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Borehole Data Package for RCRA Wells 299-E25-93 and 299-E24-22 at Single-Shell Tank Waste Management Area A-AX, Hanford Site, Washington

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S. M. Narbutovskih

December 2003

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

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Summary

Two new Resource Conservation and Recovery Act (RCRA) groundwater monitoring wells were installed at single-shell tank Waste Management Area (WMA) A-AX in fiscal year 2003 to fulfill commitments for well installations proposed in the draft *Hanford Federal Facility Agreement and Consent Order M-24-00*. Well 299-E24-22 has been installed upgradient and well 299-E25-93 downgradient of the WMA. Specific objectives for these wells include monitoring the impact, if any, that potential releases from inside the WMA may have on current groundwater conditions (i.e., improved network coverage); differentiating upgradient groundwater contamination from contaminants released at the WMA; and improving the determination of groundwater flow direction (i.e., improved water table determinations).

This report supplies the information obtained during drilling, characterization, and installation of the two new groundwater monitoring wells, 299-E25-93 and 299-E24-22. This document also provides a compilation of hydrogeologic and well construction information obtained during drilling, well construction, well development, pump installation, aquifer testing, and sample collection/analysis activities.

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1.0 Introduction

Two new Resource Conservation and Recovery Act (RCRA) groundwater monitoring wells were installed at single-shell tank Waste Management Area (WMA) A-AX in fiscal year 2003 to fulfill commitments for well installations proposed in draft *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement; Ecology et al. 1998) Milestone M-24-57 (Murphy-Fitch 2003).[(a)] The need for increased monitoring capability was identified in Narbutovskih and Horton (2001) and during a data quality objectives process for establishing an RCRA/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)/Atomic Energy Act of 1954 (AEA) integrated 200 West and 200 East Area Groundwater Monitoring Network (Byrnes and Williams 2003).

One outcome of the data quality objective process was a requirement to install additional groundwater monitoring wells in the immediate vicinity of WMA A-AX. Two wells have been installed; one located upgradient and one downgradient of the WMA (Figure 1). Specific objectives for these wells include monitoring the impact, if any, that potential releases from the WMA may have on current groundwater conditions (i.e., improved network coverage); differentiating upgradient groundwater contamination from contaminants released at the WMA; and improving the determination of groundwater flow direction (i.e., improved water table determinations). This report provides the information obtained during drilling, characterization, and installation of the two new groundwater monitoring wells at the single-shell tank WMA A-AX.

1.1 New Groundwater Monitoring Wells

The two new groundwater monitoring wells were installed between July and September 2003. The wells are identified as 299-E25-93 (well ID C4122) and 299-E24-22 (well ID C4123) and shown on a location map in Figure 1. The new wells were constructed to the specifications and requirements described in Washington Administrative Code (WAC) 173-160, and the groundwater monitoring description of work for drilling and installation (Williams 2003) and specifications used by Fluor Hanford, Inc. (FHI) for well drilling and construction. During drilling and construction of the wells, sampling and analysis activities were conducted to support screening for radiological contaminants and to collect sediment grab samples for geologic descriptions and for archiving in the Hanford Geotechnical Sample Library located at Building 3718A/B in the 300 Area.

This document provides a compilation of hydrogeologic and well construction information obtained during drilling, well construction, well development, pump installation, aquifer testing, and sample collection/analysis activities. Appendix A contains the Well Summary Sheets (as-built diagrams), the Well Construction Summary Report, the geologist's borehole log, well development and pump installation reports, and the well survey records. Appendix B contains results of field and/or laboratory determinations of physical properties of sediment samples. Appendix C contains borehole geophysical logs and borehole deviation survey results. Additional well construction documentation is on file with FHI in

(a) Letter from EJ Murphy-Fitch (Fluor Hanford Inc., Richland, Washington) to Distribution, *"Tentative Agreement on Tri-Party Agreement Negotiations on the Overall Strategy and Approach for Hanford Groundwater Protection, Monitoring, and Remediation (M-024),"* dated September 22, 2003.

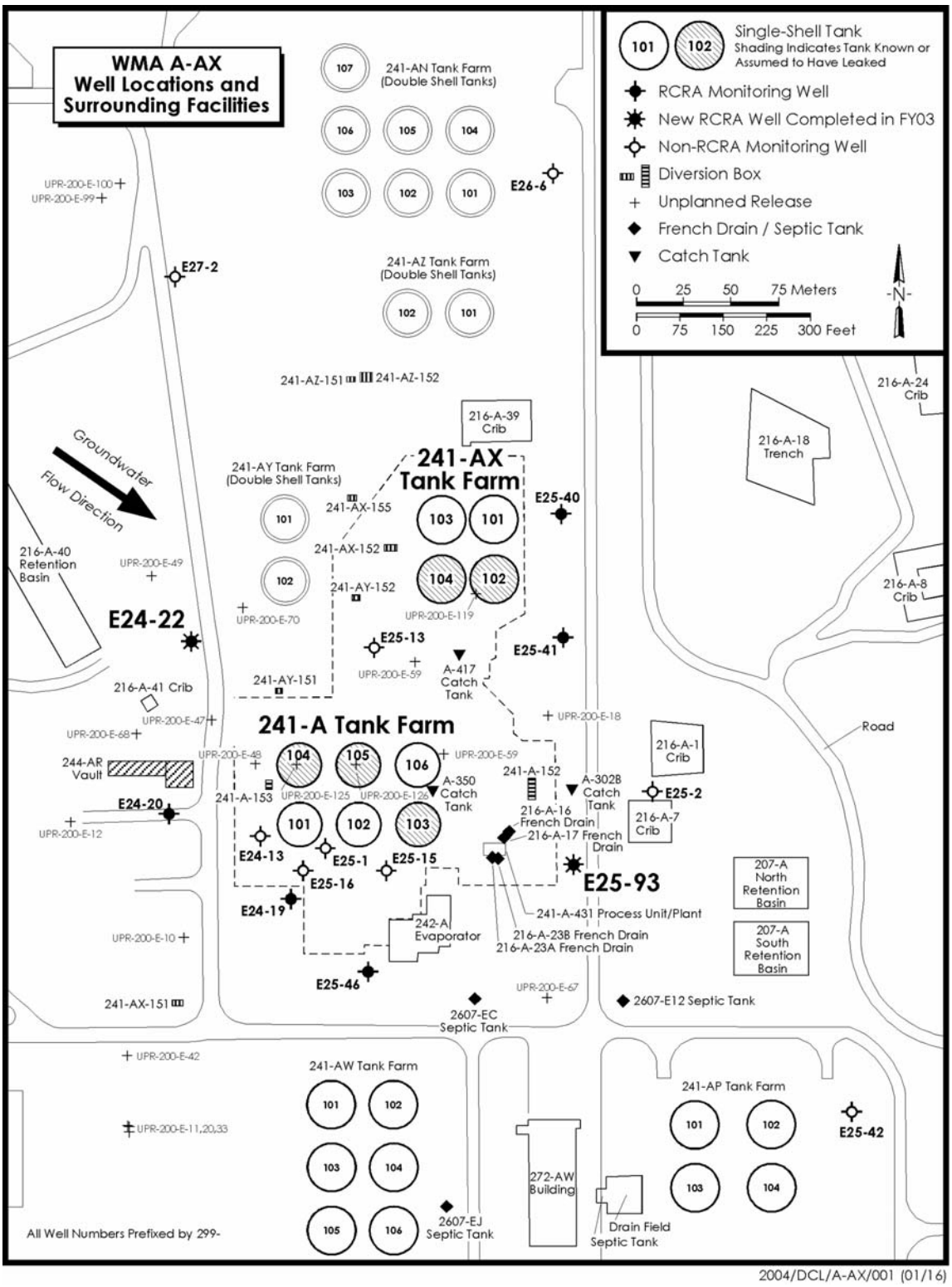

Figure 1. Map of Single-Shell Tank Waste Management Area A-AX and Locations of New and Existing Wells in the Groundwater Monitoring Network

Richland, Washington. The Records Management Information System and the Hanford Well Information System [http://apweb02/cfroot/rapidweb/phmc/cp/hwisapp/] are two electronic databases that also contain the drilling and construction records for these two wells.

English units are used in this report to describe drilling and well completion activities because that is the system of units used by drillers to measure and report depths and well construction measurements. Conversion to metric can be done by multiplying feet by 0.3048 to obtain meters or by multiplying inches by 2.54 to obtain centimeters.

2.0 Well 299-E25-93

Well 299-E25-93 is located along the southeast side of the 241-A tank farm (Figure 1). The well is downgradient of WMA A-AX and will help determine if contaminants are released from the WMA.

2.1 Drilling and Sampling

Well 299-E25-93 (well ID C4122) was drilled with a dual wall percussion rig (Becker-hammer) from surface to a total depth of 320 feet below ground surface (bgs). Temporary 9-inch-outside-diameter, dual-wall casing was used during drilling from the surface to total depth. Borehole drilling began on July 1 and total depth was reached on July 2, 2003.

Grab samples of sediment for geologic description and archive were collected at approximately 5-foot intervals from ground surface to total depth. Also, one 2-foot-long, 4-inch-diameter split spoon sample was attempted from the proposed screen interval for physical property analysis (sieve analysis) to confirm screen selection. The split spoon attempt was unsuccessful, so grab samples from the drill cuttings return line were collected from the screen interval (at ~281 feet bgs and ~316 feet bgs).

Sediments encountered during drilling consisted of backfill material and recent sediments (Holocene) deposited to a depth of approximately 10 feet bgs, Hanford formation sediments composed of sand to gravelly sand to sandy gravel from 10 feet bgs to about 266 feet bgs, and the sandy gravel of the lower Hanford formation and/or the mainstream alluvial facies of the Cold Creek unit from 266 feet bgs to approximately 317 feet bgs. Ringold Formation silty sandy gravel is indicated from 317 to 320 feet bgs total depth. The wellsite geologist's detailed lithologic borehole log and 5-foot depth interval sediment descriptions are included in Appendix A. A more complete hydrogeologic interpretation of the borehole sediments is included in Chapter 7.

The borehole and drill cuttings were monitored regularly for organic vapors and radionuclide contaminants (i.e., for alpha, beta, and gamma). Organics were not detected. The well was geophysically logged on July 7, 2003, by Stoller Corporation. Geophysical logging indicated that a slight amount of manmade cesium-137 was detected near ground surface (4.9 pCi/g maximum concentration) and at scattered intervals down to 195 feet bgs (Appendix C). Chapter 5 provides more details of geophysical logging.

2.2 Well Completion

The permanent casing and screen was installed in well 299-E25-93 in July 2003. A 35-foot-long, 4-inch-inner-diameter, stainless steel, continuous wire-wrap (0.02-inch slot) screen was set from 278.23 to 313.26 feet bgs. Below the screen interval there is a 2-foot-long stainless steel sump placed from 313.26 to 315.26 feet bgs. The permanent well casing is 4-inch-inside-diameter, stainless steel from 278.23 feet bgs to 2 feet above ground surface.

The screen filter pack is 10-20 mesh silica sand placed from 273.1 to 320 feet bgs. The sand pack was settled and initial development completed using a dual-flange surge block. The annular seal is composed of bentonite pellets from 268.5 to 273.1 feet bgs and bentonite crumbles from 10.5 to 268.5 feet bgs. The surface seal is composed of Portland cement grout from 10.5 feet bgs to ground surface. A 4-foot by 4-foot by 6-inch concrete pad was placed around the well at the surface. A protective well head casing with locking cap, four protective steel posts, and a brass marker stamped with the well ID number and Hanford well number were set into the concrete pad. The Well Construction Summary Report and Well Summary Sheet (as-built) are included in Appendix A.

A vertical borehole deviation survey was conducted utilizing a downhole gyroscope in the completed well to determine the well bottom location relative to a vertical borehole projection. Survey results are discussed in Chapter 6 and located in Appendix C.

The elevation and geographic coordinates of the well were surveyed by Fluor Federal Services on October 31, 2003. The horizontal position of the well was referenced to horizontal control stations established by the U.S. Army Corps of Engineers (USACE). The coordinates are Washington State Plane Coordinate System, South Zone, NAD83(91) datum. Vertical datum is NAVD88 and is based on existing USACE bench marks. Survey data are included in Table 1 and Appendix C. The static water level was 278.04 feet bgs on July 15, 2003.

2.3 Well Development and Pump Installation

Well 299-E25-93 was developed on August 14, 2003. Well development was performed at three different intervals. A temporary, 5-horsepower submersible pump was used for development. Depth-to-

Table 1. Survey Data for Wells 299-E25-93 and 299-E24-22

Well Name (Well ID)	Easting (m)	Northing (m)	Elevation (m)	Comments
299-E25-93 (C4122)	575,471.51	136,022.09		Center of casing
			208.040	Top of casing, N. edge
			207.265	Brass survey marker
			208.046	Top pump base plate, N. edge
299-E24-22 (C4123)	575,262.68	136,142.82		Center of casing
			210.285	Top of casing, N. edge
			209.553	Brass survey marker
			210.291	Top pump base plate, N. edge
NOTES: Horizontal Datum is NAD83(91); Vertical Datum is NAVD88; Washington State Plane Coordinates (South Zone); surveyed October 2003.				

water level was measured at 281.26 feet below top of casing (btc) prior to development. A pressure transducer was installed above the pump and connected to a Hermit datalogger to monitor water level during development. Table 2 contains the results of final well development, including pump intake depth, pump rate, pump run time, drawdown, recovery time, final turbidity (NTU), and stabilized conductivity and temperature readings. A total of 4,547 gallons of water was pumped.

A dedicated Redi-Flo-3, 0.7-horsepower Grundfos™ submersible sampling pump was installed in well 299-E25-93 on September 16, 2003. The sampling pump intake was set at 286.1 feet btc, approximately 5 feet below the water table, and connected to the surface with 3/4-inch-diameter stainless steel riser pipe.

Table 2. Well Development Information for Well 299-E25-93

Pump Rate	Pump Intake Depth (ft btc)	Pumping Run Time (min)	Drawdown (ft)	Final Readings	Recovery Test Time (min)
25.5 gpm	316.1	59	0.2	1.26 NTU, 564 µs/cm, 20.4 C	11 (99.8%)
26 gpm	306	64	<0.1	0.83 NTU, 550 µs/cm, 21.6 C	14 (100%)
26 gpm	296	53	<0.1	1.19 NTU, 555 µs/cm, 20.6 C	10 (100%)

ft btc = Feet below top of casing.
gpm = Gallons per minute.
min = Minutes.
NTU = Nephelometric turbidity unit.
µs/cm = micro siemen per centimeter.

3.0 Well 299-E24-22

Well 299-E24-22 is located on the west side of the tank farm (Figure 1). The well is upgradient of the WMA A-AX and will help differentiate upgradient groundwater contamination from contaminants released at the WMA.

3.1 Drilling and Sampling

Well 299-E24-22 (well ID C4123) was also drilled with a Becker -hammer rig from surface to a total depth of 330 feet bgs. Temporary 9-inch-outside-diameter, dual-wall casing was used for drilling throughout the borehole to total depth. Borehole drilling began on July 10 and reached total depth on July 11, 2003.

Grab samples of sediment for geologic description and archive were collected at approximately 5-foot intervals from ground surface to total depth. Also, one 2-foot-long, 4-inch-diameter split spoon sample was attempted from the proposed screen interval for sieve analysis to confirm screen selection. The split spoon retrieved 100% of sample from 286 to 288.5 feet bgs; a grab sample was also collected from the drill cuttings return line at ~321 feet bgs for sieve analysis.

Sediments encountered during drilling consist of backfill and recent sediments (Holocene) deposited to a depth of approximately 8 feet bgs, Hanford formation sediments composed of sand to gravelly sand to sandy gravel from 8 feet bgs to about 300 feet bgs, and the sandy gravel of the lower Hanford formation and/or the Cold Creek unit from 300 feet bgs to total depth (330 feet bgs). A distinct silt/clay layer was encountered from 267 to 272 feet bgs. A more complete hydrogeologic interpretation of the borehole sediments is included in Chapter 7. A detailed lithologic borehole log is provided in Appendix A.

The borehole and drill cuttings were monitored regularly for organic vapors and radionuclide contaminants (i.e., for alpha, beta, and gamma). Organic vapor analysis detected 3.6 to 3.8 parts per million organics in the borehole at 300 feet bgs. The well was geophysically logged between July 12 and July 15, 2003, by Stoller Corporation. Geophysical logging indicated that a slight amount of manmade cesium-137 was detected at scattered intervals down to 125 feet bgs (Appendix C). Chapter 5 provides more details of geophysical logging.

3.2 Well Completion

The permanent casing and screen was installed in well 299-E24-22 in July 2003. A 35-foot-long, 4-inch-inner-diameter, stainless steel, continuous wire-wrap (0.02-inch slot) screen was set from 321.26 to 286.21 feet bgs. Below the screen interval, there is a 2-foot long stainless steel sump placed from 323.68 to 321.26 feet bgs. The permanent well casing is 4-inch-inside-diameter, stainless steel from 286.21 feet bgs to 2 feet above ground surface.

The screen filter pack is 10-20 mesh silica sand placed from 330 to 281.1 feet bgs total depth. The sand pack was settled and initial development completed using a dual-flange surge block. The annular seal is composed of bentonite pellets from 281.1 to 276.1 feet bgs and bentonite crumbles from 276.1 to 10 feet bgs. The surface seal is composed of Portland cement from 10 feet bgs to ground surface. A 4-foot by 4-foot by 6-inch concrete pad was placed around the well at the surface. A protective well head casing with locking cap, four protective steel posts, and a brass marker stamped with the well ID number and Hanford well number were set into the concrete pad. The Well Construction Summary Report and Well Summary Sheet (as-built) are included in Appendix A.

A vertical borehole deviation survey was conducted in the completed well to determine the well bottom location relative to a vertical projection. Survey results are discussed in Chapter 6 and located in Appendix C.

The vertical and horizontal coordinates of the well were surveyed by Fluor Federal Services in October 2003. The horizontal position of the well was referenced to horizontal control stations established by the U.S. Army Corps of Engineers. The coordinates are Washington State Plane Coordinate System, South Zone, NAD83(91) datum. Vertical datum is NAVD88 and is based on existing USACE bench marks. Survey data are included in Table 1 and Appendix C. The static water level was 286.02 feet bgs on July 17, 2003.

3.3 Well Development and Pump Installation

Well 299-E24-22 was developed on September 8, 2003. Well development was performed at three different intervals. A temporary, 5-horsepower submersible pump was used for development. Depth to water level was measured at 288.94 feet btc prior to development. A pressure transducer was installed above the pump and connected to a Hermit™ datalogger to monitor water level during development. Table 3 contains the results of final well development, including pump intake depth, pump rate, pump run time, drawdown, recovery time, final turbidity, and stabilized conductivity and temperature readings. A total of 4,087 gallons of water was pumped.

A dedicated Redi-Flo-3, 0.7-horsepower, Grundfos™ submersible sampling pump was installed in well 299-E24-22 on September 8, 2003. The sampling pump intake was set ~7 feet below the water table at 296 feet btc and connected to the surface with 3/4-inch-diameter stainless steel riser pipe.

Table 3. Well Development Information for Well 299-E24-22

Pump Rate (gpm)	Pump Intake Depth (ft btc)	Pumping Run Time (min)	Drawdown (ft)	Final Readings	Recovery Test Time (min)
22.5	324.2	80	0.2	2.31 NTU, 519 µs/cm, 18.2 C	24 (99.9%)
24	314.2	63	<0.1	2.25 NTU, 366 µs/cm, 18.4 C	16 (100%)
25	303.1	31	<0.1	3.14 NTU, 370 µs/cm, 18.5 C	Not available

ft btc = Feet below top of casing.
gpm = Gallons per minute.
Min = Minutes.
NTU = Nephelometric turbidity unit.
µs/cm = micro siemens per centimeter.

4.0 Sampling and Analysis During Drilling

This section describes the collection and analysis of sediment samples collected during drilling from wells 299-E25-93 and 299-E24-22.

4.1 Field Screening

Sediment samples were screened in the field prior to sample collection for indications of contamination. The drill cuttings and samples were screened for volatile organic contamination, beta-gamma activity, and alpha activity by radiation control technicians and safety staff. All radiation activity levels were at or below background for wells 299-E25-93 and 299-E24-22. Volatile organic screening was performed with a photo-ionization detector. No volatile organics were detected during drilling in well 299-E25-93, but 3.6 to 3.8 parts per million concentration was detected in the well 299-E24-22 at a depth of 300 feet bgs. No action was taken, and monitoring and drilling continued.

4.2 Borehole Sampling

Sediment samples of drill cuttings were collected for geologic description (documented in the geologic borehole log) and archival from both boreholes at 5-foot intervals from ground surface to total depth. The geologic borehole logs are included in Appendix A. One-pint sediment samples collected in glass jars are archived in the Hanford Geotechnical Sample Library which is located at Building 3718A/B in the 300 Area.

Two split spoon samples were attempted from the interval to be screened at each borehole. In some cases, soil grab samples were used in lieu of split spoon samples because of incomplete sample recoveries or because the formation was not conducive to split spoon sampling. These samples were sieved for particle size distribution to provide data for screen slot size confirmation/selection. Sieve data and distribution curves are available in Appendix B.

All sediment sample depths are documented in the geologic borehole log for each well (located in Appendix A).

5.0 Geophysical Logging

A spectral gamma-ray borehole geophysical survey was conducted in both boreholes by Stoller Corporation. The spectral gamma-ray tool was used to determine the presence and concentration of manmade and naturally occurring gamma-emitting radionuclides in the boreholes. The geophysical logs have also been correlated with the geologic log data and the results are presented in Chapter 7. The full suite of logs for both wells and detailed geophysical logging reports for the two wells are provided in Appendix C. The reports also describe calibration requirements, data processing, and log plots.

Well 299-E25-93 was logged on July 7, 2003 using high resolution, spectral gamma-ray instrumentation from ground surface to 320 feet bgs inside temporary dual-wall carbon steel casing with an approximate outside diameter of 9 inches. A repeat section was run from 320 to 288 feet bgs. Measurements were made at a “move-stop-acquire” mode and at a rate of 100 seconds per foot. Cesium-137 was the only gamma-emitting manmade radionuclide detected during geophysical logging. Cesium-137 was detected at ground surface with a maximum concentration of 4.9 pCi/g. Cesium-137 was also detected sporadically at a few other depths throughout the borehole near the 0.3 pCi/g minimum detection limit. The geophysical logs are in Appendix C. Neutron-moisture logging was not completed because a dual-wall casing was used and the casing diameter was too large for the calibrated neutron moisture tool.

In well 299-E24-22, logged between July 12 and 15, the spectral gamma-ray tool was run from ground surface to a depth of 328 feet bgs within the nominal 9-inch-diameter dual-wall temporary carbon steel casing. A repeat section was run from 105 to 72 feet bgs. Measurements were made at a “move-stop-acquire” mode and at a rate of 200 seconds per foot. Cesium-137, a manmade radionuclide, was detected at a few depths throughout the borehole near the method detection limit (0.3 pCi/g). Neutron-moisture logging was not completed because a dual-wall casing was used and the casing diameter was too large for the calibrated tool.

6.0 Borehole Gyroscope Survey

Downhole deviation (gyroscopic) surveys were performed in both wells following construction to determine the vertical and horizontal location coordinates of the screened interval (i.e., water table) relative to the borehole surface location and to determine the vertical dimension of the overall well. These data are used to determine the extent of borehole deviations created during drilling. The data can also be used to correct water-level elevations from depth-to-water measurements taken in the completed wells. Refer to Appendix C for the results of these surveys.

In well 299-E25-93, results indicate that at a measured cable depth of 305 feet, the true vertical depth of the well is 304.99 feet. (Note: This is not the drilled total depth). Figure 2 illustrates the vertical and horizontal offsets from the surface projection of well 299-E25-93. The correction factor for determining the true vertical elevation of the water table is ~0.01 foot. This distance should be subtracted from the depth-to-water measurements to obtain true depth.

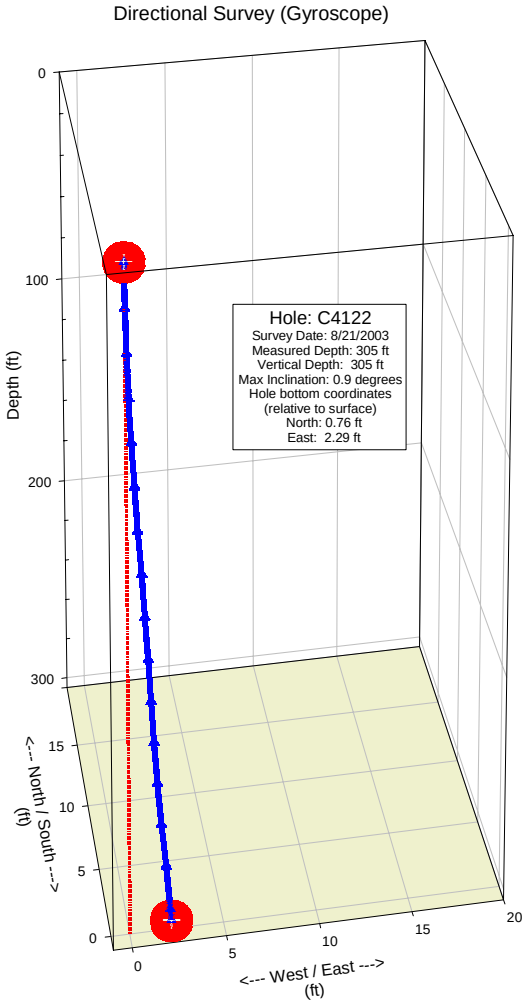

Figure 2. Vertical Profile and Bottom Hole Projections of Well 299-E25-93

In well 299-E24-22, results indicate that at a measured cable depth of 312 feet, the true vertical depth of the well is 311.65 feet. (Note: This is not the drilled total depth). Figure 3 illustrates the vertical and horizontal offsets from the surface projection of well 299-E24-22. The measured depth-to-water table is approximately 286 ft bgs and the correction factor at this depth for determining the true vertical elevation of the water table is ~0.27 foot. This distance should be subtracted from the depth-to-water measurements to obtain true depth.

7.0 Subsurface Characterization Results and Interpretation

Results from the sediment sampling, physical property analysis, geologic log, geophysical logs, well development, and aquifer testing from each borehole are correlated to provide an interpretation of the hydrogeology at each borehole. This section includes a discussion of the criteria used to evaluate and interpret the data. The composite logs in Figures 4 and 5 illustrate the interpreted hydrogeology developed for each well.

