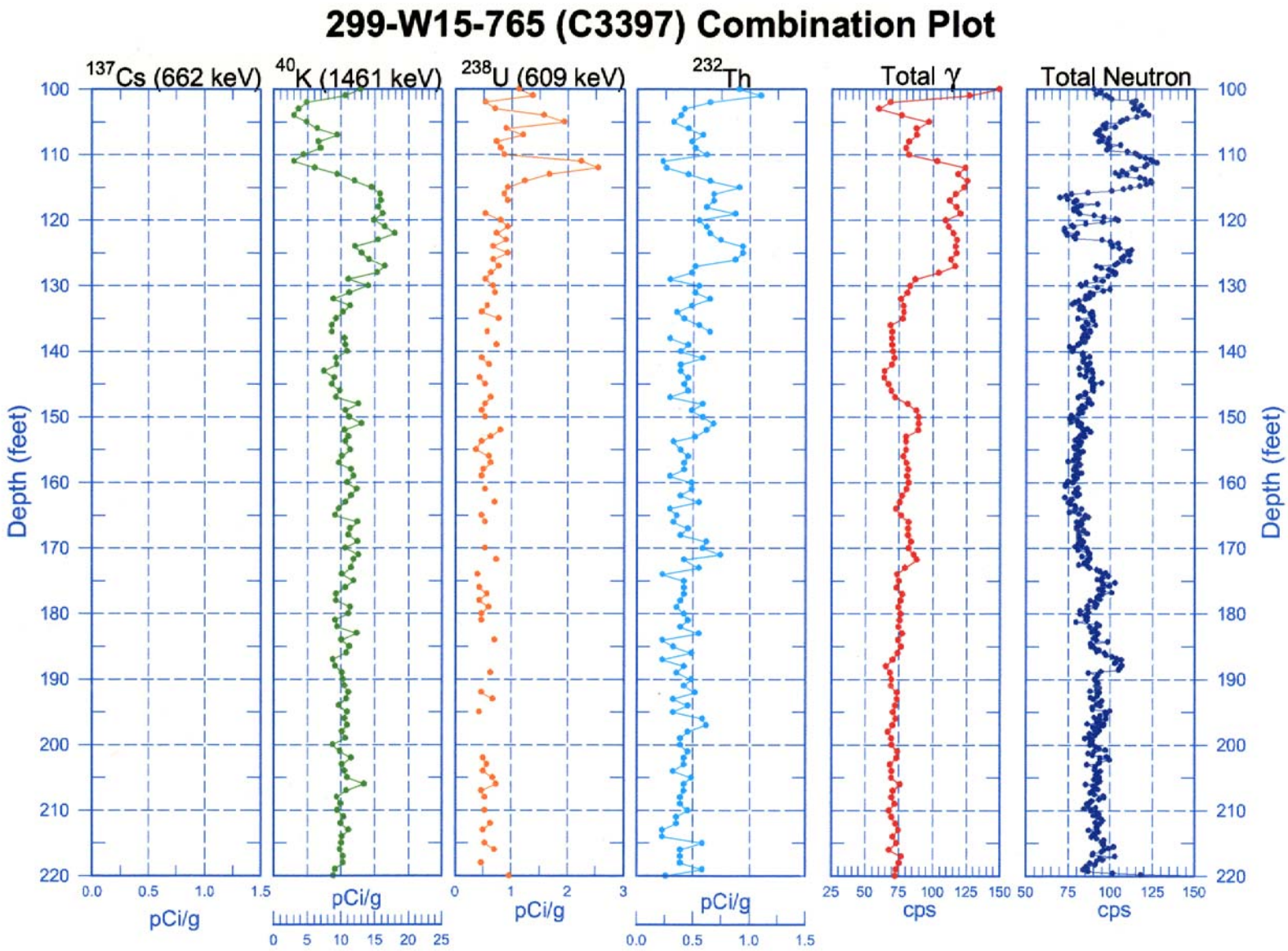


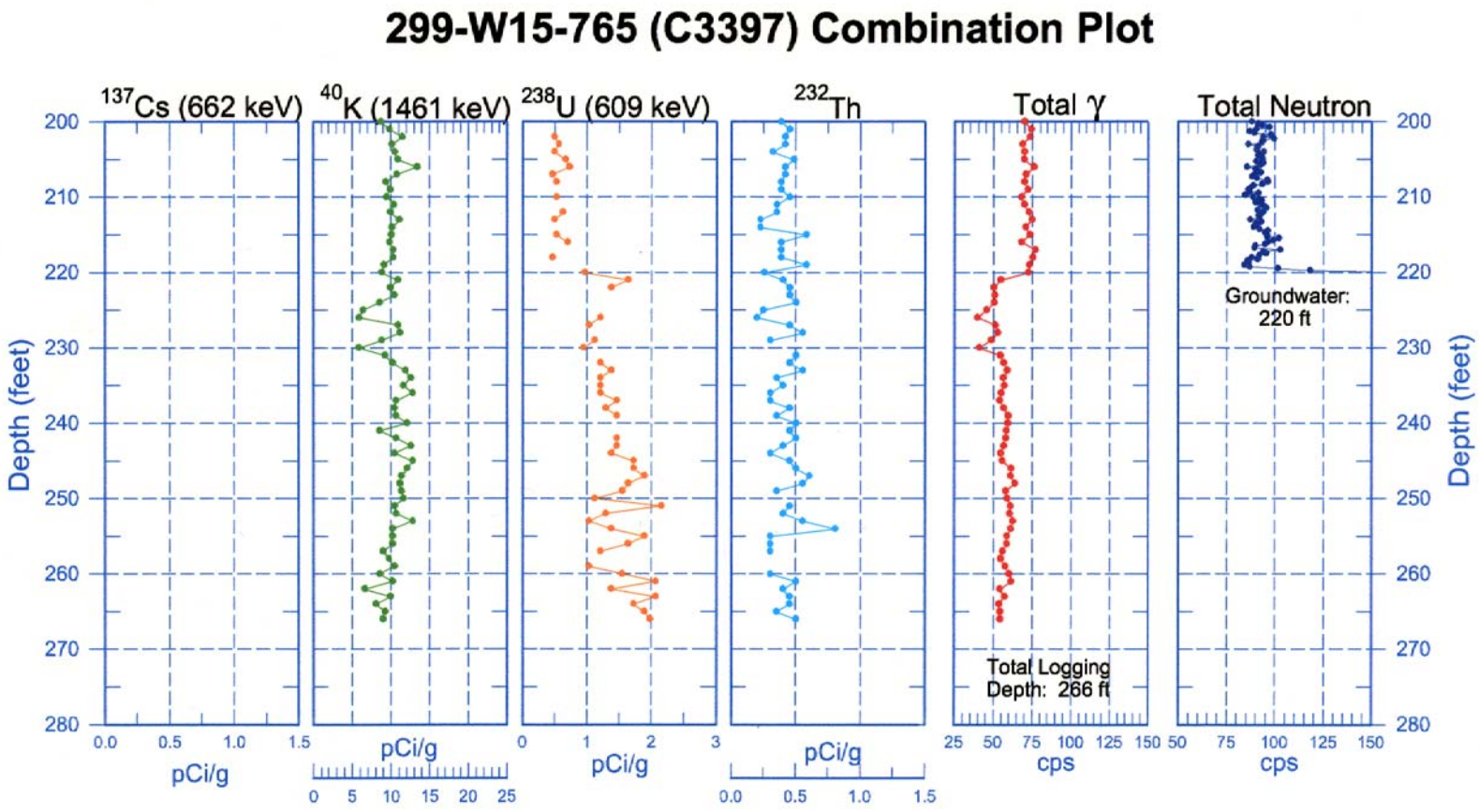
299-W15-765 (C3397)
