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Revision 0

Geologic Cross Section Development in the Vicinity of S-Complex and T-Complex to Support the 200-DV-1 Operable Unit Conceptual Models

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

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

CH2MHILL
Plateau Remediation Company
P.O. Box 1600
Richland, Washington 99352

200-DV-1

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APPROVED
By Lee Ann Snyder at 7:45 am, Oct 14, 2014

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Terms

bgs	below ground surface
CCU	Cold Creek unit
CCUc	Cold Creek unit – calcic geosol
CCUz	Cold Creek unit – silt-dominated
CHPRC	CH2M HILL Plateau Remediation Company
Freestone	Freestone Environmental Services, Inc.
GPL	HEIS geophysical log
HEIS	Hanford Environmental Information System
Hf1	Hanford formation unit 1
Hf2	Hanford formation unit 2
HGA	Hydro GeoAnalyst
HWIS	Hanford Well Information System
OU	operable unit
PNNL	Pacific Northwest National Laboratory
RFlm	Ringold Formation lower mud unit
RFtf	Ringold Formation member of Taylor Flat
RFwia	Ringold Formation member of Wooded Island – unit A
RFwie	Ringold Formation member of Wooded Island – unit E
SQL	Structured Query Language
Stoller	S.M. Stoller Corporation
WIDL	Well Information Data Lookup
WMA	waste management area

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1 Introduction

Freestone Environmental Services, Inc. (Freestone), under contract to CH2M Hill Plateau Remediation Company (CHPRC), developed geologic cross sections from select boreholes located within the 200-DV-1 Deep Vadose Zone Operable Unit (OU). This project used geophysical logging data and field-generated soil descriptions to develop an updated contacts database to assist in the generation of the vadose zone conceptual model within the 200-DV-1 OU in support of the 200-DV-1 OU work plan. This document describes the process of selecting these unit contacts, as well as the compilation of data into an environmental database software called Hydro GeoAnalyst[1,2](HGA). HGA is designed to facilitate graphics production, such as geologic cross sections. A general description of the HGA software is provided. Geophysical logging data and stratigraphic correlations are presented in Appendix A, and a lithologic data table is provided in Appendix B.

The 200-DV-1 OU work plan focuses on the nature and extent of contamination in the vadose zone sediments. As such, the geologic discussions contained in this document, for the T-Complex and S-Complex, focus primarily on the stratigraphic units occurring in the vadose zone.

[1] Hydro GeoAnalyst® is a registered trademark of Schlumberger Canada Limited Corporation, Calgary, Alberta, Canada.

[2] Additional information on HGA can be obtained from the vendor: Schlumberger Water Services, 460 Phillip Street, Suite 101, Waterloo, Ontario, Canada N2L 5J2 (phone: 519-746-1798).

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2 Geologic Cross Section Development

A total of 17 geologic cross sections throughout eight waste site subregions (six subregions in the vicinity of the T-TX-TY Tank Farm complex and two subregions in the vicinity of S-SX Tank Farm complex) were generated to support the 200-DV-1 OU work plan. The purpose of these cross sections is to illustrate the current understanding of the extent of different stratigraphic units within the vadose zone and how local geology contributed to the current chemical and radiological contamination extent.

Boreholes to include on the cross sections were selected on the basis of whether reliable lithologic and/or geophysical data were available. A flow diagram depicting the process of generating the cross sections is illustrated in Figure 2-1. Descriptions of each step in the flow diagram are provided in the following subsections.

2.1 Data Sources

Several different types of data were used by Freestone to pick the top of stratigraphic units in the 200-DV-1 OU. A hierarchy of data types was established with CHPRC to determine which data type would give the most accurate representation of the stratigraphic units. For wells that had unit picks in the Pacific Northwest National Laboratory (PNNL) contacts spreadsheet, geophysical logging data were used to validate those contacts (if geophysical data were unavailable, other field-generated sediment descriptions were used). For wells and boreholes that did not have unit picks in the contacts spreadsheet, geophysical logging data were given the highest priority to determine stratigraphic unit picks. Geophysical logging data were obtained in either the form of a log data report prepared by S.M. Stoller Corporation (Stoller) or the raw geophysical data (Microsoft Excel[3] spreadsheet) from the Hanford Environmental Information System (HEIS) Geophysical Log (GPL) database (only total gamma was available). Stratigraphic picks obtained from geophysical logging data were verified with geologist-produced borehole logs, driller-generated logs, or as-built/well summary diagrams. The lithologic data table provided in Appendix B lists all of the unit contact depths and the types of data available for each cross section well.

2.1.1 Geophysical Logging Data

Geophysical logging data were acquired from multiple sources, including Stoller, the CHPRC-maintained Integrated Document Management System, the CHPRC-maintained Environmental Dashboard Application, Well Information Data Lookup (WIDL), and the CHPRC-maintained HEIS-GPL.

Log data reports were used (in PDF format) whenever possible and included plots of potassium-40, uranium-238, thorium-232, and total gamma.

When available, data were acquired as Microsoft Excel spreadsheets containing the depth and recorded gross-gamma activity. The data were later displayed on the cross sections.

[3] Microsoft Excel® is a registered trademark of Microsoft Corporation in the United States and other countries.

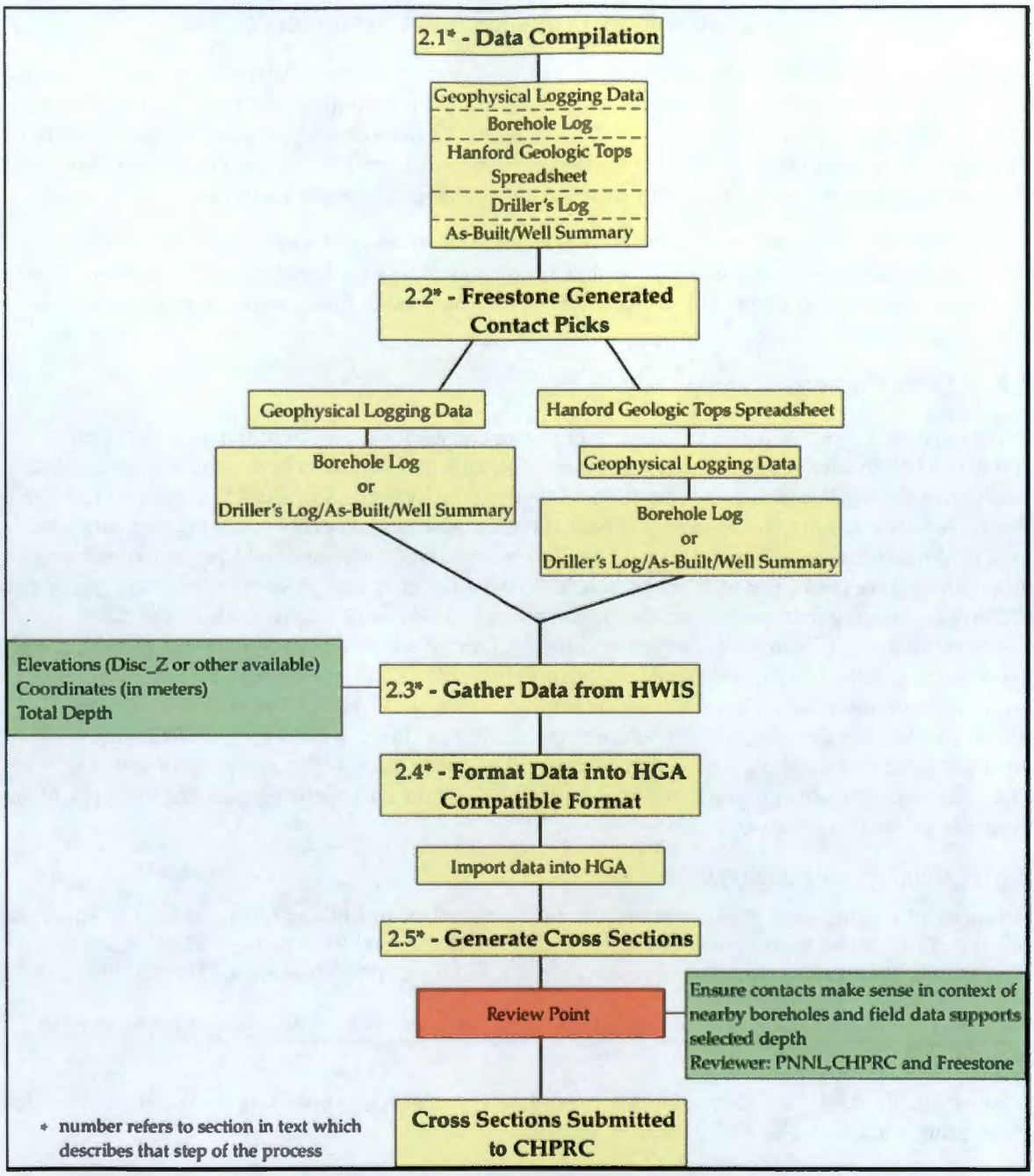

Figure 2-1. 200-DV-1 OU Cross Section Development Process

2.1.2 Pacific Northwest National Laboratory Contacts Spreadsheet

A geologic contacts spreadsheet maintained by PNNL (Microsoft Excel spreadsheet, dated October 19, 2010) was provided to Freestone that included "best estimates" for tops of geologic units selected for some of the wells within and surrounding the 200-DV-1 OU. The spreadsheet included major and minor geologic contacts (reported in feet below ground surface [bgs]) of the geologic units representative of Hanford Site suprabasalt geology, including the Hanford formation (including subunits),

the Cold Creek unit (CCU) (including subunits), and the Ringold Formation (including subunits). Explanations of the process and the criteria used to compile the geologic contacts data are published in *Hydrogeology of the Hanford Site's Central Plateau: A Status Report for 200 West Area* (PNNL-17913).

2.1.3 Borehole Logs

For wells and boreholes where geophysical logging data were available, geologist-generated borehole logs were used to validate picks derived from the geophysical logs. For wells and boreholes where geophysical logging data were not available, the borehole logs were used to determine the stratigraphic unit contact picks (provided that reliable picks could be made from the borehole logs. Borehole logs were acquired from WIDL.

2.1.4 Driller's Logs, As-Builts, and Well Summary Diagrams

For wells and boreholes where none of the previously discussed data sources were available, driller-generated logs, as-builts, and well summaries were used to derive stratigraphic unit contact picks (provided that reliable picks could be made from the driller's log/as-builts. Driller's logs, as-builts, and well summary diagrams were acquired from WIDL.

2.1.5 Geologic Units of Interest in the 200-DV-1 Operable Unit

The geologic units of interest in the 200-DV-1 OU are as follows:

- **Hanford formation:** The Hanford formation units represent the youngest units present underlying the 200-DV-1 OU. Hanford formation unit 1(Hf1) is a gravel-dominated unit, and Hanford formation unit 2 (Hf2) is sand-dominated. In some portions of the 200-DV-1 OU, the lower part of the Hf2 is coarser grained, consisting of very coarse sand to sandy gravel. In the extreme western portion of the T-Complex, a second gravel-dominated Hanford formation unit is present (Hanford formation unit 3).
- **CCU – silt-dominated (CCUz):** CCUz consist of cohesive, compacted, and massive to laminated, fine-grained sand and silt.
- **CCU – calcic geosol (CCUc):** The CCUc consists of basaltic to quartzitic gravels, sands, silt, and clay that are cemented with one or more layers of secondary, pedogenic calcium carbonate (caliche).
- **Ringold Formation member of Taylor Flat (RFtf):** RFtf consists of interstratified, well-bedded, fine to coarse sand and silt. The RFtf is not laterally continuous but is present locally in the vicinity of T-Complex and S-Complex as thin (2 to 6 m [6 to 20 ft]) erosional remnants.
- **Ringold Formation member of Wooded Island – unit E (RFwie):** RFwie is typically a sandy, gravel-dominated unit that underlies the RFtf. In this vicinity, the RFwie is typically present in both the vadose zone and uppermost portion of the unconfined aquifer.

2.2 Contact Selection

Freestone used a hierarchy of data to determine the top and bottom of each major stratigraphic unit in the 200-DV-1 OU. As previously stated, data used to determine stratigraphic contact picks include picks from the PNNL contacts spreadsheet, geophysical logs, borehole logs, driller's logs, as-builts, and well summary diagrams. When available, contact picks from the PNNL contacts spreadsheet were used. These picks were verified using geophysical logging data, and corrections/adjustments were made to the contact picks if necessary. Primarily natural gamma-logging data was used, which were comprised of the following plots: total gamma, potassium-40, uranium-238, and thorium-232. Cesium-137 plots were used to aid in determining whether peaks in the total gamma plot may have been attributable to manmade contamination. Figure 2-2 shows an example of how the total gamma geophysical plot was correlated

with stratigraphic unit contact picks. Appendix A provides correlations for the 200-DV-1 OU wells with geophysical logging data available. Figure 2-3 shows how the different geophysical plots discussed correlate with the stratigraphy. If geophysical logs were not available, the geologist-produced borehole log was used to determine stratigraphic contact picks (if possible). If a borehole log was not available, the driller's log and as-builts were used to determine stratigraphic contact picks (if possible).

The list of stratigraphic contact picks, drill depth, and data types used to determine contact picks are provided in Appendix B.

2.3 Formatting Data into Hydro GeoAnalyst-Compatible Format

All of the stratigraphic data and interpretations were processed for this project using HGA software. HGA is a software package developed by Schlumberger Water Services that enables the user to create a project-specific database.

HGA is used to collect all previous data and reports, and then consolidates this information into a powerful relational database system that can be queried and referenced. HGA operates as a desktop application based on Microsoft Structured Query Language (SQL) Server[4] technology. The package supports multiple user levels for controlled data management, with structured access privileges for setting up project data structures, checking out data to working subprojects, and submitting new or modified data. Data are imported into HGA using the Data Transfer System. Using the Data Transfer System, borehole data can be imported from practically any source format, including delimited text files, Microsoft Excel spreadsheets, Microsoft Access[5] databases, and Microsoft SQL Server databases. HGA is built on an SQL server; users may either write queries using standard SQL server query language to retrieve specific data from the database or use HGA's Query Builder. The Map Manager, built on ESRI's MapObjects[6] technology, provides a spatial view of any set of selected data. Base maps of the site can be quickly imported, allowing for meaningful interpretation of borehole and well data while maintaining the consistency and traceability of the data. The Map Manager is designed in such a way that most files required for a desired map view are generated automatically.

Geologic unit contact data were initially entered in a Microsoft Excel spreadsheet. The spreadsheet was reformatted by creating vertical columns of data that assigned a "to" and "from" depth of each unit for each well. All depths were entered into HGA as "feet bgs" to preserve the original data. No calculations were performed during this formatting. All of the data were then reviewed to ensure that all values were captured correctly and were identical to the values in the original Microsoft Excel spreadsheet.

2.4 Data from the Hanford Well Information System

Northing and easting survey coordinates and ground surface elevations (brass survey marker assumed to be ground surface) for the wells were obtained from the Hanford Well Information System (HWIS), which is maintained within the HEIS database. Elevation data acquired from the HWIS were listed in "meters," therefore requiring conversion to "feet" to be consistent with the geologic contacts elevation data. The borehole total depth entered into HGA was the reported total borehole depth available in the HWIS.

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[4] Microsoft SQL Server® is a registered trademark of Microsoft Corporation in the United States and other countries.

[5] Microsoft Access® is a registered trademark of Microsoft Corporation in the United States and other countries.

[6] ERSI MapObjects® is a registered trademark of Environmental Systems Research Institute, Inc. Corporation, Redlands, California.

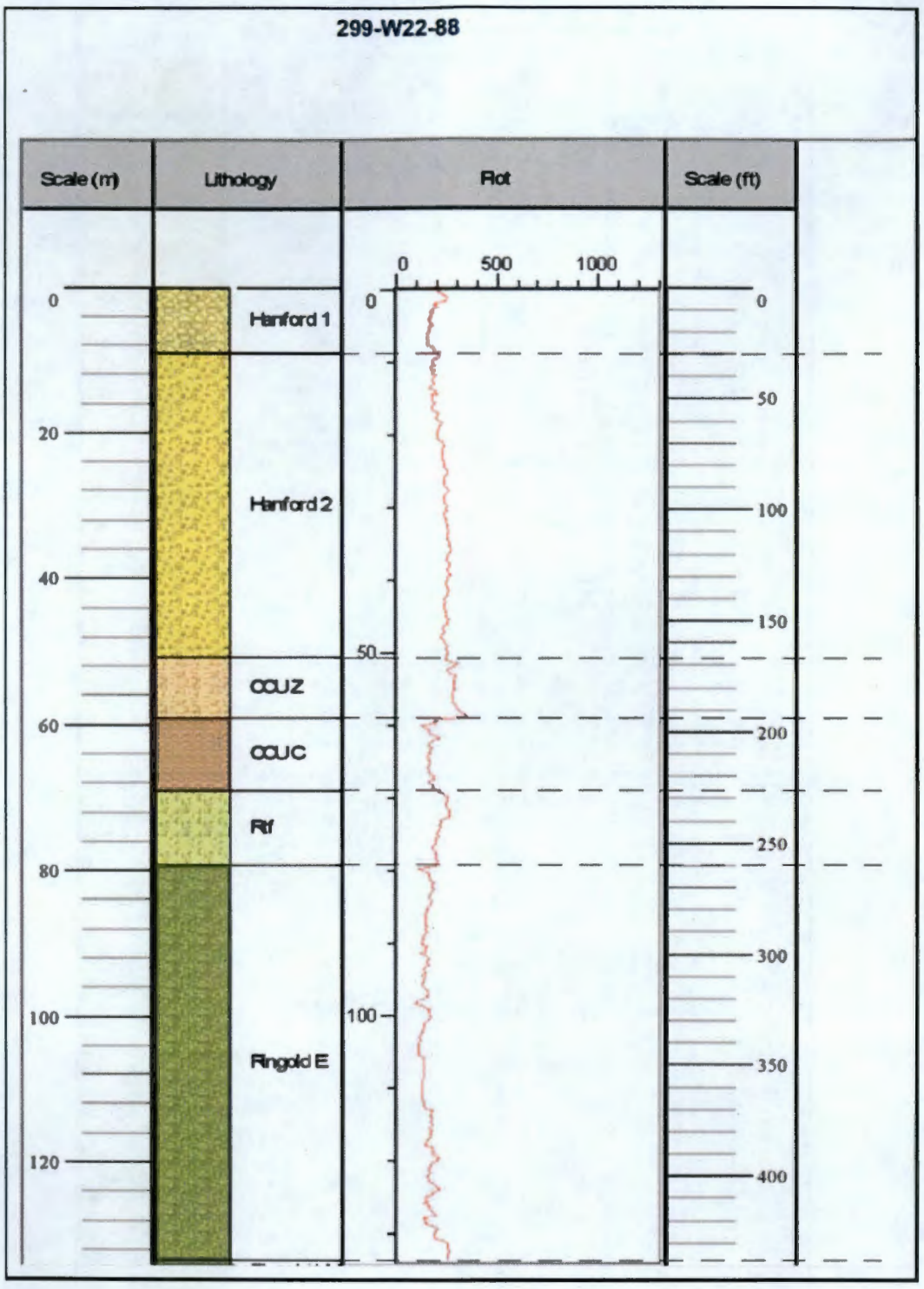

Figure 2-2. Correlation of Geophysical Borehole Log Total Gamma Plot to Stratigraphic Unit

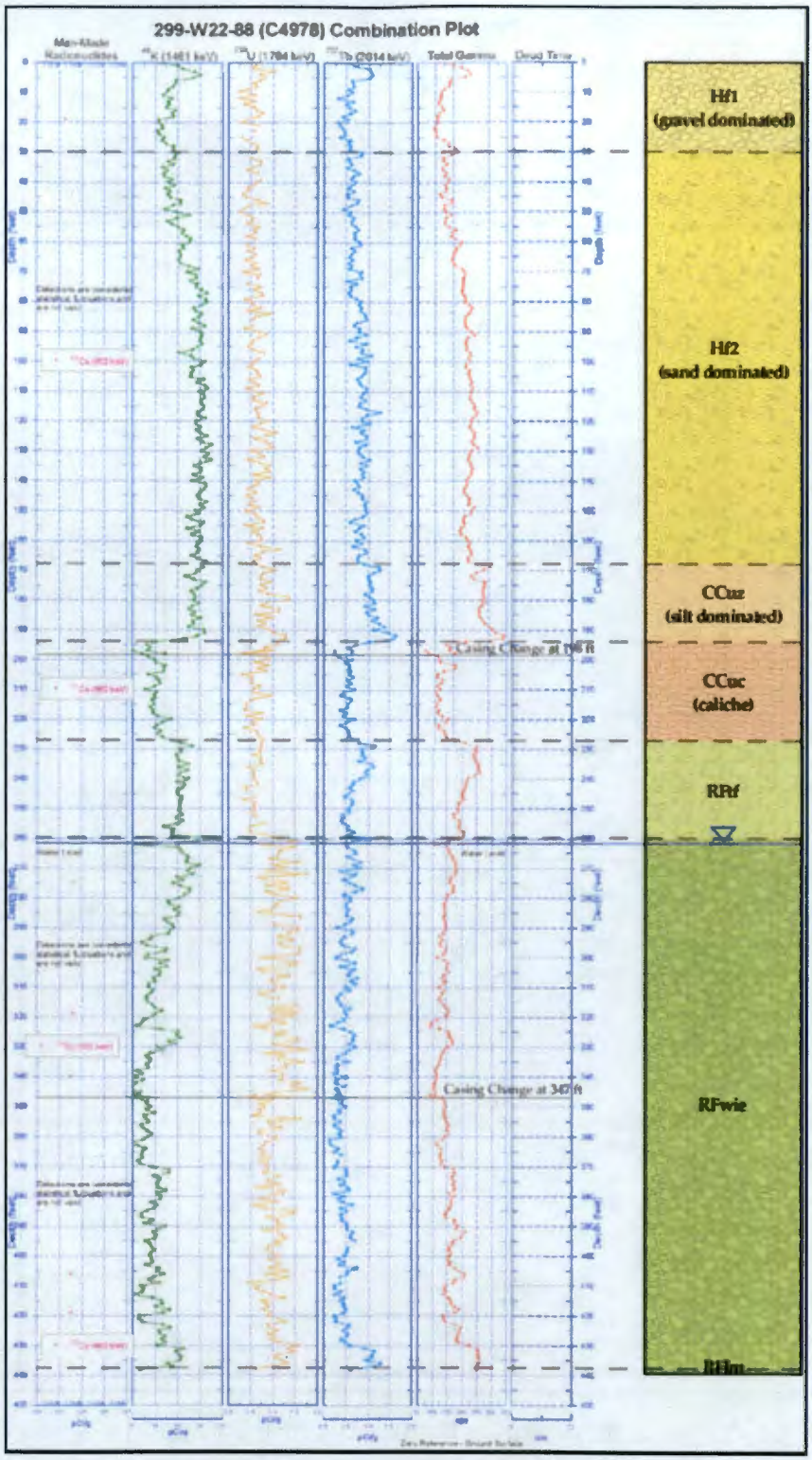

Figure 2-3. Correlation of Total Gamma, Potassium-40, Uranium-238, and Thorium-232 Geophysical Plots to Stratigraphic Units

2.5 Cross Section Construction

The various data sets listed above (e.g., geologic unit contacts, well coordinates, and elevations) were imported into HGA using the Data Transfer System module. The imported data were used to generate 4 regional cross sections and 17 site-specific representative geologic cross sections for the 200-DV-1 OU waste sites. The cross sections were generated within HGA's Map Manager tool. The Map Manager tool plots the borehole geology at each individual borehole on a cross section line. Within HGA, Freestone interpreted the data between boreholes to construct the finished cross section, which allowed for the complexities of the different geologic units to be represented on the cross sections. The project team reviewed each cross section to ensure that the most current understanding of the stratigraphy across the 200-DV-1 OU waste sites was represented.

Data were then reviewed to ensure that the contact depths made sense spatially and relative to nearby wells. Geologic contact depths that were questionable were flagged and brought to the attention of the project team for further review. Revised values were included in the data set, which is provided in Appendix B.

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3 Regional Geology

The Hanford Site and Pasco Basin lie within the Columbia Plateau of southeastern Washington State. This broad plain, situated between the Cascade Mountains to the west and the Rocky Mountains to the east, is underlain by a thick sequence of volcanic Columbia River basalt, which forms the basement rock for the region. The generalized stratigraphy beneath the Hanford Site consists of, in descending order, includes the Holocene alluvium, colluvium, and/or eolian sediments and backfill materials (all discontinuous); the Hanford formation; the CCU (formerly named the Plio-Pleistocene unit); the Ringold Formation; the Columbia River Basalt Group; and intercalated sediments of the Ellensburg Formation (Figure 3-1). The CCU and Hanford formation are both considered informal stratigraphic designations. The regional suprabasalt stratigraphy is described in more detail in the following publications:

- *Characterization of Vadose Zone Sediments Below the TX Tank Farm: Boreholes C4104, C4105, 299-W10-196, and RCRA Borehole 299-W11-39* (PNNL-14849)
- *Characterization of Vadose Zone Sediments Below the TX Tank Farm: Boreholes C3830, C3831, C3832 and 299-W10-27* (PNNL-14594)
- *Site Characterization Plan: Reference Repository Location, Hanford Site, Washington* (DOE/RW-0164)
- *Hydrogeologic Model for the Gable Gap Area, Hanford Site* (PNNL-19702)
- *Miocene- to Pliocene-Aged Suprabasalt Sediments of the Hanford Site, South-Central Washington* (BHI-00184)
- *Standardized Stratigraphic Nomenclature for Post-Ringold-Formation Sediments Within the Central Pasco Basin* (DOE/RL-2002-39)
- *The Miocene to Pliocene Ringold Formation and Associated Deposits of the Ancestral Columbia River System, South-Central Washington and North-Central Oregon* (Lindsey, 1996)
- *Thermochemical Optimization of Float Glass Composition: Low-Alumina Glass Development* (PNNL-13958)

Figures 3-2 through 3-5 show cross sections depicting the regional geology of the 200 West Area.

3.1 Holocene Deposit

Holocene deposits include natural eolian deposits as well as backfill material. Eolian deposits are generally fine-gained deposits. Backfill material is comprised mostly of gravel-dominated deposits of the native Hanford formation Hf1 that was stockpiled nearby during disposal facility construction. Some of the coarsest gravel was removed before backfilling, and all natural layering/stratification was disrupted such that the backfill is rather homogeneous and featureless compared to the undisturbed Hf1.