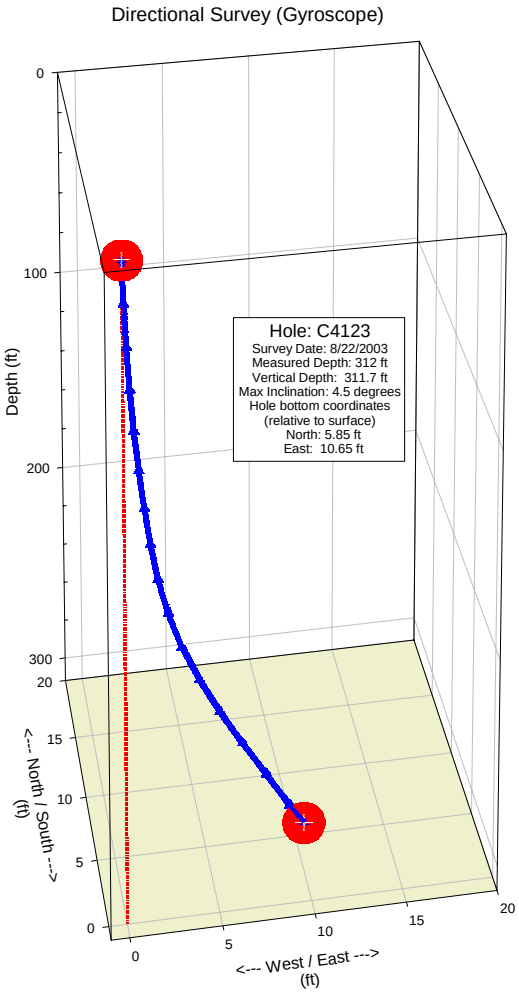

Figure 3. Vertical Profile and Bottom Hole Projections of Well 299-E24-22

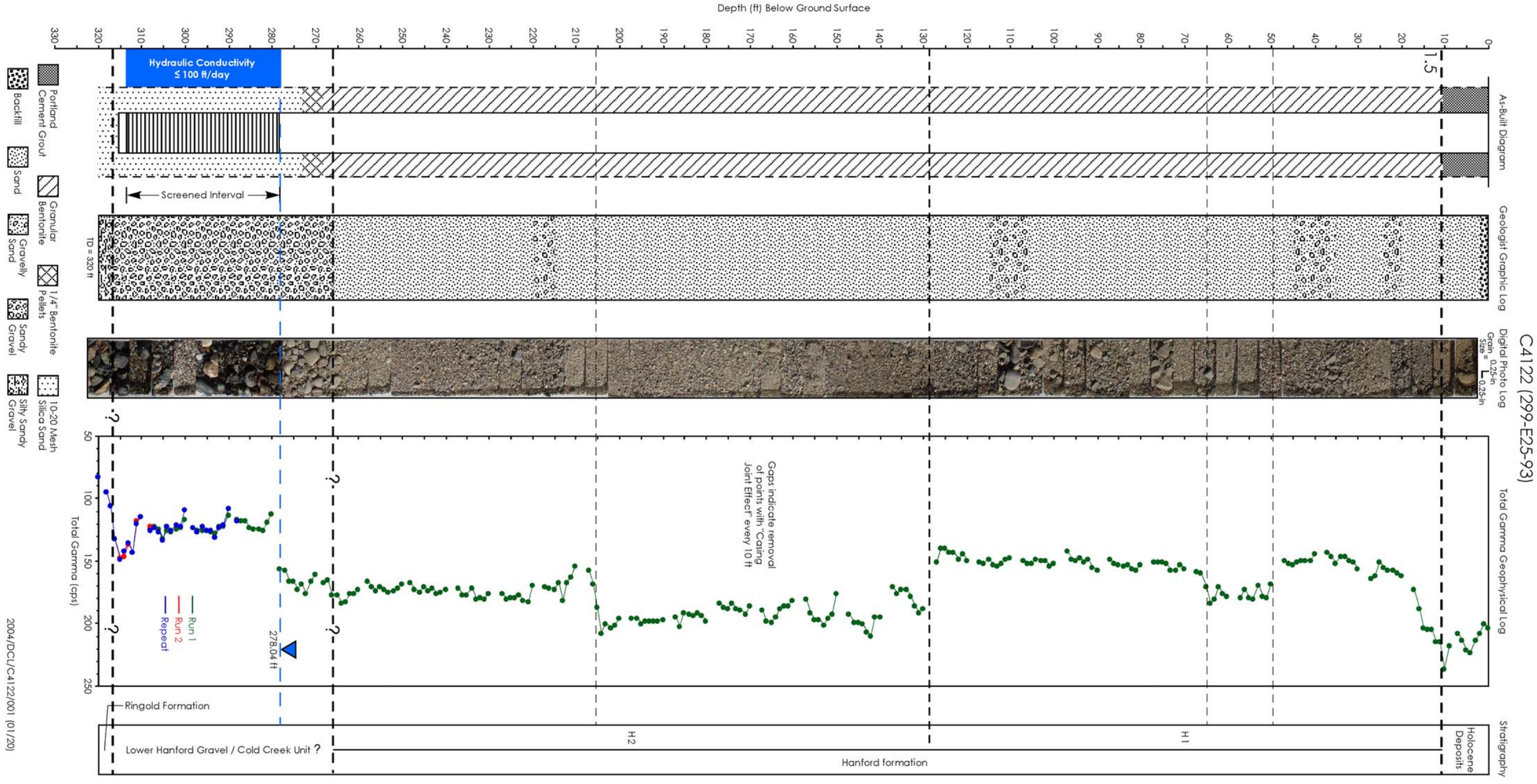

Figure 4. Hydrogeologic Interpretation for Well 299-E25-93 near Single-Shell Tank Farm WMA A-AX

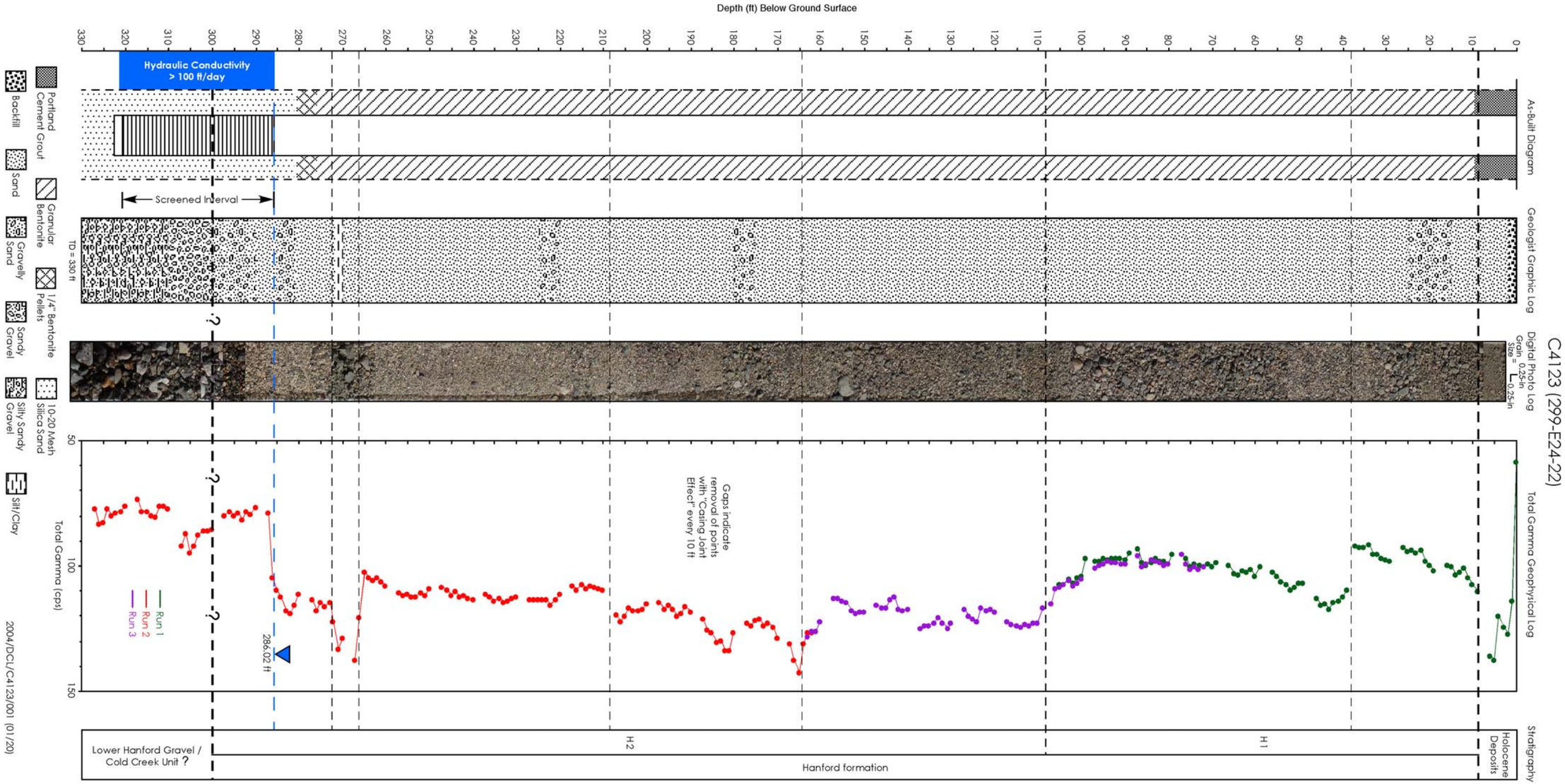

Figure 5. Hydrogeologic Interpretation for Well 299-E24-22 near Single-Shell Tank Farm WMA A-AX

7.1 Physical Properties

There was no analysis for physical properties conducted on samples from these wells except sieve analysis of sediment samples (grab or split spoon) collected from the screen interval for particle size distribution. Particle size distribution results (sieve results) are provided in Appendix B.

Grab samples collected at 5-foot-depth intervals are described on the geologist's borehole log located in Appendix A. The wellsite geologist's graphic representation of the borehole logs for both wells are illustrated in composite logs (Figures 4 and 5). The sample quality and formation representativeness of the grab samples, and thus the borehole log descriptions, are limited due to the nature of the drilling. Drill rates were very fast (>250 feet per day) and the airlifted cuttings return process, which causes gravity separation of sediments based on grain size and density, most likely mixed a lot of the sediment cuttings from different depth intervals before the cuttings reached the surface. When thin beds or sharp contacts were drilled, the returned sediments that were collected could not be easily evaluated or confidently correlated to their representative depth intervals.

The spectral gamma geophysical logs do indicate the presence of sharp contacts and/or thin bed intervals which can not always be differentiated in the returned cuttings. These changes are not documented in the geologic borehole log for these wells but evidence they exist can be seen in core data collected in a nearby well. Vadose-zone core recovered from well C4124 (299-E27-22) at single-shell tank WMA C provides evidence of these contacts and the thin, sharp lithologic changes that are seldom recognized when only evaluating drill cuttings returns from the Becker-Hammer drilling method.

7.2 Sediment Digital Photographic Log

A digital photographic log is included in each composite log for the wells (Figures 4 and 5). Grab samples from the cuttings return line (cyclone) were collected for lithologic descriptions, documented in the borehole log in Appendix A archives, and for digital photography of the sediments. These photographic log presentations, compiled from 1-inch chip tray samples collected at 5-foot-depth intervals, provide a qualitative visual tool that reveals changes in major lithologic intervals (i.e., grain size, color, and relative moisture). The digital photographic logs provide a means to illustrate subsurface lithologic and related hydrogeologic features. The interpretative value of these logs is also limited by the sample collection technique and sample container site.

7.3 Geophysical Logging

Cesium-137 was the only manmade radionuclide detected in both wells. This contaminant is mainly at the surface but there are a few sporadic detects at the minimum detectable level throughout the boreholes. Appendix C provides more details about the cesium detected in the boreholes.

For well 299-E25-93, geophysical log plots of the naturally occurring gamma emitting radionuclides (potassium, uranium, and thorium) indicate there are several distinct activity changes (inflection points) at depths of ~50, 65, 130, 205, and 279 feet bgs. These major changes correlate to lithologic features (i.e., contacts and/or thin contrasting lithologic intervals) and the water table (Figure 4). The inflections at

~50, 65, 130 and 205 feet bgs probably correspond to distinct changes in lithology (i.e., grain size, clast mineralogy, or both). As discussed in the section above, these changes are not documented in the geologic borehole log for this well but evidence they exist can be seen in core data collected in a nearby well.

For well 299-E24-22, geophysical log plots of naturally occurring radionuclides indicate there are several distinct activity changes (inflection points) at depths of ~38, 108, 165, 208, 267, 272, and 286 feet bgs. The inflections at 38, 108, 165, and 208 bgs probably correspond to unrecognized changes in lithology similar to those discussed in the previous sections. The inflections at 267 and 272 feet bgs and high gamma peaks (~268 and 271 feet bgs) correspond to a ~5 foot thick silt/clay interval that is recognized in the borehole and as clay clumps in the digital photographic logs (Figure 5). The water table is indicated at 286 feet bgs.

No attempt has been made to correlate specific units of facies between these two wells, although evaluation of the logs does suggest some continuity may exist.

7.4 Aquifer Tests

Slug testing was performed in both wells following construction and development. The slug tests are performed to provide semi-quantitative calculation of hydraulic conductivity in the unconfined aquifer (i.e., the screen interval). The slug testing results provide an objective method to evaluate the hydraulic properties of the formation and support interpretation of the hydrogeology of the aquifer system.

Highly permeable conditions are indicated from well screen development drawdown data collected during constant rate pumping in both wells. Drawdowns were less than 0.11 feet (22.5 gallons-per-minute pump rate) and 0.16 feet (25.5 gallons-per-minute pump rate) in wells 299-E24-22 and 299-E25-93, respectively. During slug testing, both wells exhibited highly permeable screened test intervals with test recovery within 10 seconds. Well 299-E24-22 exhibits an oscillatory, underdamped slug test response, while well 299-E25-93 displays a rapid, exponential decay (overdamped) test response. An oscillatory response indicates a higher permeability test interval (all other test parameters being similar, e.g., well-screen length). Preliminary average hydraulic conductivity values for the two wells are: well 299-E24-22 > 100 feet per day and well 299-E25-93 $\leq$100 feet per day. Quantitative analysis results for these two well sites will be documented in a subsequent PNNL technical report that presents hydrologic test results for slug tests conducted during fiscal year 2003.

7.5 Composite Logs

Composite logs have been assembled for each well using the well as-builts, aquifer testing results, the geologic graphic log description of the sediments, the digital photographic log, and the geophysical logs. Stratigraphic interpretation contacts and key lithologic changes are identified where possible. The composite logs for new wells 299-E25-93 and 299-E24-22 are illustrated in Figures 4 and 5, respectively. These interpretations are also consistent with Woods et al. (2003) and Williams et al. (2000).

The Hanford formation comprises most of the thick vadose zone in both wells, composed mostly of sand to silty sandy gravel. There are several distinct contacts and thin fine grain lithologic intervals (e.g.,

silt or soil horizons) within the Hanford formation, implied by the inflections on the geophysical logs. The most significant inflections are dashed on the composite log to imply a contact.

The uppermost unconfined aquifer is composed mostly of uncemented, loose, gravel to silty sandy gravel and appears characteristic of the more permeable lower Hanford formation and/or the Cold Creek unit (formerly called "reworked Ringold Formation sediments" or the "Pre-Missoula Gravel"). The contact between the lower Hanford formation and the Cold Creek unit is gradational and not easy to distinguish. The lower Hanford formation and/or Cold Creek unit upper contact is approximately located at 266 and 300 feet bgs in wells 299-E25-93 and 299-E24-22, respectively (Figures 4 and 5). Criteria for designating the Cold Creek unit sediments include dominantly gravel deposition, samples composed of less than 50% basalt, and hydraulic conductivity values (> 55 feet per day) greater than published results for known Ringold Formation sediments.(b) However, distinguishing this unit based on hydraulic conductivity valves from lower Hanford formation gravel is not possible in this area.

In well 299-E25-93, the very bottom 3 feet from 317 to 320 ft bgs (total depth) comprises a portion of the Ringold Formation Unit 9. This unit is characterized by silty sandy gravel that is less than 25% basalt, has moderate cementation, contains iron staining, micaceous material, and is described in daily drilling logs as difficult slower drilling. The interpretation of the lower Ringold Formation Unit 9 at the bottom of this well is consistent with interpretations described in Williams et al. 2000.

8.0 References

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(b) Letter report from FA Spane to VG Johnson (Pacific Northwest National Laboratory, Richland, Washington), *"Summary of Hydraulic Conductivity Estimates Obtained From Recent Hydrologic Characterization Tests Conducted in the WMA S-SX,"* 2002.

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Appendix A

Well Construction and Completion Documentation

WELL SUMMARY SHEET

Start Date: 07/01/03
Finish Date: 07/09/03
Page 1 of 2

Well ID: C4122
Well Name: 299-E25-93
Location: East of 241-A Tank Farm
Project: C403 RCRA Drilling
Prepared By: Charlene Martinez
Date: 07/15/03
Reviewed By: L.D. Walker
Date: 8/11/03
Signature: Charlene Martinez
Signature: L.D. Walker

CONSTRUCTION DATA

Dual-wall temporary casing used. 9" OD: Inner casing 7 1/6"

Protective casing set (6" ID) + 1.11' above permanent casing

4" ID SS 304 sched 10 casing:
+2.00' → 278.23'

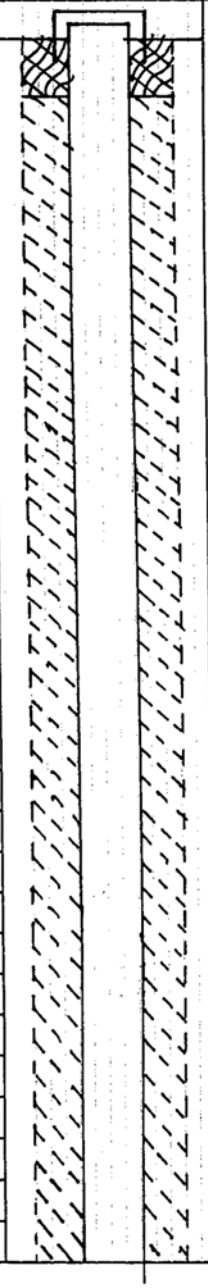
Portland Cement Grout:
0' → 10.5'

Granular Bentonite:
10.5' → 268.5'

1/4" Bentonite Pellets:
268.5' → 273.1'

All temporary casing removed from ground.

All depths are in feet below ground surface.



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
0		0'-2' Backfill material
		2'-11' SAND(S)
		Hanford Formation @ 11' bgs.
		11'-20' SAND(S)
		20'-25' Gravelly SAND(gS)
40		25'-35' SAND(S)
		35'-45' Gravelly SAND(gS)
		45'-106' SAND(S)
80		
		106'-115' Gravelly SAND(gS)
		115'-215' SAND(S)
120		
160		
200		
		215'-220' gravelly SAND(gS)
		220'-266' SAND(S)

A-6003-643 (03/03)

WELL SUMMARY SHEET

Start Date: 07/01/03
Finish Date: 07/09/03
Page 2 of 2

Well ID: C 4122
Well Name: 299-E25-93
Location: East of 241-A Tank Farm
Project: C403 RCRA drilling
Prepared By: Charlene Martinez
Date: 07/15/03
Reviewed By: L.D. Walker
Date: 8/11/03
Signature: Charlene Martinez
Signature: LD Walker

CONSTRUCTION DATA

Description	Diagram
10-20 mesh silica sand: 273.1' → 320.0'	
4" ID ss 304 schedule 10 well screen: 278.23' → 313.26'	
4" ID ss 304 schedule 10 sump/endcap 313.26' → 315.26'	
All temporary casing removed from ground.	
All depths are in feet below ground surface	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
240		
		240' - 317' sandy GRAVEL (sG)
280		
		Ringold formation @ 317' bgs
320		317' - 320' silty sandy GRAVEL (msG)
		TD @ 320' bgs.
		static water => 278.04' bgs (07/15/03)

A-6003-643 (03/03)

WELL CONSTRUCTION SUMMARY REPORT

Start Date: 07/01/03
Finish Date: 08/14/03
Page 1 of 1

d ID: C4122	Well Name: 299-E25-93	Approximate Location: East of 241-A Tank Farm
Project: C403 RCRA drilling		Other Companies: CHG, FH
Drilling Company: Layne Christensen		Geologist(s): C. Martinez, M.J. Hocking
Driller: Paul ("Derry") Lodder	License #: 1628	

TEMPORARY CASING AND DRILL DEPTH			DRILLING METHOD	HOLE DIAMETER (in.) / INTERVAL (ft)
*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.	Auger:	Diameter ____ From ____ to ____
Carbon Steel, dual	0' - 320'	9"	Cable Tool:	Diameter ____ From ____ to ____
wall casing.	____ - ____		Air Rotary:	Diameter ____ From ____ to ____
outer 9" OD	____ - ____		A.R. w/Sonic:	Diameter ____ From ____ to ____
Inner 7"/6", FJ	____ - ____		Reverse Circulation	Diameter ____ From ____ to ____
	____ - ____		(Becker Hammer)	Diameter 9" From 0' to 320'
*Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design				Diameter ____ From ____ to ____

		Drilling Fluid: N/A	
Total Drilled Depth: 320'	Hole Dia @ TD: 9"	Total Amt. Of Water Added During Drilling: -0-	
Well Straightness Test Results: Passed using 20' long, 4.5" OD Tool on 07/08/03		Static Water Level: 278.04'	Date: 07/15/03

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date	Sondes (type)	Interval	Date
Spectral Gamma	0' - 321'	07/07/03		____ - ____	
	____ - ____			____ - ____	
	____ - ____			____ - ____	

COMPLETED WELL

Size/Wt./Material	Depth	Thread	Slot Size	Type	Interval Annular Seal/Filter Pack	Volume	Mesh Size
SS 304, sched 10 riser (4" ID)	+2.0' - 278.23'	FJ80	N/A	Portland Cement Grout (94#)	0' - 106'	6 bags	N/A
SS 304, sched 10 wellscreen (4" ID)	278.23' - 313.26'	"	0.020"	Granular Bentonite (50#)	10.5' - 268.5'	132 bags	N/A
SS 304 sched 10 sump 4" ID	313.26' - 315.26'	"	N/A	Bentonite Pellets (50#)	268.5' - 273.1'	3 buckets	1/4"
	____ - ____			Colorado Silica Sand	273.1' - 320.0'	30 bags	10-20
	____ - ____				____ - ____		

OTHER ACTIVITIES

Aquifer Test: well development	Date: 08/14/03	Well Decommission:	Yes:	No:	Date:
Description: 5 HP Franklin submersible pump. Developed 3 Stages: Intake set @ 316.1' (B), 306.0' (M), 296.0' (T), Pump rate 26 gpm. Final turbidity = 1.26 NTU (B) / 10.83 NTU (M) / 1.19 NTU (T).		Description:			

WELL SURVEY DATA (If applicable)

	Protective Casing Elevation:
Washington State Plane Coordinates:	Brass Survey Marker Elevation:

COMMENTS / REMARKS

Vol calcs: P.C., 6 bags * 1.285 ft^3/bag = 7.71 ft^3; Granules, 132 bags * 0.71 ft^3/bag = 93.72 ft^3; pellets, 3 buckets * 0.662 $ft^3/bucket$ = 1.986 ft^3; 10-20 sand, 30 bags * 0.535 ft^3/bag = 16.05 ft^3

Reported By:	Title:	Signature:	Date:
Charlene Martinez	Geologist	Charlene Martinez	09/06/03

A-6003-658 (04/03)

BOREHOLE LOG

Page 1 of 8

Date: 07/01/03

Well ID: C4122 | Well Name: 299-E25-93 | Location: East of 241-A Tank Farm

Project: C403 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	BH 9" OD	N/A		0'-2' Backfill material. Crushed basaltic gravel.	Becker Hammer using dual wall casing. 9" OD
				2'-11' Sand (S) 100%. V. well sorted R, fn-med. Trace mica. non basaltic 10 YR 5/3, brown (moist). Strong rxn HCl.	Eolian sands @ 2' bgs.
5	Grab				Collect 5' archive sample
	BH			11'-20' Sand (S) 95% sand, 5% silt. V. poorly sorted, SR-SA, vfn-vcse grained 85% basalt, 15% qtz/other 10 YR 3/2, very dark grayish brown (moist) mod. rxn HCl.	Hanford formation @ 11' bgs
10	Grab				Collect 10' archive sample.
	BH			20'-25' gravelly SAND(gS) 15% gravel, 80% sand, 5% silt. Gravel, mod. sorted, R, basaltic. Sand, v. poorly sorted. vfn-vcse, SR-SA, 90% basalt 10% qtz/other. No rxn HCl. 10YR3/2, v. dark grayish brown (moist)	
15	Grab				Collect 15' archive sample.
	BH				
20	Grab			25'-35' SAND(S) 100%. Poorly sorted, f-vcse grained, SR-SA, 45% basalt, 55% qtz/other. 10YR4/2, dark grayish brown (moist) micaceous. No rxn HCl.	Collect 20' archive sample.
	BH				
25	Grab				Collect 25' archive sample.
	BH			35'-45' gravelly SAND(gS) 10% gravel 85% sand, 5% silt. Gravel, well sorted, mps ~ 1", R, basaltic. Sand, poorly sorted, SR-SA, vfn-vcse grained, 90% basalt, 10% qtz/other, 10YR3/2, v. dark grayish brown (moist) No rxn HCl	
30	Grab				Collect 30' archive sample.
	BH				
35	Grab			45'-106' SAND(S) 100%. Poorly sorted, vfn-vcse, SR-SA, 90% basalt, 10% qtz/other. 10YR3/2, v. dark grayish brown (moist). No rxn HCl.	Collect 35' archive sample.
	BH				

Reported By: Charlene Martinez | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: Charlene Martinez | Date: 07/01/03 | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03)

BOREHOLE LOG

Page 2 of 8

Date: 07/01/03

Well ID: C4122 | Well Name: 299-E25-93 | Location: East of 241-A Tank Farm

Project: C403 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
40	BH Grab BH 9	n/a		@55' 45% basalt, 55% qtz/other (still sand) 10YR 4/3 (brown, moist) micaceous, SR-SR, poorly sorted. no rxn HCl.	Becker Hammer using dual wall casing. 4" OD. Collect 40' archive.
45	Grab BH 9				Collect 45' archive
50	Grab BH 9				Collect 50' archive
55	Grab BH 9				Collect 55' archive. A.M. RCT ck. ~~3.3~~ @ background
60	Grab BH 9				Collect 60' archive
65	Grab BH 9			@70' Sand grading to mod-sorted SR-R, micaceous, med-ucse grained.	Collect 65' archive
70	Grab BH 9				Collect 70' archive
75	Grab BH 9			@75'. Sand 95%, gravel < 5%, trace silt. Gravel, basaltic, well sorted, mps ~ 0.5". Sand, poorly sorted, SR-SR, vfn-ucse, 55% qtz/other, 45% basalt. 10YR 4/3, brown, no rxn HCl	collect 75' archive.