Natural Gamma Logs

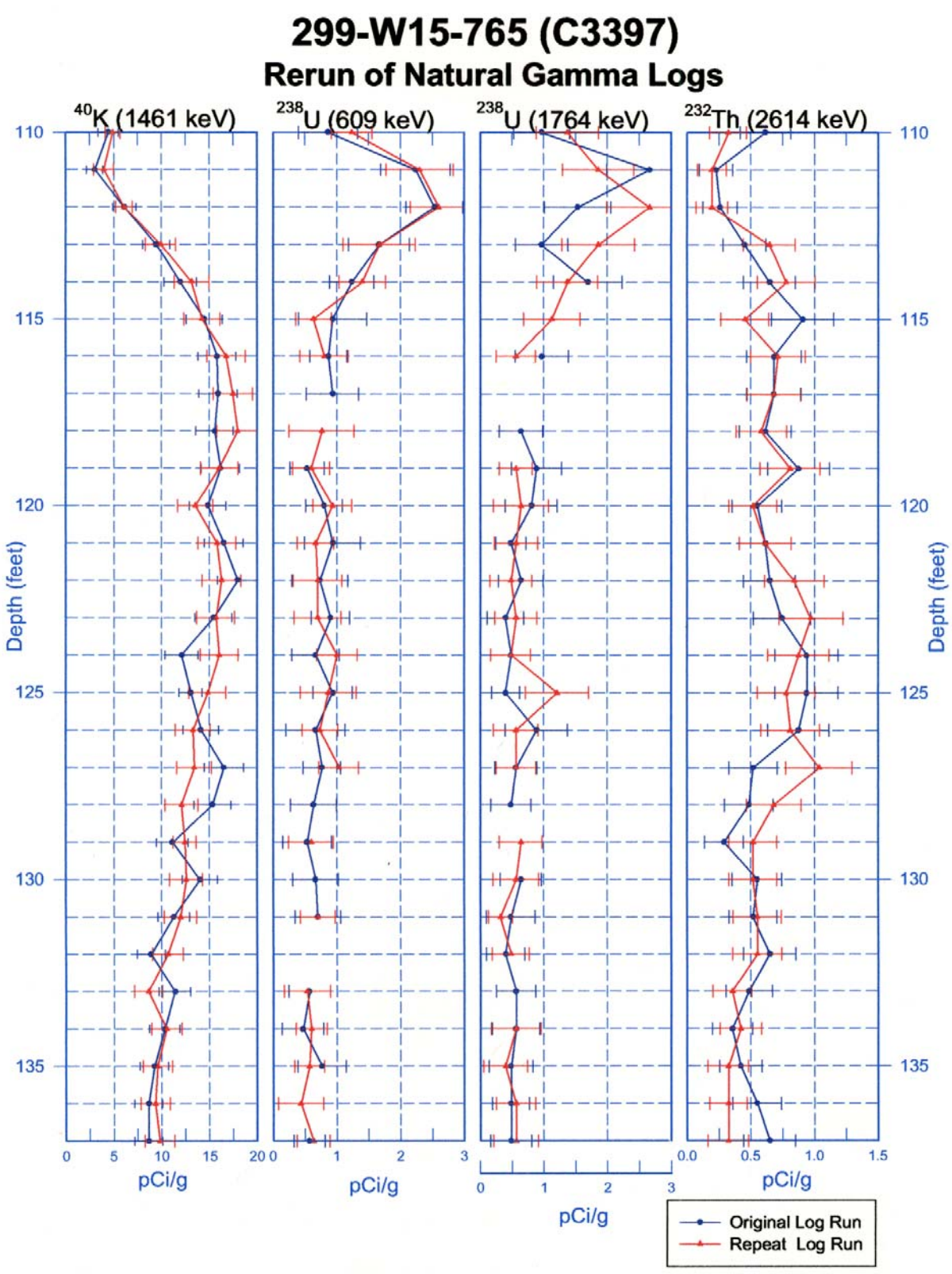


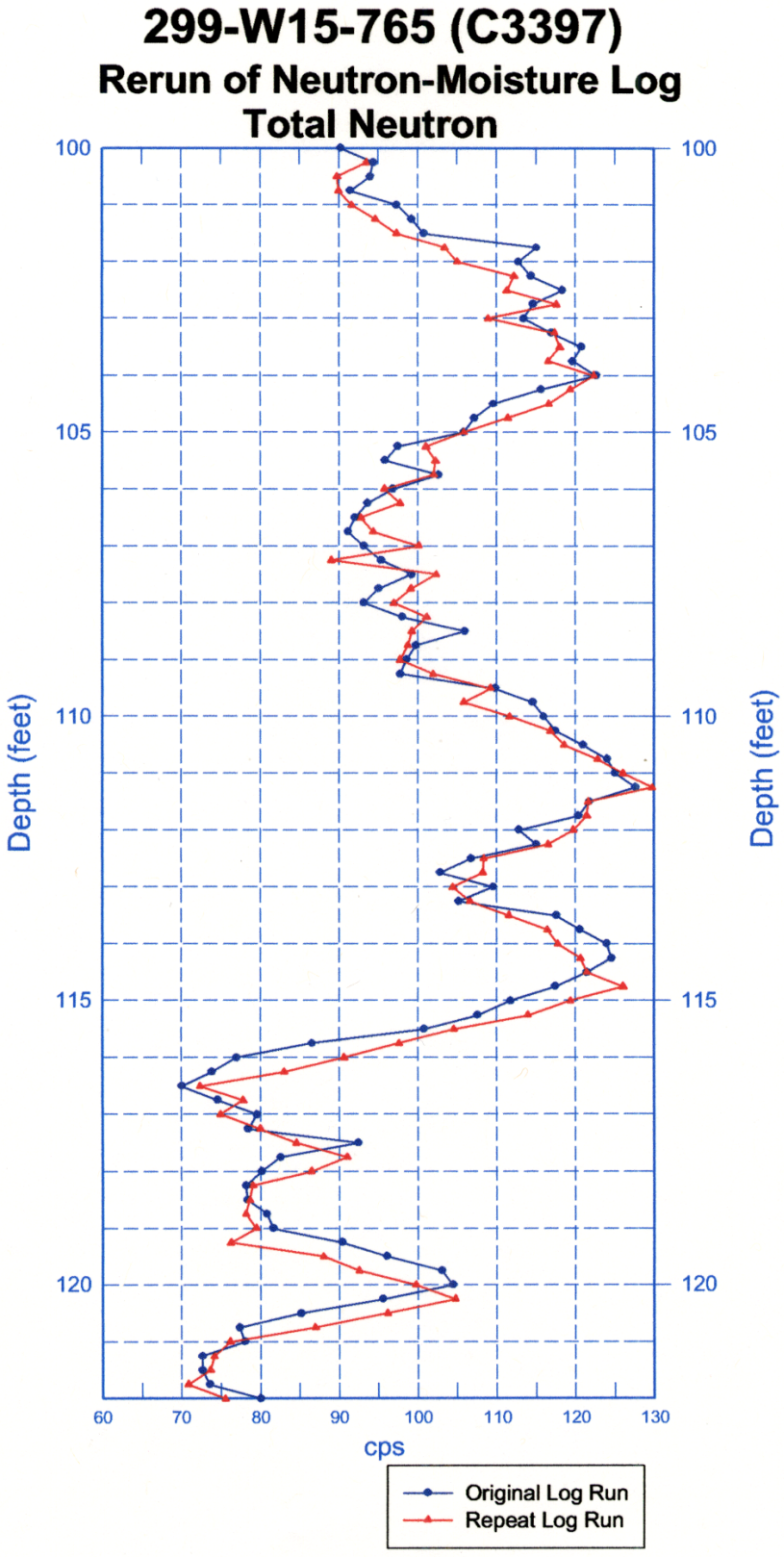

299-W15-765 (C3397)
Natural Gamma Logs
40K (1461 keV)
238U
232Th (2614 keV)
Depth (feet)
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
0 5 10 15 20 25
pCi/g
0 1 2 3
pCi/g
0.0 0.5 1.0 1.5
pCi/g
609 keV
MDL
1764 keV
MDL