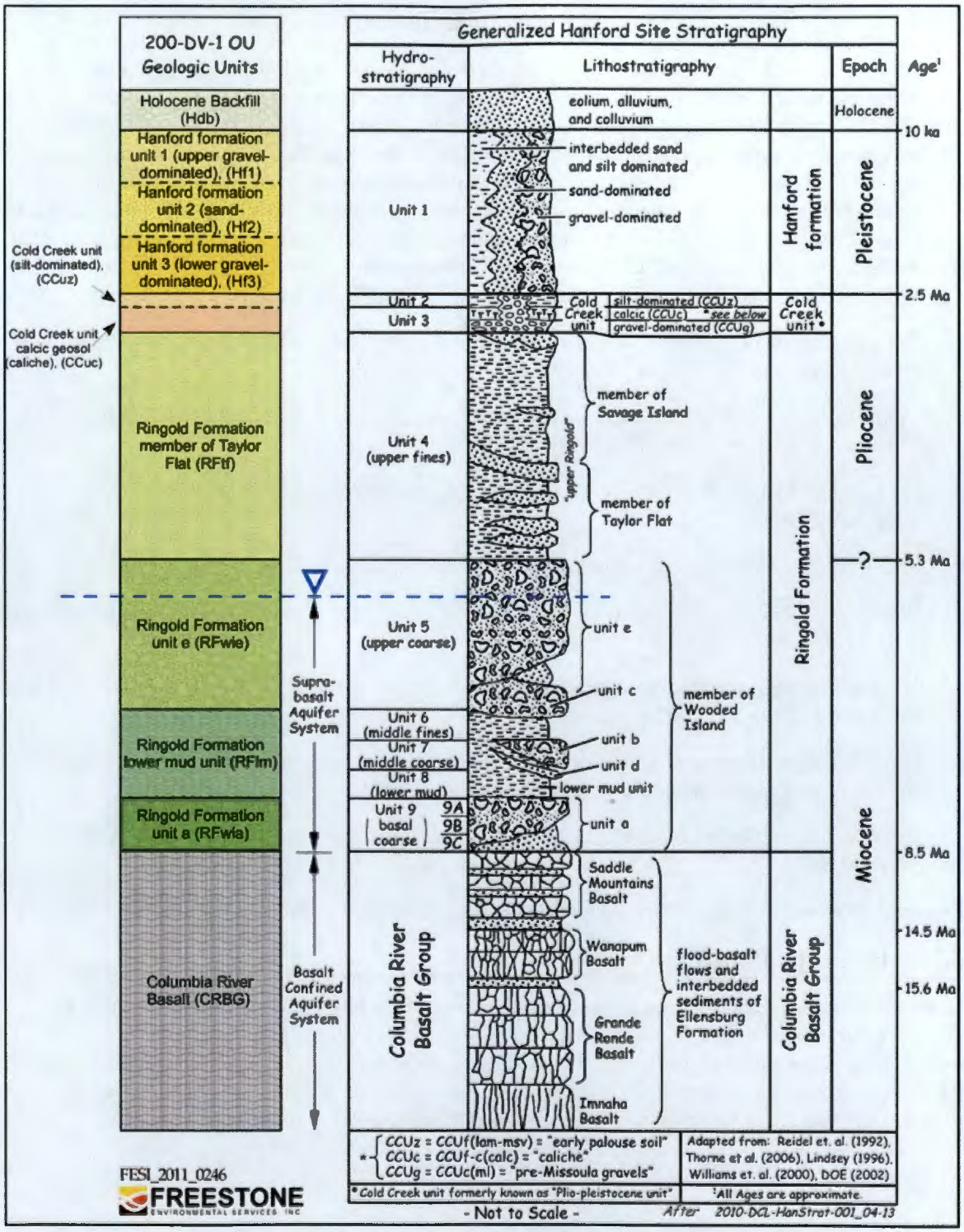

Figure 3-1. Correlation of 200-DV-1 OU Stratigraphy to Generalized Hanford Site Stratigraphy

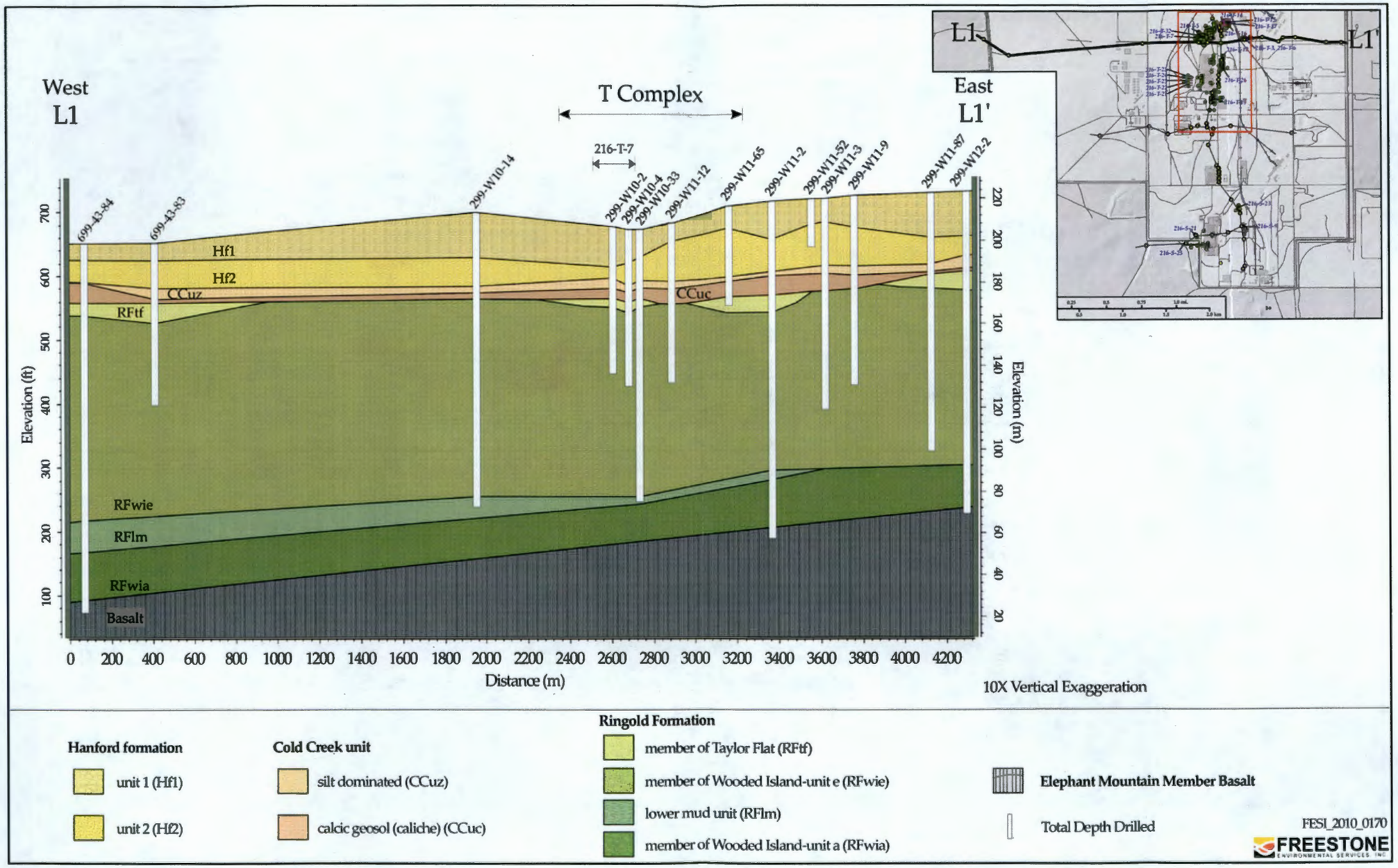

Figure 3-2. Regional Cross Section L1-L1'

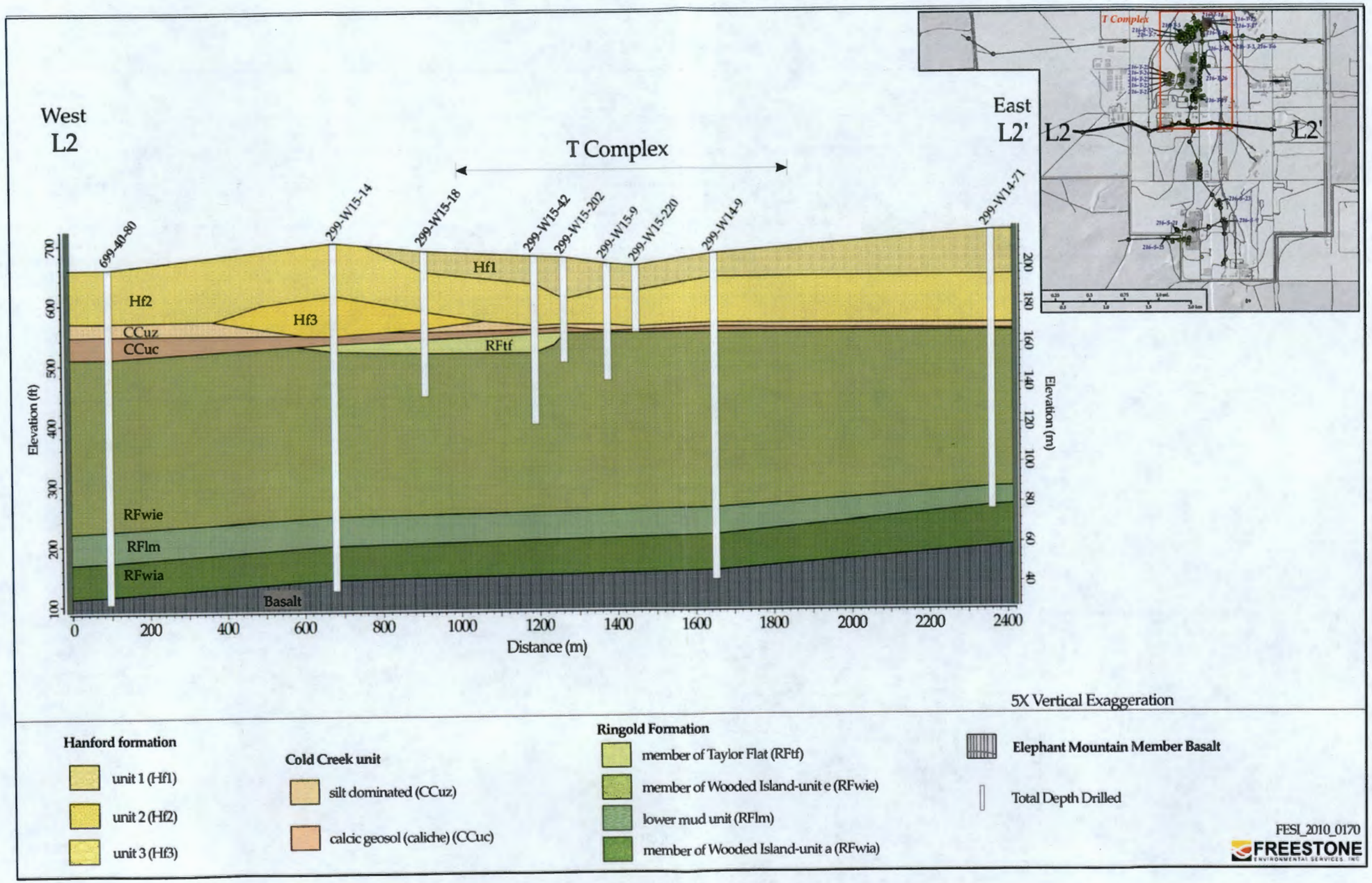

Figure 3-3. Regional Cross Section L2-L2'

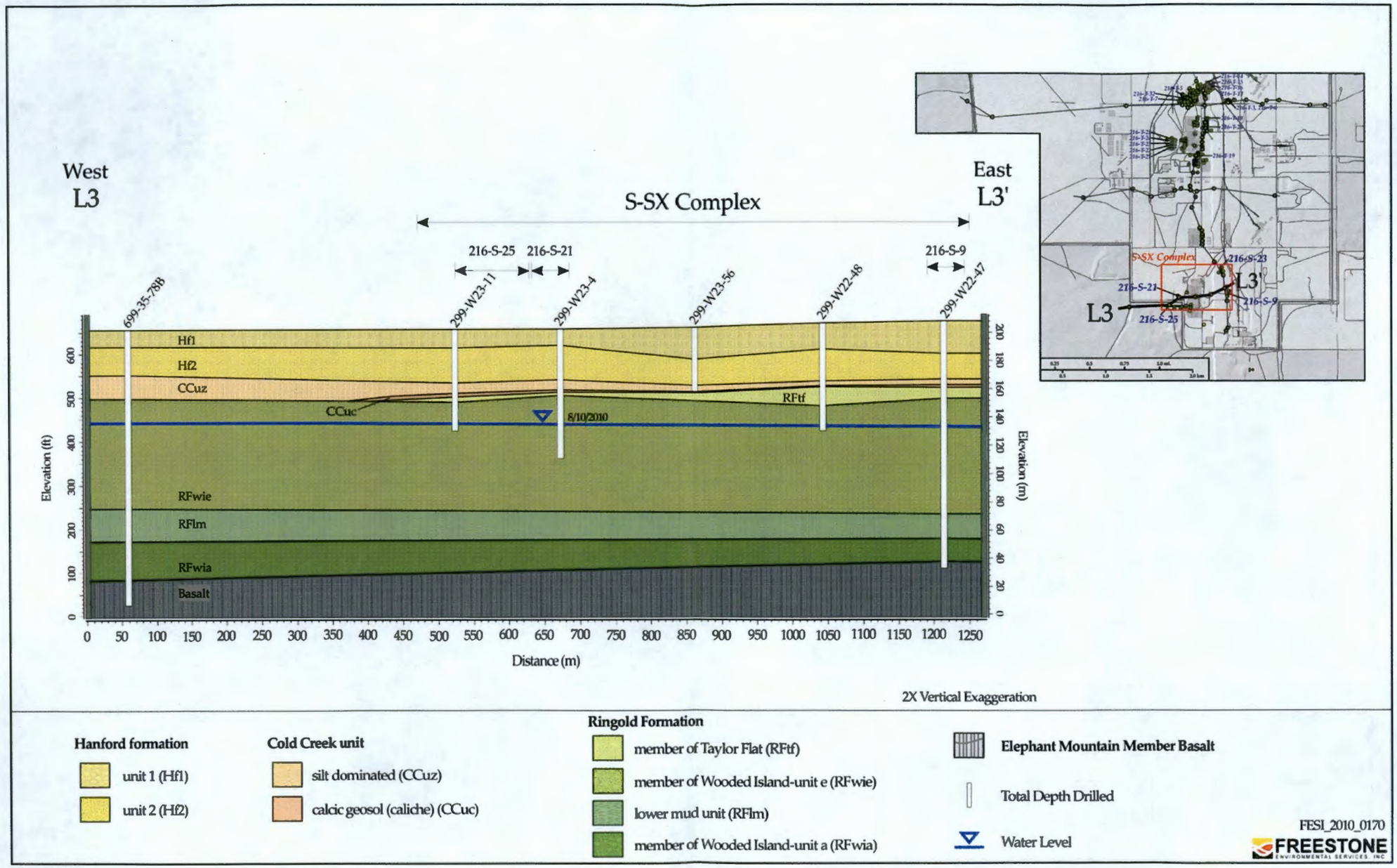

Figure 3-4. Regional Cross Section L3-L3'

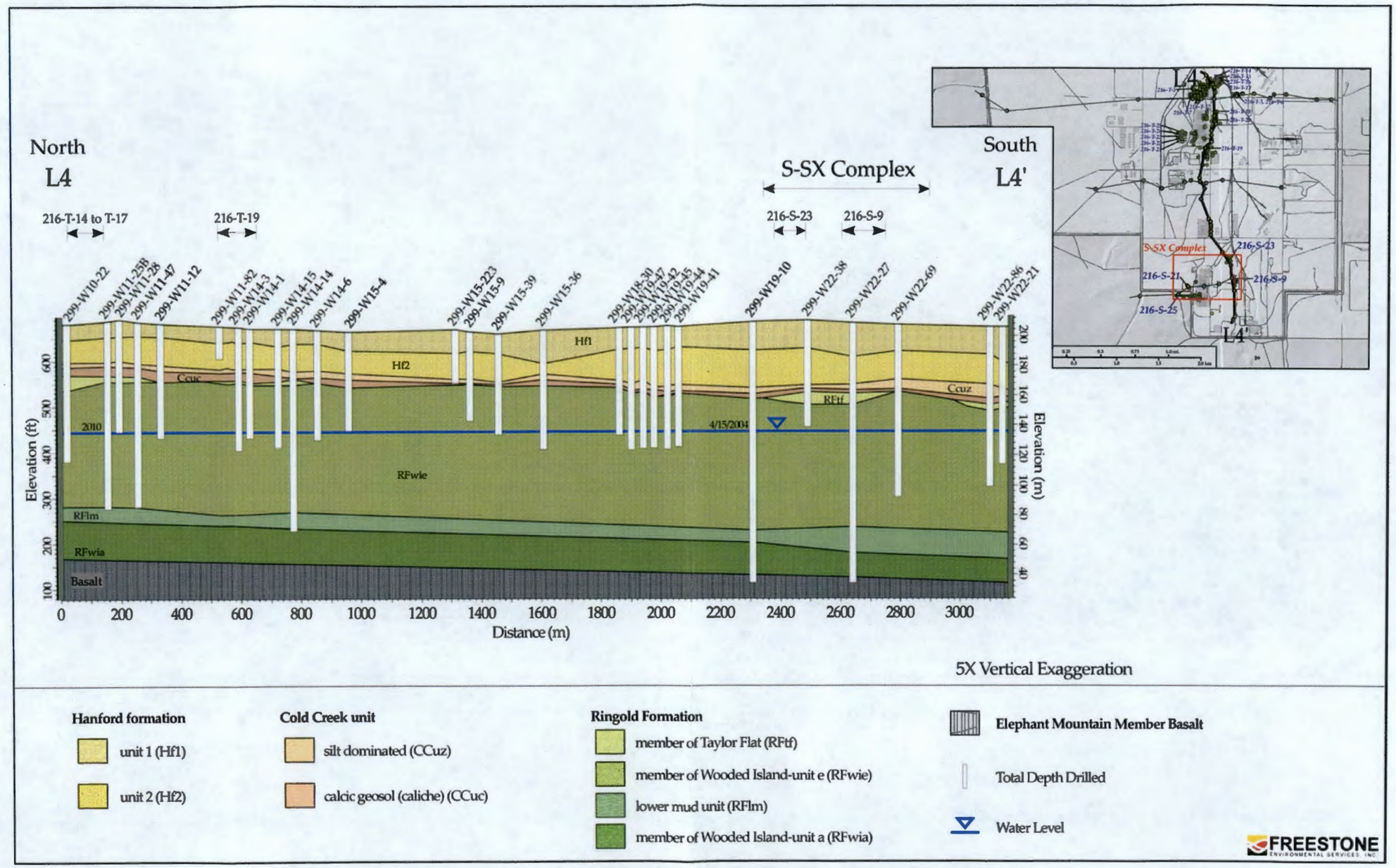

Figure 3-5. Regional Cross Section L4-L4'

3.2 Hanford Formation

The Hanford formation is the informal name given to all glacio-fluvial deposits from cataclysmic Ice Age floods that occurred more than 15,000 years ago. The Hanford formation consists of mostly unconsolidated sediments that cover a wide range in grain sizes, from pebble to boulder gravel, fine- to coarse-grained sand, silty sand, and silt. The Hanford formation is further subdivided into gravel-, sand-, and silt-dominated facies, which transition into one another vertically, as well as laterally with distance from the main, high-energy flood currents (DOE/RW-0164; DOE/RL-2002-39; "Quaternary Geology of the Columbia Plateau" [Baker et al., 1991]). Subunits (Hf1, Hf2, and Hf2-lower coarse) of the Hanford formation have been defined by delineating contiguous sediments that are predominately composed of one of the lithofacies types described below:

- **Gravel-dominated facies:** This facies sometimes consists of coarse-grained basaltic sand and granule to boulder gravel. These deposits display an open framework texture, massive bedding, plane to low-angle bedding, and large-scale planar cross bedding in outcrop. Gravel-dominated beds sometimes grade upward into the sand- and silt-dominated facies. Gravel clasts are dominantly basalt with lesser amounts of Ringold Formation clasts, granite, quartzite, and gneiss (WHC-SD-EN-TI-008, *Geologic Setting of the 200 West Area: An Update*). The gravel-dominated facies was deposited by high-energy floodwaters in or immediately adjacent to the main cataclysmic flood channelways.

- **Sand-dominated facies:** This facies consists of fine- to coarse-grained sand and granule gravel. The sands typically have high basalt content and are commonly referred to as black, gray, or "salt-and-pepper" sands. They may contain small pebbles and rip-up clasts and pebble-gravel interbeds, and they often grade upward into thin (less than 1 m [3.3 ft]) zones of silt-dominated facies. This facies commonly displays plane lamination and bedding, and less commonly channel cut-and-fill sequences. The sand-dominated facies was deposited adjacent to the main flood channelways during the waning stages of flooding. The facies is transitional between the gravel- and silt-dominated facies.

- **Silt-dominated facies:** This facies consists of thin-bedded, plane-laminated, and ripple cross-laminated silt and fine- to coarse-grained sand. Beds are typically a few inches to several tens of inches thick and commonly display normally graded bedding (WHC-SD-EN-TI-012, *Geologic Setting of the 200 East Area: An Update*). Sediments of this facies were deposited under slackwater conditions and in backflooded areas (DOE/RW-0164; Baker et al., 1991).

The sand and gravel fractions of the Hanford formation generally consist of about 50 percent basalt and 50 percent felsic material (RHO-BWI-ST-14, *Subsurface Geology of the Cold Creek Syncline*). This mineral assemblage gives the Hanford formation its characteristic "salt-and-pepper" appearance that is often noted in driller's and geologist's logs. The felsic component is composed of quartz, feldspar, and mica, with some samples containing greater than 10 percent pyroxene, amphibole, mica, chlorite, ilmenite, and magnetite. The silt- and clay-sized fractions consist of quartz, feldspar, mica, and smectite.

A composite photograph and facies analysis of a portion of the 218-E-12B Burial Ground (submarine trenches) is shown in Figure 3-6. The walls of this large, 15 m (49.2 ft) deep open pit (photographed and surveyed soon after excavation) expose a sequence of flood gravels, sands, and silts deposited during the last late-Pleistocene cataclysmic floods. Within the excavation, the upper gravel sequence (Hf1) and the uppermost portion of the sand sequence (Hf2) appear to be represented. The pebbly sand (i.e., sand-dominated facies) lies directly beneath and grades upward into the upper silty-sand layer (sand-dominated facies). The silty sand is overlain in sharp contact by sandy gravel (i.e., gravel-dominated facies) along an erosional unconformity. An unknown amount of the silty sand

was likely removed before deposition of the overlying sandy gravel during a subsequent cataclysmic flood. The higher moisture content of the silty-sand layer (evidenced by darker color) is typical of these fine-grained layers, as they represent preferential absorption of meteoric water.

Figure 3-6. Excavation Exposure Showing Hanford Formation Sand and Gravel Facies

3.2.1 Hanford Formation Gravel-Dominated Sequence (Hf1)

The Hanford formation gravel-dominated sequence overlies the Hanford formation sand-dominated sequence. Based on observations of outcrop and intact core samples, the Hanford formation gravel sequence is interpreted to consist of the high-energy, gravel-dominated facies interbedded with lenticular and discontinuous layers of the sand-dominated facies. Silt-dominated facies may also be present, although they likely constitute a relatively small percentage of the total. Figure 3-7 shows typical Hf1 sediment.

Figure 3-7. Photograph of Gravel-Dominated Hanford Formation Hf1

3.2.2 Hanford Formation Sand-Dominated Sequence (Hf2)

The Hf2 consists of predominantly sand-dominated facies of the Hanford formation (Figure 3-8). Internally, this sequence likely contains multiple graded beds of plane- to foreset-bedded sand or gravelly sand several meters or more thick, which sometimes grades upward into silty sand or silt. Cementation is very minor or absent in the Hf2, and total calcium carbonate content is generally a few weight-percent or less.

Figure 3-8. Photograph of Hf2 Sand Sequence in Sample

3.3 Cold Creek Unit

The CCU includes the sedimentary sequence that disconformably overlies the Ringold Formation and underlies cataclysmic flood deposits of the Hanford formation. The CCU includes those deposits formerly referred to as the "Plio-Pleistocene unit" and "pre-Missoula Gravels," as well as the "early Palouse soil" and "caliche layer" within the 200 West Area (DOE/RL-2002-39). The CCU appears to be correlative to other sidestream alluvial, eolian, and pedogenic deposits found near the base of the ridges bounding the Pasco Basin on the north, west, and south. These sedimentary deposits are inferred to have a late Pliocene to early Pleistocene age (DOE/RW-0164). The surfaces of the Ringold Formation and the CCU in the 200 West Area dip to the south (PNNL-15955, *Geology Data Package for the Single-Shell Tank Waste Management Areas at the Hanford Site*). This surface also dips to the east between the 200 West and 200 East Areas.

The CCU is divided into five facies within the central Pasco Basin, two of which occur within the 200 West Area. The CCU facies discussed in this report are the silt-dominated (CCUz) and the calcic geosol (caliche) (CCUc). Environments of deposition for these facies are interpreted as overbank eolian and calcic paleosol. The CCU facies typically grade laterally and vertically, as well as intercalating with one another.

The CCU is important because its fine-grained sediments and/or its carbonate-rich paleosols can have a significant impact on contaminant movement in the vadose zone. Perched water zones above the CCU

have been encountered in several wells in 200 West Area, however, not beneath the T-Complex or S-Complex waste sites in the 200-DV-1 OU. The CCU is indicated by a thick (up to 2 to 14 m [7 to 46 ft]) layer of well-sorted silt and/or fine sand underlain by a carbonate-cemented silty and sandy gravel sequence that unconformably overlies Ringold Formation sediment. Figures 3-9 and 3-10 show examples of the CCU silt sediments (CCUz).

Figure 3-9. Contact Between Hf2 Sand (left) and CCUz Silt (right) Strata

Figure 3-10. Mud (Silt) from the CCUz

The CCUc is closely associated and typically directly beneath the CCUz. Within this sand and gravel sequence, there is a distinctive sudden shift in the calcium carbonate content from 0 percent below to 2 to 3 percent calcium carbonate above over a short distance. The cause and significance of this marker horizon are not clear but may represent a transition in climate to more arid conditions that promote higher calcium carbonate content (which is known to have occurred during Pliocene to Pleistocene times) (PNNL-19277, *Conceptual Models for Migration of Key Groundwater Contaminants Through the Vadose Zone and into the Upper Unconfined Aquifer Below the B-Complex*). Figures 3-11 and 3-12 show the nature of the CCU in this region. Figure 3-11 shows the structure of the uppermost CCU surface (top of the CCUz). Figure 3-12 shows the thickness of the CCU (combined thickness of both CCUz and CCUc).

3.4 Ringold Formation

Sediments associated with the Ringold Formation filled the basin to at least 274 m (900 ft) elevation (Lindsey, 1996) during the late Miocene to Pliocene time (10.5 to 3.4 million years ago). Since that time, however, the Ringold Formation has been significantly eroded by fluvial downcutting of the ancestral Columbia River and cataclysmic Ice Age flooding. The fluvial-lacustrine Ringold Formation (BHI-00184), which overlies the basalt over most of the central Pasco Basin, is present as several subunits: the RFtf, the RFwie, the Ringold Formation lower mud unit (RFlm), and the Ringold Formation member of Wooded Island unit A (RFwia). Typically only the RFtf and the uppermost portion of the RFwie are present in the vadose zone beneath the T-Complex and S-Complex waste sites; the RFwie, RFlm, and RFwia comprise the suprabasalt aquifer in the 200 West Area.

In the 200 West Area, erosional remnants of the RFtf consists of fine-grained fluvial sand and overbank facies with localized stringers of calcium carbonate. The RFtf occurs discontinuously beneath the 200 West Area (Figures 3-2 through 3-5).

The RFwie is the thickest of the Ringold Formation units present in the Central Plateau and the 200 West Area. It consists of well-rounded gravel in a sand and silt matrix deposited by major rivers. Gravel lithologies are varied with sources outside of the Columbia Basin. Cementation varies from well- to poorly indurated. The thickness of the RFwie is largely influenced by structural (i.e., Cold Creek syncline) and erosional (i.e., Cold Creek and Hanford floods) processes. Increasing thicknesses to the west of the 200 West Area and to the south of the 200 East Area are a combination of both processes.