Reported By: Charlene Martinez | Title: Geologist | Signature: Charlene Martinez | Date: 07/01/03

Reviewed By: L.D. Walker | Title: Geologist | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 8

Date: 07/01/03

Well ID: C4122 | Well Name: 299-E25-93 | Location: East of 241-A Tank Farm

Project: C403 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
80	BH 9" Grab	n/a		@ 80' sand, v well sorted, (v fn-med grained) SR-R, 45% basalt, 55% qtz/other, no rxn HCl, micaceous.	Becker Hammer using dual wall casing, 9" OD. Collect 80' archive
	BH 9"				
85	Grab BH 9"				Collect 85' archive
90	Grab BH 9"			@ 90' trace of pea-sized, R basaltic gravel, still sand. Sand, poorly sorted, vfn-vcse, SR-SA, 45-55% basalt, 50% qtz/other, 10YR 4/3 brown, moist, no rxn HCl	Collect 90' archive
95	Grab BH 9"				Collect 95' archive
100	Grab BH 9"			@ 100' sand grading to mod. sorted sand, m-vcse grained, no gravel. Basalt increasing to 60%, 10YR 3/3, dark brown, moist	Collect 100' archive
105	Grab BH 9"			@ 105' trace well sorted gravel @ 105' basaltic. Sand, poorly sorted, SR-SA, vfn-vcse, 40% basalt, 60% qtz/other, 10YR 3/3, dark brown, moist	Collect 105' archive
110	Grab BH 9"			106'-115' gravelly SAND(gS) 20% gravel, 80% sand. Gravel, R, well-sorted, mps ~ 0.5", Basaltic. Sand, SR-SA, poorly sorted, vfn-vcse. Basalt - 60%, qtz/other 40%.	Collect 110' archive
115	Grab BH 9"			10YR 3/2, v. dark grayish brown (moist) No rxn HCl.	Collect 115' archive

Reported By: Charlene Martinez | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: Charlene Martinez | Date: 07/01/03 | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03)

BOREHOLE LOG

Page 4 of 8

Date: 07/01/03

Well ID: C 4122 | Well Name: 299-E25-93 | Location: East of 241-A Tank Farm

Project: CY03 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	BH 9" Grab BH 9"	n/a		45'-215' Sand (S) 100%, poorly sorted, SR-SA, vfn-vcse grained. 60-65% basalt, 30-35% qtz/other. 10YR 3/2 v. dark grayish brown (moist) micaceous. no rxn HCl.	Becker Hammer using dual wall casing. 9" OD. Collect 120' archive
125	Grab BH 9"				collect 125' archive
130	Grab BH 9"				collect 130' archive
135	Grab BH 9"			@ 135' trace basaltic gravel (<5%)	collect 135' archive
140	Grab BH 9"			@ 140' sand, grading to mod-well sorted, med-vcse grained.	collect 140' archive
145	Grab BH 9"			@ 145' sand, v. well sorted, SR-R, vfn-med grained, basalt 30%, qtz/other 70%, micaceous 10YR 4/4 dark yellowish brown (moist) no rxn HCl. (145'-150')	collect 145' archive
150	Grab BH 9"			@ 150' back to basaltic, poorly sorted sand as described above. (150'-155')	collect 150' archive
155	Grab BH 9"			@@ 155' another layer of vfn-med grained, well sorted sand as described @ 145'. (155'-160')	collect 155' archive

Reported By: Charlene Martinez | Title: Geologist | Signature: Charlene Martinez | Date: 07/01/03

Reviewed By: L.D. Walker | Title: Geologist | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03

BOREHOLE LOG

Page 5 of 8

Date: 07/01/03

Well ID: C4122 | Well Name: 299-E25-93 | Location: East of 241-A tank farm

Project: C403 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
160	BH 9" Grab	N/A		@160' sand, vfn-vcse grained, 60% basalt, 40% qtz/other, poorly sorted, SR-SA, 10YR4/2 dark grayish brown (moist), no rxn HCl. (160'-165')	Becker Hammer using dual wall casing 9" OD. Collect 160' archive.
165	Grab BH 9"			@165' sand, vfn-med grained, well-sorted, SR-R, 70% qtz/other, 30% basalt. 10YR4/4 dark yellowish brown (moist) no rxn HCl. (165'-170')	Collect 165' archive.
170	Grab BH 9"			@170' basaltic (60%) vfn-vcse grained poorly sorted, SR-SA sand. 10YR4/3 dark grayish brown (moist). No rxn HCl.	Collect 170' archive.
175	Grab BH 9"				Collect 175' archive.
180	Grab BH 9"				Collect 180' archive.
185	Grab BH 9"				Collect 185' archive.
190	Grab BH 9"				Collect 190' archive.
195	Grab BH 9"			@195' sand, not as coarse, silt increase ~ to 5%. Basaltic, SR-SA.	Collect 195' archive.

Reported By: Charlene Martinez | Title: Geologist | Signature: Charlene Martinez | Date: 07/01/03

Reviewed By: L.D. Walker | Title: Geologist | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03)

BOREHOLE LOG

Page 6 of 8

Date: 07/01/03

Well ID: C4122 | Well Name: 299-E25-93 | Location: East of 241-A Tank Farm

Project: C4 03 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
200	BH 9" Grab BH 9"	n/a		@ 200' sand (95%) silt (5%) sand, med-vcse, mod-well sorted, SR-SA, 60% basalt, 40% qtz/other, micaceous 10YR4/3, brown, moist no rxn HCl.	Becker Hammer using dual wall casing 9" OD. Collect 200' archive
205	Grab BH 9"				Collect 205' archive. Am IH ck organics < detect.
210	Grab BH 9"				Collect 210' archive
215	Grab BH 9"			215-220' gravelly SAND(gS) 10% gravel, 85% sand, 5% silt. Gravel, R-SR, well sorted, predominately pea-size gravel, mps. ≤0.5", basaltic. Sand, v. poorly sorted, SR-SA, vfn-vcse grained. 60% basalt, 40% qtz/other. Trace mica. 10YR 4/3 brown (moist) no rxn HCl.	Collect 215' archive
220	Grab BH 9"			220-230' SAND(S) 95% sand, 5% silt, trace gravel. Sand, v. poorly sorted, SR-SA, vfn-vcse grained. 60% basalt, 40% qtz/other. 10YR 4/3 brown (moist) no rxn HCl.	Collect 220' archive
225	Grab BH 9"				Collect 225' archive
230	Grab BH 9"				Collect 230' archive
235	Grab BH 9"				Collect 235' archive.

Reported By: Charlene Martinez | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: Charlene Martinez | Date: 9/10/03 | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03

BOREHOLE LOG

Page 7 of 8

Date: 07/01/03

Well ID: C4122 | Well Name: 299-E25-93 | Location: East of 241-A Tank Farm

Project: CY03 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
240	BH 9" Grab BH 9"	n/a		@240' Sand, trace gravel, trace silt. sand, v. poorly sorted, fine-coarse grained, SR-SA, 60-65% basalt, 20-35% qtz/other. 10YR 4/3 brown (moist) no rxn HCl.	Becker Hammer using dual wall casing. 9" OD. Collect 240' archive
245	Grab BH 9"				Collect 245' archive
250	Grab BH 9"				Collect 250' archive
255	Grab BH 9"				Collect 255' archive
260	Grab BH 9"			266'-317' Sandy GRAVEL (SG) 45% gravel, 50% sand, 5% silt. Gravel, mod sorted, pea-sized to med. pebbles, SA-R, sand, poorly sorted, SR-SA, med-v.c.s.e grained. 10YR 5/3 brown (moist) no rxn HCl.	Collect 260' archive. Cont. RCT coverage between 260'-280' bgs. 2x BKG @ background
265	Grab BH 9"				Collect 265' archive
270	Grab BH 9"				Collect 270' archive
275	Grab BH 9"			Tagged g.w. @ 278.04' bgs (07/15/03)	Collect 275' archive. FMIH ck. organics < detect. E.O.S. @ 280' bgs (07/01/03). Start @ 280' bgs (07/02/03)

Reported By: Charlene Martinez | Title: Geologist | Signature: Charlene Martinez | Date: 07/01/03

Reviewed By: L.D. Walker | Title: Geologist | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03)

BOREHOLE LOG

Page 8 of 8

Date: 07/01/03

Well ID: C4122 | Well Name: 299-E25-93 | Location: East of 241-A Tank Farm

Project: C403 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
280	BH 9"	n/a			Becker Hammer using dual wall casing. 9" OD
	Grab	200 blows			Collect 280' archive
	SS# 1	0% rec			SS# 1 280 - 282.5' bgs
	BH 9"	n/a			no recovery
285	Grab				Collect 285' archive
	BH 9"				Am Ref ck
					4.3.0 @ background
290	Grab				Collect 290' archive
	BH 9"				
295	Grab				Collect 295' archive
	BH 9"				
300	Grab				Collect 300' archive
	BH 9"				
305	Grab				Collect 305' archive
	BH 9"				Am IH ck
					organics < detect.
310	Grab				Collect 310' archive
	BH 9"			312'-320' Silty Sandy GRAVEL (msG) 60% gravel, 30% sand, 10% silt. Gravel, poorly sorted, SA-R, 20% basalt, 80% qtz/other. Sand, poorly sorted, SR-SA, vfn-vcse, 25% basalt, 75% qtz/other, moderate cementation, Fe oxide staining, micaceous. Sample- wet.	
315	Grab				Collect 315' archive. Ringold fmtn @ 312' bgs
	SS# 2	200 blows 15% rec.			
	BH 9"	n/a			Collect 320' archive. TD @ 320' bgs.
320	Grab				

Reported By: Charlene Martinez | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: Charlene Martinez | Date: 07/09/03 | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03)

WELL DEVELOPMENT AND TESTING DATA

Report # 3
Page 1 of 3

Well Name:	Well ID:	Well Location:	Date:
299-E25-93	C4122	East of 241-A Tank Farm	08/14/03

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

Has the well been surveyed? ☐ Yes ☒ No

Does the well have a cement pad? ☒ Yes ☐ No

PART 1

STATIC WATER LEVEL:

Start of Job 281.26' TOC

End of Job —

DEPTH TO BOTTOM:

Start of Job 318.82' TOC

End of Job —

PART 2

WELL DEVELOPMENT DATA

Pump Model Franklin 5 HP submersible

Intake Depth B 316.1' / m 306' / T 296'

Starting Turbidity B 12.6 / m 69.1 / T 6.14

Pump Start	Stop	Flow Rate
(59 mins) 1041	(1504.5 gals) 1140	25.5 gpm
(64 mins) 1238	(1664 gals) 1342	26.0 gpm
(53 mins) 1437	(1378 gals) 1530	26.0 gpm
1504.5 + 1664 + 1378 = 4547 gals		6.5 gpm

Total Pumped 4547 gals.

Final Turbidity B 1.26 / m 0.83 / T 1.19

XD SN/Range (PSI) 20.0 psi

PART 3

INSTANTANEOUS SLUG TEST

Static Water Level (TOC)

Transducer Depth

Baseline Start

Injection Start

Baseline Start

Withdrawal Start

Slug Volume

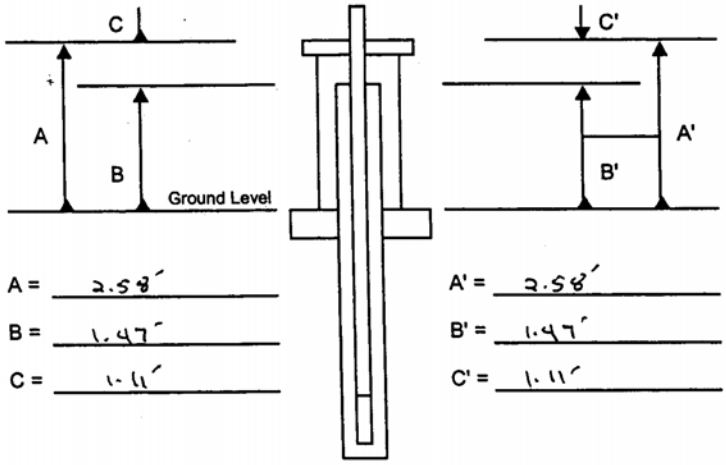
XD SN/Range (PSI)

Not used 08/14/03 Charlene Martinez

PART 4

Last Recorded Measurements Date: 08/06/03

Current Measurements Date: 08/14/03



A = 2.58'

B = 1.47'

C = 1.11'

A' = 2.58'

B' = 1.47'

C' = 1.11'

Are there any reference marks on the casing strings? ☐ Yes ☐ No

PART 5

COMMENTS:

0850 Tagged g.w. => 281.26' from TOC

0852 Tagged bottom => 318.82' from TOC. no fill

0852 Pump setting rig on site. Setting up.

0906 measured pump: motor = 2.3'. Intake @ 2.3'-2.5' (0.2' long). upper portion of pump => 2.35' long. Total pump = 4.65' long. Franklin 5 HP submersible electric.

0907 Assembling pump. Testing. Works.

0929 Tripping in pump / tremmie pipe.

0938 Purge water truck on site.

0940 Instruments calibrated.

1025 Pump / tremmie pipe installed. Pump @ 316.1' TOC.

1030 Setting transducer.

Prepared by (print name):	Signature:	Date:
Charlene Martinez	Charlene Martinez	08/14/03
Reviewed by (print name):	**Signature:**	**Date:**
L.D. Walker	L.D. Walker	10-1-03

A-6003-644 (03/03)

FIELD ACTIVITY REPORT - DAILY DRILLING

Date: 08/14/03

Well ID: C4122 | Well Name: 299-E25-93

Location: East of 241-A Tank Farm | Report No.: 3 (well development)

Start	Finish	Total
Time 0845	Time 1600	Time 7.25 hrs
Hole Depth/Csg — / —	Hole Depth/Csg — / —	Hole Depth/Csg — / —

Reference Measuring Point: GROUND SURFACE

Casing String No. 1 2 3 4 ____ Rod Size:

See Report No. 1 well Development

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth (Attach applicable drawings and document straightness test results)
1040		32.704 initial head (Bottom Interval)
1041		Test #1 started. Flow meter => 25.5 gpm. XD = 32.553.
1046		Initial measurements: pH 8.111, Turb 126 NTU, T = 20.8; cond 567 µS/cm
1059		pH meter quit working.
		meter Readings: Bottom Interval
	Time	~~µS/cm~~ cond; NTU Turb; °C T; XD (ft); drawdown (ft)
	1059	559 3.47 20.5 32.597 0.107
	1111	565 1.68 21.2 32.585 0.119
	1130	558 1.35 22.2 32.584 0.12
	1138	564 1.26 20.4 32.548 0.156
1140		End test #1. Start recovery test (#2) XD = 32.625'
	1151	Final XD => 32.649'; 99.8% recovery. Stop test #2
1156		Removing 20' tremmie pipe. Tripping in 10' to reset the pump. new intake depth @ 306' bgs.
1203	1235	Purge water truck off-site. Back on site
1238	1342	Begin test #3 (initial head, 22.598') before test.
		Initial readings: middle interval (306' Intake depth)
		XD 22.585'. cond 552 µS/cm = 24.2°C; Turb. 109.1 NTU. 25 gpm from flowmeter.
		Meter Readings (middle interval)
	Time	µS/cm cond; NTU Turb; T°C; XD (ft); drawdown (ft)
	1252	548 1.75 23.6 22.599 0
	1324	554 0.75 20.6 22.531 0.0607
	1338	550 0.83 21.6 22.615 0
1342	1358	Start recovery test (#4) Final XD = 22.608'; 100% recovery

Reported By: Charlene Martinez | Reviewed By:

Title: Geologist | Date: 08/14/03 | Title: | Date:

Signature: Charlene Martinez | Signature:

A-6003-651 (04/03)

FIELD ACTIVITY REPORT - DAILY DRILLING

Continuation Page

Date: 08/14/03

Well Name: 299-E25-93

Well ID: C4122

Location: East of 241-A Tank Farm

Continuation of Report No.: 3 (well development)

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth
1359	1432	Purge water truck off-site. Back
1400		Remove 10' tremmie pipe. Set intake of pump @ 296' bgs, for
	1405	3rd development interval. TOP interval
1437	1530	Initial readings: 12.651' XD. Begin test #5 for 3rd interval
		Readings: XD = 12.570'; 26 gpm, T=22.4° C, turb 6.14 NTU
		cond = 554 µS/cm
		Meter readings 3rd interval (TOP)
	Time	XD (ft) T °C Turb (NTU) Cond (µS/cm) drawdown
	1505	12.621 20.9 1.94 555 0.03'
	1517	12.630 21.4 1.49 551 0.021'
		12.615 20.6 1.19 555 0.036'
1530	1540	Begin recovery test (#6) Stop recovery. Final XD = 12.660' 100% rec.
1550		Transducer pulled from well. Tremmie pipe + pump still in well.
		Unable to tag bottom or ground water.
1553		Geologist off site to complete sieve analyses.

Not used Charlene Martinez 08/14/03

Reported By: Charlene Martinez	Reviewed By:
Title: Geologist Date: 08/14/03	Title: Date:
Signature: Charlene Martinez	Signature:

A-6003-652 (04/03)

FIELD ACTIVITY REPORT - WELL SERVICES

Page 1 of 1

Date	Well No.	Rig Type/Model	Rig No.	Contract/Work Order No.	Report No.
09/16/03	299-E25-93 C4122	Pump setting rig			1

Purpose: Install pumps in C403 RCRA wells.

Reference:

Location: East of 241-A Tank Farm

HISTORICAL DATA

Construction Depth: 315.26' bgs

Casing Size	Type	Set At
4" ID SS304, sch. 10		+2.0' - 278.23'

Casing Perforations Schedule: Interval 278.23' - 313.26'

Well Screen(s) Type: 4" ID SS304, sch 10, 0.020" slot Interval

Last Recorded Depth-to-Water	Last Recorded Depth-to-Bottom
281.26'	318.82'

Current Depth-to-Water	Current Depth-to-Bottom
281.3'	318.92'

PUMP SYSTEM CONFIGURATION

	Pre-Maintenance	Post-Maintenance
Pump Type: 0.7 HP	Grundfos Redi flo3	
Pump Model	Prod #24903713 model A	
Tubing Size/Type	0.75" OD SS 304 sch. 40	
Length-Bottom of Tubing to Pump Intake	1.11'	
Tubing Length	285.0'	
Length-Top of Tubing to Reference Point		
Pump Intake Set at (Depth)	286.1' TOC	

Reference/Measuring Point: Top of casing

Start Time: 0845
End Time: 1315
Time:
Contract Time:
Total Time: 4.5 hrs

Personnel
FH - fwos (T. Hottell)
CH6 geologist - C. Martinez
Layne Christensen drill crew:
- Dale
- Ken
- Paul

Materials Used
Grundfos Redi flo3 pump
0.75" OD schedule 40, ss304 tremmie pipe.
28 => 10' sections = 280'
1 => 5' section = 5'

Description of Operations/Remarks

0845 On-site. FWOS (T. Hottell) & drill crew @ laydown yard testing pump.
0900 Tagged g.w. (281.3' TOC). Tagged TD (318.92' TOC).
1038 Pump setting rig & drill crew on site.
1039 Setting up rig.
1050 Installing 0.7 HP Grundfos Redi flo3 pump & 0.75" OD tremmie pipe. Intake of Pump set @ 286.1' TOC
1300 Landing plate stuck on 5' casing. While removing 5' casing crew discovered wire on pump had broken. Cut ~ 1' off wires; wire splicing kit in town.
1315 Geologist released. Drill crew off-site to decon more tremmie pipe, will repair wires in A.M.
1320 Geologist off site.

not used
Charlene Martinez 09/16/03

Report By: Charlene Martinez
Title: Geologist
Signature: Charlene Martinez

Reviewed By: L.D. Walker
Title: Geologist Date: 10-1-03
Signature: L.D. Walker

DISTRIBUTION: White-Field File Custodian Yellow-Group Files Pink-Project Coordinator Goldenrod-Team Leader BC-6000-278 (04/91)

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend **Company:** Fluor Federal Services
Date Requested: 9/29/03	**Requestor:** Chris S. Wright (FH)
Date of Survey: 10/31/03	**Surveyor:** Fluor Federal Services Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** Grant F. Brazil, P.L.S.
Description of Work: Civil Survey of Groundwater Monitoring Well C4122 (299-E25-93).	**Horizontal Datum:** NAD83(91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 200E

Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
2E-127 (FFS) and 2E-134 (FFS)

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

Well ID	Well Name	Easting	Northing	Elevation	
C4122	299-E25-93	575471.51	136022.09		Center of Casing
				208.040	Top Casing, N. Edge
				207.265	Brass Survey Marker
				208.046	Top Pump Base-plate, N. Edge

Notes:

Surveyor Statement:
I, Grant F. Brazil, a Professional Land Surveyor registered in the State of Washington (Registration No. 22326), hereby certify that this report is based on a field survey performed in October, 2003 under my direct supervision, and that the data contained here is true and correct.

Original to:
Distribution by DIS:

WELL SUMMARY SHEET

Start Date: 07/10/03
Finish Date: 07/17/03
Page 1 of 2

Well ID: C 4123
Well Name: 299-E24-22
Location: West of 241-AY Tank Farm
Project: C4103 RCRA drilling
Prepared By: Charlene Martinez
Date: 08/06/03
Reviewed By: L.D. Walker
Date: 8/11/03
Signature: Charlene Martinez
Signature: L.D. Walker

CONSTRUCTION DATA

Description	Diagram
9" OD dual wall temporary carbon steel casing.	
6" ID protective casing set + 1.0 ' above permanent	
4" ID ss 304, sched 10 riser: +2.00' → 286.21'	
Portland cement grout: 0' → 10.0'	
Granular bentonite: 10.0' → 276.1'	
All temporary casing removed from ground:	
All depths are in feet below ground surface.	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
0		0'-2' Backfill material (crushed gravel)
		2'-15' SAND (S)
		15'-25' gravelly SAND (gS)
		25'-175' SAND (S)
40		
80		
120		
160		
		175'-180' gravelly SAND (gS)
		180'-220' SAND (S)
200		
		220'-225' gravelly SAND (gS)
		225'-270' SAND (S)

A-6003-643 (03/03)

WELL SUMMARY SHEET

Start Date: 07/10/03
Finish Date: 07/17/03
Page 2 of 2

Well ID: C4123
Well Name: 299-E24-22
Location: West of 241-AY Tank Farm
Project: CY03 RCRA drilling
Prepared By: Charlene Martinez Date: 08/06/03
Reviewed By: L.D. Walker Date: 8/11/03
Signature: Charlene Martinez
Signature: L.D. Walker

CONSTRUCTION DATA

Description	Diagram
1/4" bentonite pellets: 276.1' → 281.1'	
10-20 mesh silica sand: 281.1' → 330'	
0.020" slot cont. wire-wrap wellscreen (ss 304 sched. 10) 286.21' → 321.26'	
ss 304 sched. 10 sump/ ~~cattp~~ endcap: 321.26' → 323.68'	
All temporary casing removed from ground.	
All depths are in feet below ground surface	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
240		
		270'-272' silt/clay (m)
280		272'-281' SAND (S)
		281'-285' gravelly SAND (gS)
		285'-290' SAND (S)
		290'-300' gravelly SAND (gS)
		300'-310' sandy GRAVEL (sG)
320		310'-330' silty sandy GRAVEL (msG)
		TD = 330' bgs
		static water => 286.02' bgs (07/17/03)
360		

A-6003-643 (03/03)

WELL CONSTRUCTION SUMMARY REPORT

Start Date: 07/10/03
Finish Date: 09/08/03
Page 1 of 1

ID: C4123	Well Name: 299-E24-22	Approximate Location: West of 241-A-Y Tank Farm
Project: C403 RCRA drilling		Other Companies: FH, CHG
Drilling Company: Layne Christensen		Geologist(s): C. Martinez, M.J. Hocking
Driller: Paul ("Dery") Lodder	License #: 1628	

TEMPORARY CASING AND DRILL DEPTH			DRILLING METHOD	HOLE DIAMETER (in.) / INTERVAL (ft)
*Size/Grade/Lbs. Per Ft.	Interval	Shoe O.D./I.D.	Auger:	Diameter ____ From ____ to ____
Dual-wall, carbon steel,	0' - 320'	9"	Cable Tool:	Diameter ____ From ____ to ____
FJ. 9" OD (outer)	____ - ____		Air Rotary:	Diameter ____ From ____ to ____
7"/6" (inner)	____ - ____		A.R. w/Sonic:	Diameter ____ From ____ to ____
	____ - ____		Reverse Air (Becker Hammer)	Diameter 9" From 0' to 330'
	____ - ____			Diameter ____ From ____ to ____
*Indicate Welded (W) - Flush Joint (FJ) Coupled (C) & Thread Design				Diameter ____ From ____ to ____

Drilling Fluid: N/A

Total Drilled Depth: 330'	Hole Dia @ TD: 9"	Total Amt. Of Water Added During Drilling: —	
Well Straightness Test Results: Passed using 4.5" OD, 20.4' long on 07/15/03.		Static Water Level: 286.02'	Date: 07/17/03

GEOPHYSICAL LOGGING

Sondes (type)	Interval	Date	Sondes (type)	Interval	Date
Spectral Gamma	0' - 328.8'	07/12/03 & 07/14 & 07/15, 2003		____ - ____	
	____ - ____			____ - ____	
	____ - ____			____ - ____	

COMPLETED WELL

Size/Wt./Material	Depth	Thread	Slot Size	Type	Interval Annular Seal/Filter Pack	Volume	Mesh Size
4" ID SS304 sch.10 casing	+2.0' - 286.21'	F480	N/A	Portland cement (94#)	0' - 10.0'	5 bags	N/A
4" ID SS304 sch.10 wellscreen	286.21' - 321.26'	"	0.020"	Granular Bentonite (50#)	10.0' - 276.1'	114 bags	N/A
4" ID SS304 sch.10 sump.	321.26' - 323.68'	"	N/A	Bentonite Pellets (50#)	276.1' - 281.1'	2.5 buckets	1/4"
	____ - ____			Colorado Silica Sand (50#)	281.1' - 330.0'	33 bags	10-20
	____ - ____				____ - ____		

OTHER ACTIVITIES

Aquifer Test:	Date:	Well Decommission:	Yes:	No:	Date:
Description:		Description:			

WELL SURVEY DATA (if applicable)

	Protective Casing Elevation:
Washington State Plane Coordinates:	Brass Survey Marker Elevation:

COMMENTS / REMARKS

Vol. calcs. => P.C., 5 bags * 1.285 ft³/bag = 6.43 ft³; Granules => 114 bags * 0.21 ft³/bag = 90.94 ft³; Pellets => 2.5 buckets * 0.62 ft³/bucket = 1.55 ft³; Sand => 33 bags * 0.535 = 17.66 ft³.

Reported By:	Title:	Signature:	Date:

A-6003-658 (04/03)

BOREHOLE LOG

Page 1 of 9

Date: 07/10/03

Well ID: C4123 | Well Name: 299-E24-22 | Location: West of 241-AY Tank Farm N.W. of 241-A Tank farm

Project: CY03 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	BH 9"	n/a		0-2' Backfill material. Crushed gravel	Dual wall casing 9"OD: 7"/6"
				2'-15' SAND(S) 100%, v. well sorted, vfn-med grained, SR-R. 10YR 3/3, dark brown, moist, strong rxn HCl. Non-basaltic.	Becker Hammer drilling. Aeolian sand 2'-10'
5	Grab BH 9"			@ 10'-15' sand basaltic, (65%) 35% qtz/other. Poorly sorted, SR-SA vfn-v'csse grained. Trace mica. 10YR 3/2 v. dark grayish brown (moist) Strong rxn HCl.	Collect 5' archive. Hanford fmtn @ 10' bgs
10	Grab BH 9"			15'-25' gravelly SAND(gS) 15% gravel, 80% sand, 5% silt. Gravel mod-sorted, SA-R, basaltic. Sand poorly sorted, SR-SA, vfn-vcse grained, 80% basalt, 20% sand 7.5YR 3/1 v. dark gray (moist) mps ~ 1"	Collect 10' archive.
15	Grab BH 9"				Collect 15' archive.
20	Grab BH 9"			25'-175' Sand(s) 5% gravel, 95% sand, trace silt. Gravel, basaltic, mod-sorted, SR-R Sand. 40% basalt, 40% qtz/other, poorly sorted, SR-SA 10YR 4/2 dark grayish brown (moist) no rxn HCl.	Collect 20' archive.
25	Grab BH 9"			@ 30' basalt content increasing to ~ 70%.	Collect 25' archive.
				@ 35' sand grading to well-sorted, med-v. csse. grained. Basalt, 45%, qtz/other 55%, micaceous SR-SA 10YR 5/2 grayish brown (moist) no rxn HCl.	
30	Grab BH 9"				Collect 30' archive.
35	Grab BH 9"				Collect 35' archive.

Reported By: Charlene Martinez | Title: Geologist | Signature: Charlene Martinez | Date: 07/10/03

Reviewed By: L.D. Walker | Title: Geologist | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03

BOREHOLE LOG

Date: 07/10/03

Well ID: C4123 | Well Name: 299-E24-22 | Location: West of 241-AY Tank Farm, N.W. of 241-A Tank Farm

Project: CY03 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
40	BH9" Grab BH9"	n/a		@ 40' sand grading to vfn-vcse grained, 20% basalt, 30% qtz, other, poorly sorted, SR-SA. moist	Becker Hammer rig using 9" OD dual wall casing. Collect 40' archive
45	Grab BH9"				Collect 45' archive
50	Grab BH9"				Collect 50' archive
55	Grab BH9"			sand is increasing in basalt content (~80%) moist @ 55'	Collect 55' archive
60	Grab BH9"				Collect 60' archive
65	Grab BH9"				Collect 65' archive
70	Grab BH9"				Collect 70' archive
75	Grab BH9"				Collect 75' archive

Reported By: Charlene Martinez | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: Charlene Martinez | Date: 07/10/03 | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03)

BOREHOLE LOG

Page 3 of 9

Date: 07/10/03

Well ID: c4123 | Well Name: 299-E24-22 | Location: West of 241-AY Tank Farm N.W. of 241-A Tank Farm

Project: CX03 BCR | 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
80	BH9" Grab BH9"	N/A		@ 80' traces of well sorted SR-R gravel, basaltic mps ~ 0.5". Sand continues to be 80% basalt, 20% poorly sorted as before. moist	Becker Hammer using 9" dual wall casing. Collect 80' archive.
85	Grab BH9"				Collect 85' archive
90	Grab BH9"				collect 90' archive
95	Grab BH9"				collect 95' archive
100	Grab BH9"			@ 100' gravel increasing to 5%. Basaltic, well sorted mps ≤ 1". SR-R sand, basaltic, vfn-vcse, SR-SA	Collect 100' archive
105	Grab BH9"				Collect 105' archive
110	Grab BH9"			@ 110' sand, med-vcse grained, well-sorted, SR-SA, 45% basalt, 55% qtz/other. Trace mica. 7.5YR 5/3 brown (moist) no rxn HCl.	Collect 110' archive IH ck. Organics < detect.
115	Grab BH9"			@ 115' sand grading back to 60% basalt, 40% qtz/other, SR-SA, poorly sorted, vfn-vcse grain 2.5YR 4/2 brown, moist no rxn HCl.	Collect 115' archive.