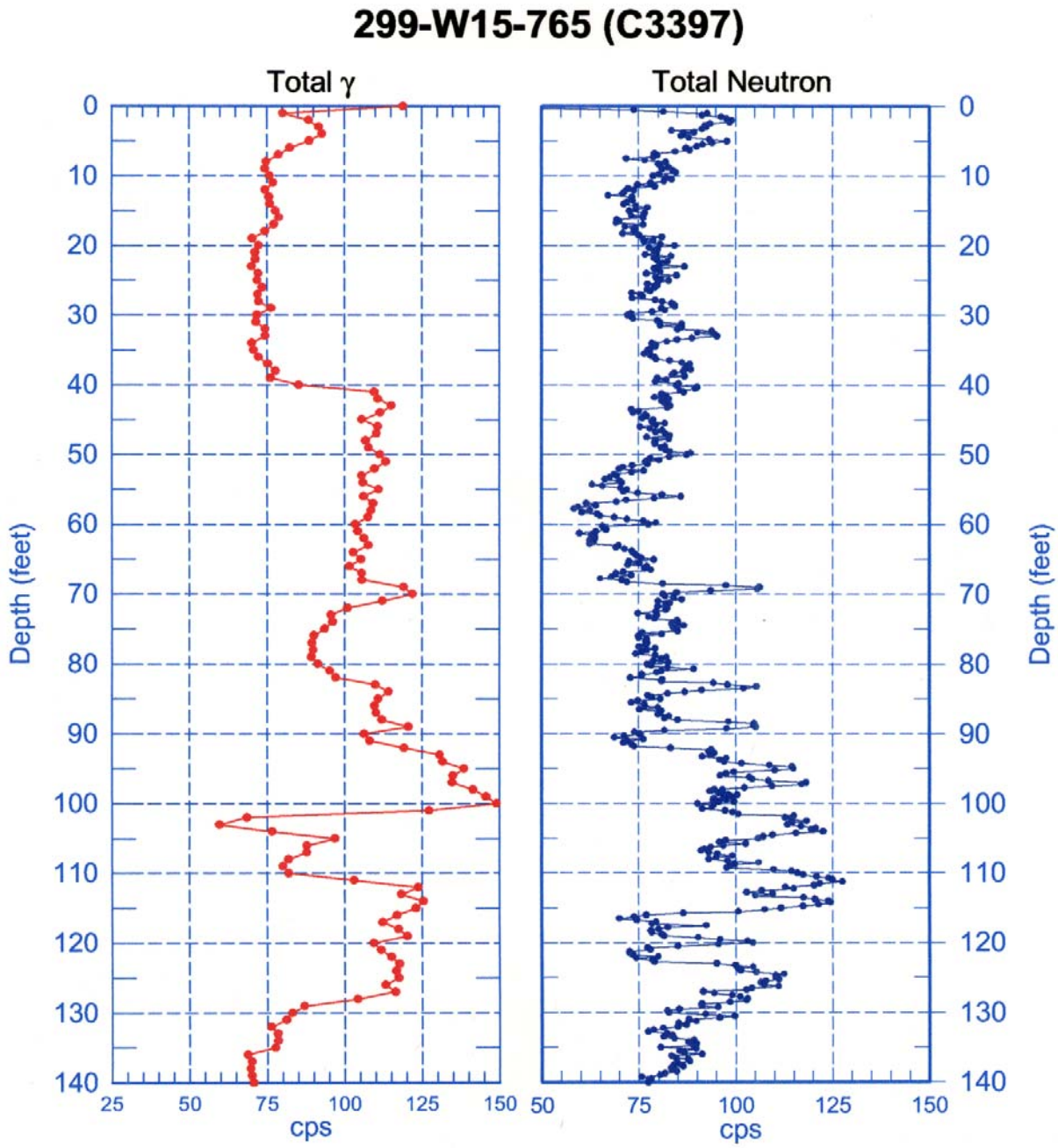

299-W15-765 (C3397) Combination Plot
137Cs (662 keV)
40K (1461 keV)
238U (609 keV)
232Th
Total γ
Total Neutron
Depth (feet)
pCi/g
cps