3.5 Columbia River Basalt Group

The Columbia River Basalt Group is divided into the three formations that underlie this region, including the Grand Ronde Basalt, Wanapum Basalt, and the Saddle Mountains Basalt. About 300 separate flows have been identified (PNNL-19702). The last basalt flows to reach the Pasco Basin occurred between 8.5 to 10.5 million years ago (DOE/RW-0164). The extrusion of volcanic basalt flows occurred very rapidly at first and then slowed over time. More time between basalt eruptions allowed for accumulation of sediments between younger basalt flows (i.e., Saddle Mountains Basalt). The sedimentary interbeds of the Ellensburg Formation, along with porous basalt flow tops and bottoms, form confined aquifers that may extend across the Pasco Basin (DOE/RW-0164). The uppermost basalt surface represents the bedrock base of the suprabasalt aquifer system. Beneath the 200 West Area, the uppermost basalt unit consists of the Elephant Mountain Member of the Saddle Mountains Basalt formation. In general, lavas of the Saddle Mountains Basalt and the overlying suprabasalt sediments thicken to the south toward the axis of the Cold Creek syncline.

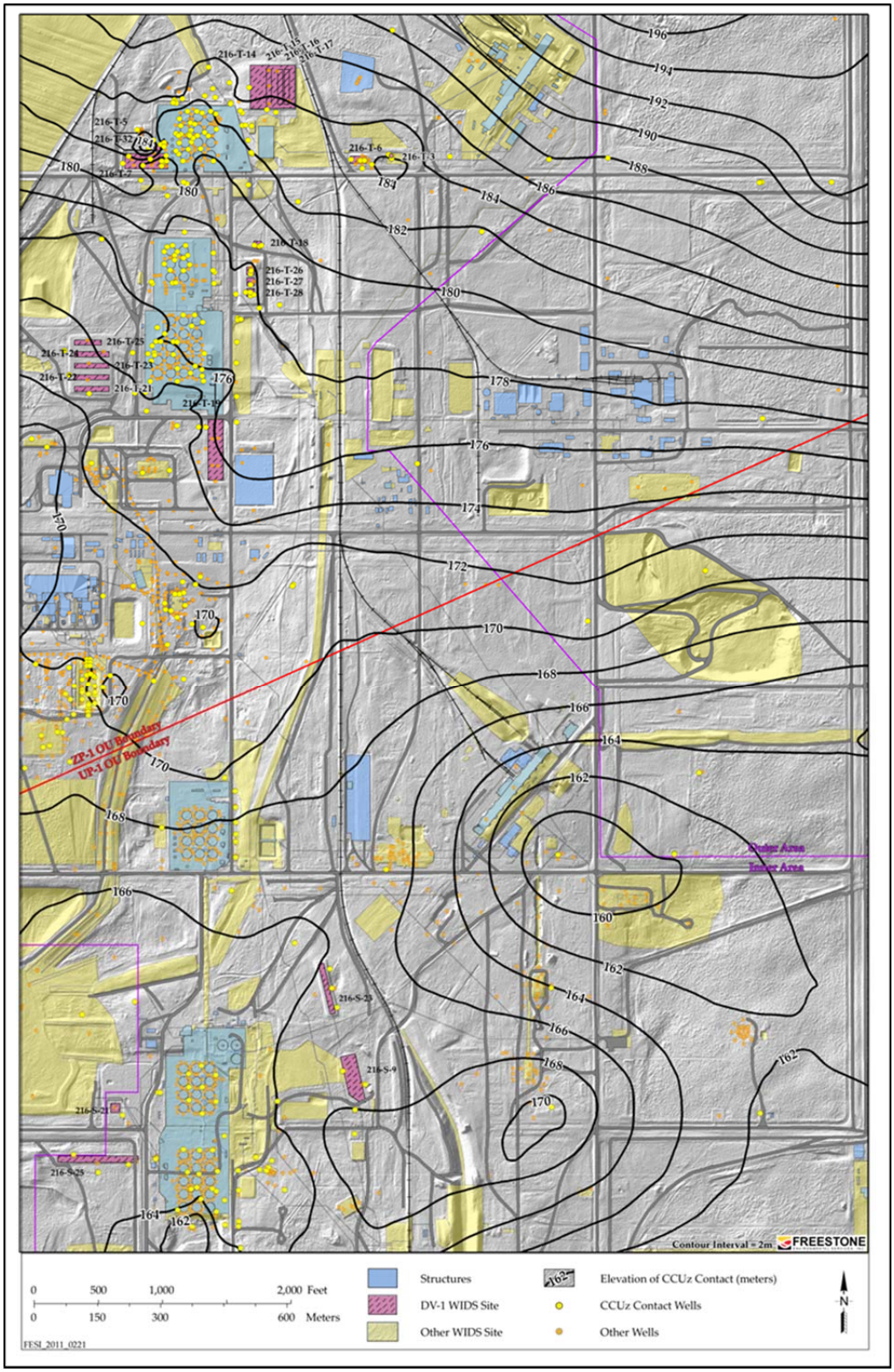

Figure 3-11. Structure of the Uppermost CCU in the Vicinity of T-Complex and S-Complex

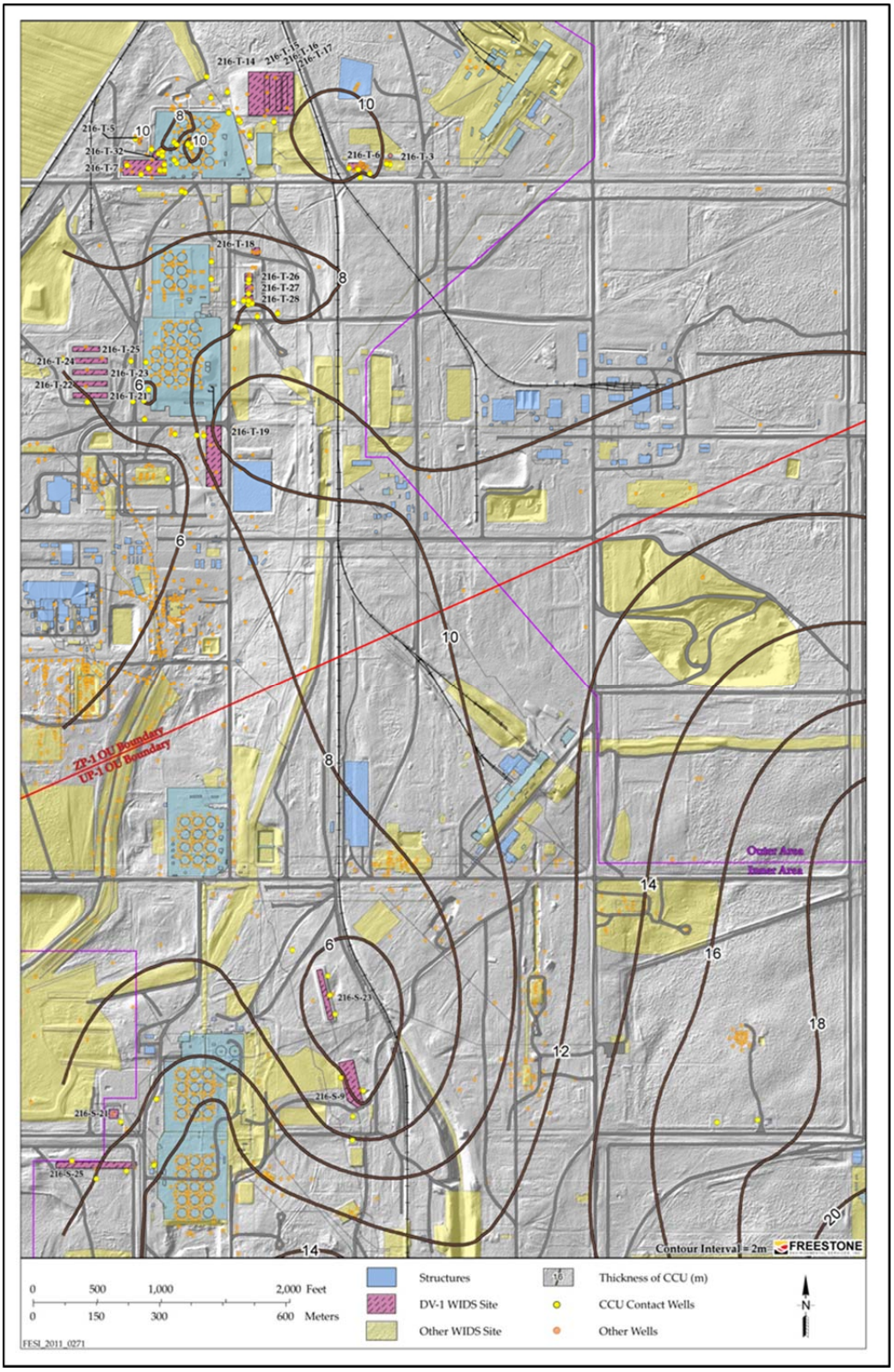

Figure 3-12. Isopach Map of the CCU in the Vicinity of T-Complex and S-Complex

The Elephant Mountain Member, the uppermost basalt unit beneath the 200 West Area, is a medium- to fine-grained tholeiitic basalt with abundant microphenocrysts of plagioclase (DOE/RW-0164). The Elephant Mountain Member has been dated by the "K/Ar" method to be about 10.5 million years old and consists of two flows beneath the 200 West Area.

3.6 Clastic Dikes

Clastic dikes are vertical to subvertical sedimentary structures that crosscut normal sedimentary layering. Clastic dikes are a common geologic feature of the Hanford formation in the 200 Areas, especially in the sand- and silt-dominated facies. Clastic dikes are much less common in the gravel-dominated facies of the Hanford formation. The mechanism under which clastic dikes could act as conduits to transfer/bypass surrounding vadose sediment and allow quicker migration potential of contaminants from the near-surface disposal facilities to the water table is still not well understood.

Clastic dikes occur in swarms and form four types of networks (BHI-01103, *Clastic Injection Dikes of the Pasco Basin and Vicinity*): (1) regular-shaped polygonal patterns, (2) irregular-shaped polygonal patterns, (3) pre-existing fissure fillings, and (4) random occurrences. In outcrop, regular clastic dikes are fairly common in the sand-dominated Hanford formation facies but are relatively rare in the gravel-dominated facies. Regular polygonal networks resemble four- to eight-sided polygons and typically range from 3 cm (1.2 in.) to 1 m (3.3 ft) in width, from 2 m (6.6 ft) to greater than 20 m (65.6 ft) in depth, and from 1.5 to 100 m (4.9 to 328.1 ft) along the strike. Smaller dikelets, sills, and small-scale faults and shears are commonly associated with master dikes that form the polygons.

In general, a clastic dike has an outer skin of silt clay with coarser infilling material. Silt-clay linings are commonly 0.03 to 1.0 mm (0.001 to 0.04 in.) in thickness, but linings up to about 10 mm are known to occur. The width of individual infilling layers ranges from as little as 0.01 mm (0.0004 in.) to more than 30 cm (11.8 in.), and their length can vary from about 0.2 m (0.7 ft) to more than 20 m (65.6 ft). Infilling sediments are typically poor- to well-sorted sand but may contain clay, silt, and gravel (HNF-5507, *Subsurface Conditions Description of the B-BX-BY Waste Management Area*).

4 Subregion Geology

The T-Complex and S-Complex waste sites in the 200-DV-1 OU are located in the 200 West Area of the Hanford Site. Understanding the geologic framework is fundamental to vadose zone conceptual site model development for the contaminant distribution below the complexes. Of particular interest are the interrelationships between the coarser and finer grained strata, as well as the degree of contrast in their physical and geochemical properties.

4.1 216-T-3 Reverse Well and 216-T-6 Cribs

The vadose zone underlying the 216-T-3 reverse well and 216-T-6 Cribs (Figure 4-1) is approximately 80 m (262.4 ft) thick. The suprabasalt aquifer system in this area is estimated to be approximately 73 m (239.5 ft) thick. Aquifer thickness is inferred from regional top of basalt maps since none of the wells in this area were drilled to basalt. Groundwater generally flows to the northeast beneath this subregion and is known to contain dissolved contaminants from past disposal facilities within the 200 West Area. Perched groundwater was not identified during review of borehole logs in the vicinity of the 216-T-3 reverse well and 216-T-6 Cribs, but perching may have occurred based on residual cesium-137 contamination detected above the CCU in wells near the reverse well.

The 216-T-6 Cribs (216-T-6-1 and 216-T-6-2) are constructed in the near-surface Hanford formation sediments of the vadose zone. The bottom of the cribs lie within the gravel-dominated Hf1 at 6.1 m (20 ft) bgs.

The 216-T-3 reverse well was drilled to a depth of 62.8 m (206 ft) bgs and penetrated through the Hanford formation (Hf1 and Hf2), the CCU (CCUz and CCUc), and the Ringold Formation (the well penetrated the RFtf and was drilled partially through the RFwie). The reverse well was perforated from just above CCUz at 31.89 m (104.5 ft) bgs, to the RFwie at 62.2 m (204 ft) bgs. This well was not drilled to groundwater.

Stratigraphic type logs were created using wells 299-W11-54 (Figure 4-2) and 299-W11-65 (Figure 4-3) to represent the general stratigraphy below this subregion. Borehole geology information for this subregion was limited to the driller's logs; therefore, detailed lithologic descriptions were not available. Cross sections depicting the stratigraphy of the subregion are shown in Figures 4-4 and 4-5. Detailed descriptions of the individual geologic units beneath the 216-T-3 reverse well and the 216-T-6 Cribs are provided in the following subsections.

4.1.1 Holocene Backfill

Up to several meters of recent (Holocene age) sediment is seen as backfill across the subregion above the Hanford formation. Backfill material is located within the construction areas of the 216-T-6 Cribs. The backfill is the native Hanford formation Hf1 material that was stockpiled nearby during crib construction. Some of the coarsest gravel was removed before backfilling, and all natural layering/stratification was disrupted such that the backfill is rather homogeneous and featureless compared to the undisturbed Hf1.

4.1.2 Hanford Formation

The Hanford formation comprises the majority of the vadose zone sediment beneath the subregion, ranging in thickness from 26 to 33 m (85.3to 108.3 ft). Both the Hf1 (coarse-grained sandy gravel or gravel) and the Hf2 (fine-grained sand) are present. Also evident beneath the northeastern portion of the subregion is a coarser grained sandy gravel to gravel overlying the CCU. This coarser unit is referred to as the Hf2–lower coarse (designated elsewhere on the Hanford Site as Hanford formation unit 3). Where

it occurs, the Hf2-lower coarse is approximately 5 m (16 ft) thick. The geophysical log plots suggest the occurrence of the Hf2-lower coarse at wells 299-W11-65 and 299-W11-1, although descriptions from the available driller's logs do not corroborate this interpretation. Driller's logs and geophysical log plots indicate that there may be discontinuous fine-grained lenses within the Hf2 (wells 299-W11-1, 299-W11-59, 299-W11-60, 299-W11-62, and 299-W11-65). Driller's logs and geophysical log plots also indicate that there may be discontinuous coarse-grained lenses within the Hf2 in the central portion of the subregion.

Differentiating the Hanford subunits using geophysical logging data was sometimes complicated by the occurrence of radiological contamination, drilling methods, and the sometimes gradational nature of the unit contacts.

4.1.3 Cold Creek Unit

The CCU underlies the Hanford formation and is locally divided into two subunits: the CCUz and the CCUc. Both the CCUz and CCUc are laterally continuous throughout the subregion and have a slight dip to the west-southwest. The upper and lower contacts of these subunits were largely defined using the spectral and gross-gamma borehole geophysical log plots as shown in stratigraphic type logs (Figures 4-2 and 4-3). The CCUz is generally indicated by the occurrence of sand and clay, as noted on the driller's logs. The CCUc is described as a calcium carbonate-rich silty sand overlying a distinct caliche layer. The base of the CCUc beneath the caliche layer consists of yellowish-brown sandy silt. The CCUz and CCUc have uniform thicknesses beneath the subregion of 3 and 8 m (9.8 and 26.2 ft), respectively

4.1.4 Ringold Formation

The total thickness of the Ringold Formation was not penetrated during the drilling of the nine wells evaluated for the subregion cross section development. Based on geologic descriptions in the subregion vicinity (PNNL-15955), the Ringold Formation is comprised of units RFtf, RFwie, RFlm, and RFwia.

The RFtf ranges in thickness from 2 to 6 m (6.6 to 19.7 ft) in this subregion. Due to lack of well control, it is unclear if the bed is dipping or remains horizontal. The RFtf overlies the RFwie, which represents the lowermost Ringold Formation unit in the vadose zone. The contact between the RFtf and RFwie is distinct both in the geologist's borehole logs and in the geophysical logging plots. RFwie is described as a pebble to cobble gravel with a fine- to coarse-grained sand matrix. Gravel content is usually greater than 60 to 70 percent. The sediments in the RFwie are variably consolidated, usually poorly sorted, and show variable amounts of calcium carbonate. Iron oxide staining is common (PNNL-15955). Beneath the adjacent T-TX-TY Tank Farms, the RFwie is between 39 and 85 m (128 and 279 ft) thick; the upper boundary of unit E dips slightly toward the west or southwest beneath Waste Management Area (WMA) T (PNNL-15955). The RFwie, RFlm, and RFwia comprise the suprabasalt aquifer system in this subregion. The RFlm and RFwia are not described in this report due to their occurrence in the saturated zone.

4.2 216-T-5 Trench, 216-T-7 Crib and Tile Field, and 216-T-32 Cribs

The vadose zone underlying the 216-T-5 Trench, 216-T-7 Crib and Tile Field, and 216-T-32 Cribs (Figure 4-6) is approximately 71 m (233 ft) thick. The suprabasalt aquifer system is estimated to be approximately 77 m (252.6 ft) thick. Aquifer thickness is inferred from the regional top of basalt maps since none of the wells in this area were drilled to basalt. Groundwater generally flows to the northeast beneath this subregion and is known to contain dissolved contaminants from past disposal facilities within the 200 West Area. Perched groundwater was identified to have occurred at wells 299-W10-2 and 299-W10-196 during review of borehole logs near the vicinity of the 216-T-5 Trench, 216-T-7 Crib and Tile Field, and 216-T-32 Cribs.

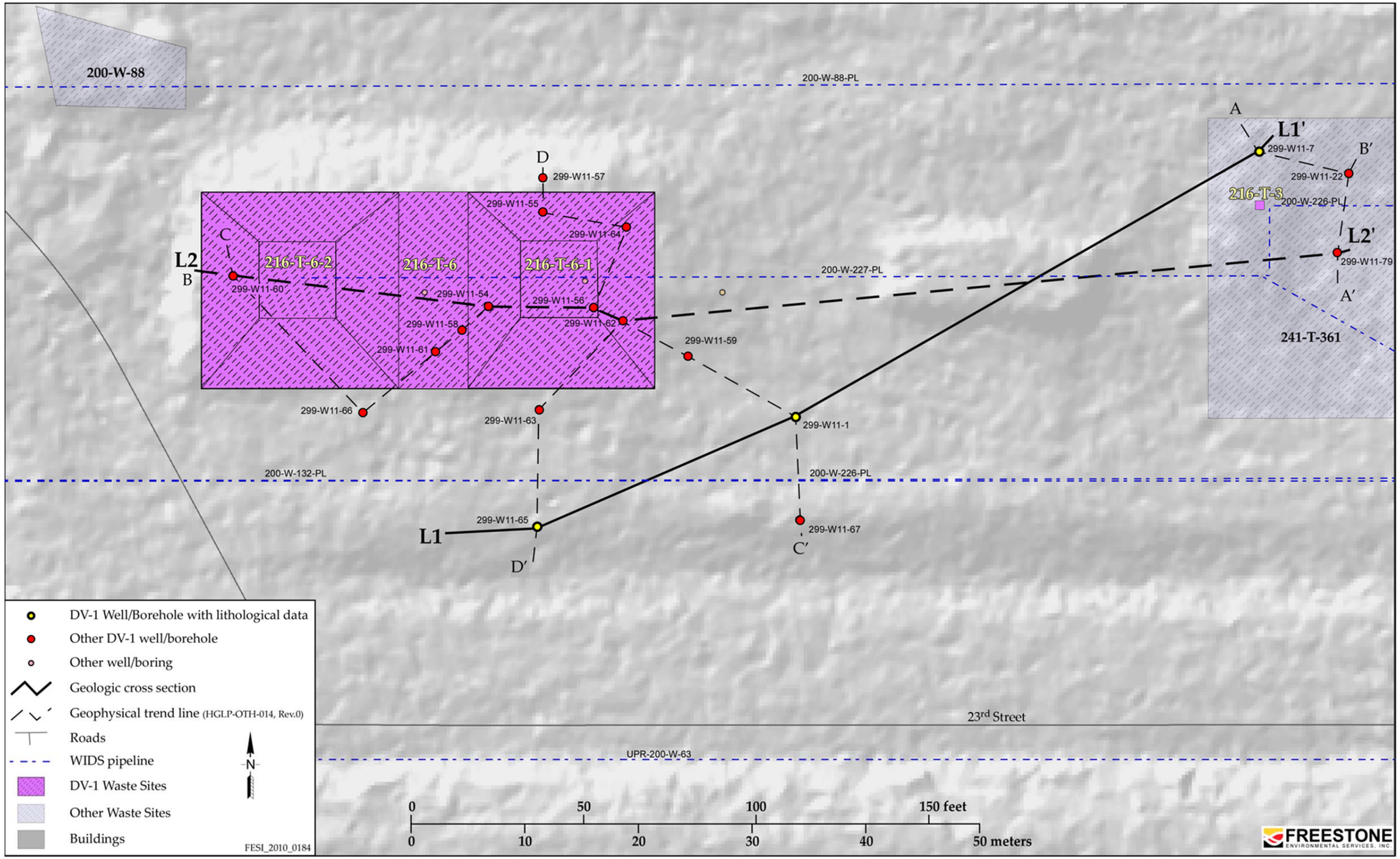

Figure 4-1. 216-T-3 Reverse Well and 216-T-6 Cribs Subregion Base Map and Cross Section Locations

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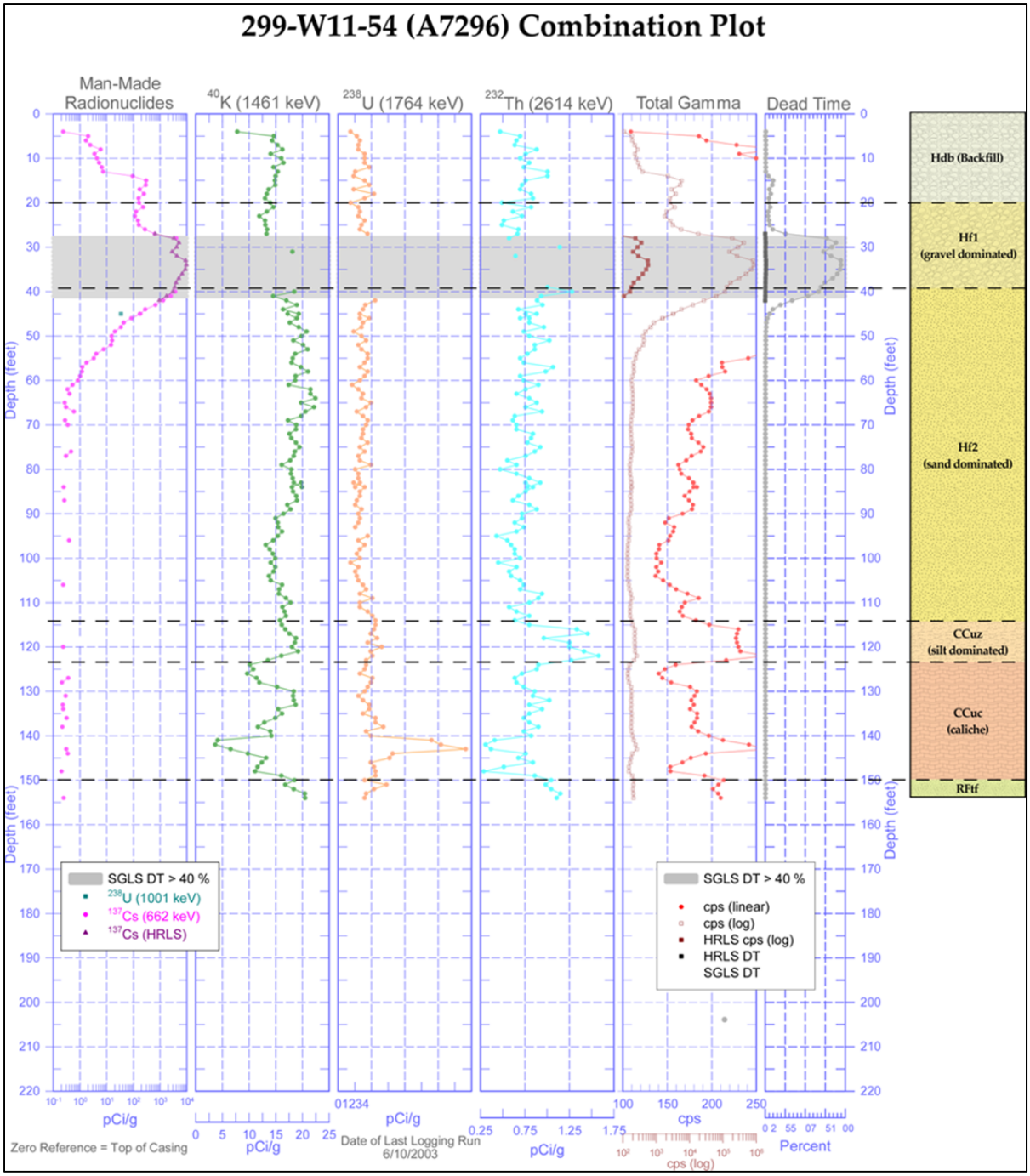

Figure 4-2. Stratigraphic Type Log for Well 299-W11-54

All three subregion waste sites are constructed within the near-surface Hanford formation sediments of the vadose zone. The bottom of the 216-T-5 Trench is constructed at 3.7 m (12 ft) bgs. The bottom of the 216-T-7 Crib and Tile Field is at 7.9 and 7.6 m (26 and 25 ft) bgs, respectively. The bottoms of the 216-T-32 Crib #1 and Crib #2 are constructed at 7.9 m (26 ft) bgs.