Reported By: Charlene Martinez | Title: Geologist | Signature: Charlene Martinez | Date: 07/15/03

Reviewed By: L.D. Walker | Title: Geologist | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03

BOREHOLE LOG

Date: 07/10/03

Well ID: C4123 | Well Name: 299-E24-22 | Location: West of 241-AY Tank Farm

Project: CY03 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	BH 9" Grab BH 9"	N/A		@120' same desc. as 115'.	Becker Hammer using 9 4 00 dual wall casing. Collect 120' archive
125	Grab BH 9"			@125' trace of well sorted, pea-size basaltic gravel, SR-R (<5%)	Collect 125' archive
130	Grab BH 9"				Collect 130' archive
135	Grab BH 9"			@135' trace of pea-size basaltic gravel	Collect 135' archive
140	Grab BH 9"			@140' sand grading to well-sorted, med-vcse grained, SR-SA, 40% basalt, 60% qtz/other, 10YR5/3 brown, moist, no rxn HCl. Trace pea-sized gravel.	Collect 140' archive.
145	Grab BH 9"			@145' Increase in pea-size basaltic gravel (<5%)	Collect 145' archive
150	Grab BH 9"				Collect 150' archive.
155	Grab BH 9"				Collect 155' archive.

Reported By: Charlene Martinez | Title: Geologist | Signature: Charlene Martinez | Date: 07/10/03

Reviewed By: L.D. Walker | Title: Geologist | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03)

BOREHOLE LOG

Page 5 of 9

Date: 07/10/03

Well ID: C4123 | Well Name: 299-E24-22 | Location: West of 241-AY Tank Farm

Project: C403 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
160	BH9" Grab BH9"	N/A		@ 160' sand grading to well-sorted, SR-SA med-vcse grain. Trace mica, 40% basalt, 60% qtz/other.	Becker Hammer using 9" OD dualwall casing. Collect 160' archive.
165	Grab BH9"				Collect 165' archive.
170	Grab BH9"			@ 170' sand grading to poorly sorted, 65% basalt, 35% qtz/other, SR-SA vfn-vcse grain.	Collect 170' archive.
175	Grab BH9"			175–180' gravelly SAND (gS) 10% gravel, 90% sand. Gravel, well-sorted, SR-R basaltic, mps ≤1". Sand, v poorly sorted, SR-SA, 65% basalt, 35% qtz/other, vfn-vcse grain. 7.5YR 4/2 brown (moist) no rxn HCl.	Collect 175' archive.
180	Grab BH9"			180–220' SAND (S) 100%. v poorly sorted, vfn-vcse grained, SR-SA, 70% basalt, 30% qtz/other 7.5YR 4/1 dark gray (moist). no rxn HCl	Collect 180' archive.
185	Grab BH9"			@ 185' basalt content decreasing to ~60%. qtz/other increasing to 40% sand grading to mod-well sorted, SR-SA, med-vcse grained.	Collect 185' archive.
190	Grab BH9"				Collect 190' archive.
195	Grab BH9"			@ 195' traces of pea-sized gravel, basaltic. Sand as above.	Collect 195' archive.

Reported By: Charlene Martinez | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: Charlene Martinez | Date: 07/10/03 | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03)

BOREHOLE LOG

Date: 07/10/03

Well ID: C4122 | Well Name: 299-E24-22 | Location: West of 241-AY Tank Farm

Project: CY03 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
200	BH9" Grab BH9"	n/a		@200' sand grading to poorly sorted, SR-SA, vfn-vcse grained. 60% basalt, 40% qtz/other. Trace gravel. Trace mica.	Becker Hammer using 9" OD dual-wall casing. Collect 200' archive. RCT ck. of 3.15 @ background
205	Grab BH9"			@205 sand grading to med-well sorted med-vcse grained. Trace gravel. Basalt content 60%, qtz/other 40%.	Collect 205' archive
210	Grab BH9"				Collect 210' archive
215	Grab BH9"			@215' sand grading to poorly sorted vfn-vcse grained. Trace gravel.	Collect 215' archive
220	Grab BH9"			220'–225' gravelly SAND(gS) 15% gravel, 85% sand. Gravel, poorly sorted SR-A, pea-size to med pebbles. 35% qtz/other, 65% basalt. mps ~ 16". Sand, SR-SA, poorly sorted. 60% basalt, 40% qtz/other, vfn-vcse grained. 2.5Y 3/2 v. dark grayish brown, moist. no rxn HCl. Trace mica.	Collect 220' archive
225	Grab BH9"				Collect 225' archive
230	Grab BH9"			225–270' SAND(S) 100%. SR-SA, mod-well sorted, med-vcse grained. Trace mica. 55% basalt, 45% qtz/other. 2.5Y 4/3 olive brown, moist. no rxn HCl.	Collect 230' archive
235	Grab BH9"				Collect 235' archive

Reported By: Charlene Martinez | Title: Geologist | Signature: Charlene Martinez | Date: 07/10/03

Reviewed By: L. D. Walker | Title: Geologist | Signature: L D Walker | Date: 10/1/03

A-6003-642 (03/03)

BOREHOLE LOG

Page 7 of 9

Date: 07/10/03

Well ID: C4122 | Well Name: 299-E24-22 | Location: West of 241-AY Tank Farm

Project: CY03 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
	BH 9"	n/a		@ 240' same as previous description (225')	Becker Hammer using 9" OD dual wall casing
240	Grab BH 9"				collect 240' archive
245	Grab BH 9"				collect 245' archive
250	Grab BH 9"				collect 250' archive
255	Grab BH 9"				collect 255' archive
260	Grab BH 9"				collect 260' archive; End of shift @ 260' bgs (07/10/03)
				@ 265' sand grading to poorly sorted, vfn-vcse. grain, basaltic. Trace of well-sorted, SR-R gravel (< 5%) pebbles to sm. pebbles. Basaltic	Start 07/11/03
265	Grab BH 9"				collect 265' archive
270	Grab BH 9"			270' – 272' SILT (m) clay 100% very compact matrix, mod. plasticity, laminar bedding, traces of Fe oxide staining. Color 10Y 5/1 greenish gray (moist) outer color. Inner color 2.5Y 5/4 light olive brown (moist). Also 2.5Y 5/6 light olive brown (moist). Weak to no rxn HCl.	collect 270' archive
275	Grab BH 9"				collect 275' archive

Reported By: Charlene Martinez | Reviewed By: L.D. Walker

Title: Geologist | Title: Geologist

Signature: Charlene Martinez | Date: 07/10/03 | Signature: L.D. Walker | Date: 10/1/03

A-6003-642 (03/03

BOREHOLE LOG

Date: 07/11/03

Well ID: C4123 | Well Name: 299-E24-22 | Location: West of 241-AY Tank farm

Project: C403 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
280	BH 9" Grab	N/A		272'–281' SAND(s) 100%, trace of pea-size gravel (basaltic), Sand, SR-SA, poorly sorted, vfn-vcse grained, 65% basalt, 35% qtz/other, trace mica, no rxn HCl, 2.5Y3/2 v. dark grayish brown (moist)	Becker Hammer using 9" OD dual wall casing. Collect 280' archive.
285	Grab				G.w. @ 286.02' bgs (7/10/03). Collect 285' archive.
	SS# 1 100% rec.				SS# 1 interval (286.0'–288.5') sieve analysis indicated a silty sand here.
290	BH 9" Grab BH 9"	N/A		281'–285' gravelly SAND(gS) 15% gravel 85% sand, Gravel, pred. pea-size to sm pebbles, well-sorted, SR-R, basaltic. Sand, SR-SA, poorly sorted, vfn-vcse, 65% basalt, 35% qtz/other. 2.5Y3/2, v. dk grayish brown no rxn HCl.	Collect 290' archive.
295	Grab BH 9"			285–290' SAND(s) 100% poorly sorted, vfn-vcse, SR-SA, 75% basalt, 25% qtz/other. Trace gravel (basaltic) 2.5Y3/2, v. dk. grayish brown (very moist @ 286' bgs)	Collect 295' archive.
300	Grab BH 9"				RCT ck. of 3.8 @ background. Collect 300' archive. IH ck: 3.6–3.8 ppm organics in borehole. Oxygen % depletion may be corrosive (acid or basic) or possible rad.
305	Grab BH 9"			290'–300' gravelly SAND(gS) 20% gravel, 80% sand, Gravel, well sorted, pea-size - sm pebbles, SR-R, basaltic. Sand, SR-SA, vfn-vcse, poorly sorted, 65% basalt, 35% qtz/other. 2.5Y3/3, v dk grayish brown	Collect 305' archive.
310	Grab BH 9"			300'–310' sandy GRAVEL(sG) 70% gravel, 25% sand, 5% silt. Gravel, 35% basalt, 65% qtz/other, v poorly sorted, SA-R, pea-size to med cobbles mps 3-4". Sand, poorly sorted, vfn-vcse grained, SR-SA, 65% basalt, 35% qtz/other sample wet.	larger cobbles @ 310' bgs > 5". Collect 310' archive.
315	Grab BH 9"			310' (next page)	Collect 315' archive.

Reported By: Charlene Martinez | Title: Geologist | Signature: Charlene Martinez | Date: 07/11/03

Reviewed By: L.D. Walker | Title: Geologist | Signature: L.D. Walker | Date: 10/1/03

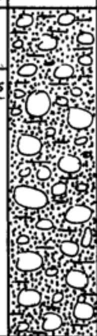
A-6003-642 (03/03)

BOREHOLE LOG

Page 9 of 9

Date: 07/11/03

Well ID: C4123	Well Name: 299-E24-22	Location: west of 241-AY Tank Farm
Project: C403 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
320	BH 9"	n/A		310'-330' Silty Sandy GRAVEL (msG)	Becker Hammer using 9" OD
	Grab			70% gravel, 20% sand, 10% silt	dual-wall casing
	BH 9" / sieve	analysis		Gravel, SR-A, v. poorly sorted, pea-size to	Collected 320' archive
	BH 9"	n/A		med cobbles (mps ~6") 55% basalt,	Collect sample @ 321' bgs
				45% qtz/other. Sand, mod-sorted, SR-R,	for sieve analysis (from cyclone)
325				70% basalt, 30% qtz/other, pred.	
	Grab			vfn-med grain (~20% vcse-cse),	Collect 325' archive
	BH 9"			micaceous, Fe oxide staining. Sample	
				wet.	
330	Grab				
	TD =	330'	bgs		Collect 330' archive
				TD = 330' bgs	
335					

Reported By: Charlene Martinez		Reviewed By: L.D. Walker	
Title: Geologist		Title: Geologist	
Signature: Charlene Martinez	Date: 07/11/03	Signature: LD Walker	Date: 10/1/03

A-6003-642 (03/03)

WELL DEVELOPMENT AND TESTING DATA

Well Name:	Well ID:	Well Location:	Date:
299-E24-22	C4123	West of 241-A4 Tank Farm	09/08/03

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

Has the well been surveyed? ☐ Yes ☒ No | Does the well have a cement pad? ☒ Yes ☐ No

PART 1

STATIC WATER LEVEL:

Start of Job 288.94' TOC

End of Job 288.9' TOC

DEPTH TO BOTTOM:

Start of Job 326.5' TOC

End of Job 326.45' TOC

PART 2

WELL DEVELOPMENT DATA

Pump Model Franklin 5 HP Submersible

	B	M	T
Intake Depth	324.2'	314.2'	303.1'
Starting Turbidity	24.3	50.8	14.4

Pump Start	Stop	Flow Rate
(40 mins) 0850	(1800 gals) 1010	22.5 gpm
(43 mins) 1059	(1512 gals) 1202	24 gpm
(31 mins) 1229	725 gals 1300	25 gpm
1800 + 1512 + 725 = 4087 gals		

Total Pumped 4087 gals

	B	M	T
Final Turbidity	2.31	2.25	3.14

XD SN/Range (PSI) 20.0 psi

PART 3

INSTANTANEOUS SLUG TEST

Static Water Level (TOC)

Transducer Depth

Baseline Start

Injection Start

Baseline Start

Withdrawal Start

Slug Volume

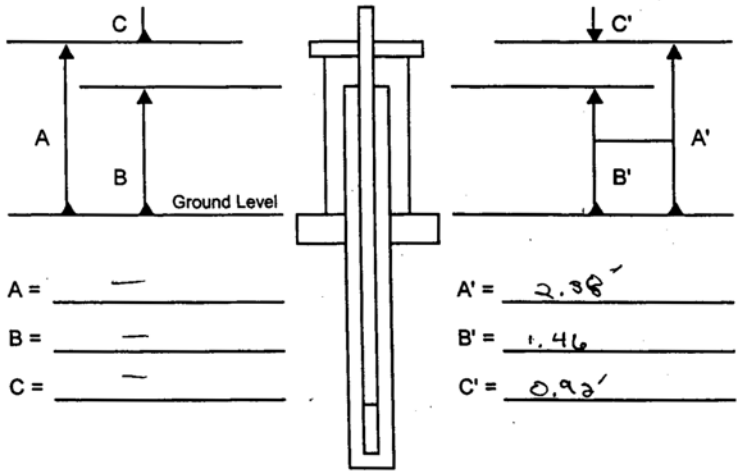
XD SN/Range (PSI)

Not Conducted 09/08/03

PART 4

Last Recorded Measurements Date:

Current Measurements Date: 09/08/03



A = —

B = —

C = —

A' = 2.38'

B' = 1.46

C' = 0.92'

Are there any reference marks on the casing strings? ☐ Yes ☒ No

PART 5

COMMENTS: 0600 P.O.D. Safety meeting. Discussing well development activities. Its raining. Its pouring

0620 on site. waiting for pump setting rig.

0835 Tagged g.w. @ 288.94' (TOC)

Tagged TD @ 326.5' (TOC)

0850 Rig on site.

0710 Setting up rig.

0735 Tripping in Pump & trremie pipe.

0740 Calibrating instruments.

0838 Lowering transducer

0849 Initial XD => 32.688'.

0850 Begin test # 1: Readings: COND 497 | TURB 24.3 | T 18.7 | XD 32.583'

Prepared by (print name):	Signature:	Date:
Charlene Martinez	Charlene Martinez	09/08/03
Reviewed by (print name):	**Signature:**	**Date:**
L.D. Walker	L.D. Walker	10-1-03

A-6003-644 (03/03)

FIELD ACTIVITY REPORT - DAILY DRILLING

Date: 09/08/03

Well ID: C4123 | Well Name: 299-E24-22

Location: West of 241-AY Tank Farm | Report No.: 1 (Well Development)

Start	Finish	Total
Time 0600	Time	Time
Hole Depth/Csg — / —	Hole Depth/Csg — / —	Hole Depth/Csg — / —

Reference Measuring Point: GROUND SURFACE

Casing String No. 1 2 3 4 ____ Rod Size: See Report No. 1

Time/Depth From	Time/Depth To	Description of Activities/Operations with Depth (Attach applicable drawings and document straightness test results)
0850	Test Start	Readings: Test #1 (324.2' TOC) 22.5 gpm
	Time XD TURB Cond T	
	0932 32.645' 3.32 515 17.9	
	0944 32.658 3.22 508 17.8	
	0959 32.667 2.29 521 17.9	
	1008 32.667 2.31 519 18.2	
1010	1034	Shut off pump start recovery (test #2). Stop test. XD = 32.667'. 99.9% recov.
1016	1054	Purge water truck off site.
1036	1040	moving pump up 10'. Intake @ 314.2' (TOC). Ready for test #3
		Readings: Test #3 (314.2' TOC). Start test (1059) Initial XD = 23.311'
	Time XD TURB cond T	24 gpm Drawdown
	1101 23.284 50.8 378 18.3	0.027
	1118 23.2866 5.00 363 18.1	0.045
	1132 23.284 3.29 362 18.2	0.027
	1144 23.293 2.72 364 18.1	0.018
	1200 23.284 2.25 366 18.4	0.027
1202	1218	Shut pump off start recovery (test #4) Stop test. XD = 29.32' 100% rec.
1219	1225	move pump up 10'. Intake @ 303.1' TOC
1229		Readings: Test #5 (303.1' TOC). Initial XD = ~~11.883~~ 12.017' start test (1229) 25 gpm
	Time XD TURB cond T	1300 Stop test #5. Begin recovery (#6)
	1232 11.993 14.4 374 18.5	1301 Hermit died. Back on, recovery test
	1245 11.999 4.36 371 18.4	still running. XD = 12.044' 100% rec.
	1253 11.999 3.30 368 18.5	1310 Stop test. Recovery test didn't work.
	1300 12002 3.14 370 18.5	Hermit blitzed.
		1315 Removing transducer, Hermit pipe & pump. Install perm. pump.

Reported By: Charlene Martinez | Reviewed By:

Title: Geologist | Date: 09/08/03 | Title: | Date:

Signature: Charlene Martinez | Signature:

A-6003-651 (04/03)

FIELD ACTIVITY REPORT - WELL SERVICES

Page 1 of 1

Date	Well No. C4123	Rig Type/Model	Rig No.	Contract/Work Order No.	Report No.
09/08/03	299-E34-22	Pump setting rig			1

Purpose	Reference	Location
Install sampling/monitoring pump in CY03 RCRA wells.		west of 241-AY Tank Farm

HISTORICAL DATA

Construction Depth	323.68' (bgs)	
Casing Size: 4" ID	Type: SS 304	Set At: +2.00 – 284.71' bgs
Casing Perforations Schedule: 0.020" cont. wire wrap.		Interval
Well Screen(s) Type SS 304		Interval: 286.21' – 321.26'
Last Recorded Depth-to-Water: 288.9' TOC	Last Recorded Depth-to-Bottom: 326.5' TOC	
Current Depth-to-Water: 288.9' TOC	Current Depth-to-Bottom: 326.45' TOC	

PUMP SYSTEM CONFIGURATION

[redacted]	Pre-Maintenance	Post-Maintenance
Pump Type: Model Aisenta ??	Grundfos	
Pump Model: (cm) 5HP (0.7)	Redi-Flo 3	
Tubing Size/Type	0.75" / SS 304L	
Length-Bottom of Tubing to Pump Intake	0.9'	
Tubing Length	295'	
Length-Top of Tubing to Reference Point		
Pump Intake Set at (Depth)	295.9'	

Reference/Measuring Point: Top of casing (TOC)

Start Time	1400
End Time	1600
Time	
Contract Time	
Total Time	2.0

Personnel: Layne Christensen ⇒ Dave Dewitt, Shawn; FH ⇒ Tim Hottell; CHG ⇒ Charlene Martinez

Materials Used: SS 304L, Schedule 40 0.75" tremmie pipe + SS couplers. (cm) 5HP Grundfos Redi-Flo3 pump. 0.7

Description of Operations/Remarks

Bottom of pump = 1.62'
Intake = 0.22' Total = 2.74'
Top = 0.9'

1405 ~~0205~~ (cm) Tripping in 5HP, Grundfos Redi-flo3 pump, + 0.75" SS 304L, schedule 40 tremmie pipe + couplers.

1524 Pump/pipe installed.

1525 Rigging down pump setting rig.

1555 Control box not programmed for pump. Geologist released.

09/19/03 Pump tested. works (cm) 09/19/03

Not used Charlene Martinez 09/08/03

Report By: Charlene Martinez	Reviewed By: L.D. Walker
Title: Geologist	Title: Geologist Date 10/1/03
Signature: Charlene Martinez	Signature: LD Walker

DISTRIBUTION: White-Field File Custodian Yellow-Group Files Pink-Project Coordinator Goldenrod-Team Leader BC-6000-278 (04/91)

WELL SURVEY DATA REPORT

Project:	**Prepared By:** Neil P. Fastabend **Company:** Fluor Federal Services
Date Requested: 9/29/03	**Requestor:** Chris S. Wright (FH)
Date of Survey: 10/31/03	**Surveyor:** Fluor Federal Services Survey Dept.
ERC Point of Contact:	**Survey Co. Point of Contact:** Grant F. Brazil, P.L.S.
Description of Work: Civil Survey of Groundwater Monitoring Well C4123 (299-E24-22).	**Horizontal Datum:** NAD83(91)
	Vertical Datum: NAVD88
	Units: Meters
	Hanford Area Designation: 200E

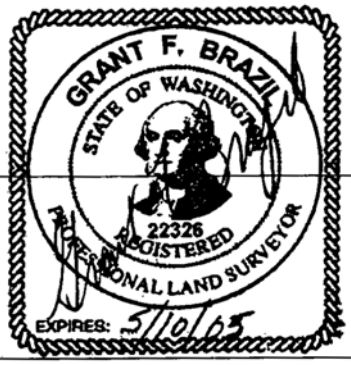
Coordinate System: Washington State Plane Coordinates (South Zone)

Horizontal Control Monuments:
2E-127 (FFS) and 2E-134 (FFS)

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

Well ID	Well Name	Easting	Northing	Elevation	
C4123	299-E24-22	575262.68	136142.82		Center of Casing
				210.285	Top Casing, N. Edge
				209.553	Brass Survey Marker
				210.291	Top Pump Base-plate, N. Edge

Notes:



Surveyor Statement:
I, Grant F. Brazil, a Professional Land Surveyor registered in the State of Washington (Registration No. 22326), hereby certify that this report is based on a field survey performed in October, 2003 under my direct supervision, and that the data contained here is true and correct.

Original to:
Distribution by DIS:

Appendix B

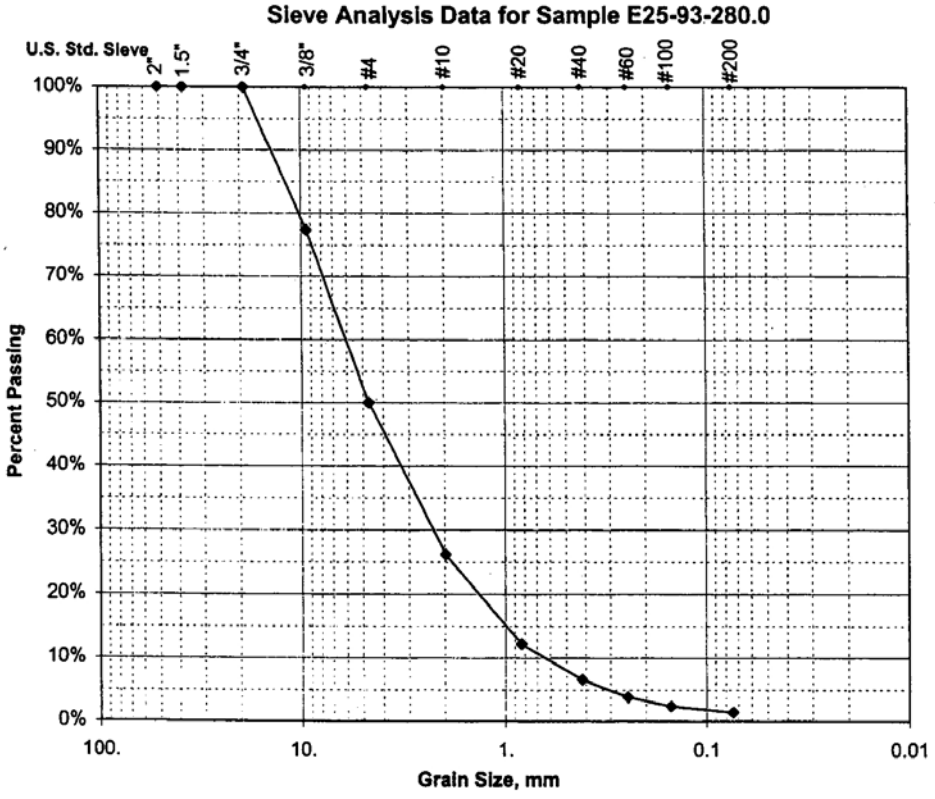
Sediment Samples Physical Properties Data

CH2M Hill Hanford, Inc.

SIEVE ANALYSIS

WELL NAME	299-E25-93	DEPTH	280.0-282.5	SAMPLE#	E25-93-280.0	WELL ID#	C4122
TESTED BY	CRM	CONTACT	Dave Weekes	PHONE	372-9350	DATE	07/07/2003

SAMPLE WT (g)	SIEVE SIZE IN.	CUMULATIVE WEIGHT(g)	% WEIGHT RETAINED	% PASSING	Grain Size (mm)	COMMENTS
1307.00	2"	0.0	0.0	100.0	50.80	
	1.5"	0.0	0.0	100.0	38.10	
	3/4"	0.0	0.0	100.0	19.05	
	3/8"	296.0	22.6	77.4	9.42	
	#4	653.8	50.0	50.0	4.70	
	#10	965.0	73.8	26.2	1.98	
	#20	1147.7	87.8	12.2	0.83	
	#40	1220.6	93.4	6.6	0.42	
	#60	1256.5	96.1	3.9	0.25	
	#100	1275.9	97.6	2.4	0.150	
	#200	1288.4	98.6	1.4	0.074	



Comments: Gravel - Field geologist collected sample from cyclone. Split spoon had 0% recovery.
Sieve analysis may not be representative of formation due to collection method.
All data are accurately and completely recorded.
Checked By: L. D. Walker Date: 10-1-03

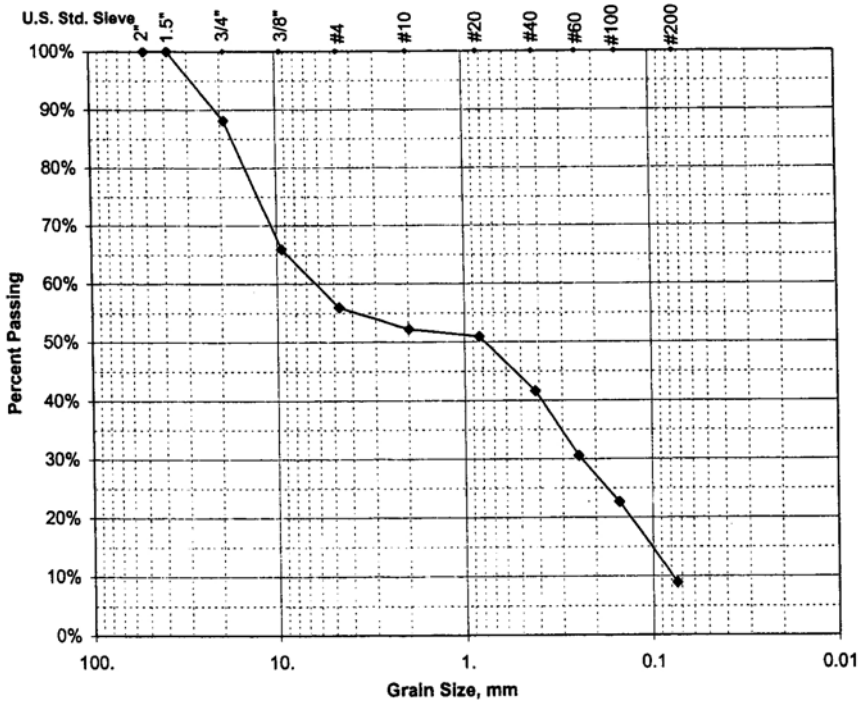
CH2M Hill Hanford, Inc.