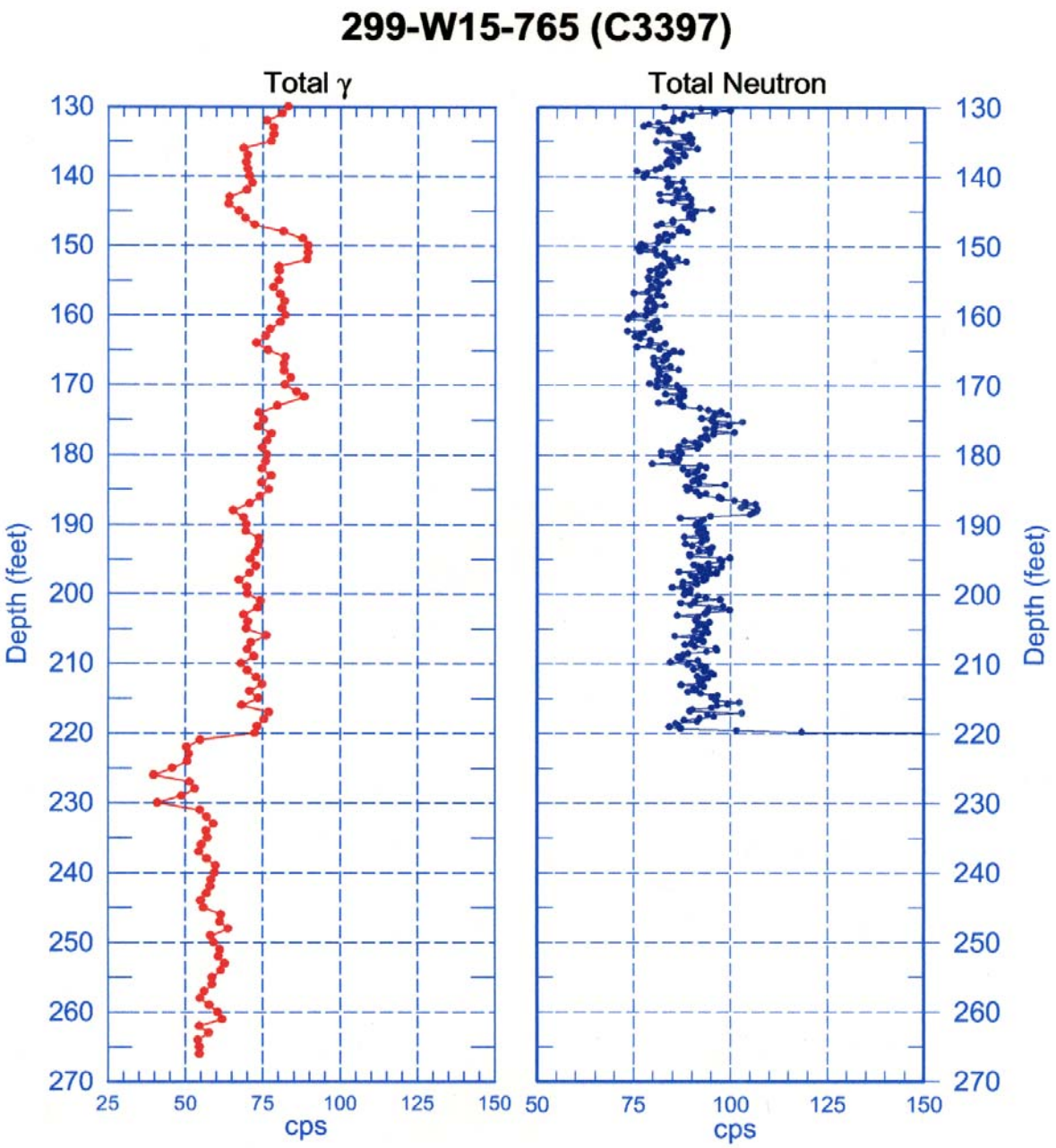

299-W15-765 (C3397) Combination Plot
137Cs (662 keV)
40K (1461 keV)
238U (609 keV)
232Th
Total γ
Total Neutron
Depth (feet)
pCi/g
cps


299-W15-765 (C3397) Combination Plot
137Cs (662 keV)
40K (1461 keV)
238U (609 keV)
232Th
Total γ
Total Neutron
Depth (feet)
200
210
220
230
240
250
260
270
280
0.0 0.5 1.0 1.5
pCi/g
0 5 10 15 20 25
pCi/g
0 1 2 3
pCi/g
0.0 0.5 1.0 1.5
pCi/g
25 50 75 100 125 150
cps
50 75 100 125 150
cps
Groundwater:
220 ft
Total Logging
Depth: 266 ft


299-W15-765 (C3397)
Rerun of Natural Gamma Logs
40K (1461 keV)
238U (609 keV)
238U (1764 keV)
232Th (2614 keV)
Depth (feet)
110
115
120
125
130
135
0 5 10 15 20
0 1 2 3
0 1 2 3
0.0 0.5 1.0 1.5
pCi/g
Original Log Run
Repeat Log Run


299-W15-765 (C3397)
Rerun of Neutron-Moisture Log
Total Neutron
100
105
110
115
120
Depth (feet)
60
70
80
90
100
110
120
130
cps
Original Log Run
Repeat Log Run


299-W15-765 (C3397)
Total γ
Total Neutron
Depth (feet)
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
25
50
75
100
125
150
cps
50
75
100
125
150
cps


299-W15-765 (C3397)
Total γ
Total Neutron
Depth (feet)
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
25
50
75
100
125
150
cps

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