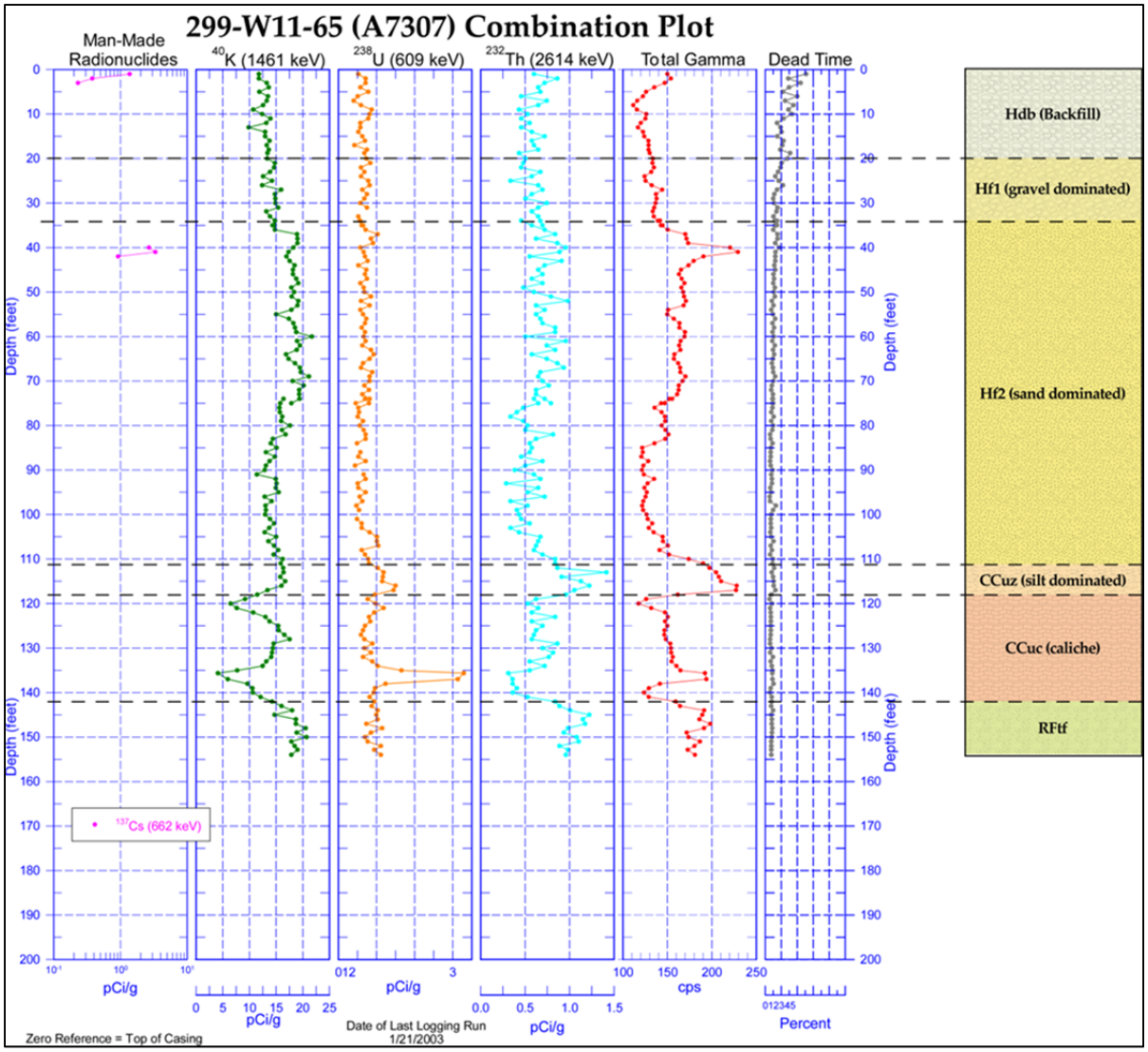

Figure 4-3. Stratigraphic Type Log for Well 299-W11-65

Stratigraphic type logs were created using wells 299-W10-33 (Figure 4-7) and 299-W10-28 (Figure 4-8) to represent the general stratigraphy below this subregion. Within this subregion, these two wells provided the best geologic descriptions of the 24 boreholes evaluated. Three cross sections (Figures 4-9, 4-10, and 4-11) were developed to illustrate the subregion geology. The following subsections provide descriptions of the individual geologic units beneath the 216-T-5 Trench, 216-T-7 Crib and Tile Field, and 216-T-32 Cribs.

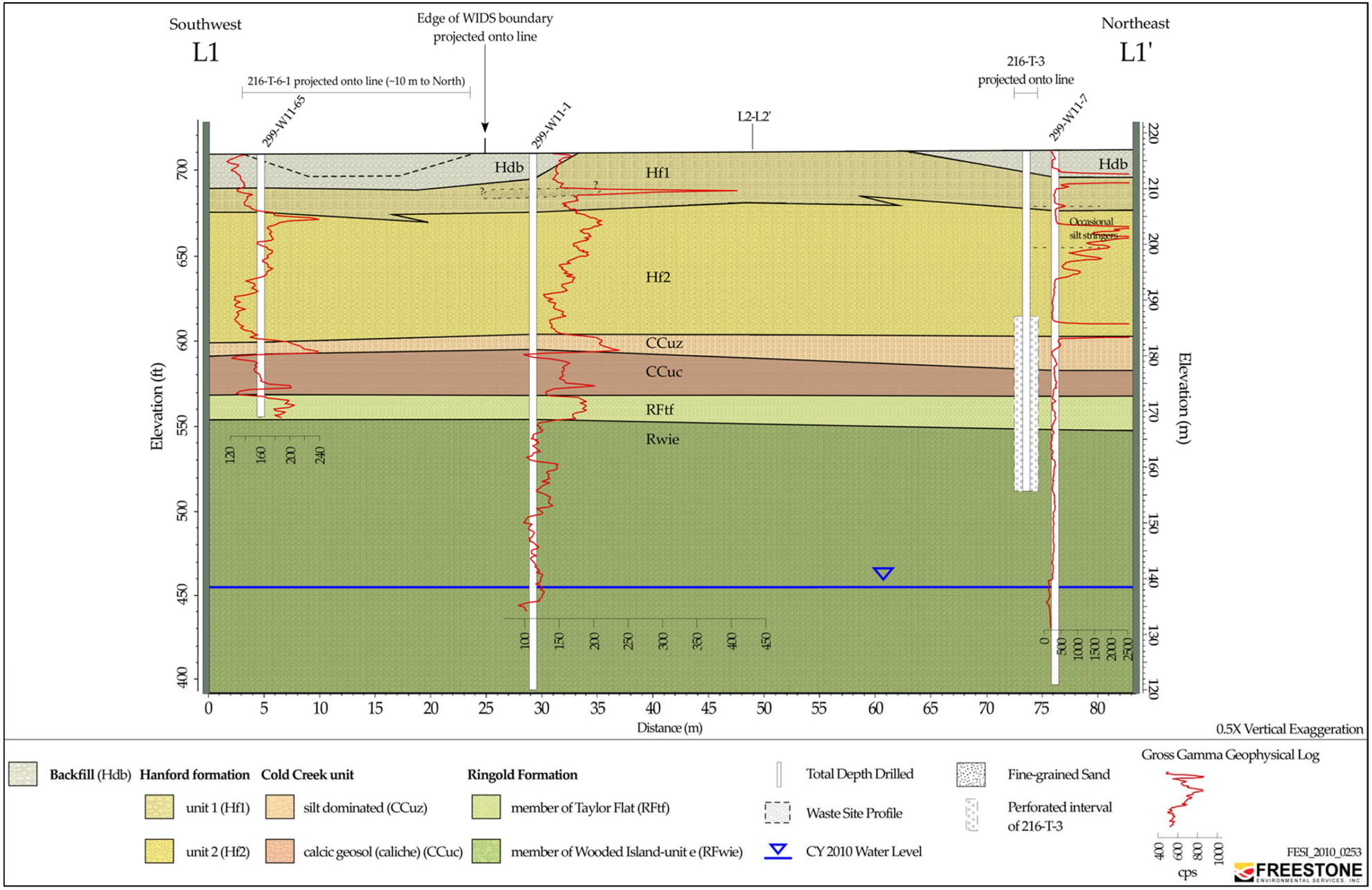

Figure 4-4. Geologic Cross Section L1-L1'

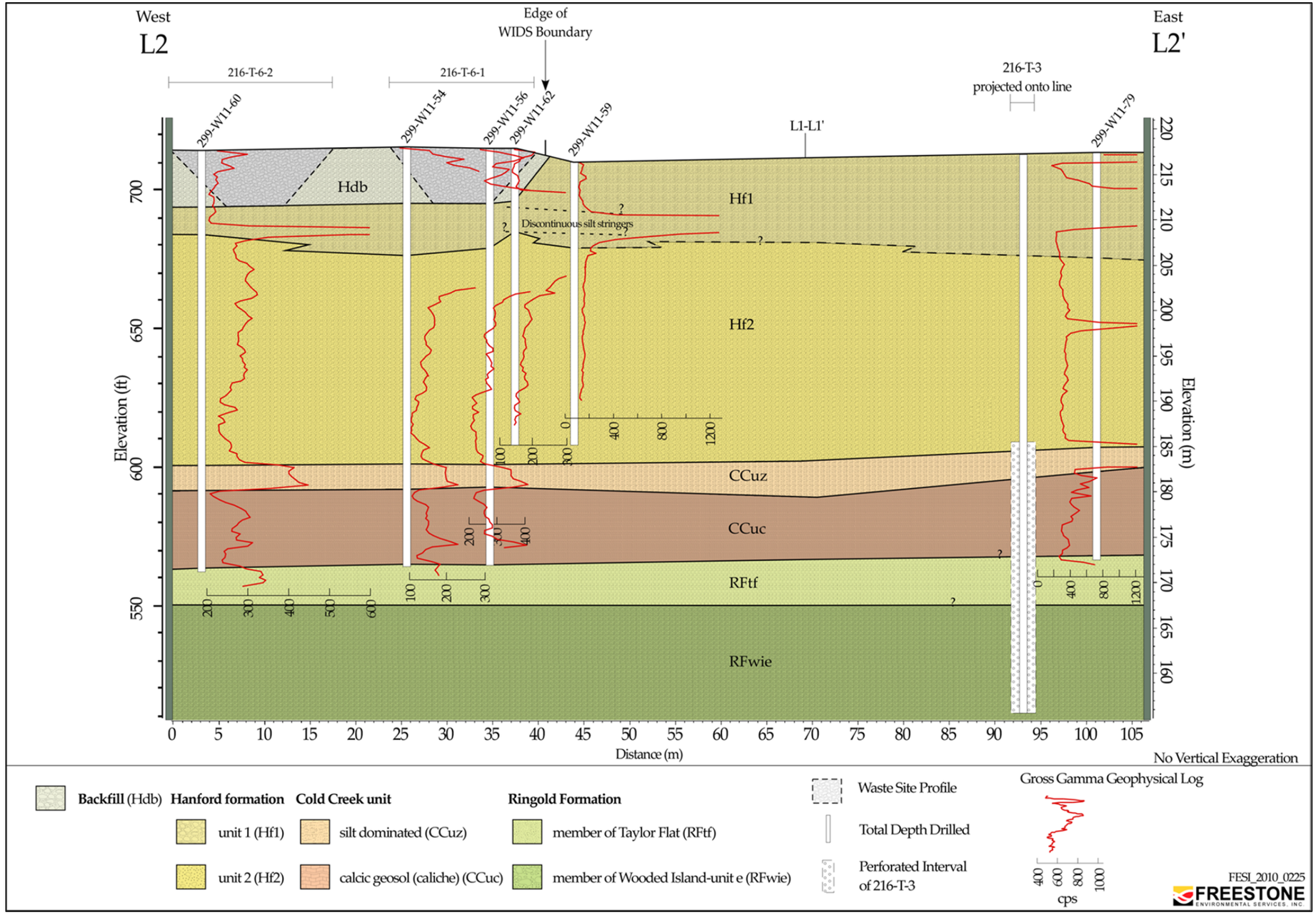

Figure 4-5. Geologic Cross Section L2-L2

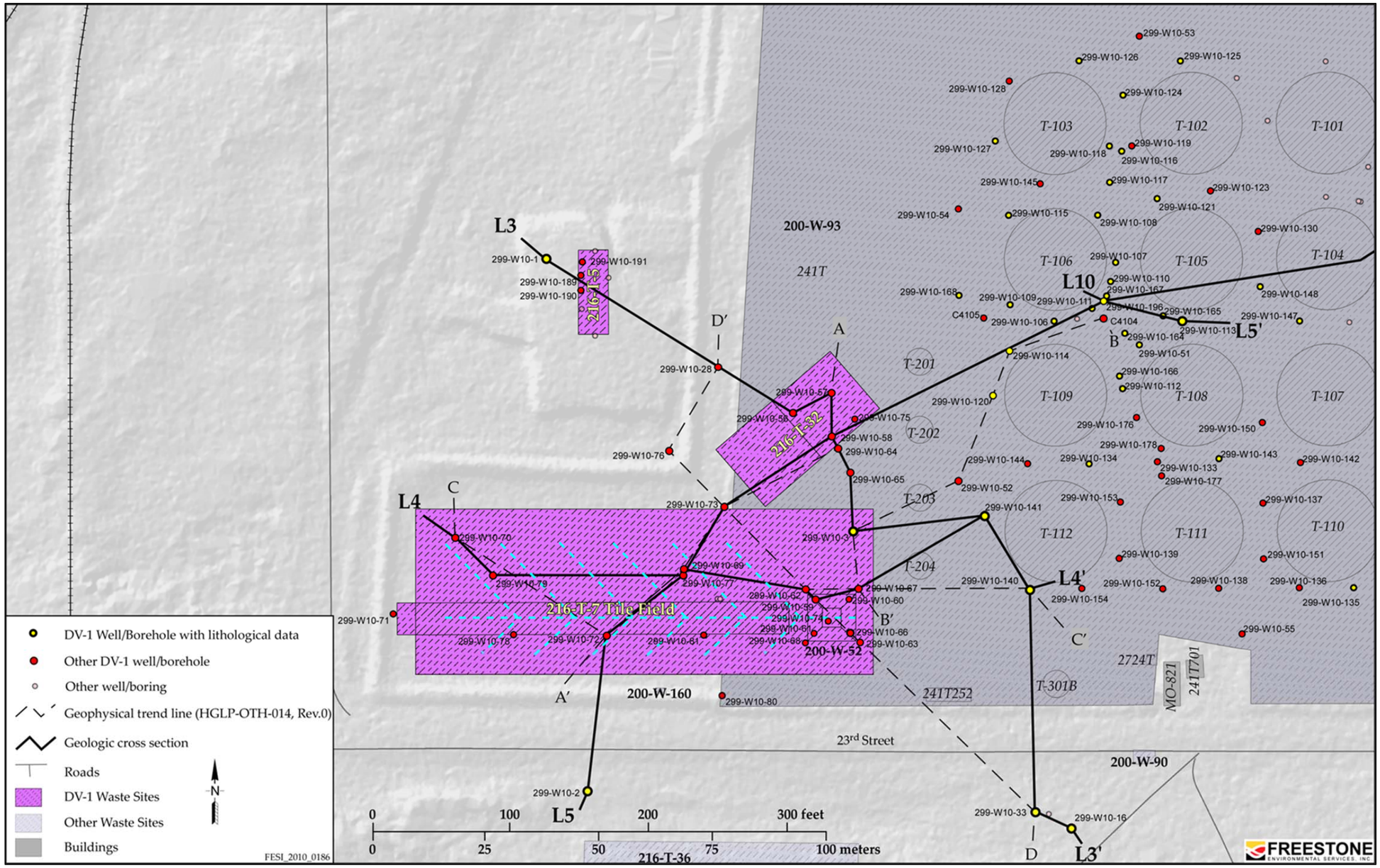

Figure 4-6. 216-T-5 Trench, 216-T-7 Crib and Tile Field, and 216-T-32 Cribs Subregion Base Map and Cross Section Locations

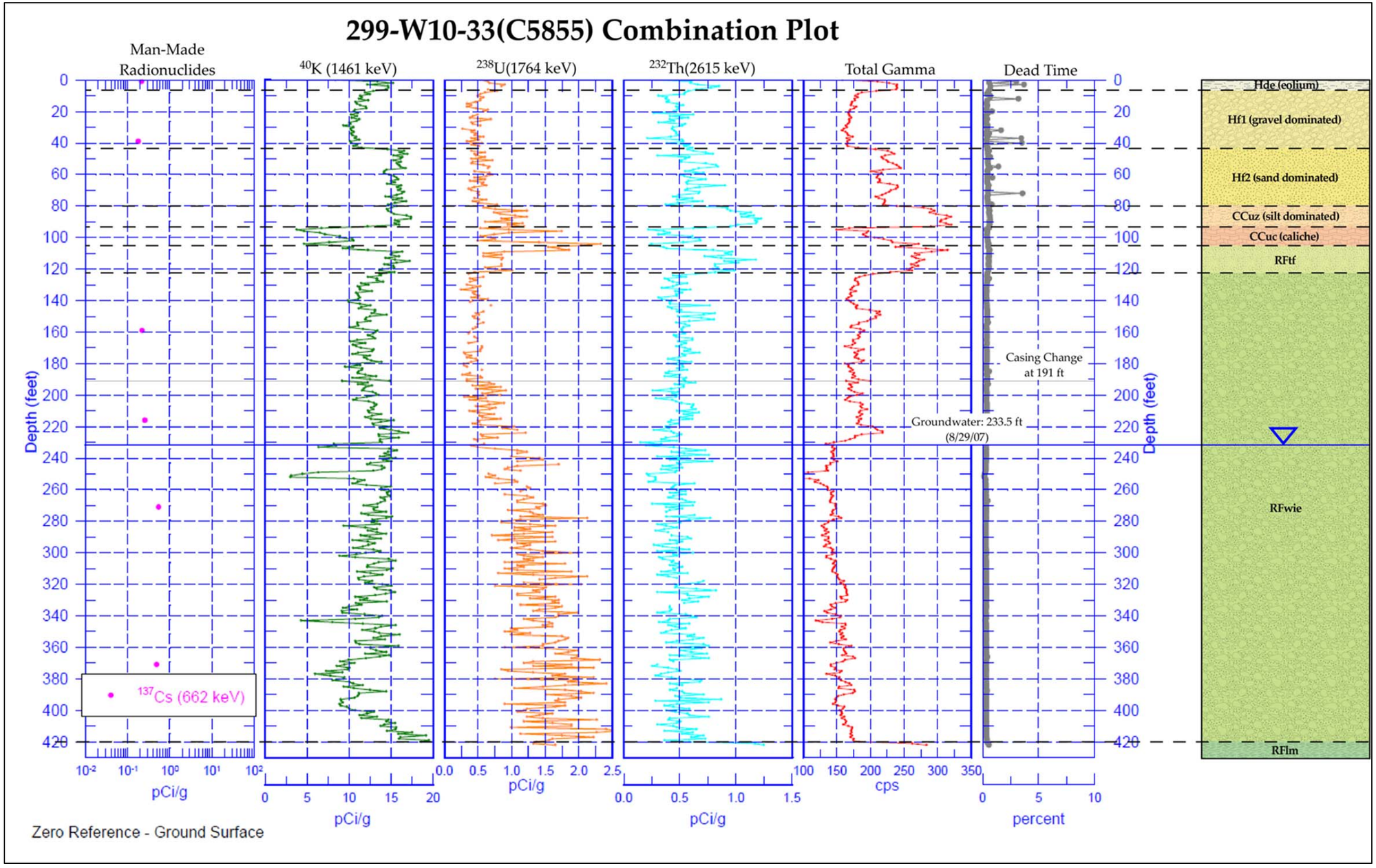

Figure 4-7. Stratigraphic Type Log for Well 299-W10-33

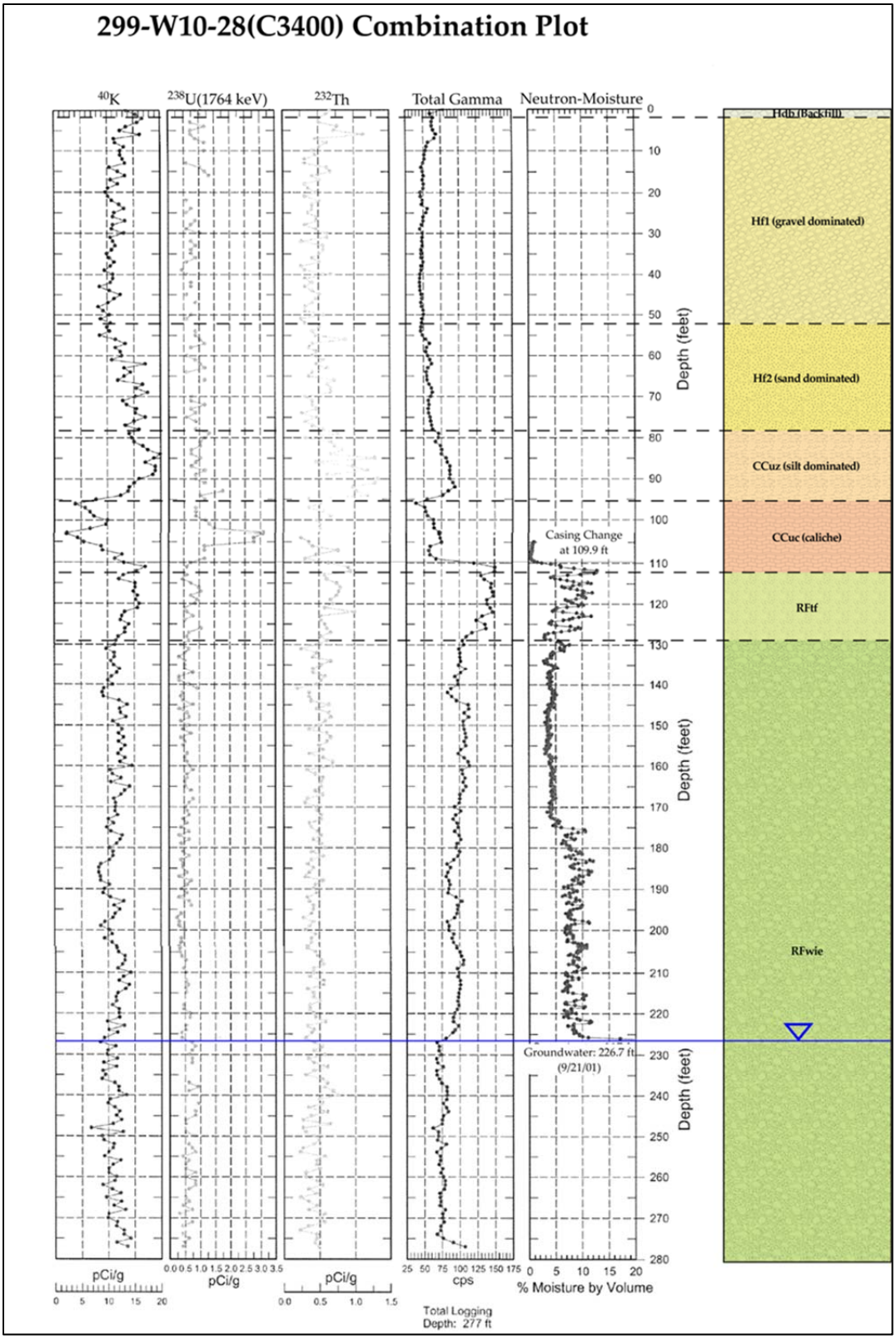

Figure 4-8. Stratigraphic Type Log for Well 299-W10-28

4.2.1 Holocene Backfill

Much of the recent (Holocene age) fine-grained sediment has been removed in this subregion and is only present in the northern portion of the subregion (in the vicinity of the 216-T-5 Trench). Backfill material is located within the construction areas of the 216-T-5 Trench, 216-T-7 Crib and Tile Field, and 216-T-32 Cribs. The backfill is the native Hanford formation Hf1 material that was stockpiled nearby during crib construction. Some of the coarsest gravel was removed before backfilling, and all natural layering/stratification was disrupted such that the backfill is rather homogeneous and featureless compared to the undisturbed Hf1.

4.2.2 Hanford Formation

The Hanford formation comprises the majority of the vadose zone sediment beneath the subregion, ranging in thickness from 10 to 23 m (32.8 to 75.5 ft). Both the Hf1 subunit (coarse-grained sandy gravel or gravel) and the Hf2 subunit (predominantly sand) are present. This subregion has a significant amount of excavation and backfill, therefore contacts between backfill and the Hf1 were almost indistinguishable. Care was taken to use all available information (including borehole logs, driller's logs, and old waste site schematics) to ensure that the most accurate contact pick was selected.

Beneath the 216-T-7 Crib and Tile Field and the 216-T-32 Cribs, contamination was detected at approximately 10.7 m (35 ft) bgs and appears to be bound in a silty-sand sediment within the Hf1. Geophysical logs record this contamination by a sharp gamma increase at approximately 192 m (630 ft) in elevation on cross sections L-L3', L4-L4', and L5-L5' (Figures 4-9, 4-10, and 4-11). Borehole logs from wells 299-W10-56, 299-W10-57, 299-W10-58, 299-W10-64, 299-W10-65, 299-W10-69, 299-W10-70, and 299-W10-73 indicate that a silt layer is present at this depth.

Without the geophysical borehole log data, the correlation and differentiation of the Hanford subunits would not be possible. However, even using geophysical logging data, correlations were sometimes complicated by the occurrence of radiological contamination, drilling methods, and the sometimes gradational nature of the unit contacts.

4.2.3 Cold Creek Unit

The CCU underlies the Hanford formation and is locally divided into the CCUz and CCUc subunits. Both the CCUz and CCUc are laterally continuous throughout the subregion. The upper and lower contacts of these subunits were largely defined using the spectral and gross-gamma borehole geophysical log plots as shown in stratigraphic type logs (Figures 4-7 and 4-8). Based on the geologist's borehole log for wells 299-W10-33 and 299-W10-28, the CCUz is described as a light yellowish-brown sandy silt comprised of approximately 80 percent silt and 20 percent very fine to fine sand. The CCUc is described as a calcium carbonate-rich silty sand overlying a distinct caliche layer. The CCUz is approximately 3 to 6 m (9.8 to 19.7 ft) thick and dips from the northwest to southeast and thins to the east. The CCUc is approximately 4 to 6 m (13.1 to 19.7 ft) thick and thickens to the east.

4.2.4 Ringold Formation

The total thickness of the Ringold Formation was not penetrated during drilling of the 24 wells evaluated for the subregion cross section development. Based on geologic descriptions in the subregion vicinity (PNNL-15955), the Ringold Formation is comprised of units RFtf, RFwie, RFlm, and RFwia.