SIEVE ANALYSIS

WELL NAME	299-E25-93	DEPTH	315.0-317.5	SAMPLE#	E25-93-315.0	WELL ID#	C4122
TESTED BY	CRM	CONTACT	Dave Weekes	PHONE	372-9350	DATE	07/07/2003

SAMPLE WT (g)	SIEVE SIZE IN.	CUMULATIVE WEIGHT(g)	% WEIGHT RETAINED	% PASSING	Grain Size (mm)	COMMENTS
1067.40	2"	0.0	0.0	100.0	50.80	
	1.5"	0.0	0.0	100.0	38.10	
	3/4"	0.0	11.9	88.1	19.05	
	3/8"	127.5	34.1	65.9	9.42	
	#4	363.9	44.1	55.9	4.70	
	#10	471.1	47.8	52.2	1.98	
	#20	510.2	49.1	50.9	0.83	
	#40	523.9	58.4	41.6	0.42	
	#60	623.1	69.5	30.5	0.25	
	#100	741.9	77.4	22.6	0.150	
	#200	1288.4	91.1	8.9	0.074	

Sieve Analysis Data for Sample E25-93-315.0



Comments: Gravel - Field geologist collected sample from cyclone. Split spoon had 0% recovery.
Sieve analysis may not be representative of formation due to collection method.
All data are accurately and completely recorded.
Checked By: L.D. Walker Date: 10-1-03

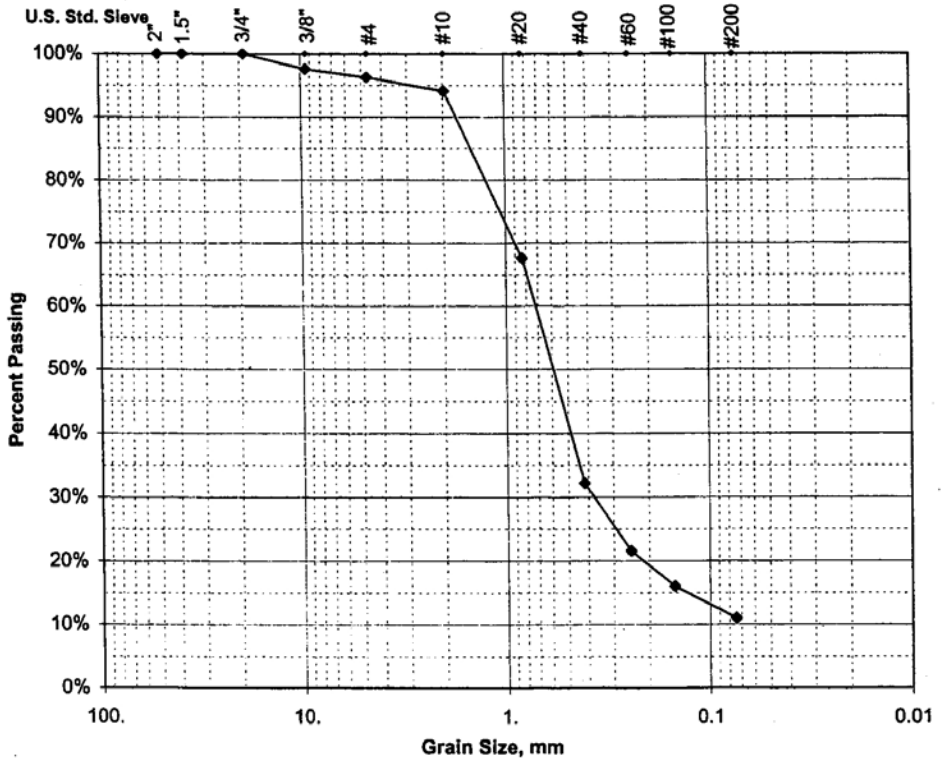
CH2M Hill Hanford, Inc.

SIEVE ANALYSIS

WELL NAME	299-E24-22	DEPTH	286.0-288.5	SAMPLE#	E24-22-286.0	WELL ID#	C4123
TESTED BY	CRM	CONTACT	Dave Weekes	PHONE	372-9350	DATE	07/14/2003

SAMPLE WT (g)	SIEVE SIZE IN.	CUMULATIVE WEIGHT(g)	% WEIGHT RETAINED	% PASSING	Grain Size (mm)	COMMENTS
1262.60	2"	0.0	0.0	100.0	50.80	
	1.5"	0.0	0.0	100.0	38.10	
	3/4"	0.0	0.0	100.0	19.05	
	3/8"	30.9	2.4	97.6	9.42	
	#4	47.2	3.7	96.3	4.70	
	#10	74.6	5.9	94.1	1.98	
	#20	409.0	32.4	67.6	0.83	
	#40	856.6	67.8	32.2	0.42	
	#60	990.9	78.5	21.5	0.25	
	#100	1060.3	84.0	16.0	0.150	
	#200	1124.1	89.0	11.0	0.074	

Sieve Analysis Data for Sample E24-22-286.0



Comments: Silty Sand.

All data are accurately and completely recorded.

Checked By: L.D. Wells/KCF Date: 10-1-03

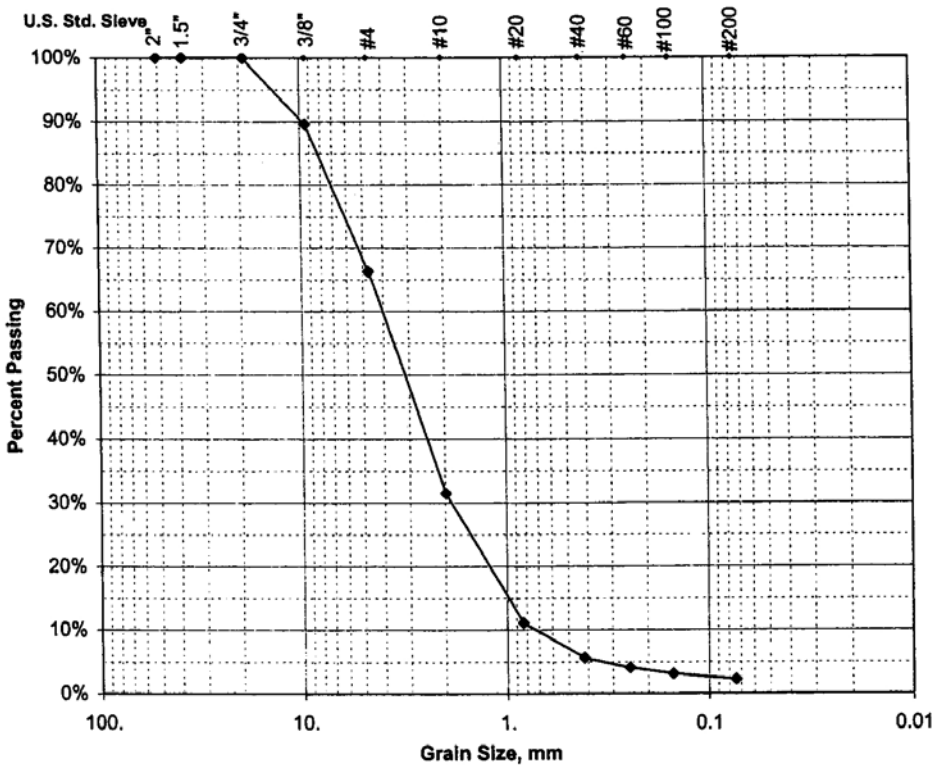
CH2M Hill Hanford, Inc.

SIEVE ANALYSIS

WELL NAME	299-E24-22	DEPTH	321	SAMPLE#	E24-22-321.0	WELL ID#	C4123
TESTED BY	CRM	CONTACT	Dave Weekes	PHONE	372-9350	DATE	07/14/2003

SAMPLE WT (g)	SIEVE SIZE IN.	CUMULATIVE WEIGHT(g)	% WEIGHT RETAINED	% PASSING	Grain Size (mm)	COMMENTS
1047.70	2"	0.0	0.0	100.0	50.80	
	1.5"	0.0	0.0	100.0	38.10	
	3/4"	0.0	0.0	100.0	19.05	
	3/8"	109.2	10.4	89.6	9.42	
	#4	353.6	33.8	66.2	4.70	
	#10	718.0	68.5	31.5	1.98	
	#20	931.3	88.9	11.1	0.83	
	#40	989.1	94.4	5.6	0.42	
	#60	1005.4	96.0	4.0	0.25	
	#100	1015.1	96.9	3.1	0.150	
	#200	1024.6	97.8	2.2	0.074	

Sieve Analysis Data for Sample E24-22-321.0



Comments: Gravel. Sample collected from cyclone. Fines washed away.
Sample not representative of formation.
All data are accurately and completely recorded.
Checked By: L.D. Walker Date: 10-1-03

Appendix C

Borehole Geophysical Logs Gyroscope Surveys

Stoller
Grand Junction Office established 1959

C-4122
Log Data Report

Borehole Information:

Borehole: C-4122			Site: East of A Tank Farm		
Coordinates (WA St Plane)		GWL[1] (ft): 281		GWL Date: 07/02/03	
North (estimated)	East (estimated)	Drill Date	Ground Level Elevation	Total Depth (ft)	Type
136020	575460	07/03	Not available	319.5	Becker

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	4.0	9.0	8.0	0.50	+4.0	319.5
Steel Tubing	4.5	6.24	6.0	0.125	+4.5	319.5

Borehole Notes:

The casing dimensions are derived from published values for Becker drill casing. Casing thicknesses at the joints are 0.875-in. and 0.240-in. for the 8-in. and 6-in. casings, respectively. The total depth of the borehole was provided by the driller. Total logging depth was 321 ft, 1.5 ft deeper than reported by the driller. The well site geologist provided the depth to water. Borehole coordinates were provided by Fluor Hanford's person in charge and are estimates. Ground level elevation was not available. Logging data acquisition is referenced to the ground surface.

Logging Equipment Information:

Logging System:	Gamma 2E		Type:	SGLS (70%) SN: 34TP40587A
Calibration Date:	03/03	Calibration Reference:	GJO-2003-430-TAC	
		Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0	

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3 Repeat		
Date	07/07/03	07/07/03	07/07/03		
Logging Engineer	Spatz	Spatz	Spatz		
Start Depth (ft)	0.0	308.0	320.0		
Finish Depth (ft)	309.0	321.0	288.0		
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[2]	N/A	N/A		
Pre-Verification	BE055CAB	BE055CAB	BE055CAB		
Start File	BE055000	BE055310	BE055324		

Log Run	1	2	3 Repeat		
Finish File	BE055309	BE055323	BE055356		
Post-Verification	BE055CAA	BE055CAA	BE055CAA		
Depth Return Error (in.)	-1.5	N/A	0		
Comments	Log run stopped to refill sonde with liquid nitrogen.	Fine-gain adjustment made before resuming logging.	No fine gain adjustment.		

Logging Operation Notes:

Spectral gamma logging was performed in this borehole on July 7, 2003. Logging was conducted with a centralizer on the sonde, and measurements are referenced to ground surface. A repeat section was collected in this borehole to evaluate system performance.

Analysis Notes:

Analyst:	Henwood	Date:	07/11/03	Reference:	GJO-HGLP 1.6.3, Rev. 0

Pre-run and post-run verifications for the logging system were performed before and after data acquisition. The acceptance criteria were met.

A combined casing correction for 0.625-in.-thick casing was applied throughout the borehole for both casings. The combined thickness at casing joints is 1.115 in. This thickness results in a significant reduction in gamma activity detection as the detector passes by a casing joint. However, it is not practical to correct individual data points for the effect of casing joints. The influence of the thick joints is apparent on the total gamma and ^{40}K logs where reduced count rates and concentrations are exhibited at approximately 10-ft depth intervals.

SGLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with an EXCEL worksheet template identified as G2EMar03.xls using efficiency functions and corrections for casing, water, and dead time as determined from annual calibrations. Dead time corrections are applied where dead times exceed 10.5 percent; no dead times in excess of 10.5 percent were encountered. Correction for water was applied to the data below 281 ft.

Log Plot Notes:

Separate log plots are provided for the man-made radionuclide (^{137}Cs) detected in the borehole, naturally occurring radionuclides (^{40}K, ^{238}U, ^{232}Th [KUT]), a combination of man-made, KUT, and dead time, and total gamma plotted with dead time. 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. A repeat log section is also included.

Results and Interpretations:

^{137}Cs was the only man-made radionuclide detected in this borehole. ^{137}Cs was detected near the ground surface with the maximum concentration of 4.9 pCi/g detected at 0-ft depth. ^{137}Cs was also detected at a few sporadic locations throughout the borehole near its MDL of approximately 0.3 pCi/g.

The repeat sections indicated good agreement of the naturally occurring KUT.

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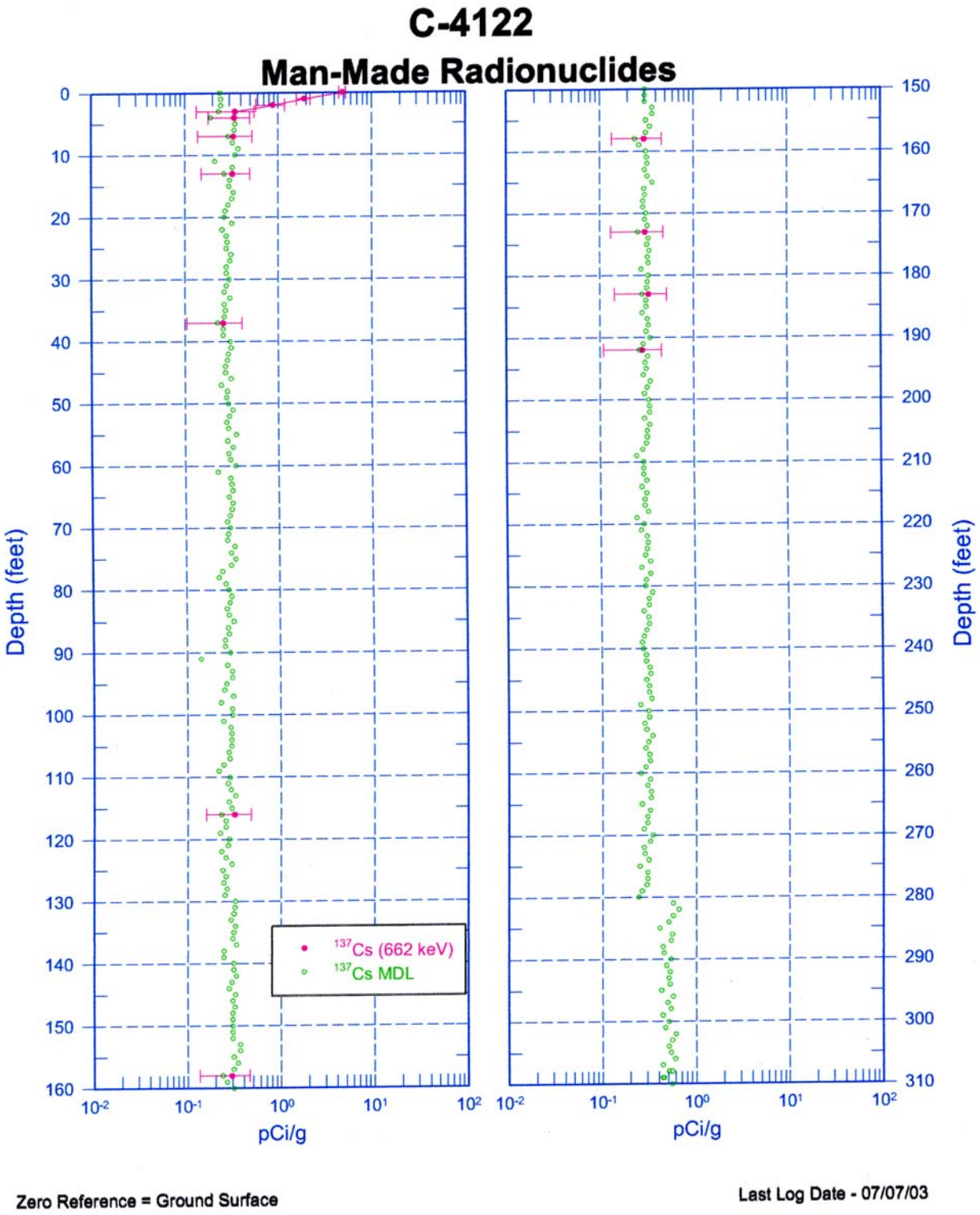
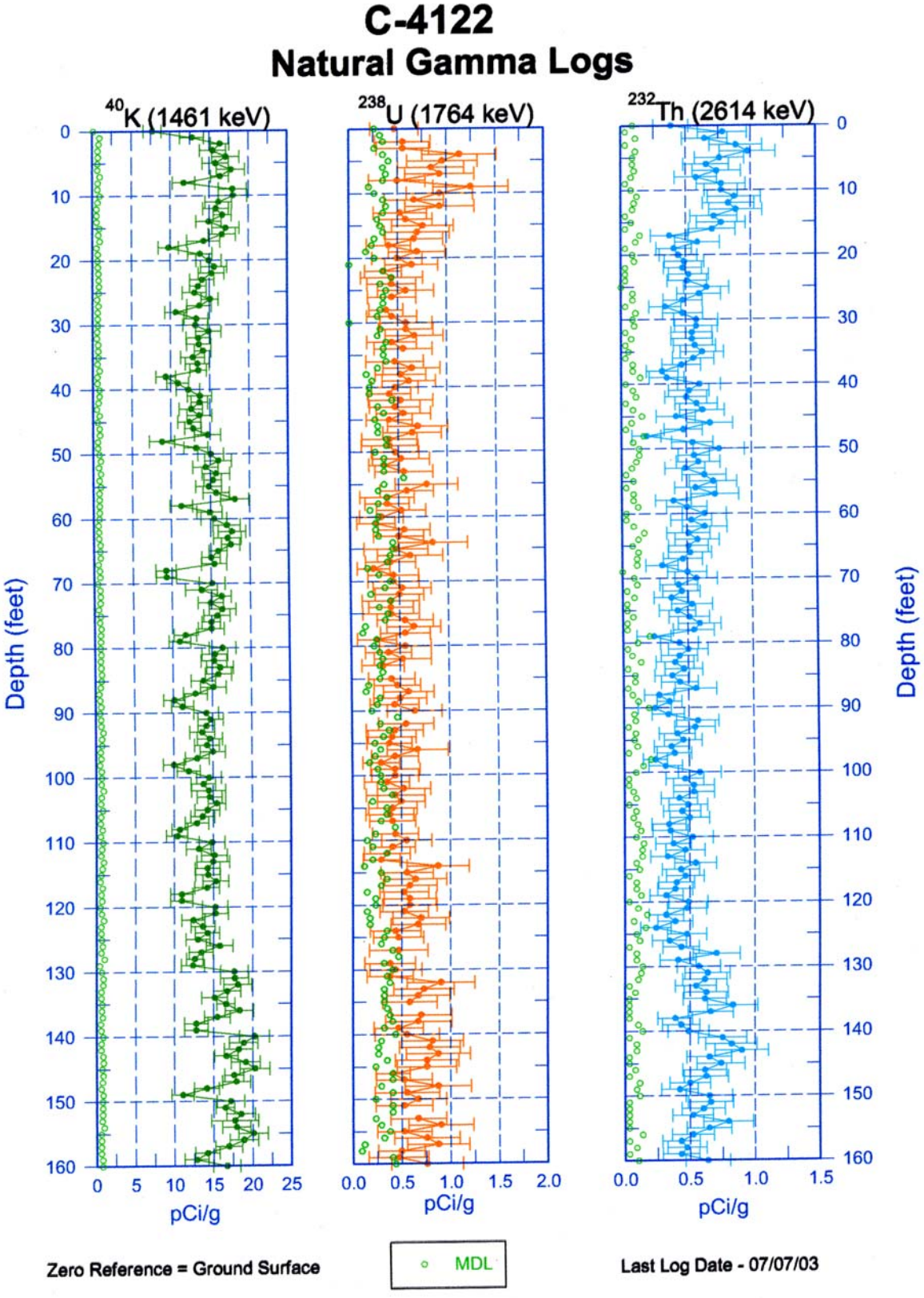
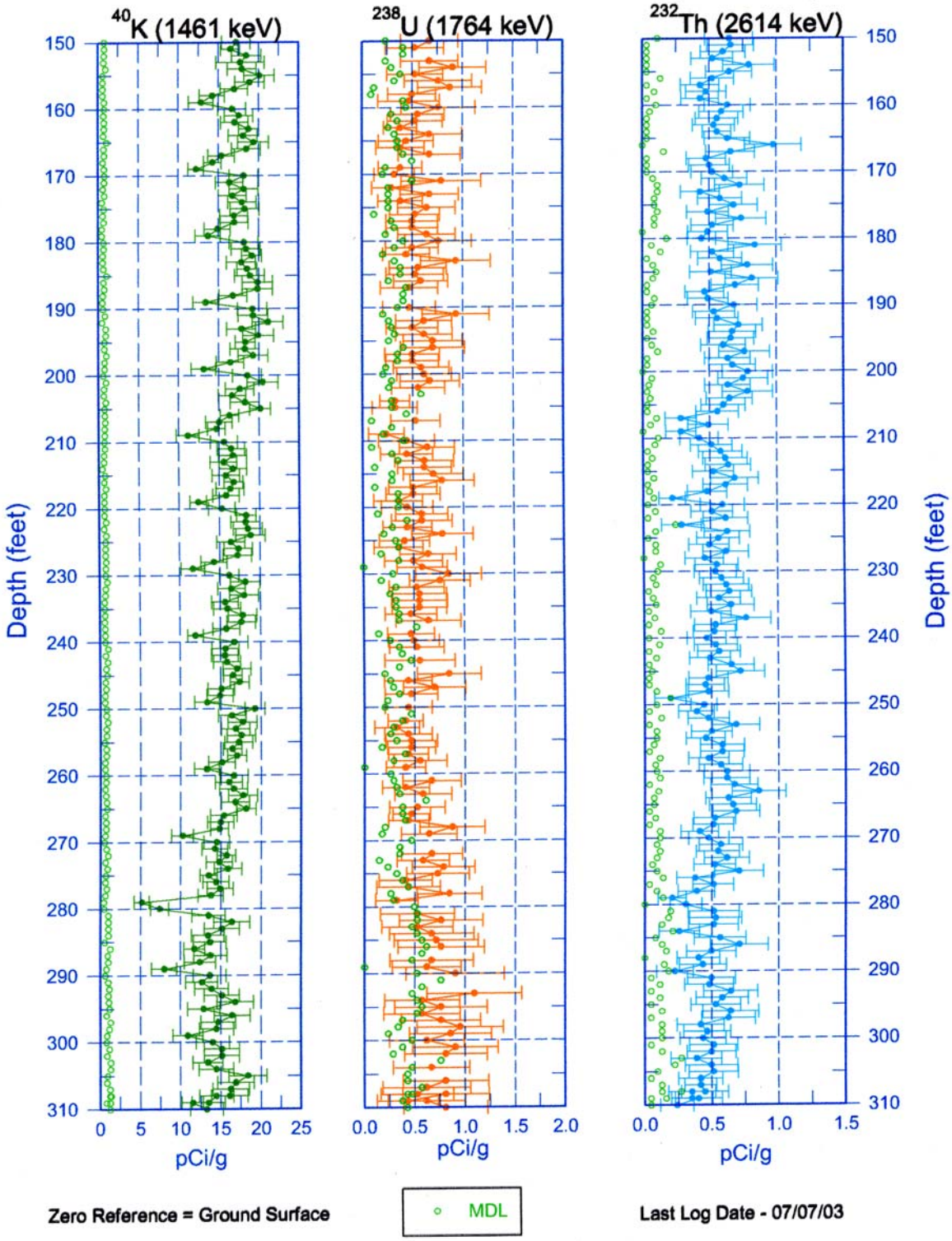
[1] GWL – groundwater level
[2] N/A – not applicable

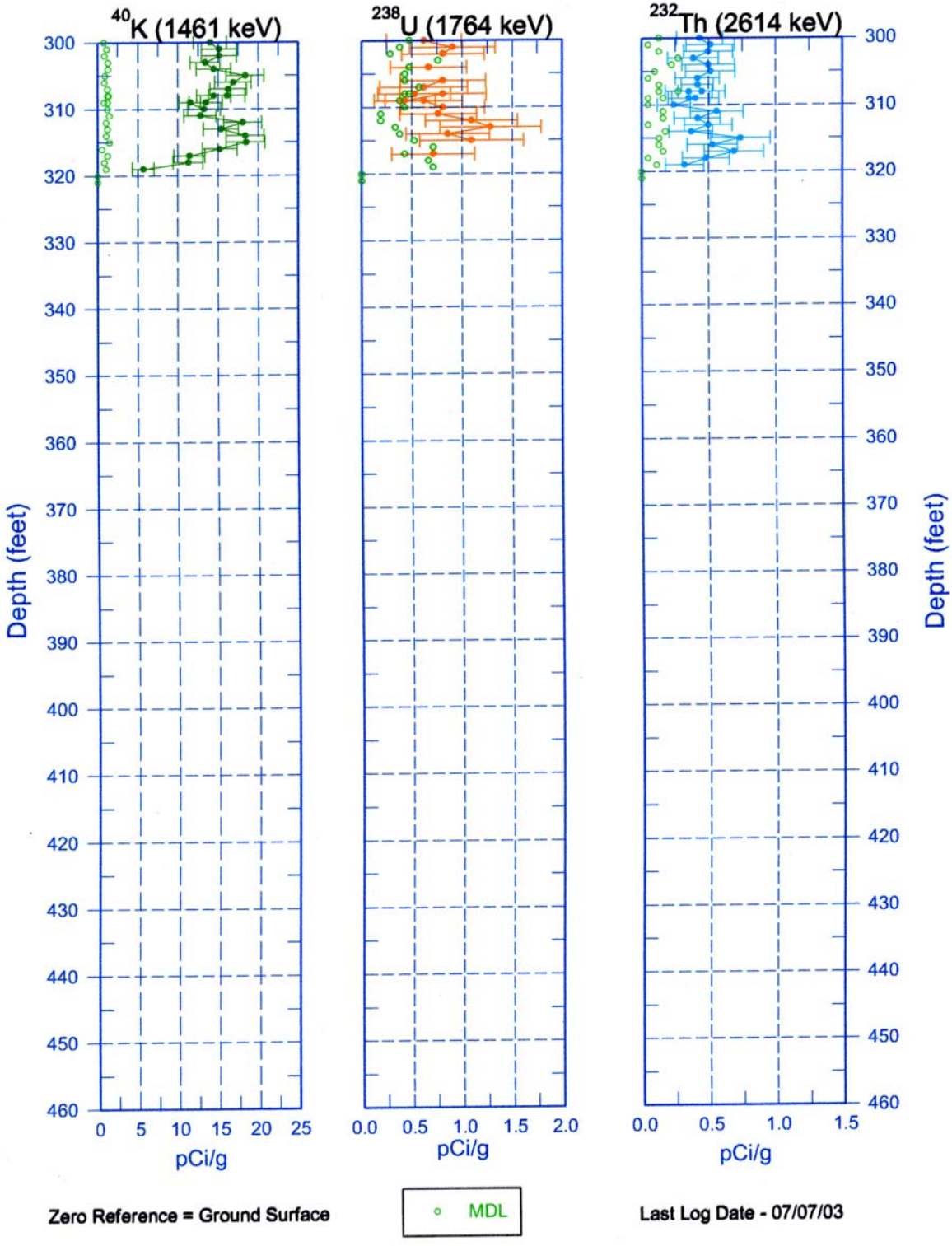

C-4122
Man-Made Radionuclides
Depth (feet)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
pCi/g
^{137}Cs (662 keV)
^{137}Cs MDL
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
Depth (feet)
Zero Reference = Ground Surface
Last Log Date - 07/07/03