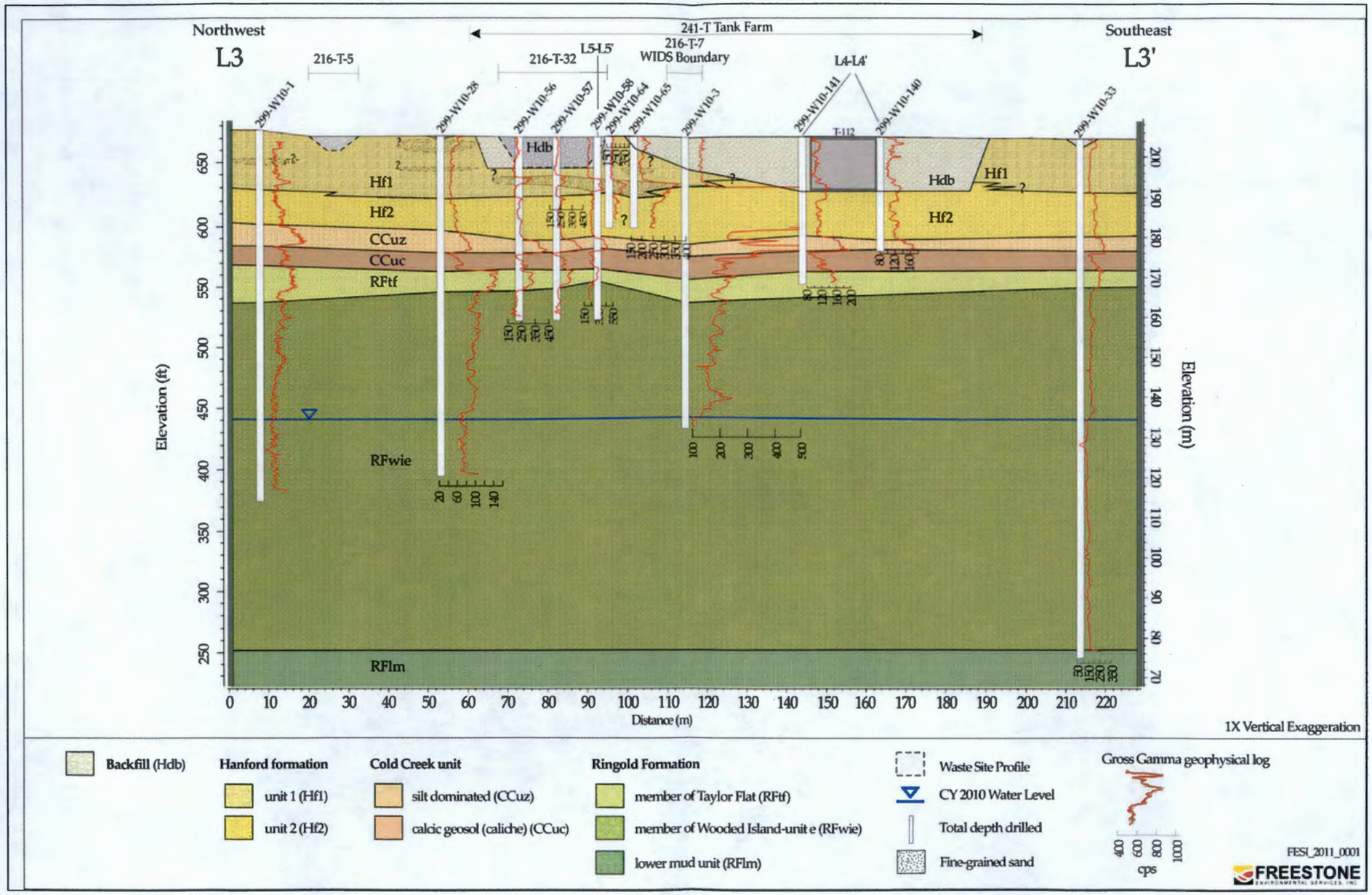

Figure 4-9. Geologic Cross Section L3-L3'

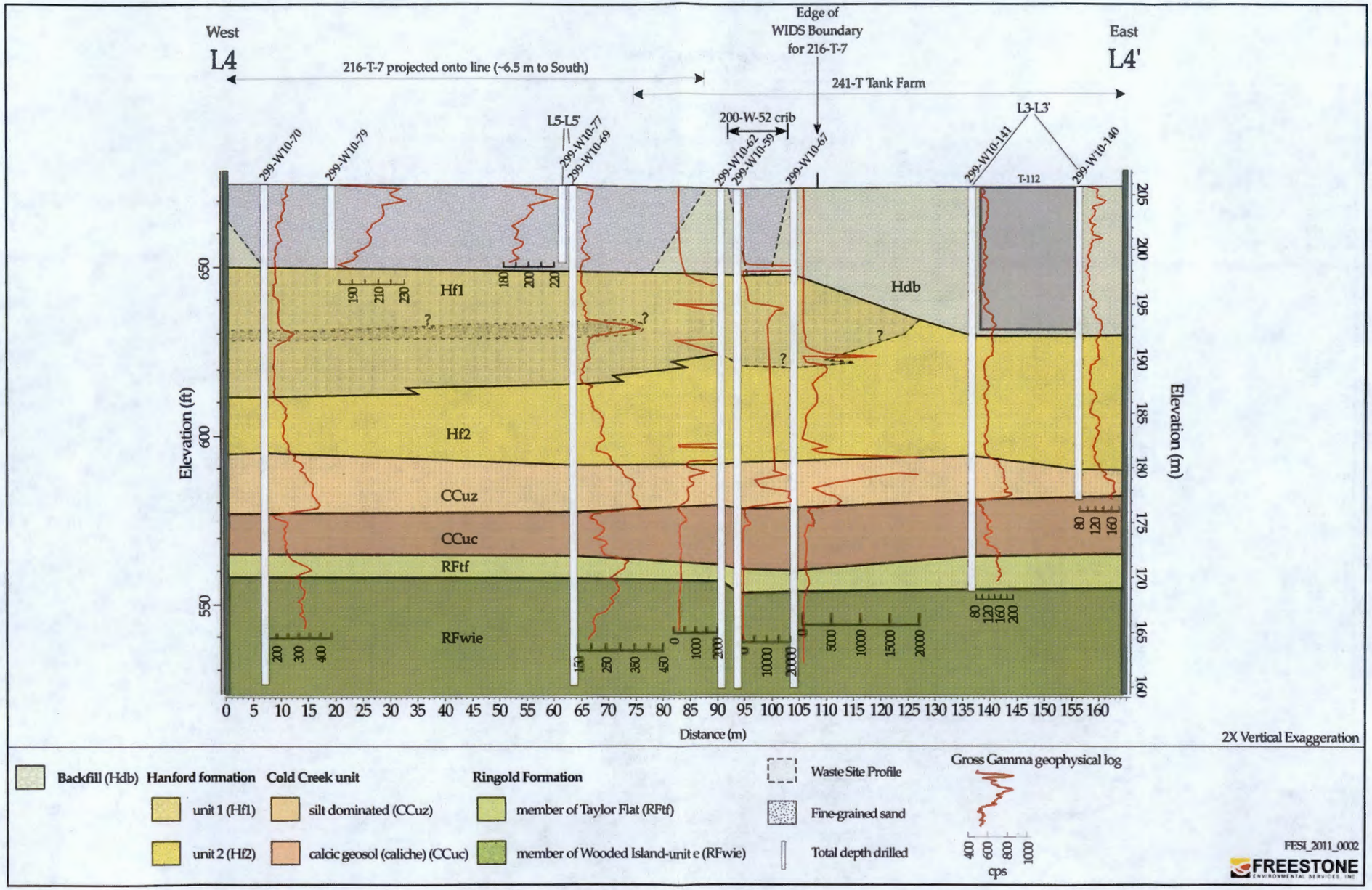

Figure 4-10. Geologic Cross Section L4-L4'

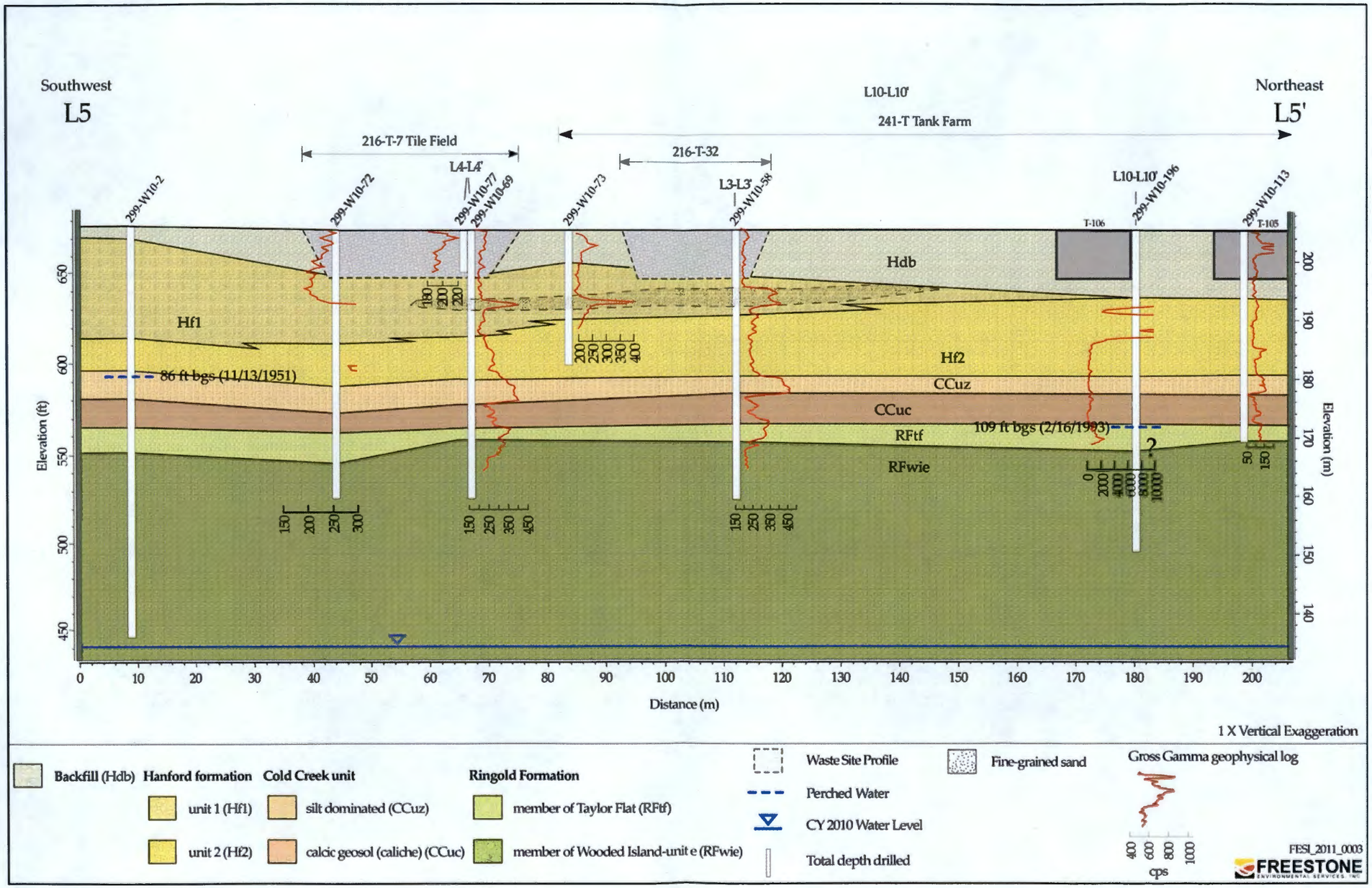

Figure 4-11. Geologic Cross Section L5-L5′

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The uppermost unit, RFtf, is predominately a well-sorted sand with minor silt. The RFtf ranges in thickness from 2 to 9 m (6.6 to 29.5 ft). This unit is generally thicker in the northern portion of the subregion (up to at least 9 m [29.5 ft]) and thinner in the southern portion of the subregion, which is consistent with the regional trend of this unit. The RFtf overlies the RFwie, which represents the lowermost Ringold Formation unit in the vadose zone. The contact between the RFtf and RFwie is distinct both in the geologist's borehole logs and in the geophysical logging plots. RFwie is described as a pebble to cobble gravel with a fine- to coarse-grained sand matrix. Gravel content is usually greater than 60 to 70 percent. The sediments in the RFwie are variably consolidated, usually poorly sorted, and show variable amounts of calcium carbonate. Iron oxide staining is common (PNNL-15955). Beneath the adjacent T-TX-TY Tank Farms, the RFwie is between 39 and 85 m (128 and 279 ft) thick; the upper boundary of unit E dips slightly toward the west or southwest beneath WMA T (PNNL-15955). In this subregion, one well (299-W10-33) penetrated the entire thickness of the RFwie and encountered the RFlm at 128 m (420 ft) bgs. At this well, the RFwie is approximately 88 m (288.7 ft) thick. The RFwie, RFlm, and RFwia comprise the suprabasalt aquifer system in this subregion. The RFlm and RFwia are not described in this report due to their occurrence in the saturated zone.

4.3 216-T-14, 216-T-15, 216-T-16, and 216-T-17 Trenches

The vadose zone underlying the 216-T-14, 216-T-15, 216-T-16, and 216-T-17 Trenches (Figure 4-12) is approximately 80 m (262.4 ft) thick. The suprabasalt aquifer system is estimated to be approximately 65 m (213.2 ft) thick. Aquifer thickness is inferred from regional top of basalt maps since none of the wells in this area were drilled to basalt. Groundwater generally flows to the northeast beneath this subregion and is known to contain dissolved contaminants from past disposal facilities within the 200 West Area. Perched groundwater was identified to have occurred at wells 299-W10-196 and 299-W11-28 during review of borehole logs in the vicinity of the 216-T-14, 216-T-15, 216-T-16, and 216-T-17 Trenches.

All four trenches were constructed in the near-surface Hanford formation sediments of the vadose zone. The bottom of the trenches were built within the gravel-dominated Hf1 at 3 m (10 ft) bgs.

Stratigraphic type logs were created using wells 299-W11-47 (Figure 4-13) and 299-W11-25B (Figure 4-14) to represent the general stratigraphy below this subregion. The geologist's borehole logs for wells 299-W11-25B and 299-W11-47 provide the best geologic descriptions of the 11 boreholes evaluated for the subregion cross section development (Figures 4-15 through 4-17). Detailed descriptions of the individual geologic units beneath the 216-T-21, 216-T-22, 216-T-23, 216-T-24, and 216-T-25 Trenches are provided in the following subsections.

4.3.1 Holocene Backfill

Up to several meters of recent (Holocene age) sediment are seen as backfill across the subregion above the Hanford formation. Backfill material is located within the construction areas of the 216-T-14, 216-T-15, 216-T-16, and 216-T-17 Trenches. The backfill is the native Hf1 material that was stockpiled nearby during crib construction. Some of the coarsest gravel was removed before backfilling, and all of the natural layering/stratification was disrupted such that the backfill is rather homogeneous and featureless compared to the undisturbed Hf1.

4.3.2 Hanford Formation

The Hanford formation comprises the majority of the vadose zone sediment beneath the subregion, ranging in thickness from 27 to 37 m (88.5 to 121.3 ft). In this subregion, the Hanford formation dips gently westward. Both the Hf1 subunit (coarse-grained sandy gravel or gravel) and the Hf2 subunit (predominantly sand) are present. In this subregion, the lithology of the Hf1 and Hf2 is generally more

homogeneous than elsewhere in the T-Complex; however, geologist's borehole logs and geophysical log plots indicate the occurrence of discontinuous fine-grained lenses within the Hf1 and Hf2 (wells 299-W11-47 and 299-W11-68). The laterally extensive Hanford formation and its uniform contact elevations provide evidence that these sediments have been relatively unaffected by post-depositional events such as channeling, erosion, uplift, or faulting.

4.3.3 Cold Creek Unit

The CCU underlies the Hanford formation and is locally divided into the CCUz and CCUc subunits. Both the CCUz and CCUc are laterally continuous throughout the subregion. The upper and lower contacts of these subunits were largely defined using the spectral and gross-gamma borehole geophysical log plots as shown in stratigraphic type logs (Figures 4-13 and 4-14). Based on the geologist's borehole log for well 299-W15-43, the CCUz is described as a light brown silty sand to sandy silt comprised of approximately 65 percent very fine to fine sand and 35 percent silt. The CCUc is described as a calcium carbonate-rich silty sand overlying a distinct caliche layer. The base of the CCUc beneath the caliche layer consists of a yellowish-brown sandy silt. The CCUz ranges in thickness from 3 to 5 m (10 to 16.4 ft), and in the southernmost part of the subregion, this unit dips slightly to the south. The CCUc ranges in thickness from 2 to 6 m (6.5 to 19.7 ft) and dips slightly to the east-southeast.

4.3.4 Ringold Formation

The total thickness of the Ringold Formation was not penetrated during drilling of the 11 wells evaluated for the subregion cross section development. Based on geologic descriptions in the subregion vicinity (PNNL-15955), the Ringold Formation is comprised of units RFtf, RFwie, RFlm, and RFwia.

The uppermost unit, RFtf, is predominately a well-sorted sand with minor silt. The RFtf ranges in thickness from 3 to 10 m (10 to 32.8 ft). This unit is generally thicker in the northern and western portion of the subregion (up to at least 10 m [32.8 ft]) and thinner in the southern and eastern portion of the subregion, which is consistent with the regional trend of this unit. The RFtf overlies the RFwie, which represents the lowermost Ringold Formation unit in the vadose zone. The contact between the RFtf and RFwie is distinct both in the geologist's borehole logs and in the geophysical logging plots. RFwie is described as a pebble to cobble gravel with a fine- to coarse-grained sand matrix. Gravel content is usually greater than 60 to 70 percent. The sediments in the RFwie are variably consolidated, usually poorly sorted, and show variable amounts of calcium carbonate. Iron oxide staining is common (PNNL-15955). Beneath the adjacent T-TX-TY Tank Farms, the RFwie is between 39 and 85 m (128 and 279 ft) thick; the upper boundary of unit E dips slightly toward the west or southwest beneath WMA T (PNNL-15955). In this subregion, four wells (299-W11-25B, 299-W11-45, 299-W1-47, and 299-W11-48) penetrated the entire thickness of the RFwie and encountered the RFlm. At these wells, the RFwie ranges in thickness from 83.4 to 85.3 m (274 to 280 ft). The RFlm has little to no change in relief. The RFwie, RFlm, and RFwia comprise the suprabasalt aquifer system in this subregion. The RFlm and RFwia are not described in this report due to their occurrence in the saturated zone.

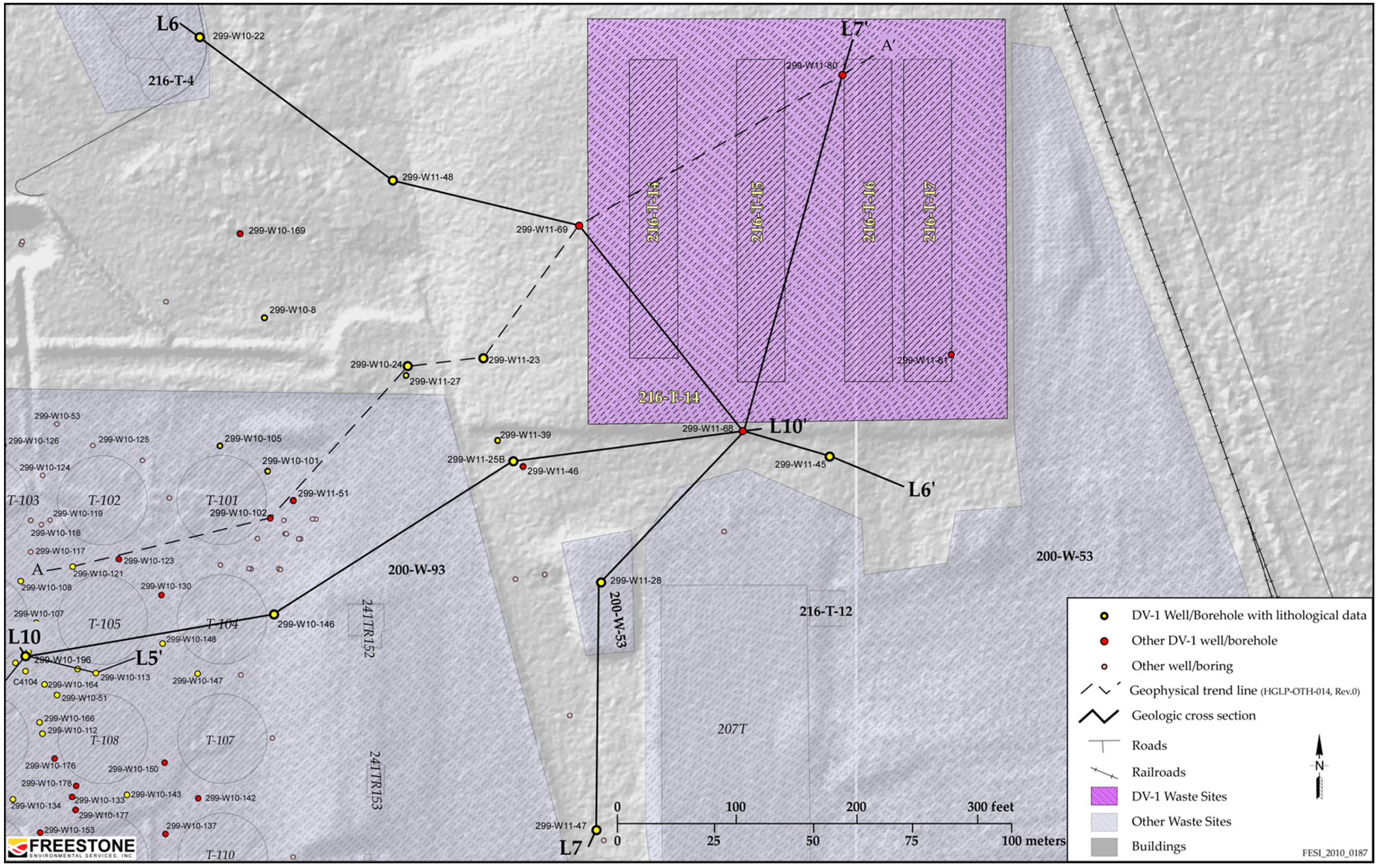

Figure 4-12. 216-T-14, 216-T-15, 216-T-16, 216-T17 Trenches Subregion Base Map and Cross Section Locations

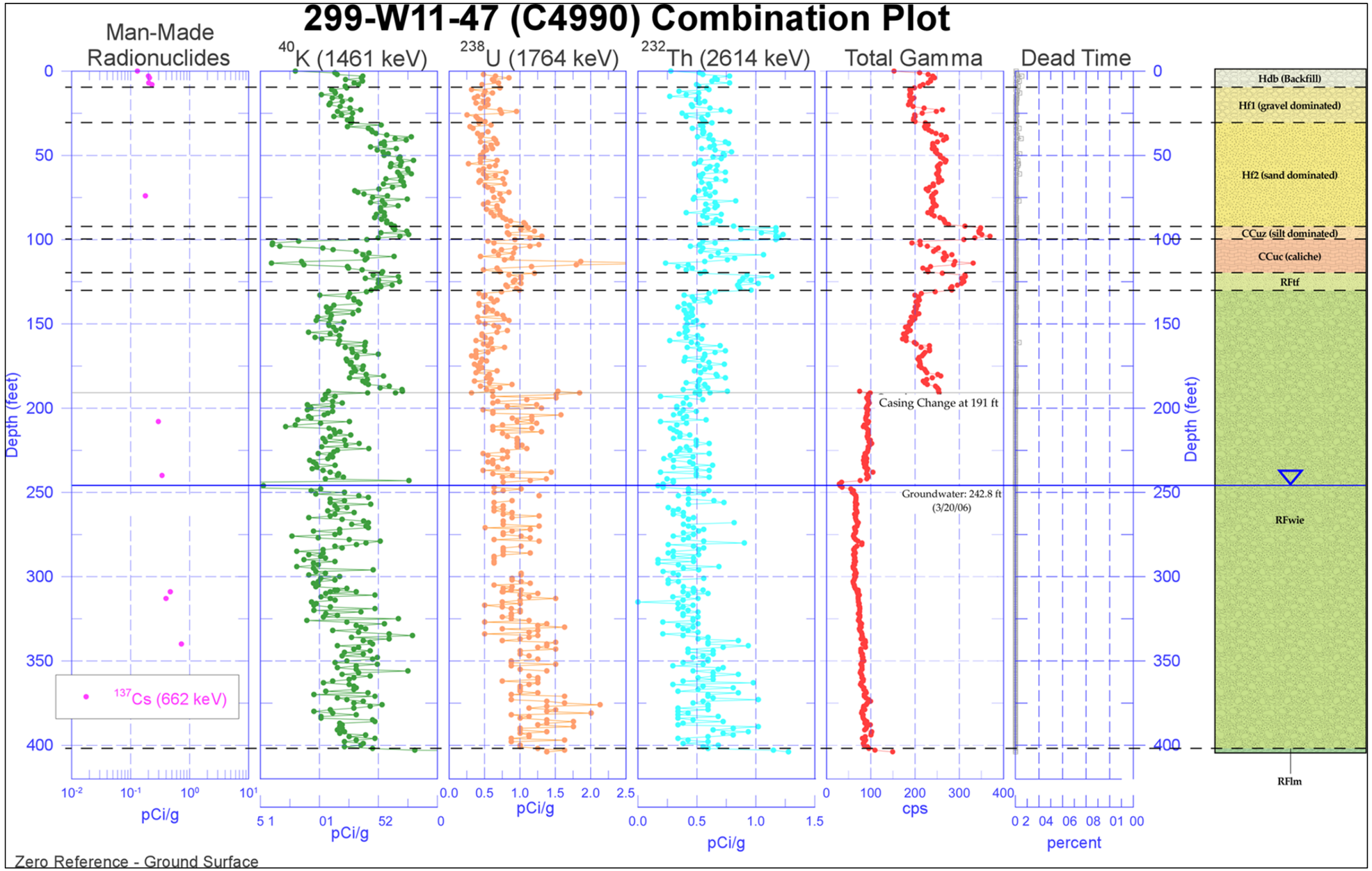

Figure 4-13. Stratigraphic Type Log for 299-W11-47

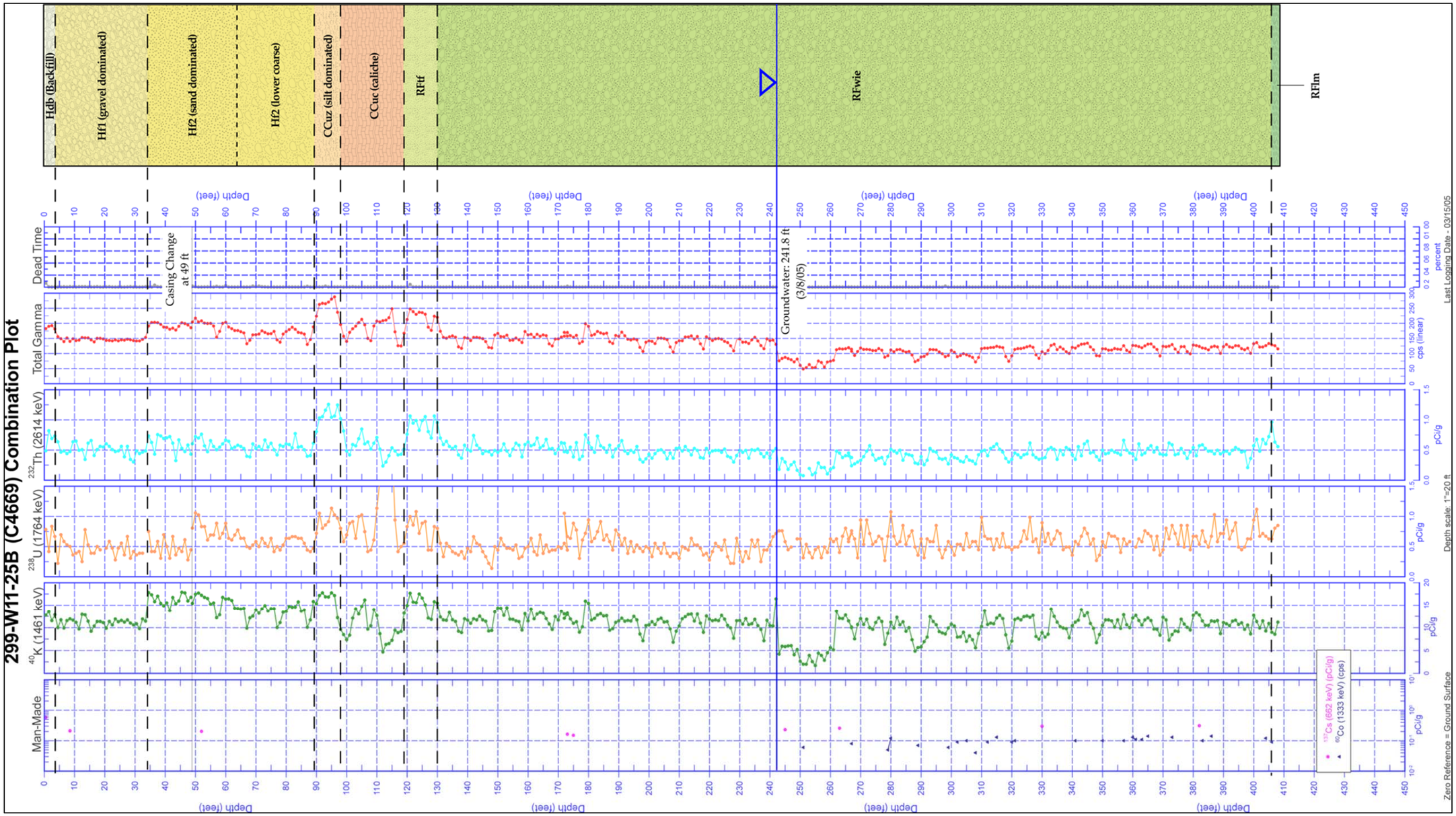

Figure 4-14. Stratigraphic Type Log for Well 299-W11-25B

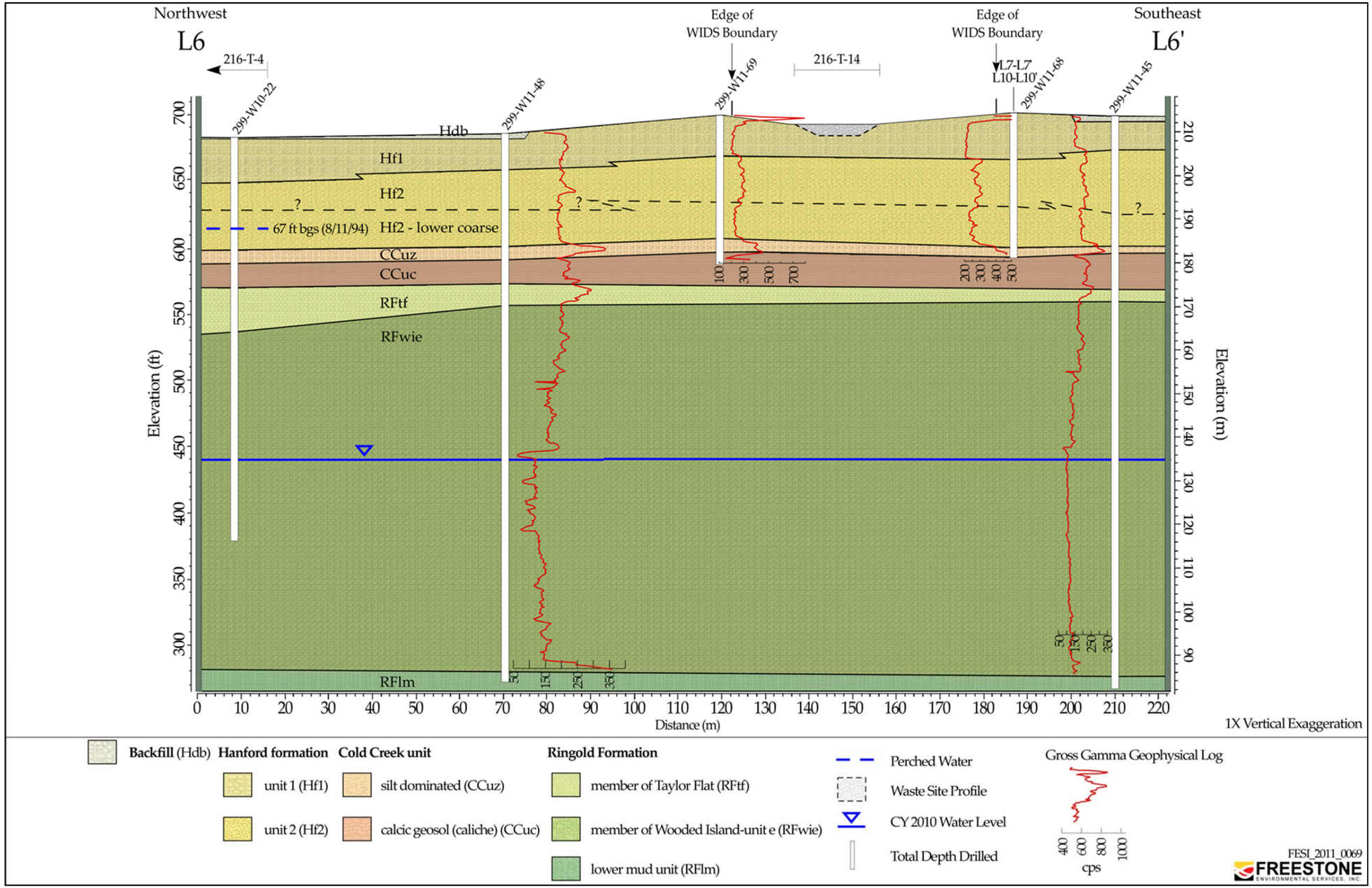

Figure 4-15. Geologic Cross Section L6-L6'

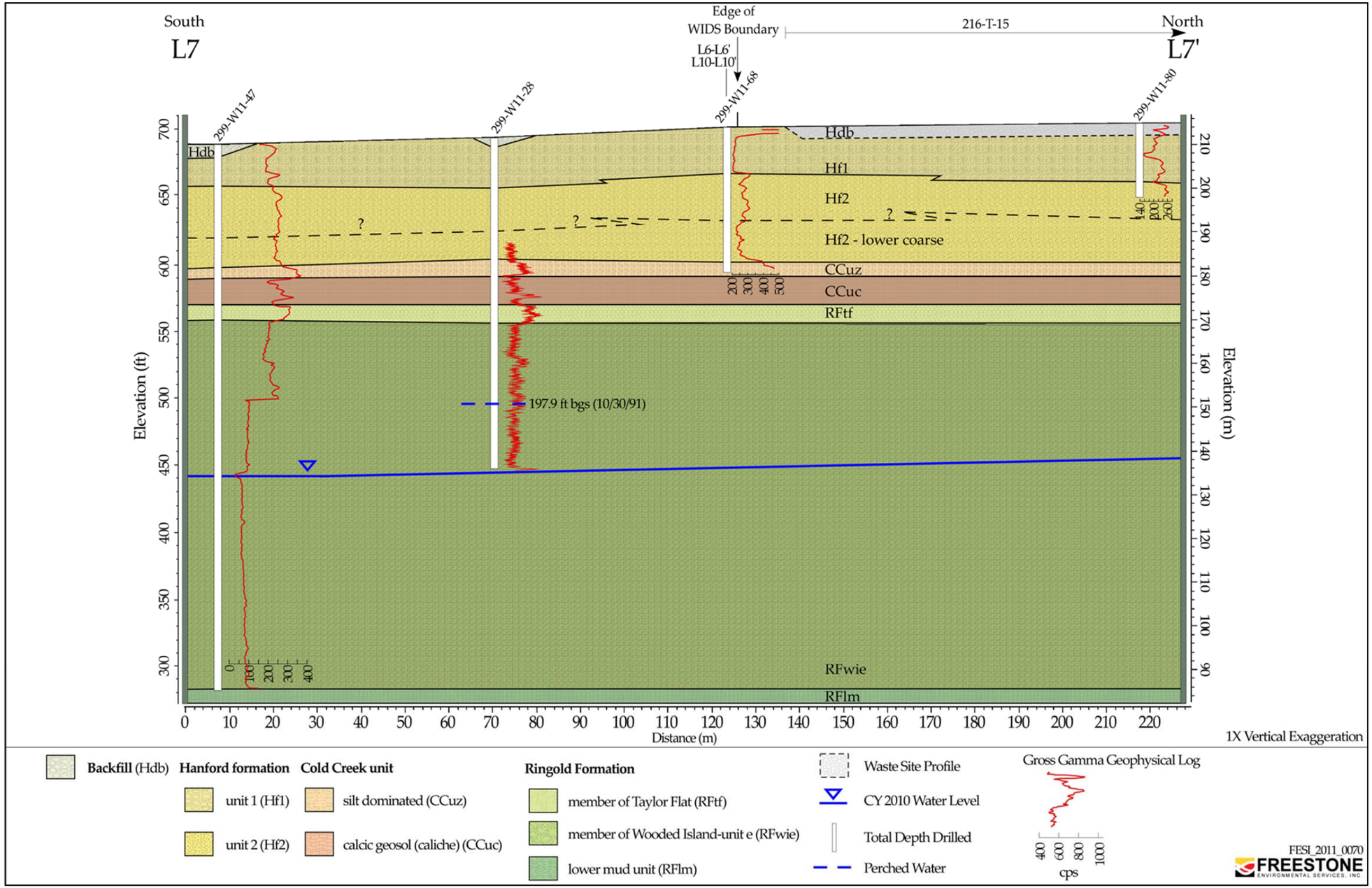

Figure 4-16. Geologic Cross Section L7-L7'

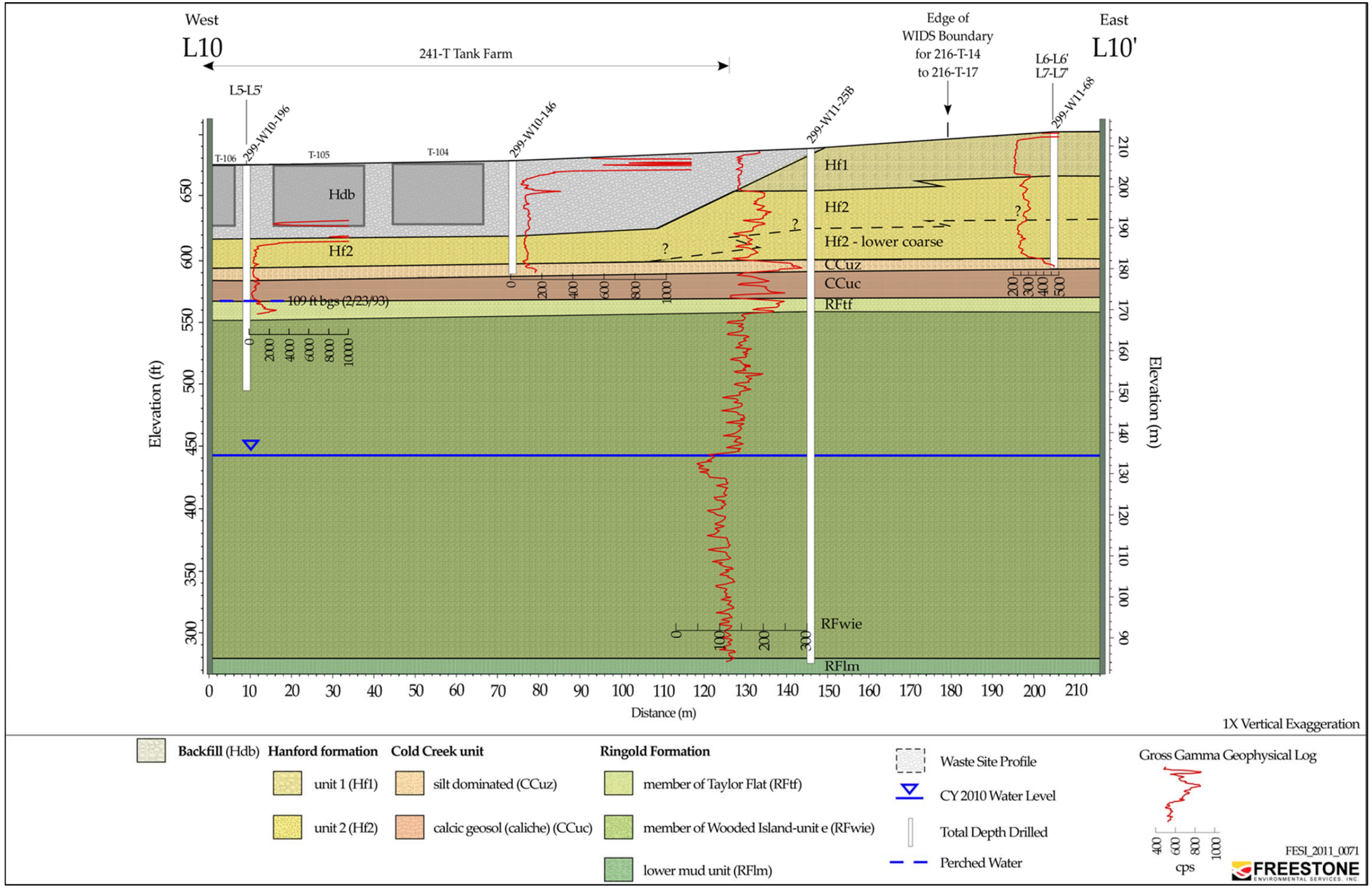

Figure 4-17. Geologic Cross Section L10-L10'

4.4 216-T-18 and 216-T-26 Cribs

The vadose zone underlying the 216-T-18 and 216-T-26 Cribs (Figure 4-18) is approximately 70 m (229.6 ft) thick. This subregion geology also includes the non-200-DV-1 OU 216-T-27 and 216-T-28 Cribs because of waste disposal history and relative location to the 216-T-26 Crib. The suprabasalt aquifer system is estimated to be approximately 84 m (275.5 ft) thick. Aquifer thickness is inferred from regional top of basalt maps since none of the wells in this area were drilled to basalt. Groundwater generally flows to the northeast beneath this site and is known to contain dissolved contaminants from past disposal facilities within the 200 West Area. Perched groundwater was not identified during review of borehole logs near the vicinity of the 216-T-18 and 216-T-26 Cribs.

The 216-T-18 and 216-T-26 Cribs are constructed in the near-surface Hanford formation sediments of the vadose zone. The bottom of the crib lies within the gravel-dominated Hf1 at 4.6 m (15 ft) bgs.

Stratigraphic type logs were created using boreholes C3102 (Figure 4-19) and C4175 (Figure 4-20) to represent the general stratigraphy below this subregion. Numerous high-quality geologist's borehole logs are available for well locations associated with the subregion cross section development (Figures 4-21 and 4-22). Detailed descriptions of the individual geologic units beneath the 216-T-18 and 216-T-26 Cribs are presented in the following subsections.

4.4.1 Holocene Backfill

Up to several meters of recent (Holocene age) sediment is seen as backfill across the subregion above the Hanford formation. Backfill material is located within the construction areas of the 216-T-18 and 216-T-26 Cribs. The backfill is the native Hf1 material that was stockpiled nearby during crib construction. Some of the coarsest gravel was removed before backfilling, and all natural layering/stratification was disrupted such that the backfill is rather homogeneous and featureless compared to the undisturbed Hf1.

4.4.2 Hanford Formation

The Hanford formation comprises the majority of the vadose zone sediment beneath the subregion, ranging in thickness from 25 to 30 m (82 to 98.4 ft). Both the Hf1 subunit (coarse-grained sandy gravel or gravel) and the Hf2 subunit (predominantly sand) are present. In this subregion, the lithology of the Hf1 and Hf2 is generally more homogeneous than elsewhere in the T-Complex. Both the Hf1 and Hf2 subunits have very little relief beneath this subregion. The laterally extensive Hanford formation and its uniform contact elevations provide evidence that these sediments have been relatively unaffected by post-depositional events such as channeling, erosion, uplift, or faulting.

4.4.3 Cold Creek Unit

The CCU underlies the Hanford formation and is locally divided into the CCUz and CCUc subunits. Both the CCUz and CCUc are laterally continuous throughout the subregion. The upper and lower contacts of these subunits were largely defined using the spectral and gross-gamma borehole geophysical log plots as shown in stratigraphic type logs (Figures 4-19 and 4-20). Based on the geologist's borehole logs, the CCUz is described as a yellowish-brown to brown sandy silt to silt comprised of approximately 70 percent silt and 30 percent very fine to fine sand. The CCUc is described as two distinct caliche layers, separated by a sandy-silt to silty-sand interval ranging in thickness from approximately 1.5 to 3 m (5 to 10 ft). The CCUz ranges in thickness from 2 to 4 m (6.5 to 13.1 ft), and in the southern most portion of the subregion this unit dips slightly to the south. The CCUc ranges in thickness from 2 to 6 m (6.5 to 19.7 ft) and appears to dip slightly to the east-southeast.

4.4.4 Ringold Formation

The total thickness of the Ringold Formation was not penetrated during drilling of the 13 wells evaluated for the subregion cross section development. Based on geologic descriptions in the subregion vicinity (PNNL-15955), the Ringold Formation is comprised of units RFtf, RFwie, RFlm, and RFwia.

The uppermost unit, RFtf, is predominately a well-sorted sand with minor silt. The RFtf ranges in thickness from 1 to 4 m (3.3 to 13.1 ft) in this subregion. The RFtf thins slightly to the north, as is evident between well 299-W11-70 and borehole C3102. The RFtf overlies the RFwie, which represents the lowermost Ringold Formation unit in the vadose zone. The contact between the RFtf and RFwie is distinct both in the geologist's borehole logs and in the geophysical logging plots. The RFwie is described as a pebble to cobble gravel with a fine- to coarse-grained sand matrix. Gravel content is usually greater than 60 to 70 percent. The sediments in the RFwie are variably consolidated, usually poorly sorted, and show variable amounts of calcium carbonate. Iron oxide staining is common (PNNL-15955). Beneath the adjacent T-TX-TY Tank Farms, the RFwie is between 39 and 85 m (128 and 279 ft); the upper boundary of unit E dips slightly toward the west or southwest beneath WMA T (PNNL-15955). The geologist's logs indicate a thin (approximately 0.3 [1 ft] thick) silt layer within the RFwie. The RFwie, RFlm, and RFwia comprise the suprabasalt aquifer system in this subregion. The RFlm and RFwia are not described in this report due to their occurrence in the saturated zone.

4.5 216-T-19 Crib and Tile Field

The vadose zone underlying the 216-T-19 Crib and Tile Field (Figure 4-23) is approximately 71 m (233 ft) thick. The suprabasalt aquifer system is estimated to be approximately 85 m (279 ft) thick. Aquifer thickness is inferred from regional top of basalt maps since none of the wells in this area were drilled to basalt. Groundwater generally flows to the northeast beneath this site and is known to contain dissolved contaminants from past disposal facilities within the 200 West Area. Perched groundwater was identified to have occurred at well 299-W15-4 during review of the borehole logs in the vicinity of the 216-T-19 Crib and Tile Field.

The bottom of 216-T-19 Crib is 9.3 m (30.6 ft) bgs and the tile field is at 6.8 m (22.3 ft) bgs. The 216-T-19 waste site is constructed within the near-surface Hanford sediments of the vadose zone.

Stratigraphic type logs were created using wells 299-W15-64 (Figure 4-24) and 299-W15-41 (Figure 4-25) and to represent the general stratigraphy below this subregion. The geologist's borehole log for well 299-15-763 provided the best geologic descriptions of the four boreholes evaluated for the subregion cross section development (Figure 4-26). Detailed descriptions of the individual geologic units beneath the 216-T-19 Crib and Tile Field are provided in the following subsections.

4.5.1 Holocene Backfill

Up to several meters of recent (Holocene age) sediment is seen as backfill across the subregion above the Hanford formation. Backfill material is located within the construction areas of the 216-T-19 Crib and Tile Field. The backfill is the native Hanford formation Hfl unit material that was stockpiled nearby during crib construction. Some of the coarsest gravel was removed before backfilling, and all natural layering/stratification was disrupted such that the backfill is rather homogeneous and featureless compared to the undisturbed Hfl.

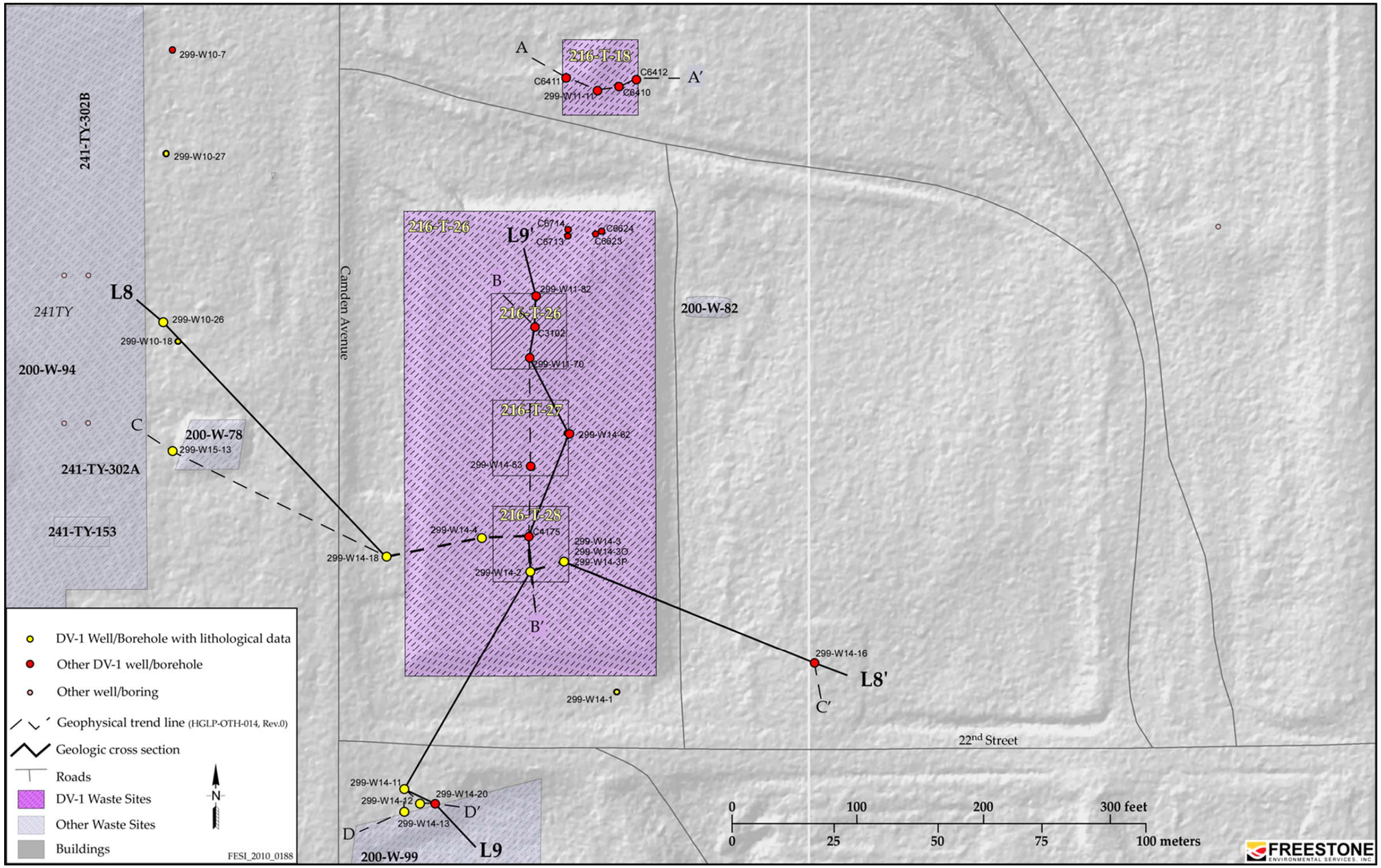

Figure 4-18. 216-T-18 and 216-T-26 Cribs Subregion Base Map and Cross Section Locations