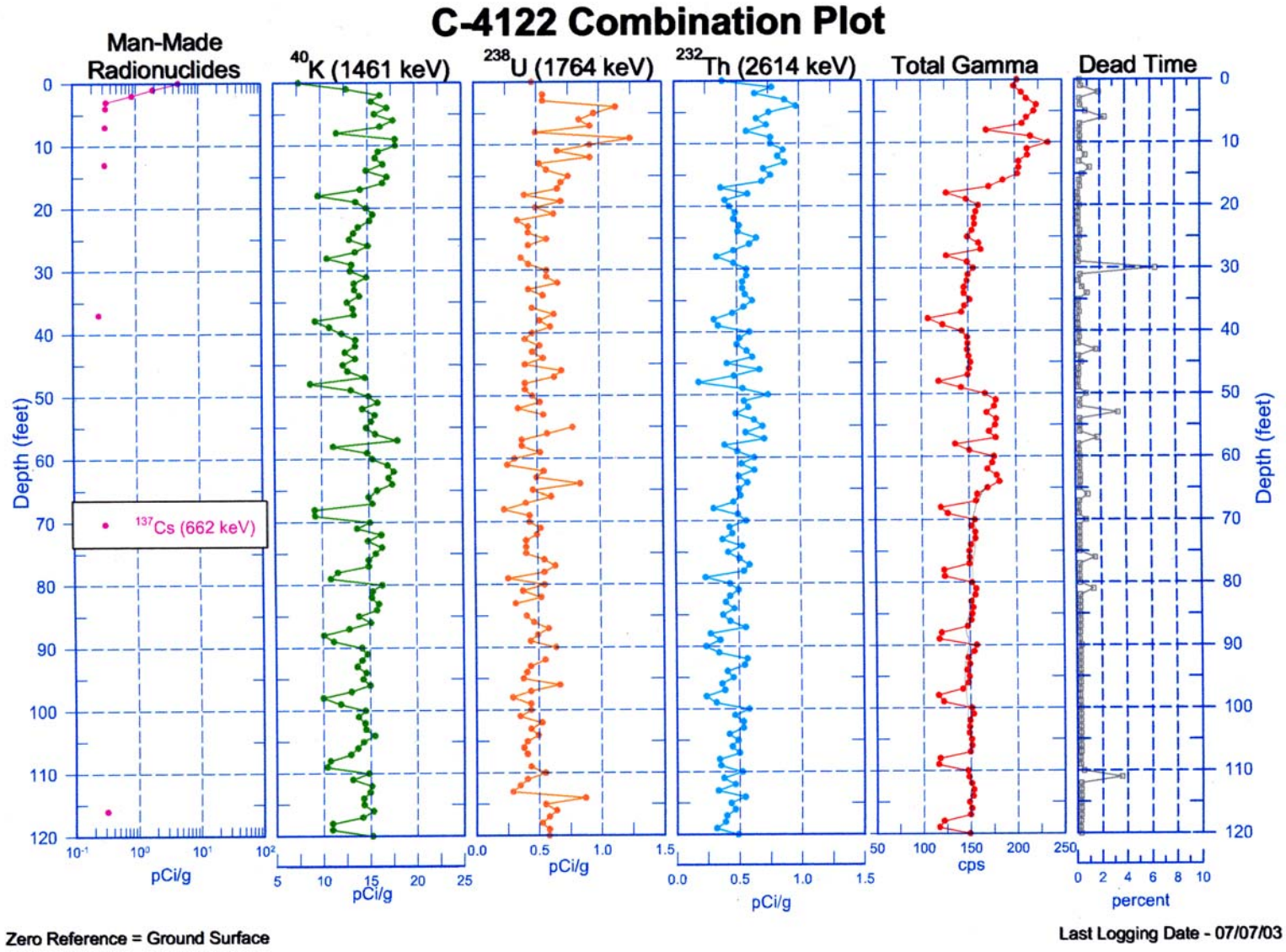

C-4122
Natural Gamma Logs
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Depth (feet)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
0 5 10 15 20 25
pCi/g
0.0 0.5 1.0 1.5 2.0
pCi/g
0.0 0.5 1.0 1.5
pCi/g
MDL
Zero Reference = Ground Surface
Last Log Date - 07/07/03

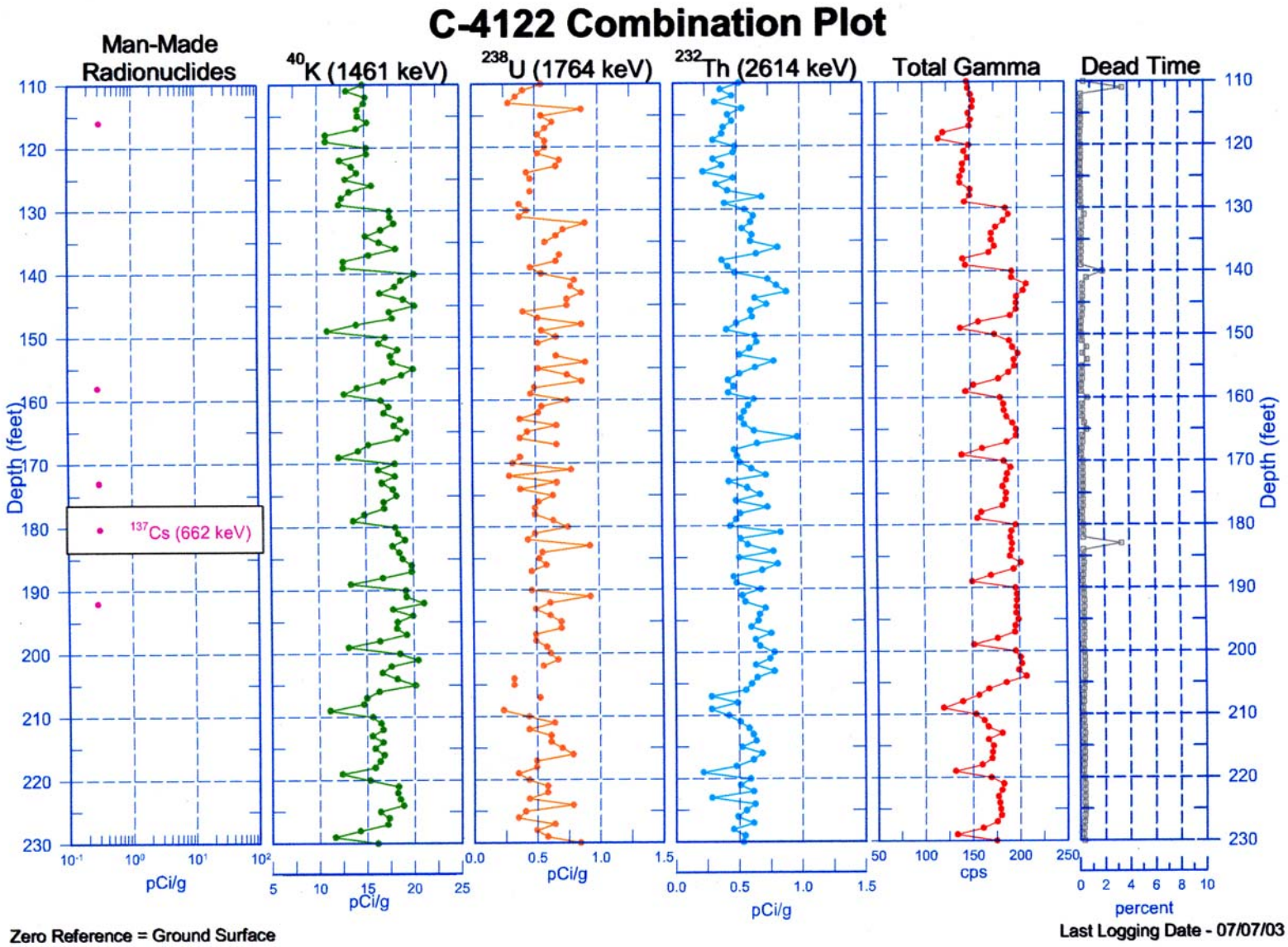
C-4122
Natural Gamma Logs

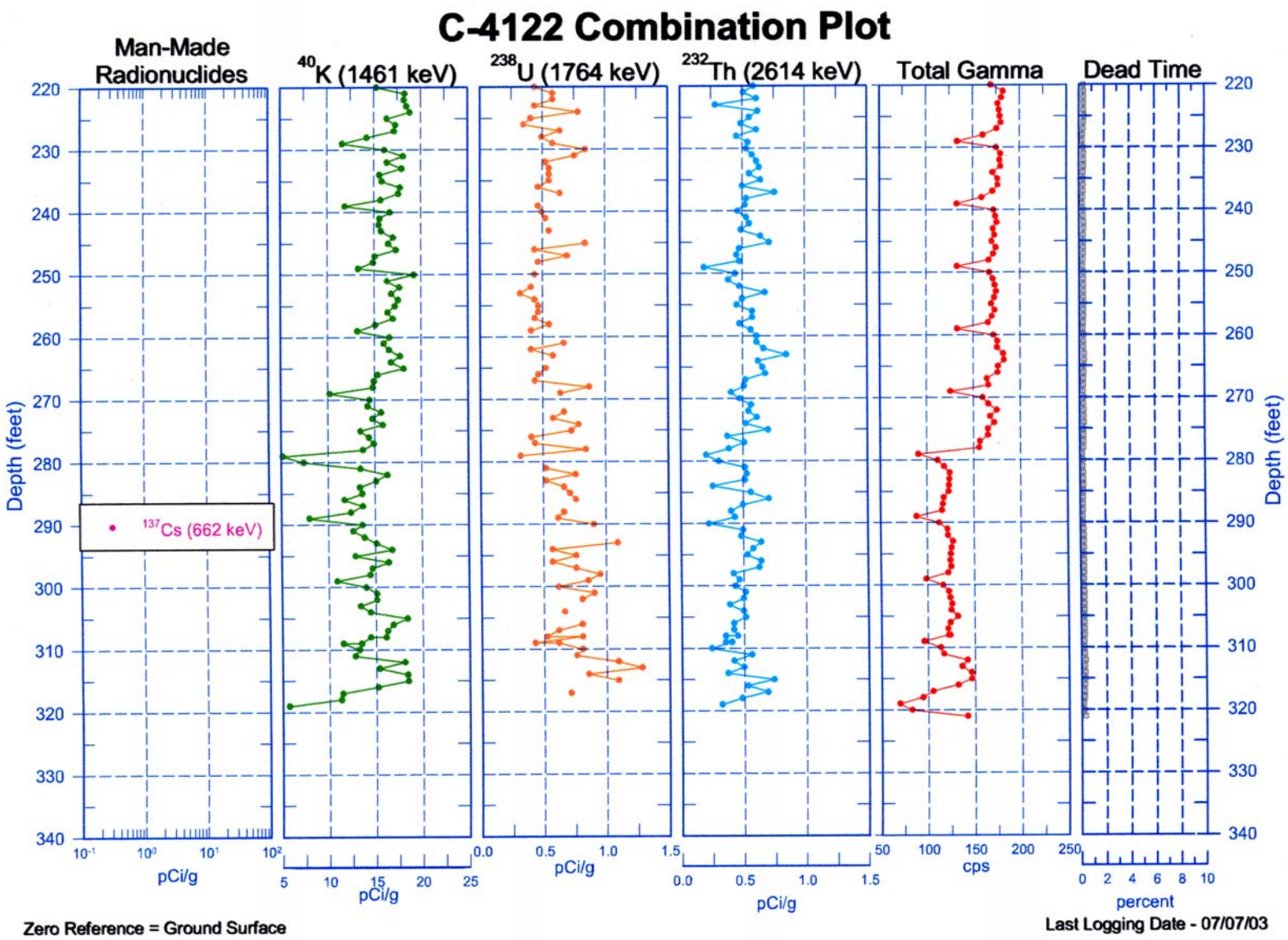


C-4122
Natural Gamma Logs

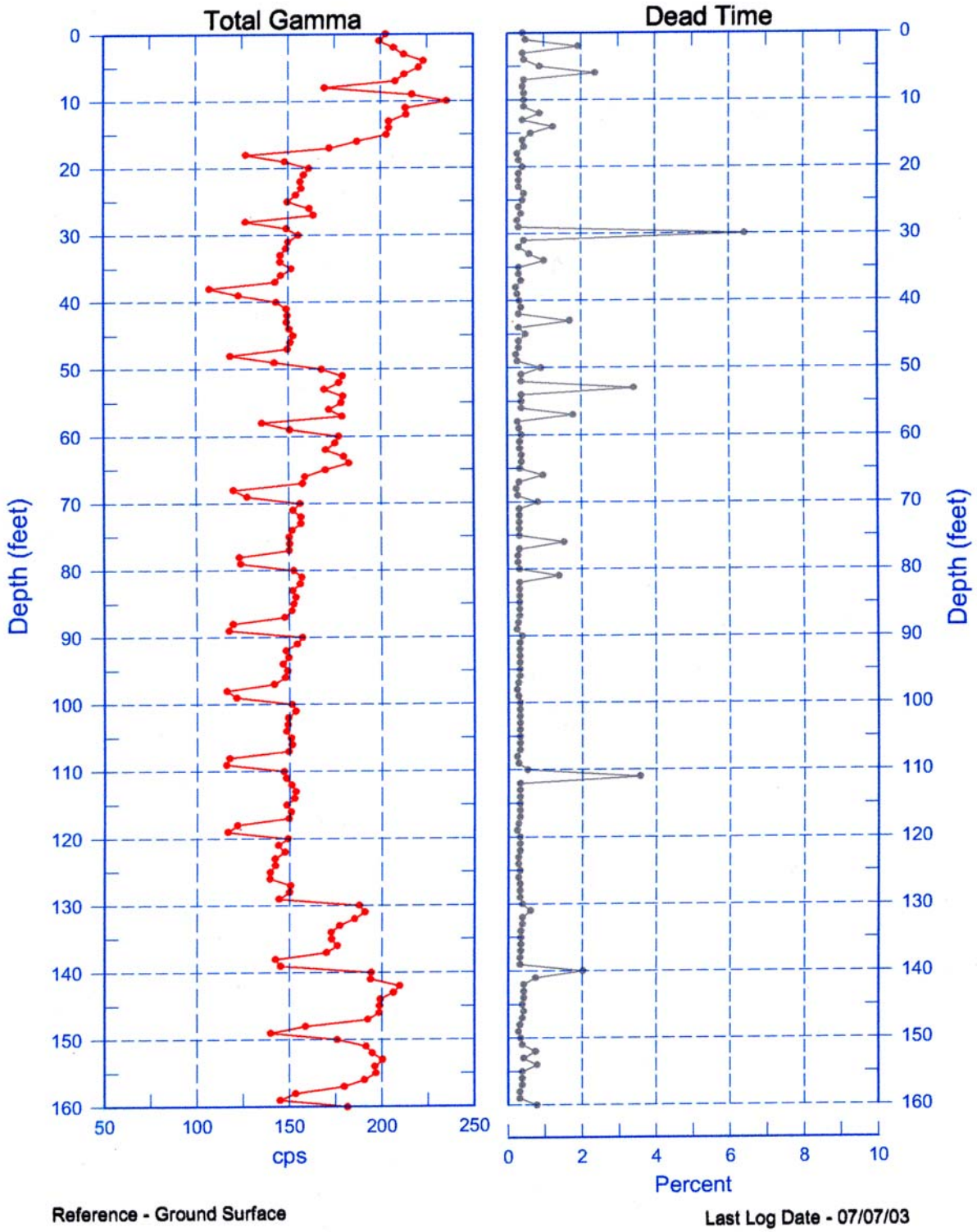



C-4122 Combination Plot
Man-Made Radionuclides
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Total Gamma
Dead Time
Depth (feet)
137Cs (662 keV)
pCi/g
cps
percent
Zero Reference = Ground Surface
Last Logging Date - 07/07/03

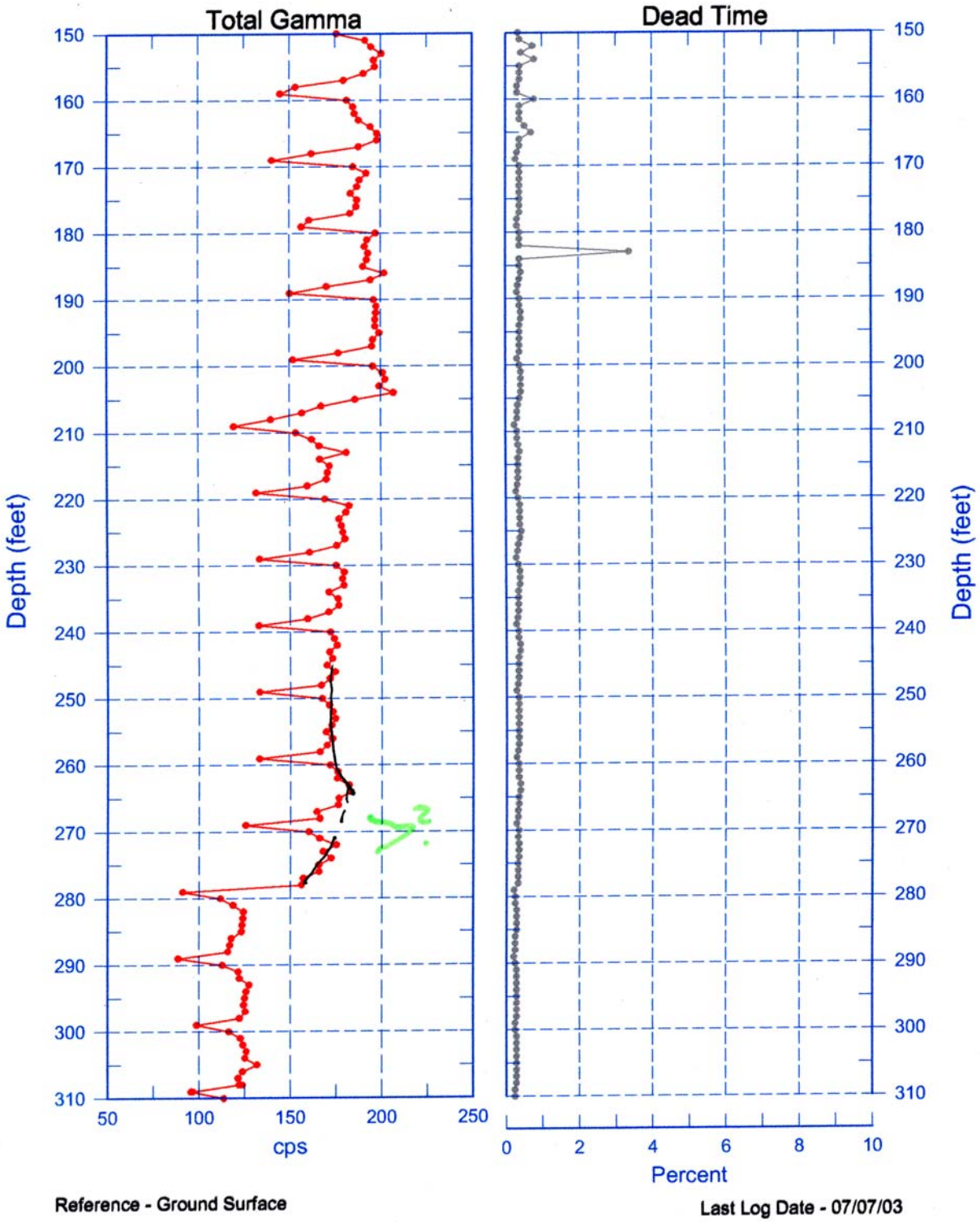

C-4122 Combination Plot
Man-Made Radionuclides
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Total Gamma
Dead Time
Depth (feet)
137Cs (662 keV)
pCi/g
cps
percent
Zero Reference = Ground Surface
Last Logging Date - 07/07/03


C-4122 Combination Plot
Man-Made Radionuclides
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Total Gamma
Dead Time
Depth (feet)
137Cs (662 keV)
pCi/g
cps
percent
Zero Reference = Ground Surface
Last Logging Date - 07/07/03

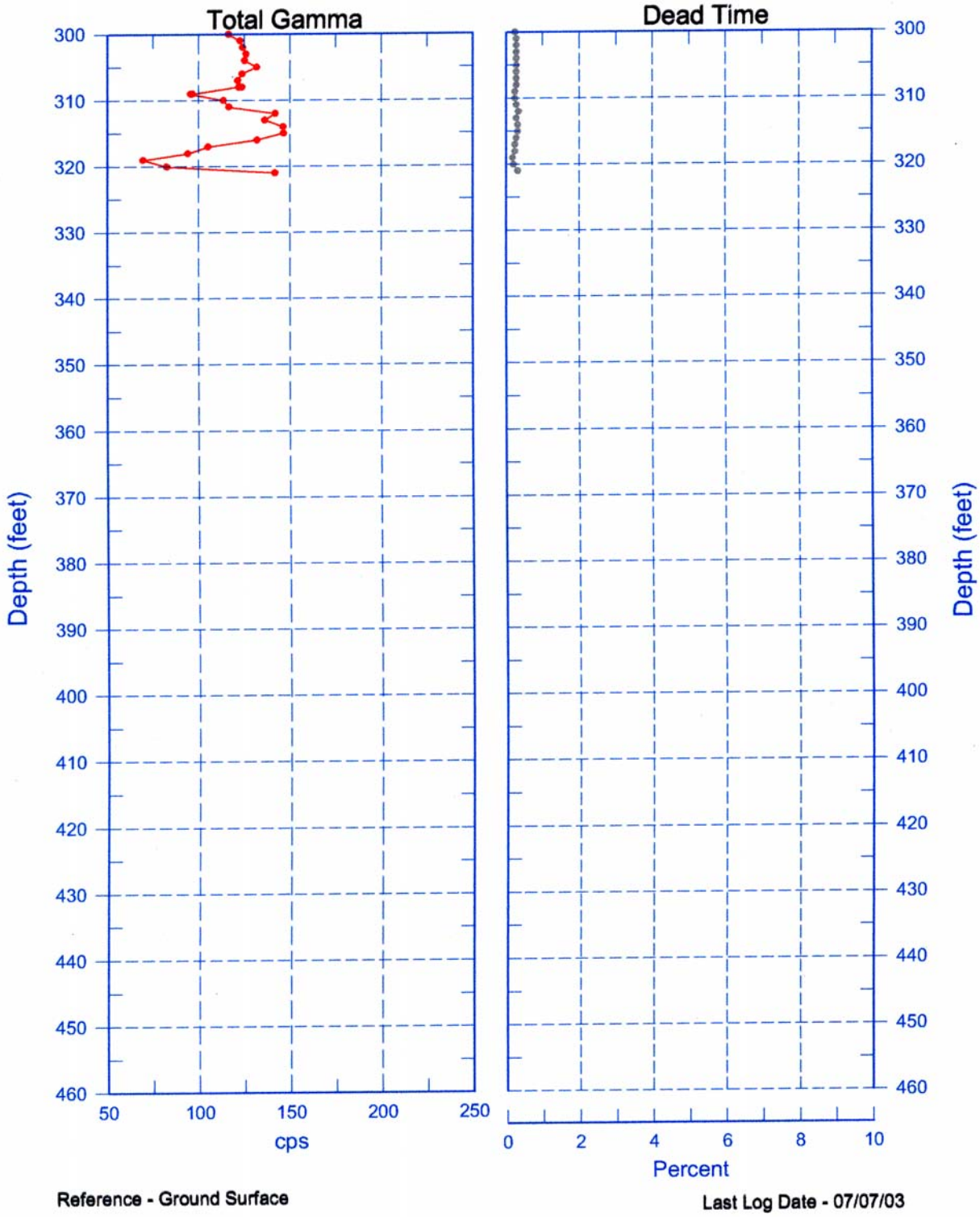
C-4122
Total Gamma & Dead Time



C-4122
Total Gamma & Dead Time

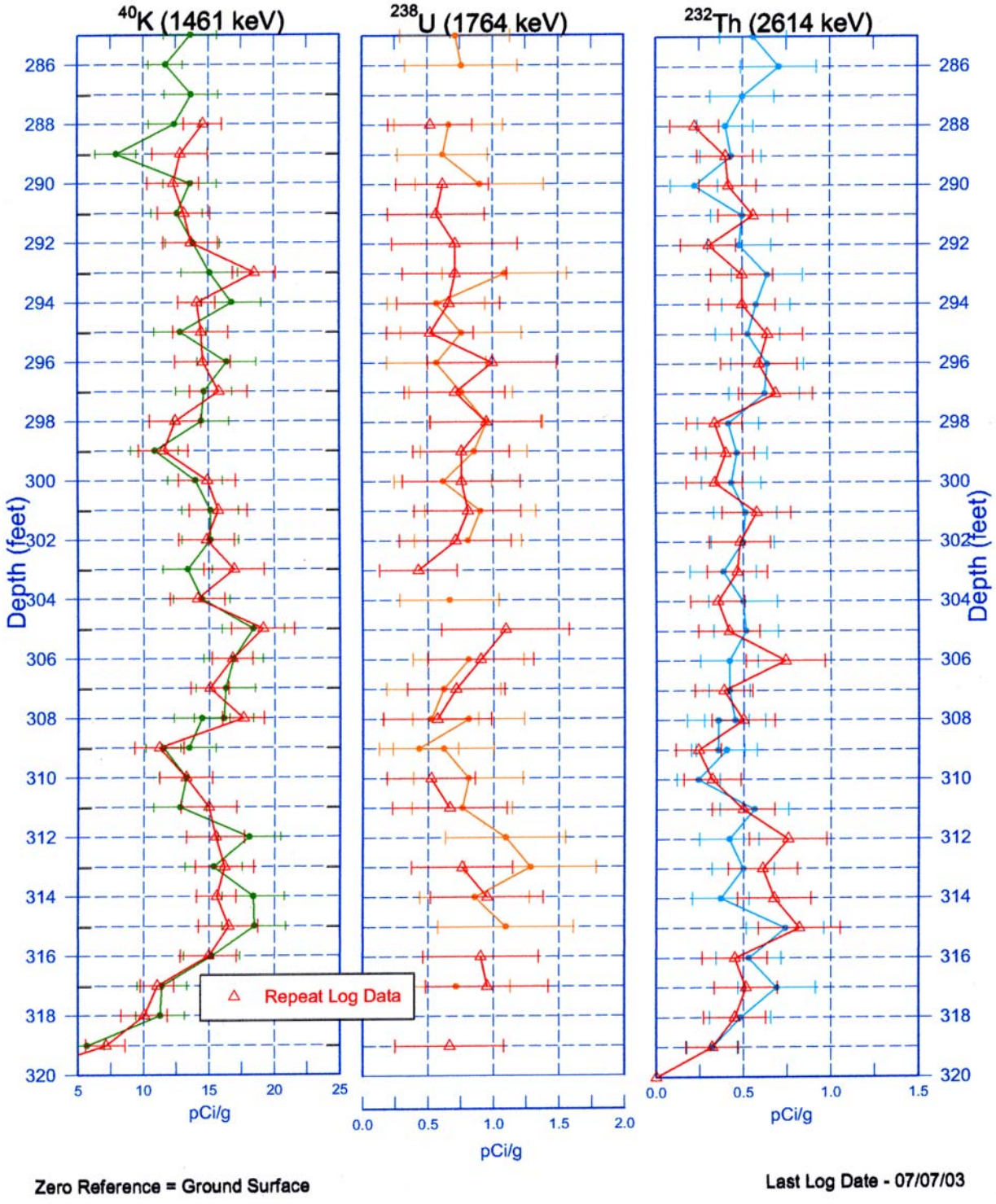


C-4122
Total Gamma & Dead Time



C-4122

Repeat Section of Natural Gamma Logs



Stoller
Grand Junction Office established 1959

C-4123
Log Data Report

Borehole Information:

Borehole: C-4123			Site: West of A Tank Farm		
Coordinates (WA St Plane)		GWL[1] (ft): 288		GWL Date: 07/11/03	
North (estimated)	East (estimated)	Drill Date	Ground Level Elevation	Total Depth (ft)	Type
136140	572265	07/03	Not available	328.0	Becker

Casing Information:

Casing Type	Stickup (ft)	Outer Diameter (in.)	Inside Diameter (in.)	Thickness (in.)	Top (ft)	Bottom (ft)
Threaded Steel	2.65	9.0	8.0	0.50	+2.65	328.0
Steel Tubing	3.1	6.24	6.0	0.125	+3.1	328.0

Borehole Notes:

The casing dimensions are derived from published values for Becker drill casing. Casing thicknesses at the joints are 0.875 in. and 0.240 in. for the 8-in. and 6-in. casings, respectively. The total depth of the borehole was provided by the driller. The well site geologist provided the depth to water. Borehole coordinates were provided by Fluor Hanford's person in charge and are estimates. Ground level elevation was not available. Logging data acquisition is referenced to the ground surface.