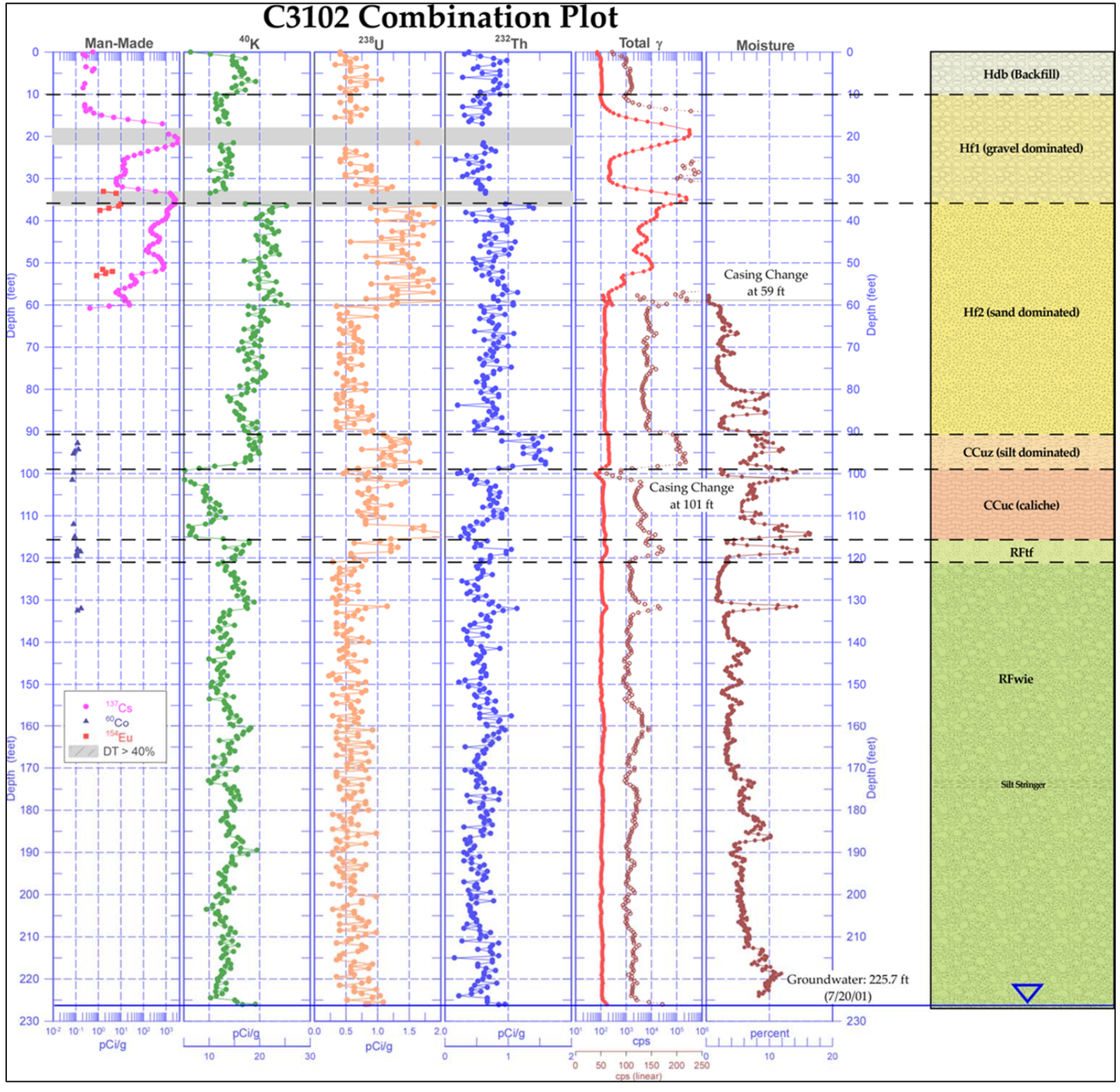

Figure 4-19. Stratigraphic Type Log for Borehole C3102

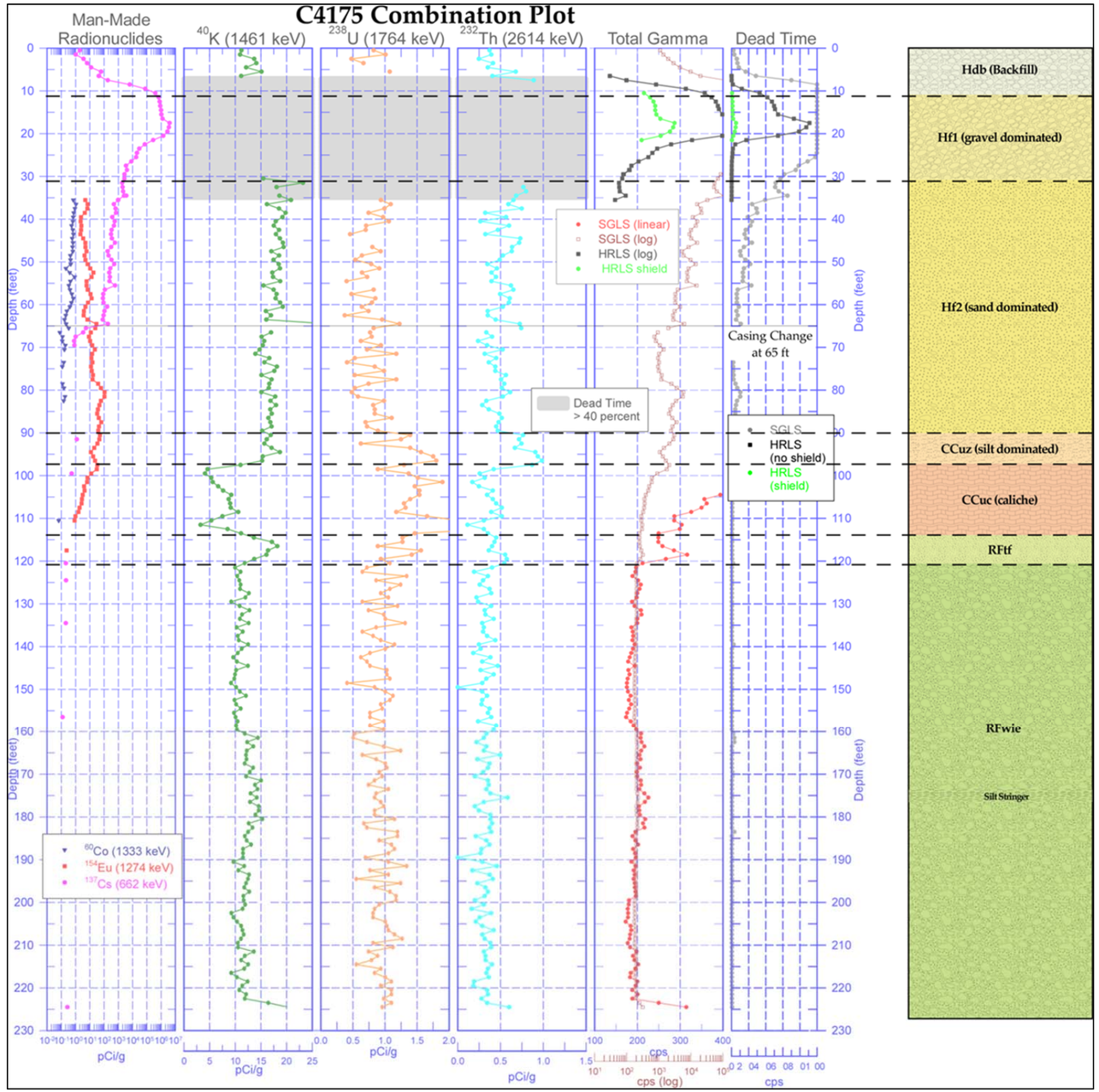

Figure 4-20. Stratigraphic Type Log for Borehole C4175

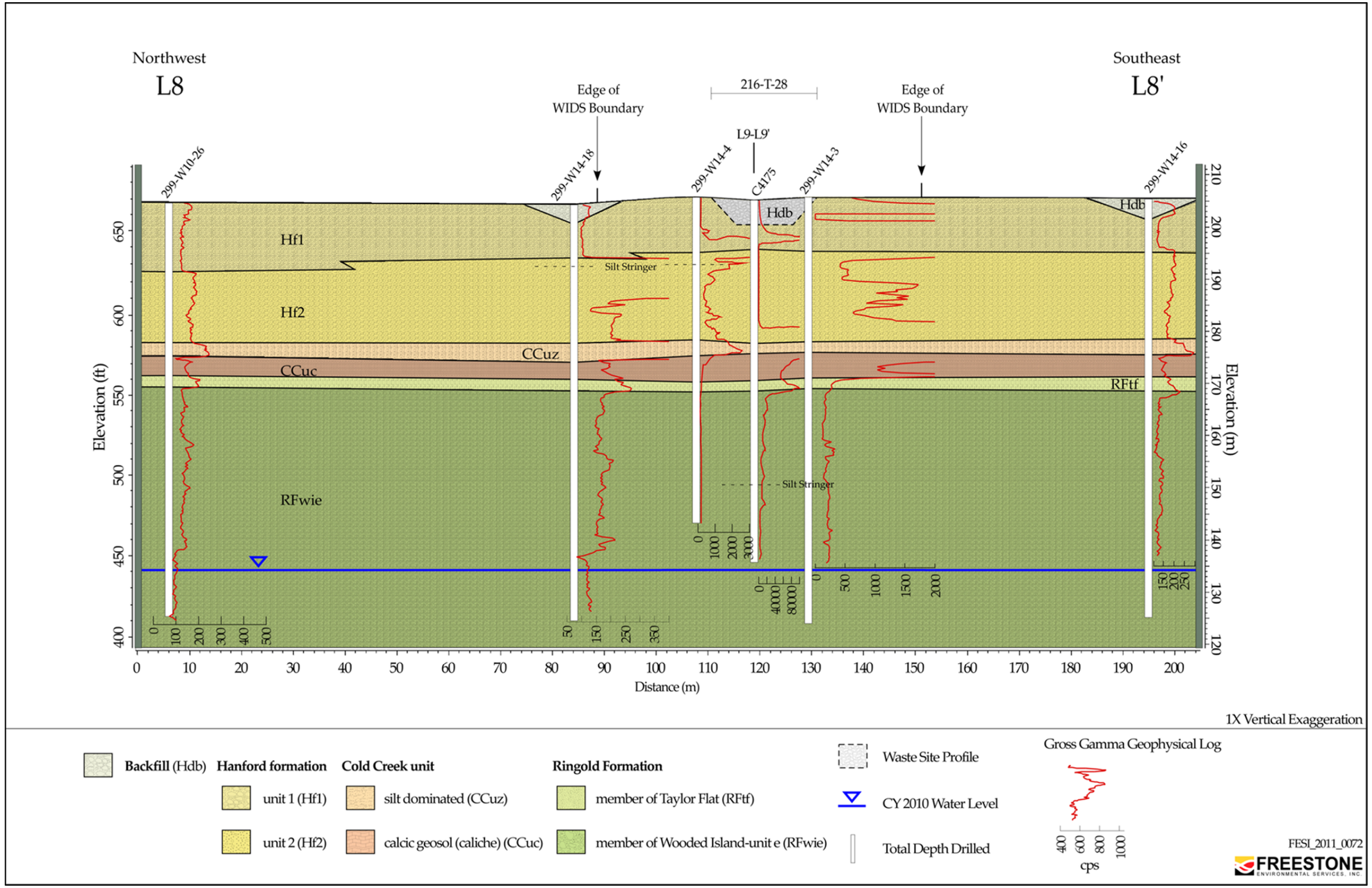

Figure 4-21. Geologic Cross Section L8-L8'

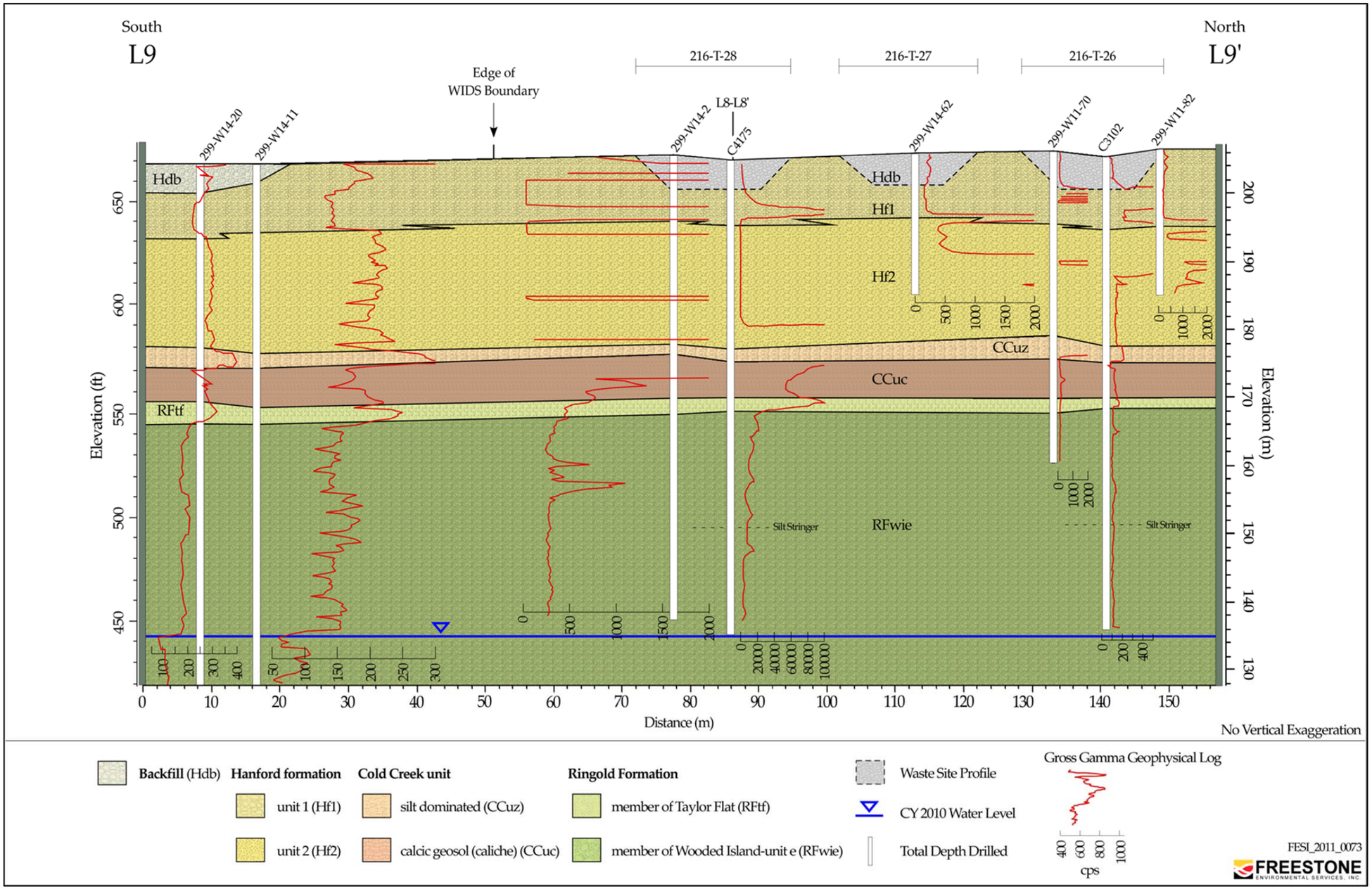

Figure 4-22. Geologic Cross Section L9-L9'

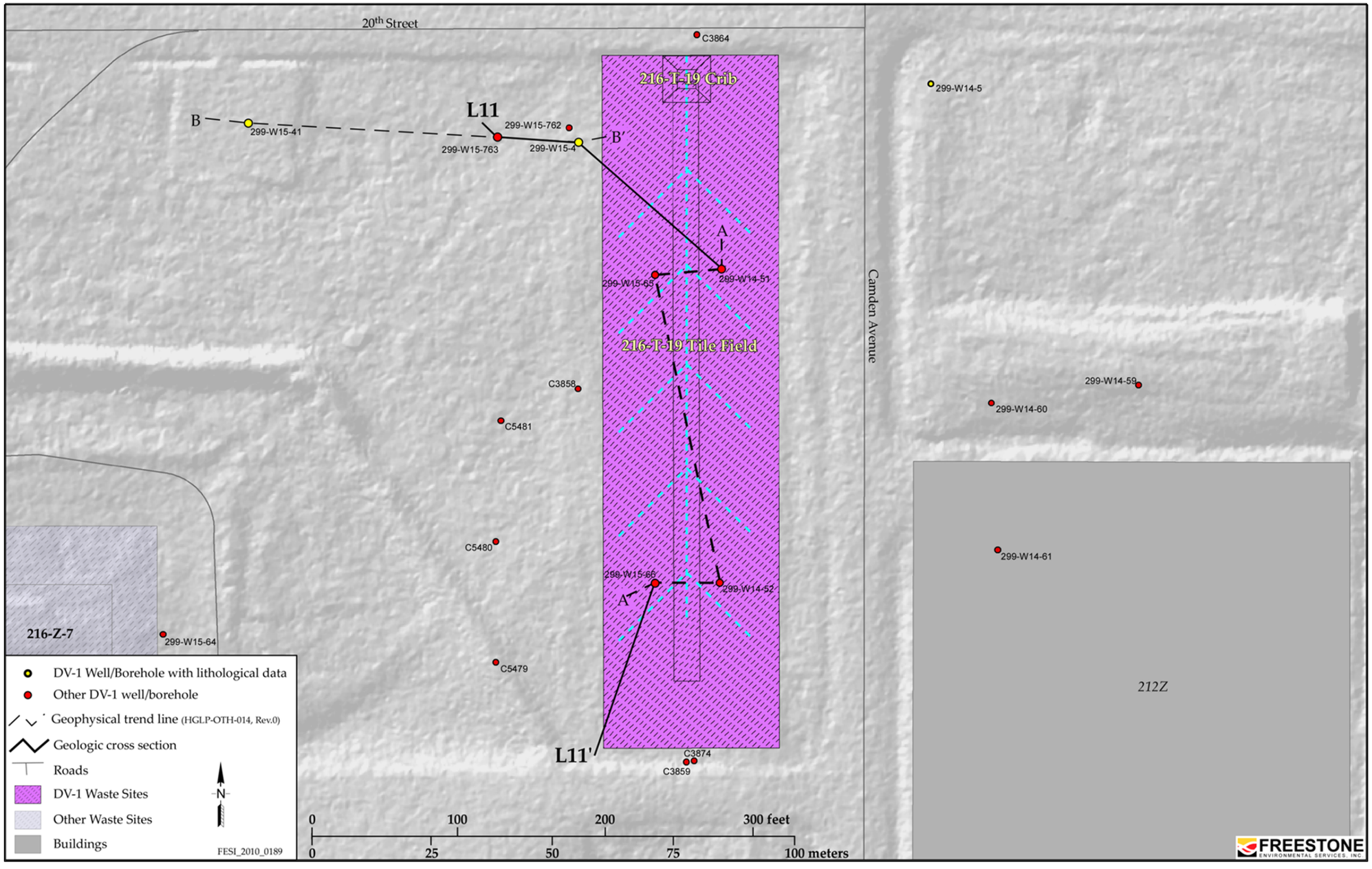

Figure 4-23. 216-T-19 Crib and Tile Field Subregion Base Map and Cross Section Locations

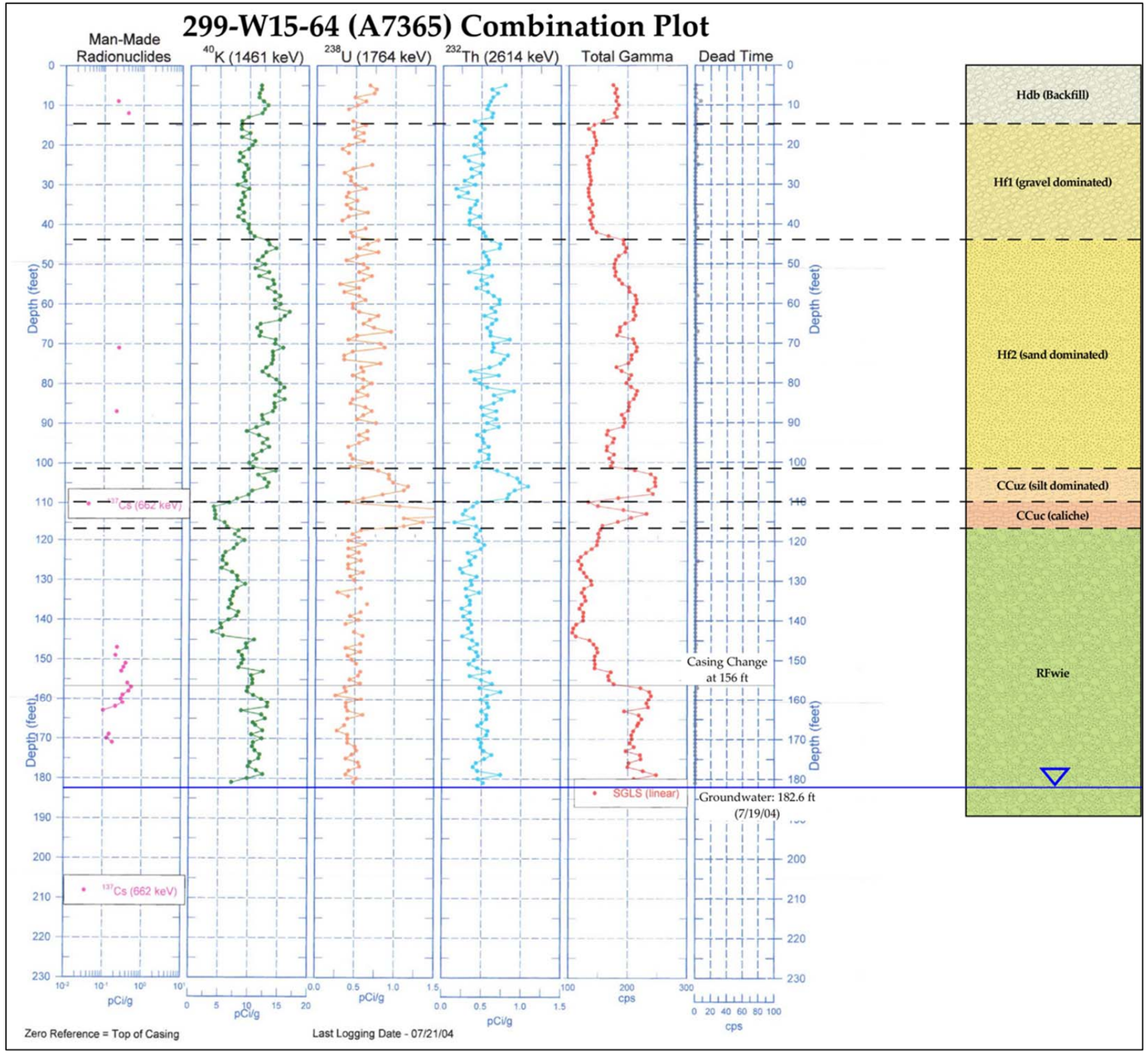

Figure 4-24. Stratigraphic Type Log for Well 299-W15-64

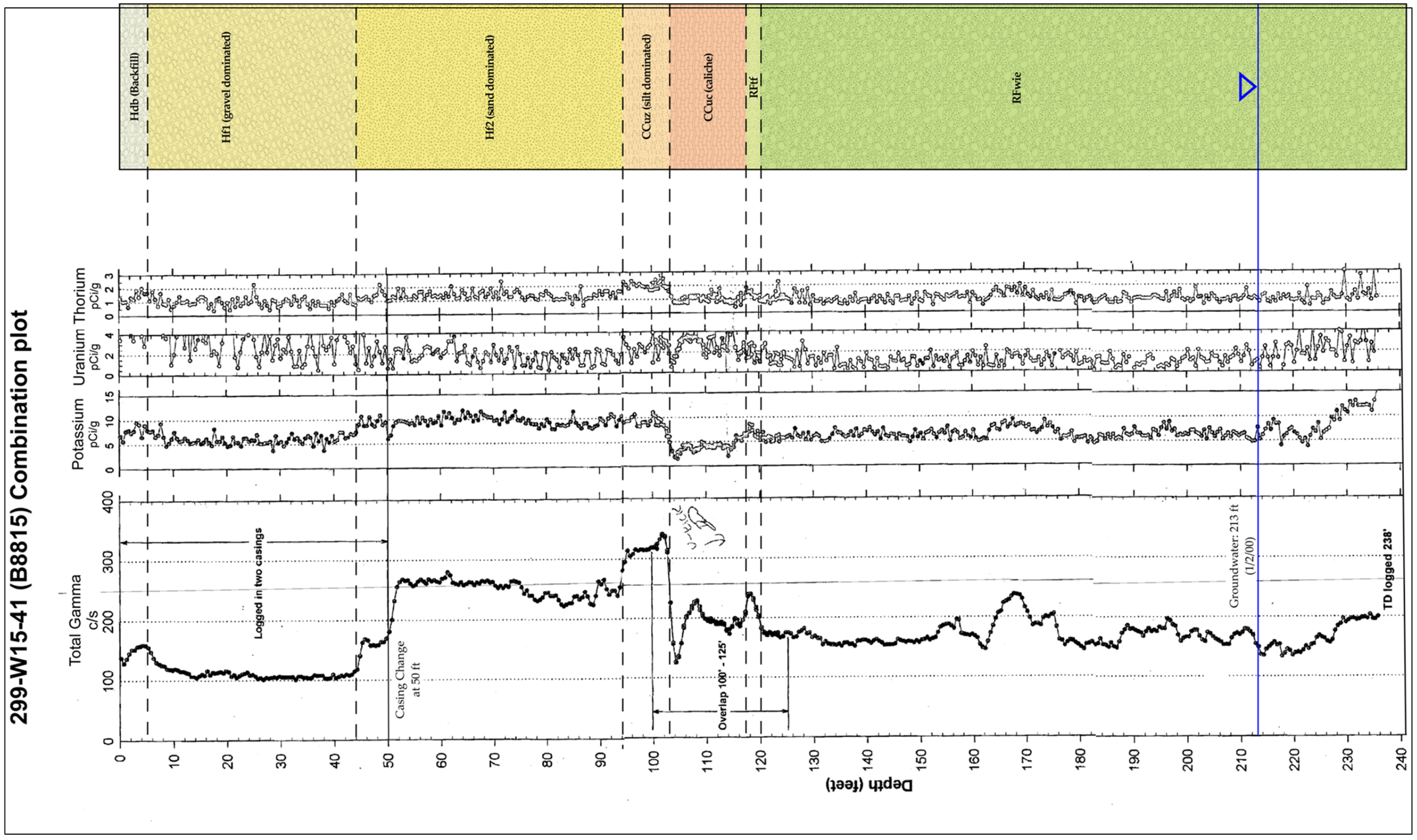

Figure 4-25. Stratigraphic Type Log for Well 299-W15-41

4.5.2 Hanford Formation

The Hanford formation comprises the majority of the vadose zone sediment beneath the subregion and is approximately 28 m (91.9 ft) thick. Both the Hf1 subunit (coarse-grained sandy gravel or gravel) and the Hf2 subunit (predominantly sand) are present. The laterally extensive Hanford formation and its uniform contact elevations provide evidence that these sediments have been relatively unaffected by post-depositional events such as channeling, erosion, uplift, or faulting.

Three boreholes (299-W15-4, 299-W15-762, and 299-W15-763) drilled west of the crib portion of the 216-T-19 Crib and Tile Field encountered a very shallow, slightly silty-sand interval, approximately 1.2 to 2.7 m (4 to 9 ft) thick within the Hf1 (Figure 4-26). This interval appears to thin to the west and does not occur at well 299-W15-41. The geologist's borehole logs for these three wells also depict a discontinuous silty-sand interval in the Hf2 at approximately 12 to 15 m (40 to 50 ft) bgs, which was approximately 0.6 to 0.9 m (2 to 3 ft) thick. At well 299-W15-762, the geologist's borehole log notes very high contamination associated with this interval. In addition to this interval, other discontinuous fine-grained layers occur in the Hf2 throughout the subregion.

Four shallow wells were drilled within the 216-T-19 Tile Field. Wells 299-W14-52 and 299-W15-65 are less than 9.1 m (30 ft) deep and provide little useful information. Total gamma logs from wells 299-W14-51 and 299-W15-66, drilled to 22.9 to 24.4 m (75 and 80 ft), respectively, did not show any evidence of gamma-emitting contamination in the Hanford formation but were not deep enough to characterize any units stratigraphically lower than the Hf1.

4.5.3 Cold Creek Unit

The CCU underlies the Hanford formation and is locally divided into the CCUz and CCUc subunits. Both the CCUz and CCUc are laterally continuous throughout the subregion. The upper and lower contacts of these subunits were largely defined using the spectral and gross-gamma borehole geophysical log plots as shown in stratigraphic type logs (Figures 4-24 and 4-25). Based on the geologist's borehole log for well 299-W15-763, the CCUz is described as a brown silt comprised of 90 percent silt and 10 percent very fine sand. The CCUc is described as two distinct caliche layers, separated by a gravelly silty-sand interval approximately 4.9 m (16 ft) thick. The CCUz and CCUc have uniform thicknesses beneath the subregion of 3 to 6 m (9.8 to 19.7 ft) and 6 m (19.7 ft), respectively.

4.5.4 Ringold Formation

The total thickness of the Ringold Formation was not penetrated during the drilling of the four wells evaluated for the subregion cross section development. Based on geologic descriptions in the subregion vicinity (PNNL-15955), the Ringold Formation is comprised of units RFwie, RFlm, and RFwia.

The uppermost unit, RFtf, which occurs in the other T-Complex subregions, is present in places to the west of the 216-T-19 Tile Field but was not noted in field documents during the drilling of wells 299-W15-763 or 299-W15-4. The RFwie is the uppermost Ringold Formation unit. The contact between the CCUc and RFwie is distinct both in the geologist's borehole logs and in the geophysical logging plots. The RFwie is described as a pebble to cobble gravel with a fine- to coarse-grained sand matrix. Gravel content is usually greater than 60 to 70 percent. The sediments in the RFwie are variably consolidated, usually poorly sorted, and show variable amounts of calcium carbonate. Iron oxide staining is common (PNNL-15955). Beneath the nearby T-TX-TY Tank Farms, the RFwie is between 39 and 85 m (128 and 279 ft) thick; the upper boundary of unit E dips slightly toward the west or southwest beneath WMA T (PNNL-15955). The RFwie, RFlm, and RFwia comprise the suprabasalt aquifer system in this subregion. The RFlm and RFwia are not described in this report due to their occurrence in the saturated zone.

4.6 216-T-21, 216-T-22, 216-T-23, 216-T-24, and 216-T-25 Trenches

The vadose zone underlying the 216-T-21, 216-T-22, 216-T-23, 216-T-24, and 216-T-25 Trenches (Figure 4-27) is approximately 72 m (236 ft) thick. The suprabasalt aquifer system in this area is estimated to be approximately 85 m (279 ft) thick. Aquifer thickness is inferred from regional top of basalt maps since none of the wells in this area were drilled to basalt. Groundwater generally flows to the east-northeast beneath this subregion and is known to contain dissolved contaminants from past disposal facilities within the 200 West Area. Perched groundwater was identified to have occurred at wells 299-W15-40 and 299-W15-80 during review of borehole logs in the vicinity of the 216-T-21, 216-T-22, 216-T-23, 216-T-24, and 216-T-25 Trenches.

The 216-T-21, 216-T-22, 216-T-23, 216-T-24 and 216-T-25 Trenches were constructed in the near-surface Hanford formation sediments of the vadose zone. The bottom of each of the cribs lie within the gravel-dominated Hf1 at 3 m (10 ft) bgs.

Stratigraphic type logs were created using wells 299-W15-43 (Figure 4-28) and 299-W15-225 (Figure 4-29) to represent the general stratigraphy below this subregion. The geologist's borehole log for well 299-W15-43 provides the best geologic descriptions of the seven boreholes evaluated for the subregion cross section development (Figures 4-30 and 4-31). Detailed descriptions of the individual geologic units beneath the 216-T-21, 216-T-22, 216-T-23, 216-T-24, and 216-T-25 Trenches are provided in the following subsections.

4.6.1 Holocene Backfill

Up to several meters of recent (Holocene age) sediment is seen as backfill across the subregion above the Hanford formation. Backfill material is located within the construction areas of the 216-T-21, 216-T-22, 216-T-23, 216-T-24, and 216-T-25 Trenches. The backfill is the native Hf1 material that was stockpiled nearby during crib construction. Backfill depth is approximately 3 m (10 ft). Some of the coarsest gravel was removed before backfilling, and all natural layering/stratification was disrupted such that the backfill is rather homogeneous and featureless compared to the undisturbed Hf1.

4.6.2 Hanford Formation

The Hanford formation comprises the majority of the vadose zone sediment beneath the subregion, with a uniform thickness of 35 m (114.8 ft). Both the Hf1 subunit (coarse-grained sandy gravel or gravel) and the Hf2 subunit (fine-grained sand) are present. Also evident beneath the northern portion of the subregion is a coarser grained sandy gravel to gravel overlying the CCU. This coarser unit is referred to as the Hf2–lower coarse (designated elsewhere on the Hanford site as Hanford formation unit 3). Where it occurs, the Hf2-lower coarse is approximately 12 m (40 ft) thick, except at well 299-W15-211 where the driller's log suggests a thickness of 18 m (60 ft).

Differentiating the Hanford subunits required the use of geophysical logging data, which was sometimes complicated by the occurrence of radiological contamination, drilling methods, and the sometimes gradational nature of the unit contacts.