Logging Equipment Information:

Logging System: Gamma 2A		Type: SGLS (35%) SN: 34TP11019B
Calibration Date: 01/03	Calibration Reference:	GJO-2003-418-TAC
	Logging Procedure:	MAC-HGLP 1.6.5, Rev. 0

Spectral Gamma Logging System (SGLS) Log Run Information:

Log Run	1	2	3	4 Repeat	
Date	07/12/03	07/14/03	07/15/03	07/15/03	
Logging Engineer	Spatz	Spatz	Spatz	Spatz	
Start Depth (ft)	105.0	328.0	163.0	105.0	
Finish Depth (ft)	0.0	162.0	104.0	72.0	
Count Time (sec)	200	200	200	200	
Live/Real	R	R	R	R	
Shield (Y/N)	N	N	N	N	
MSA Interval (ft)	1.0	1.0	1.0	1.0	
ft/min	N/A[2]	N/A	N/A	N/A	
Pre-Verification	BA209CAA	BA210CAB	BA211CAB	BA211CAB	
Start File	BA209000	BA210000	BA211000	BA211058	

Log Run	1	2	3	4 Repeat	
Finish File	BA209105	BA210166	BA211059	BA211091	
Post-Verification	BA209CAA	BA210AA	BA211CAA	BA211CAA	
Depth Return Error (in.)	0	0	Not applicable	+1	
Comments	Fine-gain adjustment made after files -076 and -095.	No fine-gain adjustment.	No fine-gain adjustment.	No fine-gain adjustment.	

Logging Operation Notes:

Spectral gamma logging was performed in this borehole between July 12 and 15, 2003. Logging was conducted with a centralizer on the sonde and measurements are referenced to ground surface. A repeat section was collected in this borehole to evaluate system performance.

Analysis Notes:

Analyst:	Henwood	Date:	07/21/03	Reference:	GJO-HGLP 1.6.3, Rev. 0

Pre-run and post-run verifications for the logging system were performed before and after data acquisition. Acceptance criteria were met except for file numbers BA209CAB and BA210CAB. The total counts per second (cps) were exceeded for the 2614- and 1461-keV energy peaks for files BA209CAB and BA210CAB, respectively. The percent change between the before and after verification (i.e., files BA211CAB and BA211CAA, log runs 3 and 4) for the 2614-keV energy peak was 22 percent, which exceeds the criterion of 10 percent. After examination of individual spectra, the logging sonde appeared to have functioned normally and the data are provisionally accepted.

A combined casing correction for 0.625-in.-thick casing was applied throughout the borehole for both casings. The combined thickness at casing joints is 1.115 in. This thickness results in a significant reduction in gamma activity detection as the detector passes by a casing joint. However, it is not practical to correct individual data points for the effect of casing joints. The influence of the thick joints is apparent on the total gamma and ^{40}K logs where reduced count rates and concentrations are exhibited at approximately 10-ft depth intervals.

SGLS spectra were processed in batch mode using APTEC SUPERVISOR to identify individual energy peaks and determine count rates. Concentrations were calculated with an EXCEL worksheet template identified as G2AFEB03.xls using efficiency functions and corrections for casing, water, and dead time as determined from annual calibrations. Dead time corrections are applied where dead times exceed 10.5 percent; no dead times in excess of 10.5 percent were encountered. Correction for water was applied to the data below 288 ft.

Log Plot Notes:

Separate log plots are provided for the man-made radionuclide (^{137}Cs) detected in the borehole, naturally occurring radionuclides (^{40}K, ^{238}U, ^{232}Th [KUT]), a combination of man-made, KUT, and dead time, and total gamma plotted with dead time. 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. A repeat log section is also included.

Results and Interpretations:

^{137}Cs was the only man-made radionuclide detected in this borehole. ^{137}Cs was detected at a few sporadic locations throughout the borehole near its MDL of approximately 0.2 pCi/g.

The repeat sections indicated good agreement of the naturally occurring KUT.

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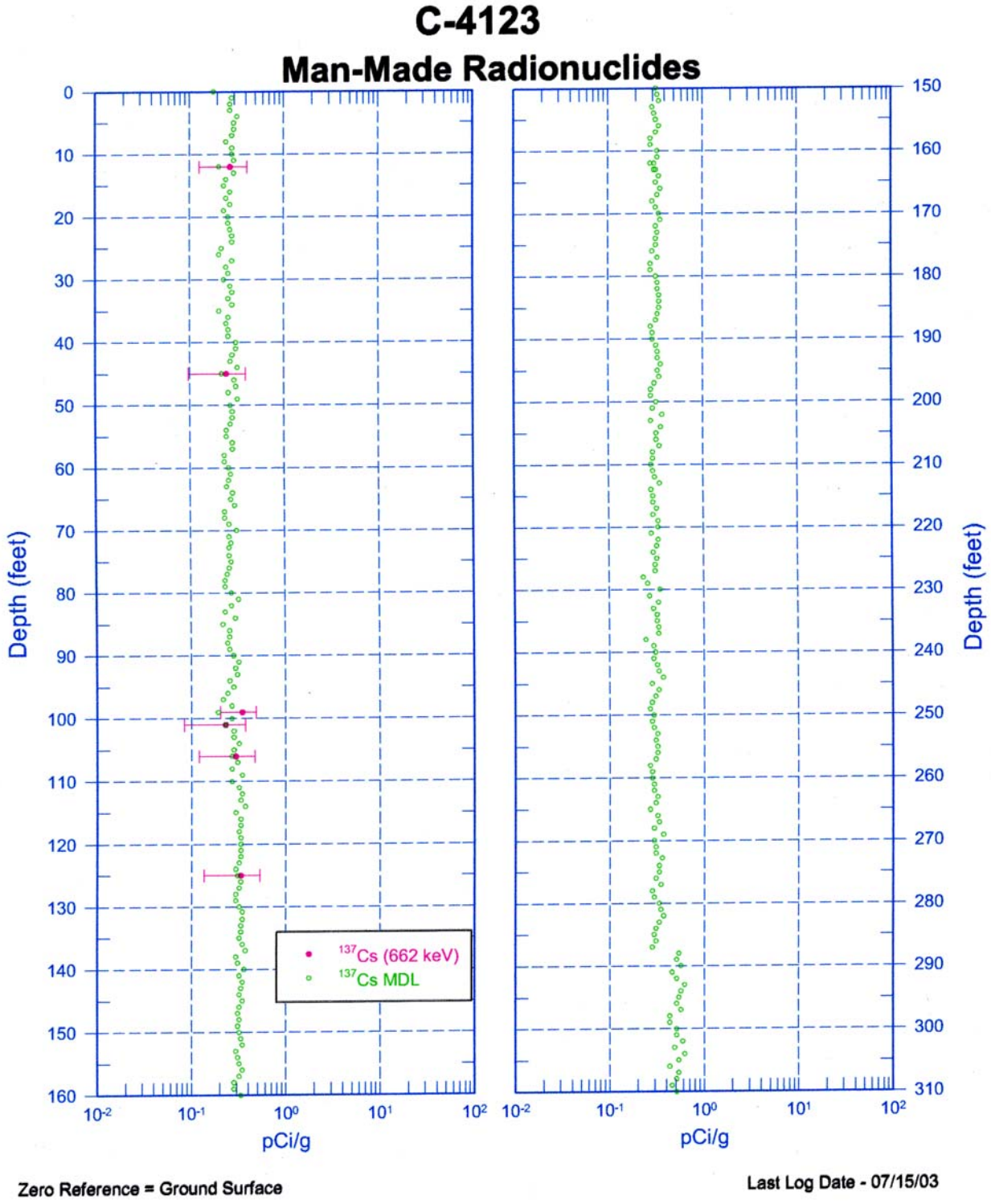
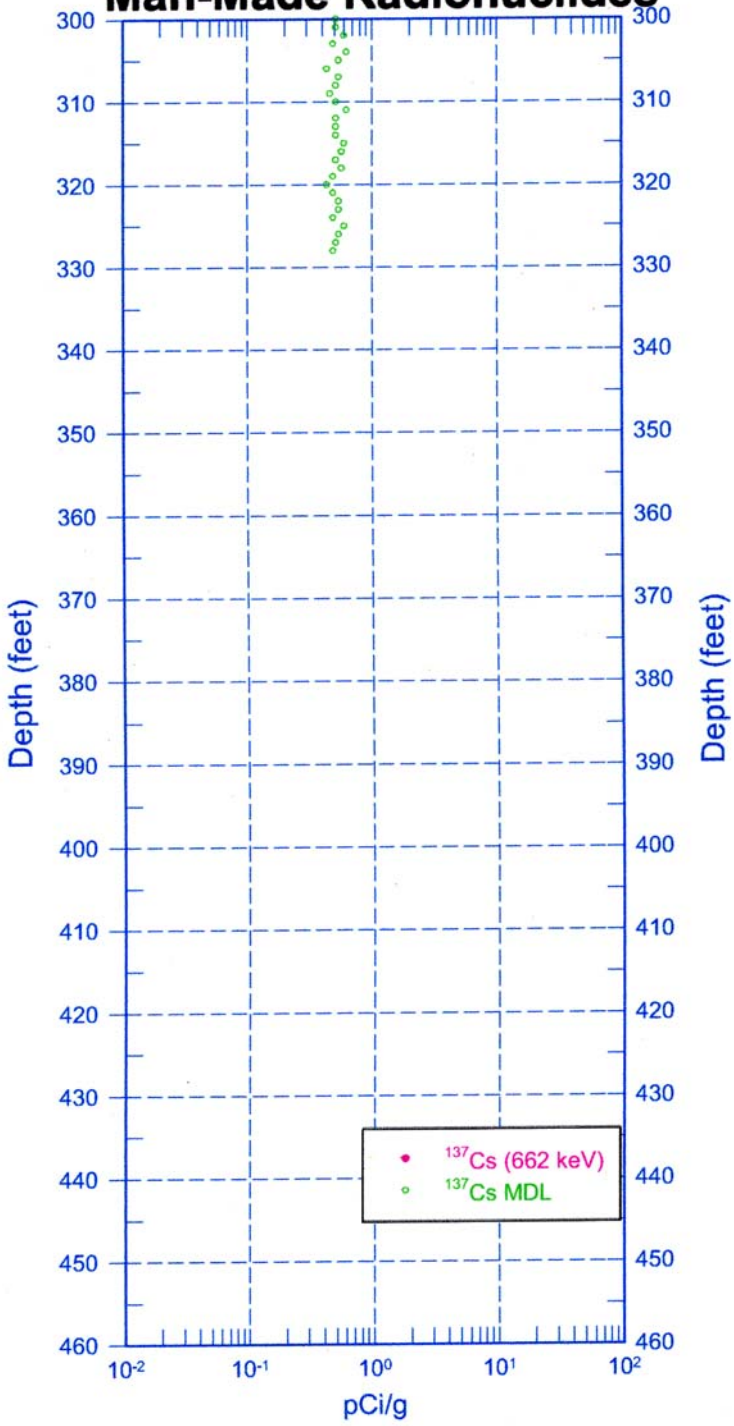
[1] GWL – groundwater level
[2] N/A – not applicable


C-4123
Man-Made Radionuclides
Depth (feet)
pCi/g
137Cs (662 keV)
137Cs MDL
Zero Reference = Ground Surface
Last Log Date - 07/15/03

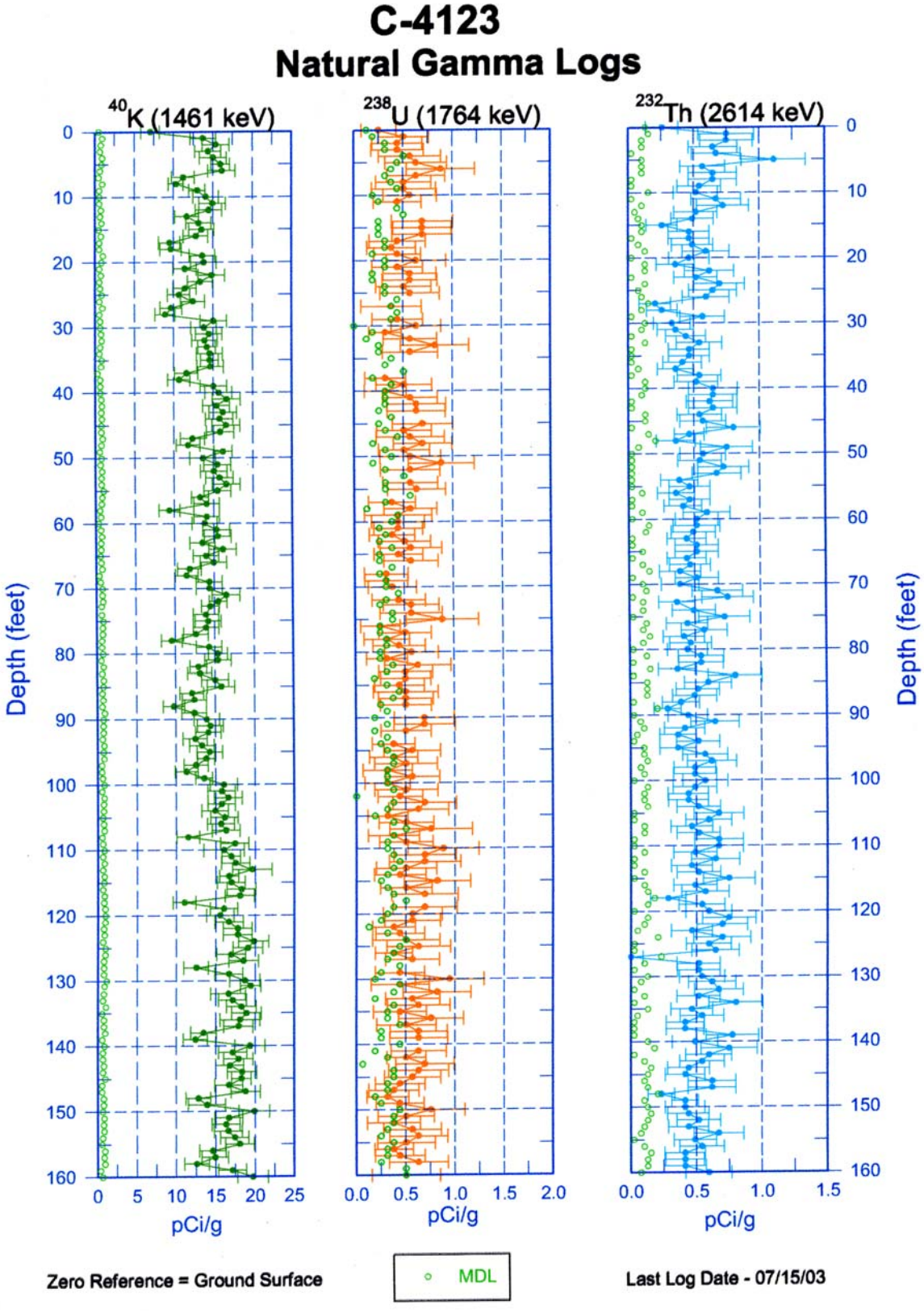
C-4123

Man-Made Radionuclides

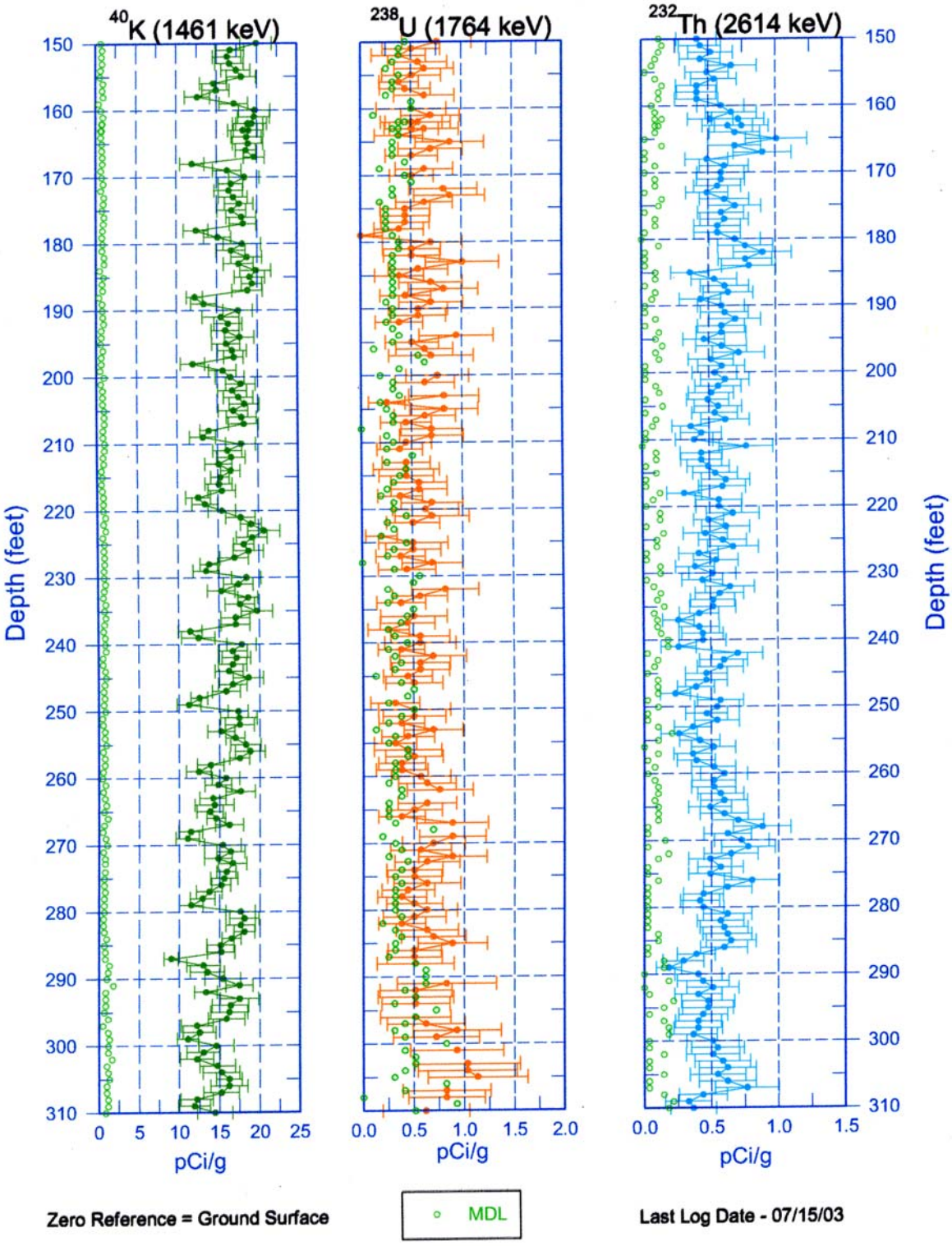


Zero Reference = Ground Surface

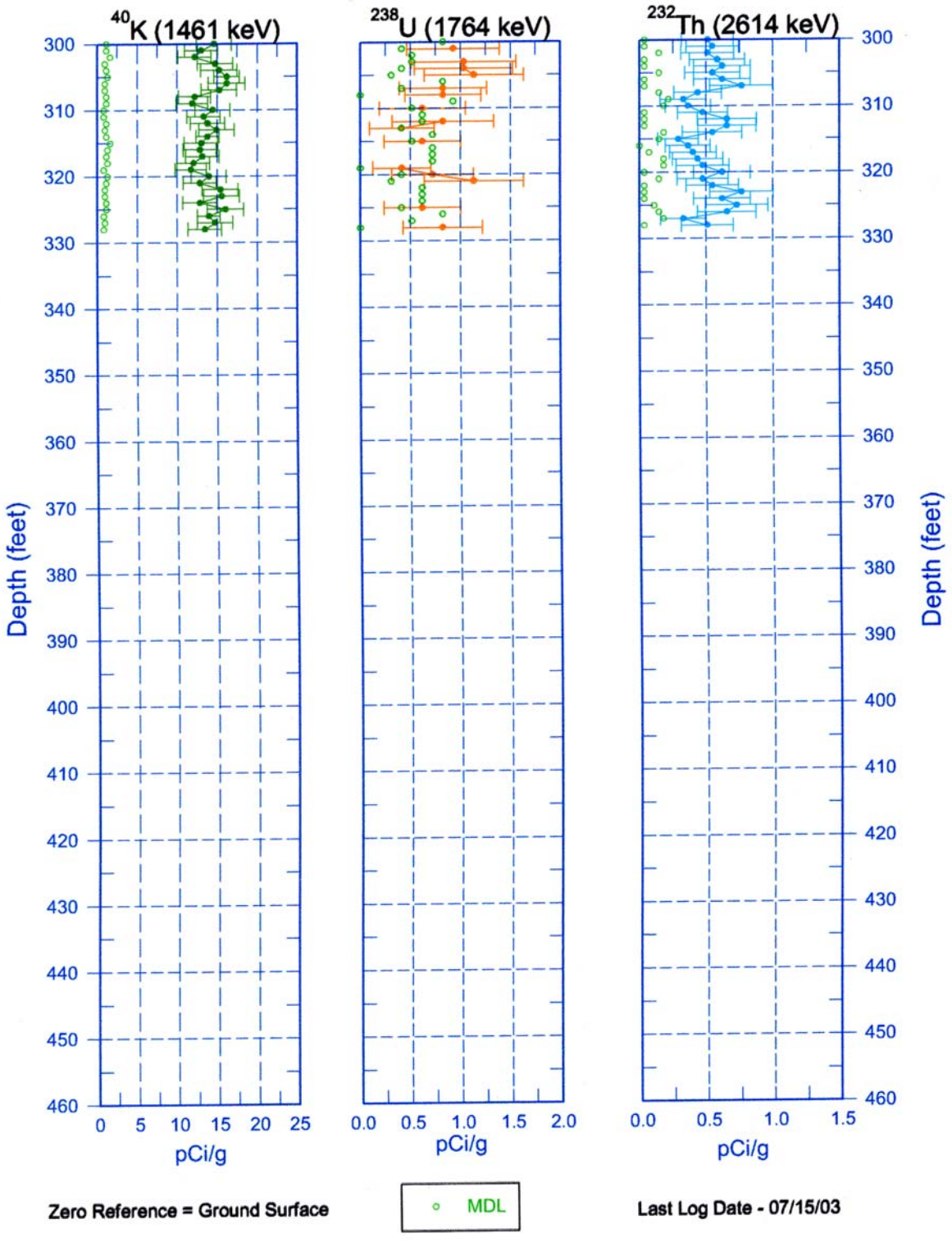
Last Log Date - 07/15/03

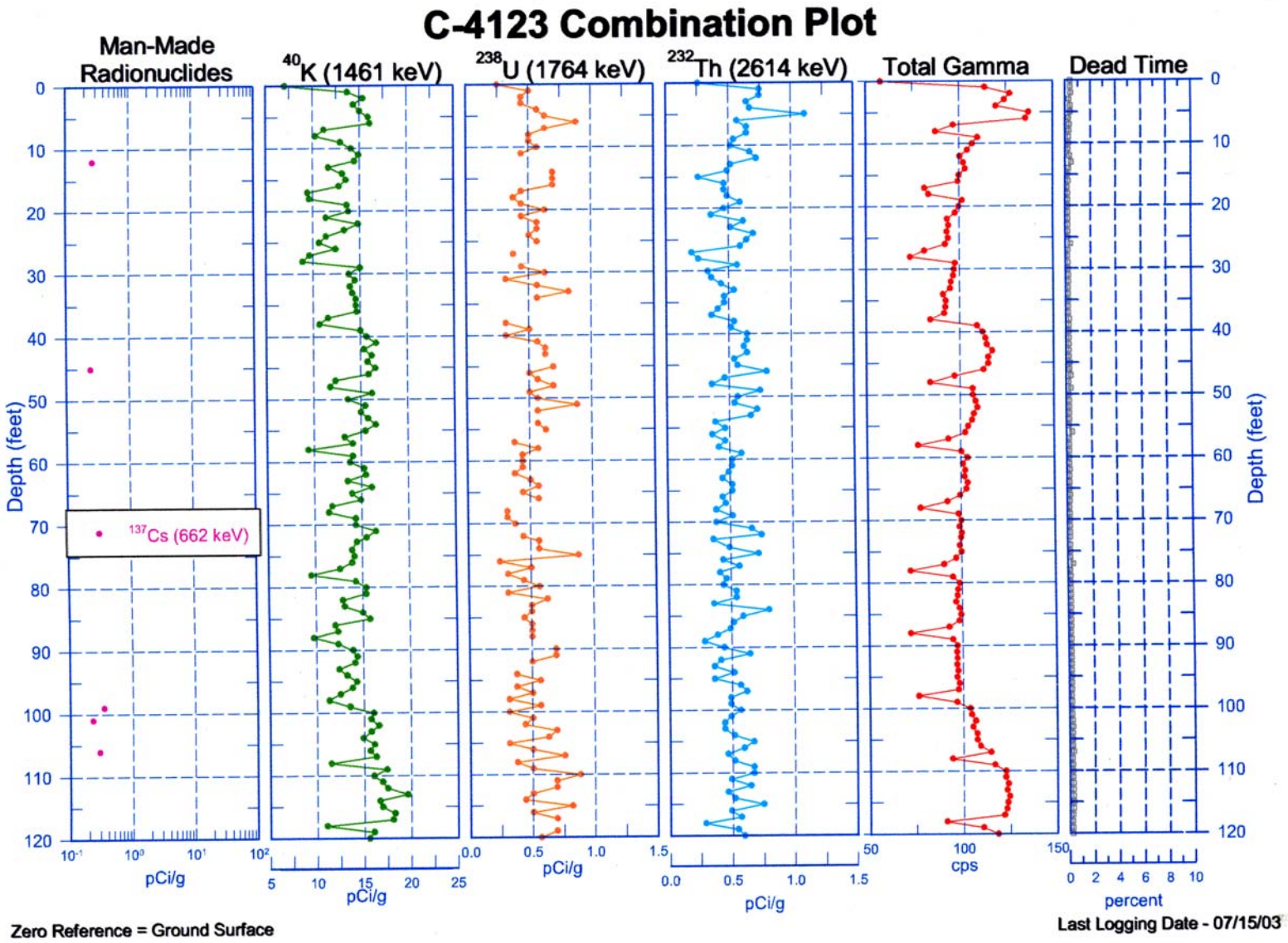

C-4123
Natural Gamma Logs
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Depth (feet)
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
0 5 10 15 20 25
pCi/g
0.0 0.5 1.0 1.5 2.0
pCi/g
0.0 0.5 1.0 1.5
pCi/g
MDL
Zero Reference = Ground Surface
Last Log Date - 07/15/03

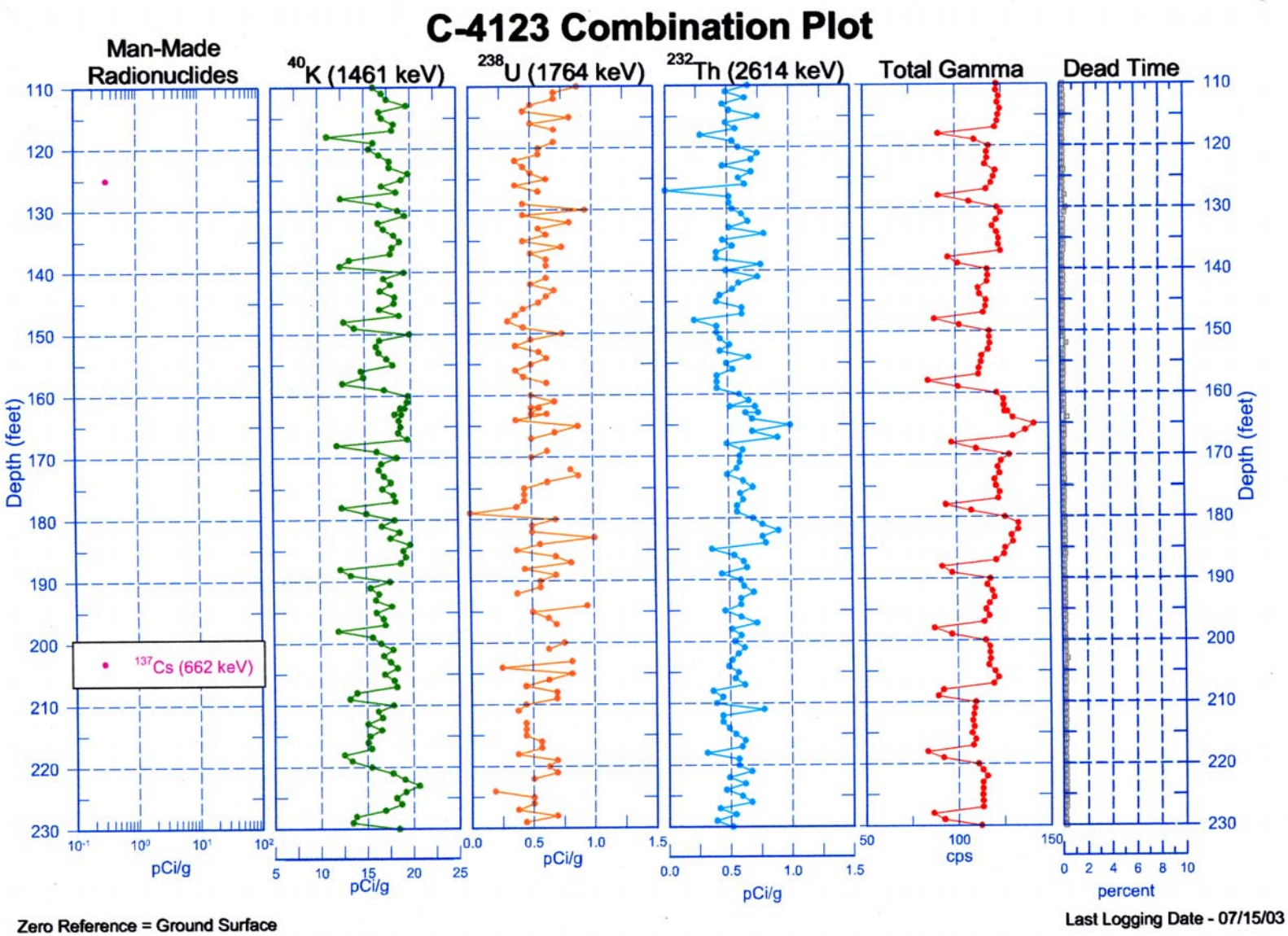
C-4123
Natural Gamma Logs

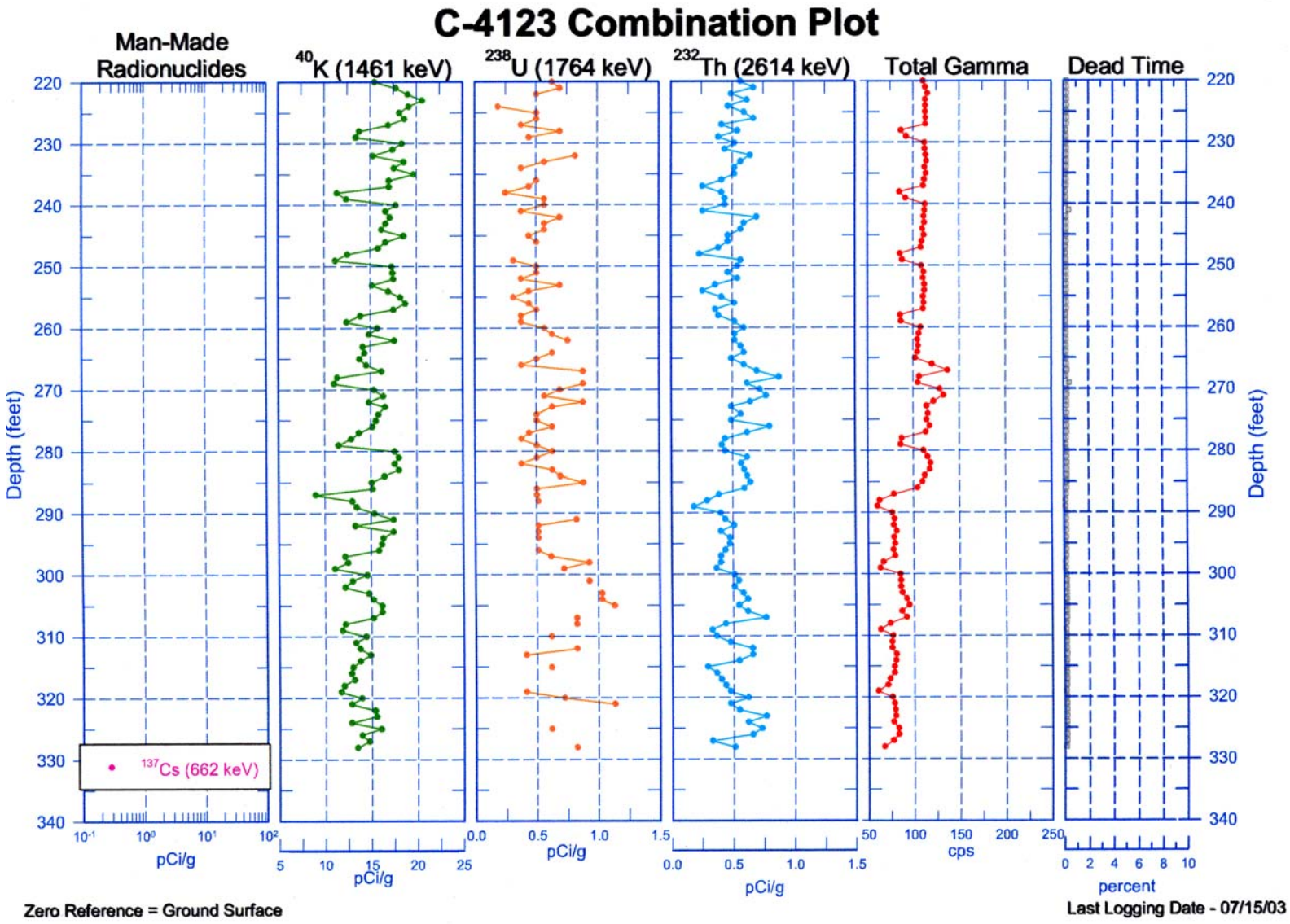


C-4123
Natural Gamma Logs

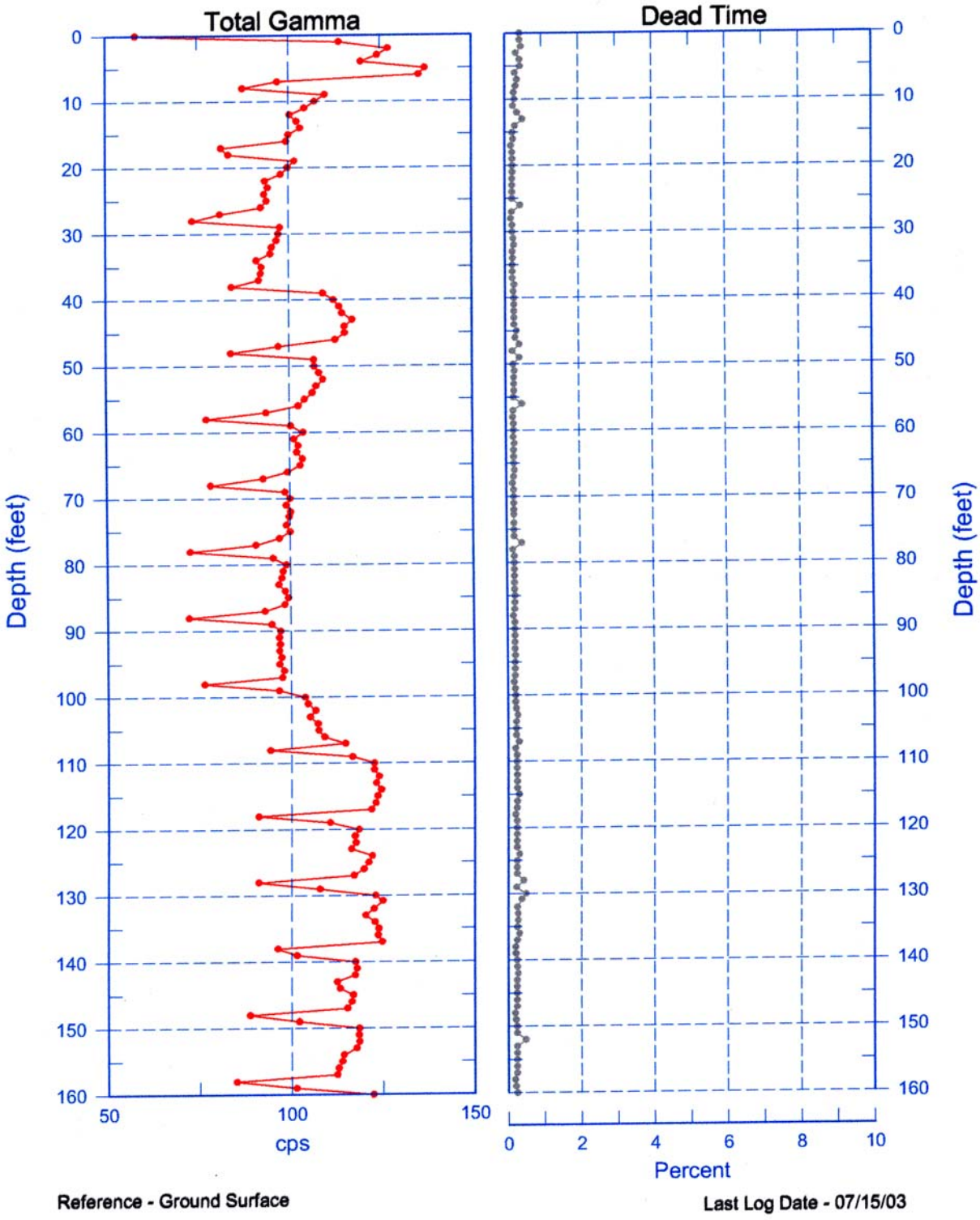



C-4123 Combination Plot
Man-Made Radionuclides
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Total Gamma
Dead Time
Depth (feet)
137Cs (662 keV)
pCi/g
cps
percent
Zero Reference = Ground Surface
Last Logging Date - 07/15/03

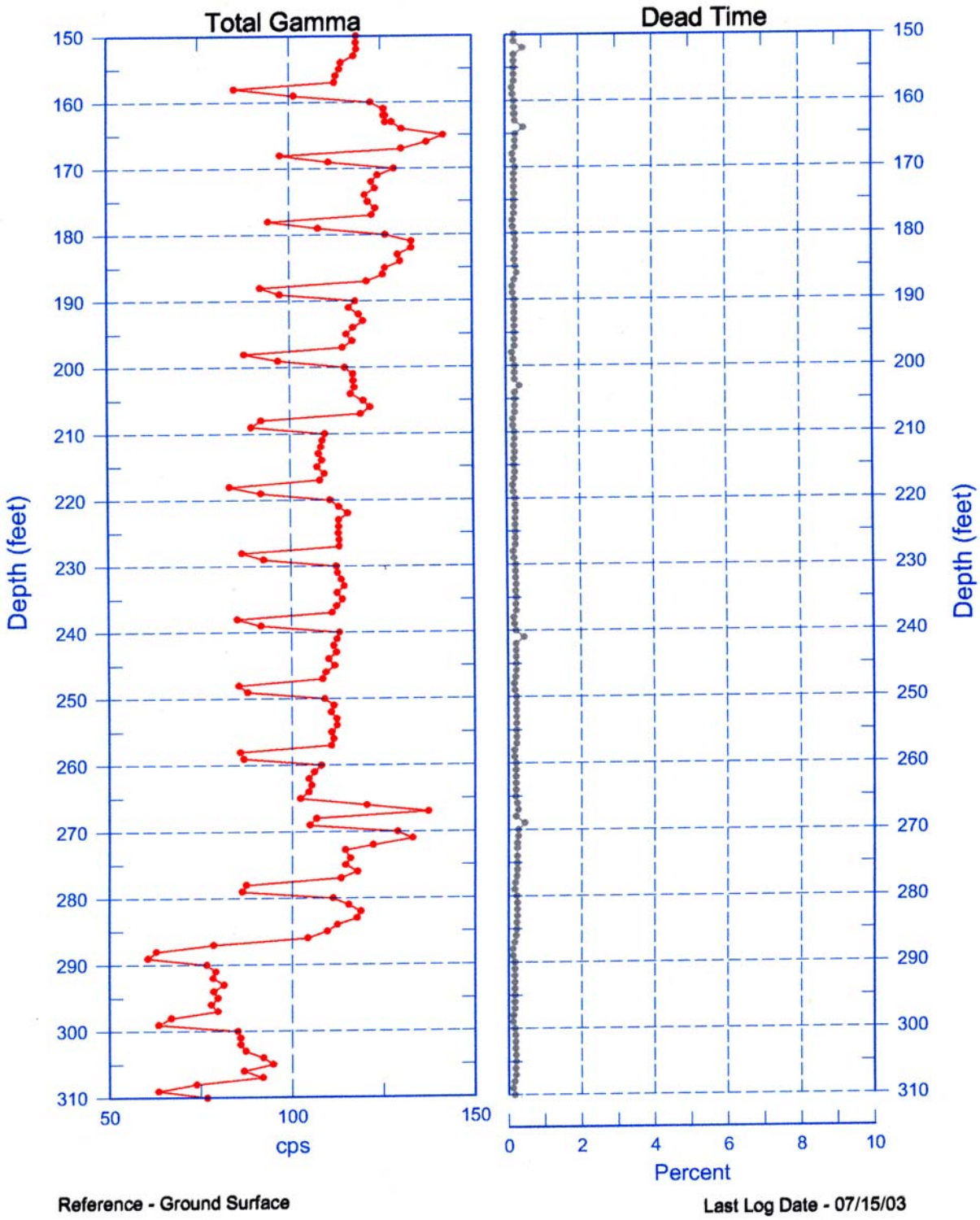

C-4123 Combination Plot
Man-Made Radionuclides
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Total Gamma
Dead Time
Depth (feet)
137Cs (662 keV)
pCi/g
cps
percent
Zero Reference = Ground Surface
Last Logging Date - 07/15/03


C-4123 Combination Plot
Man-Made Radionuclides
40K (1461 keV)
238U (1764 keV)
232Th (2614 keV)
Total Gamma
Dead Time
Depth (feet)
137Cs (662 keV)
pCi/g
cps
percent
Zero Reference = Ground Surface
Last Logging Date - 07/15/03

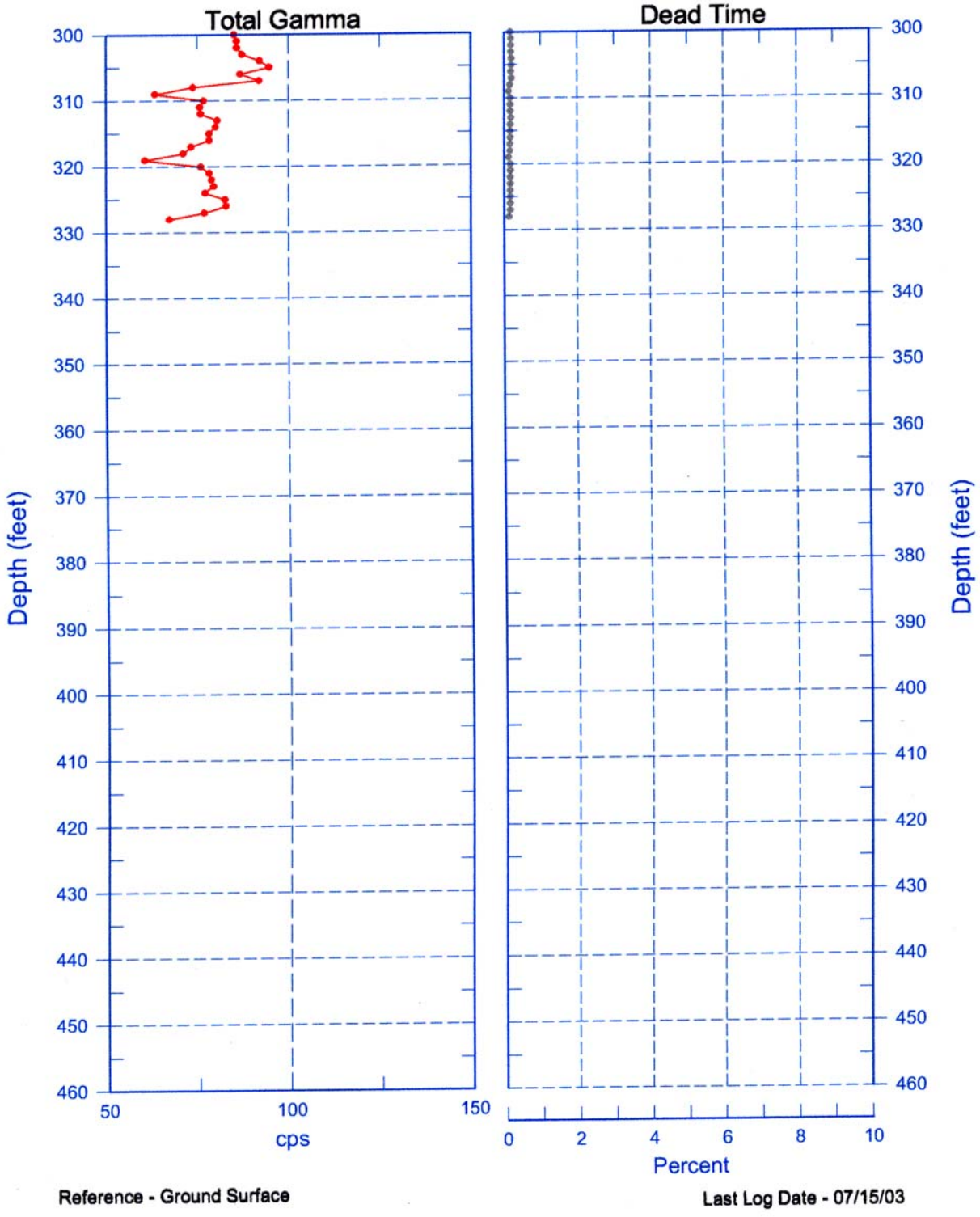
C-4123
Total Gamma & Dead Time



C-4123
Total Gamma & Dead Time



C-4123
Total Gamma & Dead Time



C-4123

Repeat Section of Natural Gamma Logs

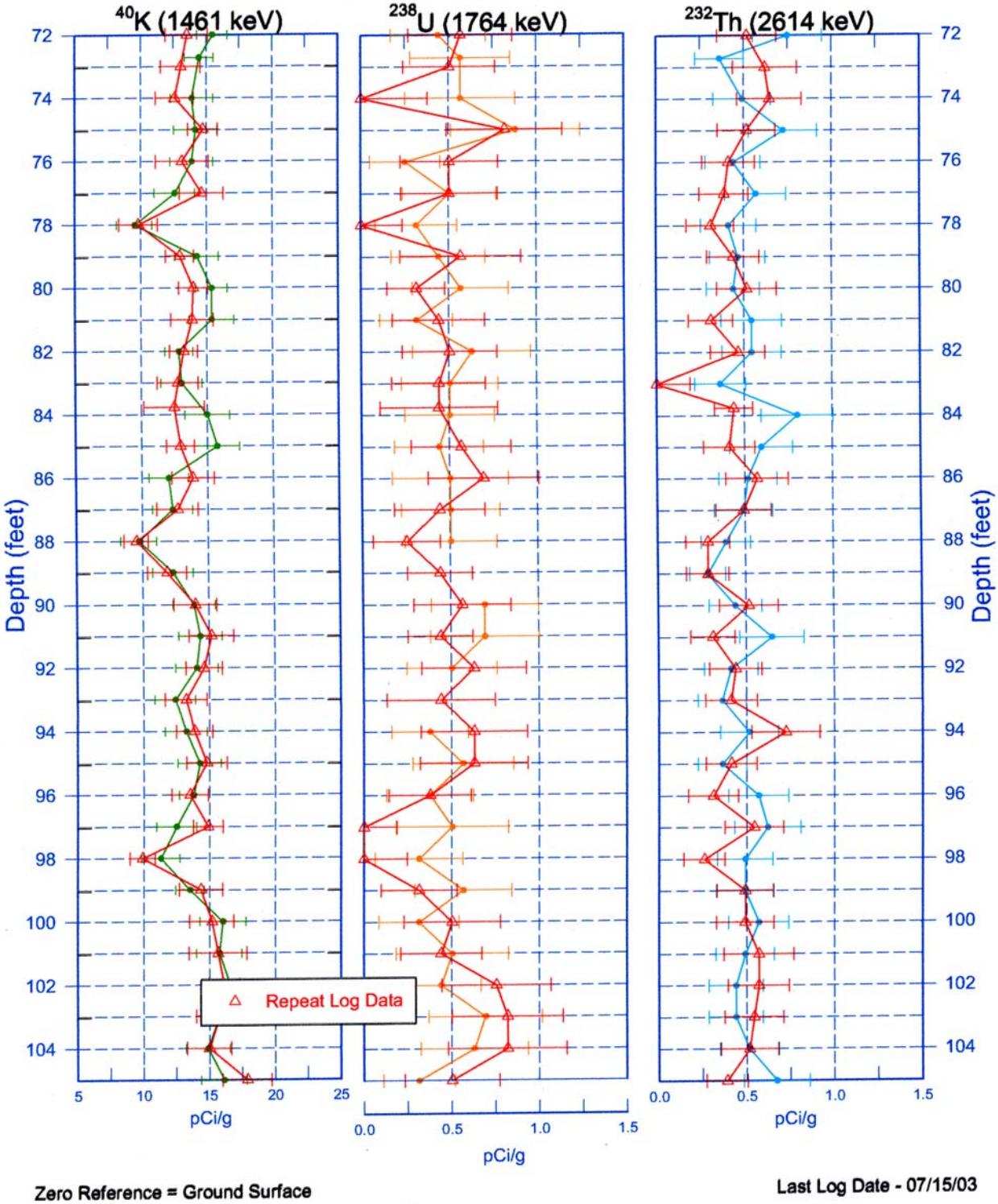


Table C.1. Gyroscope Data Report for Borehole C4122

Hole: C4122	Time	CabLength (feet)	Inclination (fromVert.)	TF Gyro	TFHighSide	CourseDir (0°...360°)		Rec.ID (17)	ClosureDir (0°..360°)	ClosureDist (feet)	TVD (+feet)	+N/-S (feet)	+E/-W (feet)	Dogleg °/ 100f
2 S	3.18	0	0.13	34.1	333	214		2 S	0	0	0	0	0	0
3 S	4.33	20	0.17	301	0	94.2		3 S	142	0.03	20	-0	0.02	1.3
4 S	5.18	40	0.23	313	14.4	92.3		4 S	106	0.09	40	-0	0.09	0.3
5 S	5.98	60	0.34	267	355	65.4		5 S	90.4	0.18	60	0	0.18	0.8
6 S	6.67	80	0.47	297	14.2	76.8		6 S	82.3	0.32	80	0.04	0.31	0.8
7 S	7.28	100	0.36	356	62.2	87.6		7 S	82.1	0.46	100	0.06	0.45	0.7
8 S	7.98	120	0.48	50.1	125	78.5		8 S	82.1	0.6	120	0.08	0.6	0.7
9 S	8.7	140	0.62	64.1	141	77.3		9 S	81.1	0.8	140	0.12	0.79	0.7
10 S	9.24	160	0.34	85.8	175	64.5		10 S	79.7	0.96	160	0.17	0.95	1.5
11 S	9.88	180	0.76	110	202	62.3		11 S	76.9	1.15	180	0.26	1.12	2.1
12 S	10.4	200	0.35	120	235	39.3		12 S	73.9	1.33	199.99	0.37	1.27	2.3
13 S	11.2	220	0.76	165	268	50.9		13 S	70.6	1.5	219.99	0.5	1.42	2.2
14 S	11.9	240	0.66	213	314	53.3		14 S	68	1.74	239.99	0.65	1.61	0.6
15 S	12.8	260	0.66	244	317	81.5		15 S	67.9	1.96	259.99	0.74	1.82	1.6
16 S	13.5	280	0.68	249	318	84.7		16 S	69.5	2.19	279.99	0.76	2.05	0.2
17 S	14.1	300	0.9	284	290	148		17 S	74.1	2.34	299.99	0.64	2.25	4.3
18 S	17.2	305	0.96	264	265	153		18 S	76	2.36	304.99	0.57	2.29	2

Table C.2. Gyroscope Data Report for Borehole C4123

Hole: C4122	Time	CabLength (feet)	Inclination (fromVert.)	TF Gyro	TFHighSide	CourseDir (0°...360°)		Rec.ID (17)	ClosureDir (0°..360°)	ClosureDist (feet)	TVD (+feet)	+N/-S (feet)	+E/-W (feet)	Dogleg °/ 100f
2 S	3.18	0	0.13	34.1	333	214		2 S	0	0	0	0	0	0
3 S	4.33	20	0.17	301	0	94.2		3 S	142	0.03	20	-0	0.02	1.3
4 S	5.18	40	0.23	313	14.4	92.3		4 S	106	0.09	40	-0	0.09	0.3
5 S	5.98	60	0.34	267	355	65.4		5 S	90.4	0.18	60	0	0.18	0.8
6 S	6.67	80	0.47	297	14.2	76.8		6 S	82.3	0.32	80	0.04	0.31	0.8
7 S	7.28	100	0.36	356	62.2	87.6		7 S	82.1	0.46	100	0.06	0.45	0.7
8 S	7.98	120	0.48	50.1	125	78.5		8 S	82.1	0.6	120	0.08	0.6	0.7
9 S	8.7	140	0.62	64.1	141	77.3		9 S	81.1	0.8	140	0.12	0.79	0.7
10 S	9.24	160	0.34	85.8	175	64.5		10 S	79.7	0.96	160	0.17	0.95	1.5
11 S	9.88	180	0.76	110	202	62.3		11 S	76.9	1.15	180	0.26	1.12	2.1
12 S	10.4	200	0.35	120	235	39.3		12 S	73.9	1.33	199.99	0.37	1.27	2.3
13 S	11.2	220	0.76	165	268	50.9		13 S	70.6	1.5	219.99	0.5	1.42	2.2
14 S	11.9	240	0.66	213	314	53.3		14 S	68	1.74	239.99	0.65	1.61	0.6
15 S	12.8	260	0.66	244	317	81.5		15 S	67.9	1.96	259.99	0.74	1.82	1.6
16 S	13.5	280	0.68	249	318	84.7		16 S	69.5	2.19	279.99	0.76	2.05	0.2
17 S	14.1	300	0.9	284	290	148		17 S	74.1	2.34	299.99	0.64	2.25	4.3
18 S	17.2	305	0.96	264	265	153		18 S	76	2.36	304.99	0.57	2.29	2