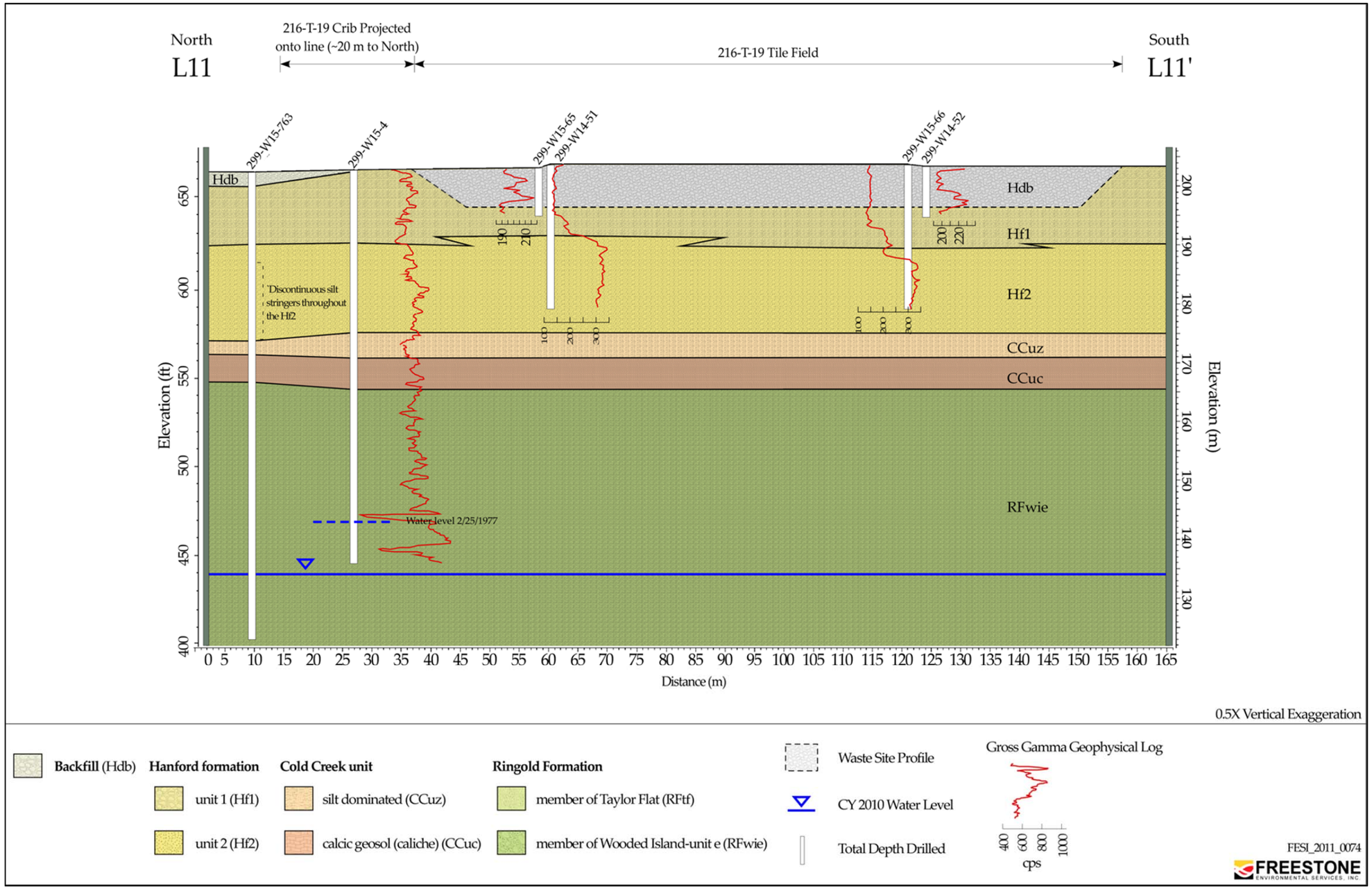

Figure 4-26. Geologic Cross Section L11-L11

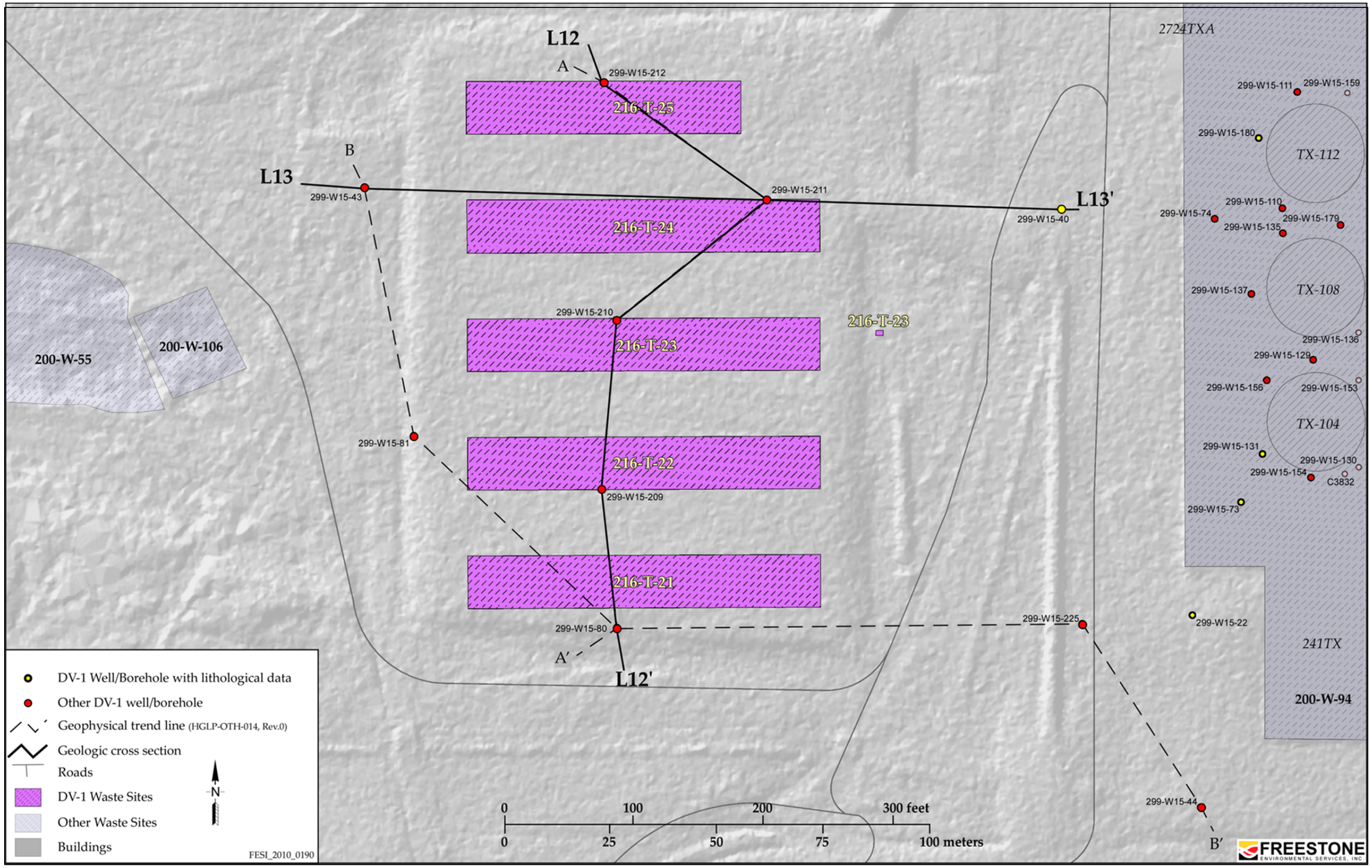

Figure 4-27. 216-T-21, 216-T-22, 216-T-23, 216-T-24, 216-T-25 Trenches Subregion Base Map and Cross Section Locations

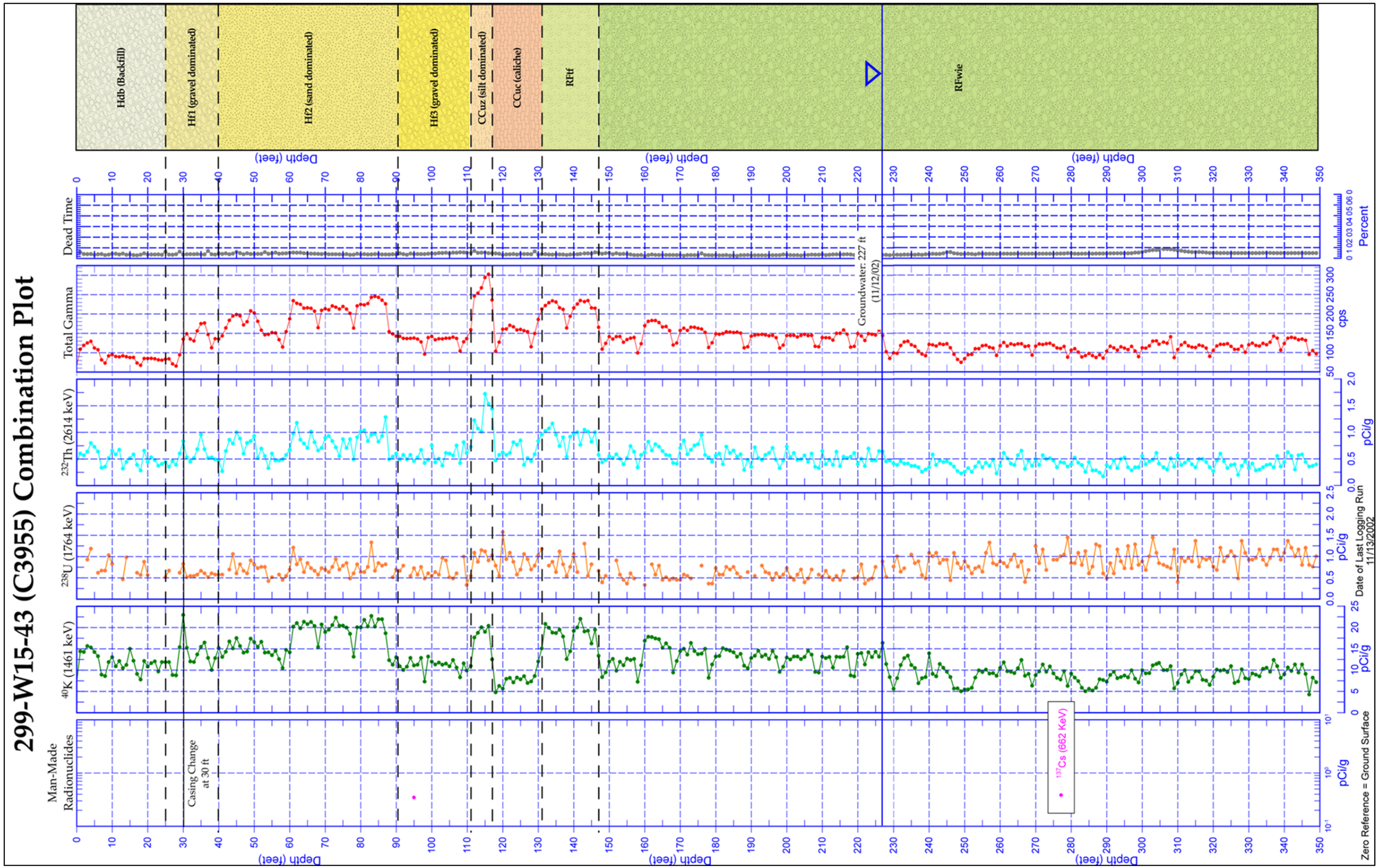

Figure 4-28. Stratigraphic Type Log for Well 299-W15-43

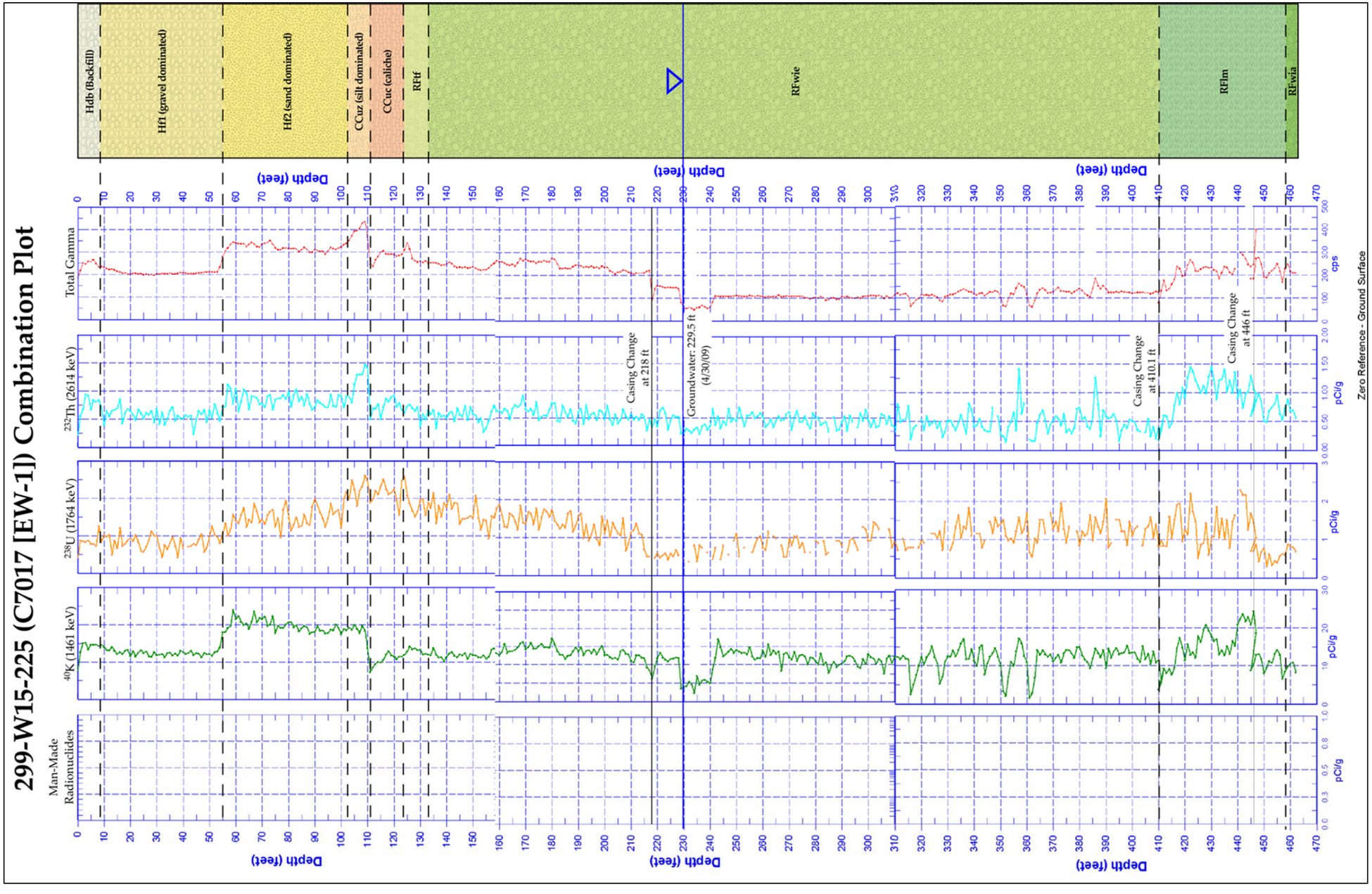

Figure 4-29. Stratigraphic Type Log for Well 299-W15-225

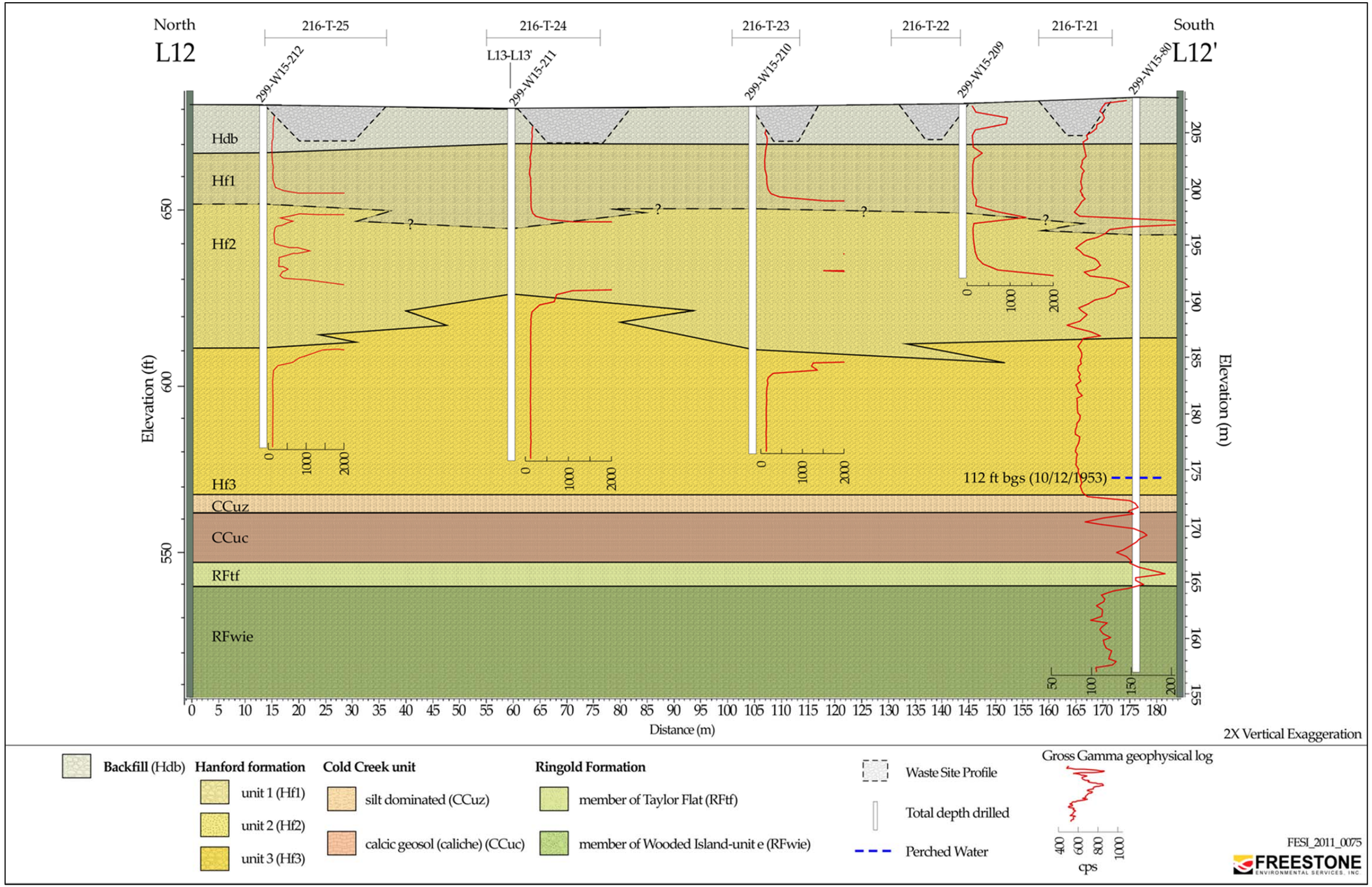

Figure 4-30. Geologic Cross Section L12-L12'

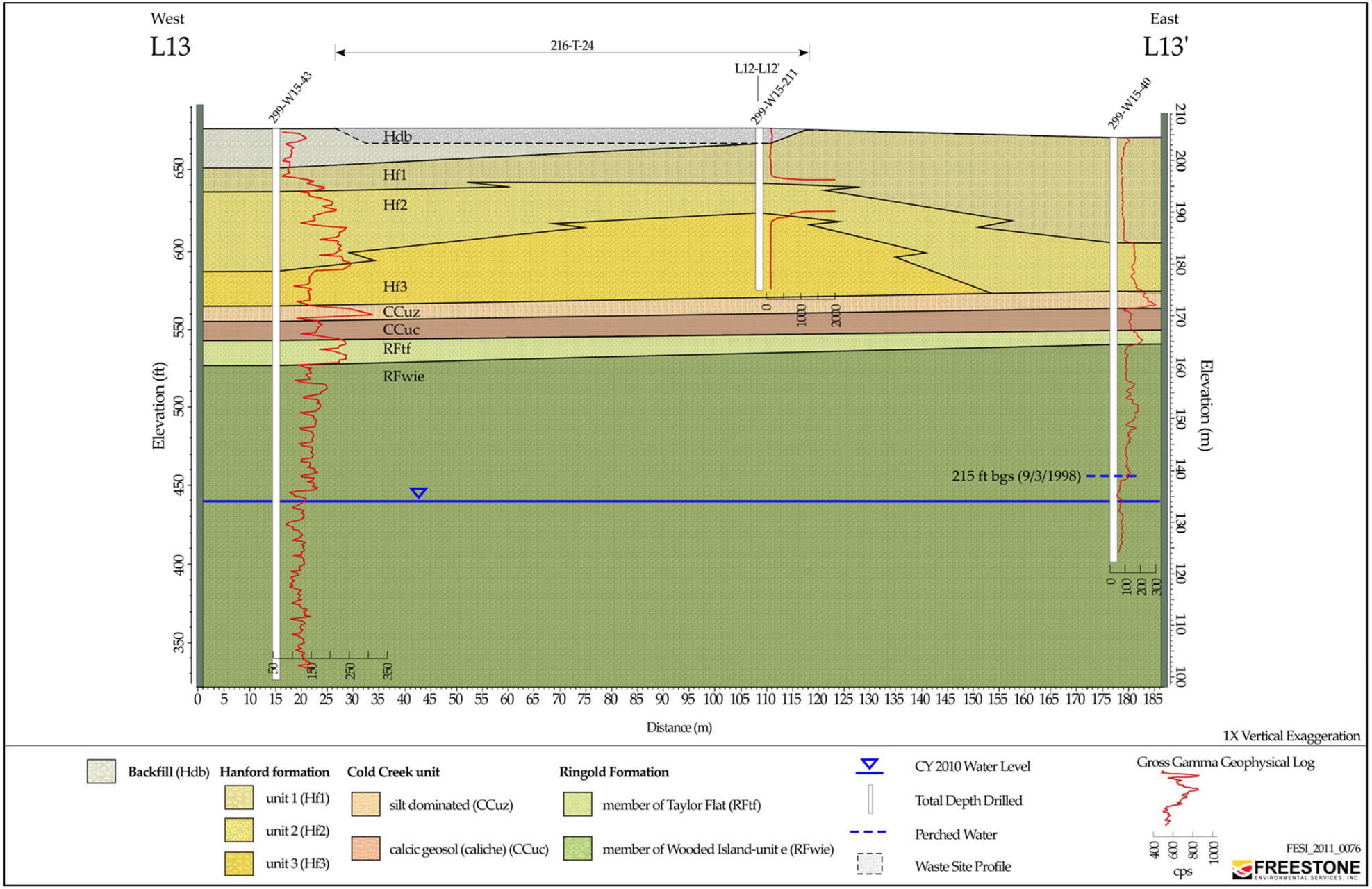

Figure 4-31. Geologic Cross Section L13-L13'

4.6.3 Cold Creek Unit

The CCU underlies the Hanford formation and is locally divided into the CCUz and CCUc subunits. Both the CCUz and CCUc occur and are laterally continuous throughout the subregion. The upper and lower contacts of these subunits were largely defined using the spectral and gross-gamma borehole geophysical log plots as shown in stratigraphic type logs (Figures 4-28 and 4-29). Based on the geologist's borehole log for well 299-W15-43, the CCUz is described as a yellowish-brown sandy silt comprised of 80 percent silt and 20 percent very fine to fine sand. The CCUc is described as a calcium carbonate-rich silty sand overlying a distinct caliche layer. The base of the CCUc beneath the caliche layer consists of a yellowish-brown sandy silt. The CCUz and CCUc have uniform thicknesses beneath the subregion of 2 and 4 m (6.5 and 13.1 ft), respectively. There does not appear to be any localized dip on this formation.

4.6.4 Ringold Formation

The total thickness of the Ringold Formation was not penetrated during drilling of the seven wells evaluated for the subregion cross section development. Based on geologic descriptions in the subregion vicinity (PNNL-15955), the Ringold Formation is comprised of units RFtf, RFwie, RFlm, and RFwia.

The uppermost unit, RFtf, is predominately well-sorted sand with minor silt. The unit is uniformly 2 m (6.5 ft) thick and is relatively flat across the subregion. The RFtf overlies the RFwie, which represents the lowermost Ringold Formation unit in the vadose zone. The contact between the RFtf and RFwie is distinct both in the geologist's borehole logs and in the geophysical logging plots. The RFwie is described as a pebble to cobble gravel with a fine- to coarse-grained sand matrix. Gravel content is usually greater than 60 to 70 percent. The sediments in the RFwie are variably consolidated, usually poorly sorted, and show variable amounts of calcium carbonate. Iron oxide staining is common (PNNL-15955). Beneath the adjacent T-TX-TY Tank Farms, the RFwie is between 39 and 85 m (128 and 279 ft) thick; the upper boundary of RFwie dips slightly toward the west or southwest beneath WMA T (PNNL-15955). The RFwie, RFlm, and RFwia comprise the suprabasalt aquifer system in this subregion. The RFlm and RFwia are not described in this report due to their occurrence in the saturated zone.

4.7 216-S-9 and 216-S-23 Cribs

The vadose zone underlying the 216-S-9 and 216-S-23 Cribs (Figure 4-32) is approximately 76 m (249.4 ft) thick. The suprabasalt aquifer system in this area is estimated to be approximately 99 m (324.8 ft) thick. Aquifer thickness is inferred from a regional top of basalt map (PNNL-17913); only one well (299-W22-27) in this area was drilled to basalt. Groundwater generally flows to the east (based on Figure 2-2 in DOE/RL-2010-11, *Hanford Site Groundwater Monitoring and Performance Report for 2009, Volumes 1 & 2*) beneath this subregion and is known to contain dissolved contaminants from past disposal facilities within the 200 West Area. Perched groundwater was not identified during review of borehole logs in the vicinity of the 216-S-9 and 216-S-23 Cribs.

The 216-S-9 and 216-S-23 Cribs are constructed in the near-surface Hanford formation sediments of the vadose zone. The bottom of the cribs lie within the gravel-dominated Hfl at 9.1 m (30 ft) bgs.

Type logs based on geophysical logs were created using wells 299-W19-7 and 299-W22-69 (Figures 4-33 and 4-34, respectively) to constrain stratigraphic contacts within this subregion. Geologic information for this subregion is limited to the driller's logs, most of which are extremely old and were used qualitatively to corroborate the geophysical log correlations. Besides the available borehole geophysical logs, more quantitative data (from which to interpret lithology) are available in the ROCSAN database. Cross sections depicting the geology of the subregion are shown in Figures 4-35 and 4-36. Detailed

descriptions of the individual geologic units beneath 216-S-9 and 216-S-23 Cribs are provided in the following subsections.

4.7.1 Holocene Deposits

Most of the recent (Holocene age), fine-grained (eolian) sediment has been removed or highly disturbed in this subregion. Several meters of backfill is present across the subregion above the Hanford formation, located within the construction areas of the 216-S-9 and 216-S-23 Cribs. The backfill is native Hanford formation (sand and gravel) material that has been recovered from several borrow pits on the site (DOE/RL-2000-61, *Draft Industrial Mineral Resources Management Plan*). During crib construction, all natural layering/stratification was disrupted such that the backfill is rather homogeneous and featureless compared to the undisturbed Hf1.

4.7.2 Hanford Formation

The Hanford formation comprises the majority of the vadose zone sediment beneath the subregion, ranging in thickness from 37 to 44 m (121.4 to 144.4 ft). Both the Hf1 subunit (coarse-grained sandy gravel or gravel) and the Hf2 subunit (predominately sand) are present. The gravel-dominated Hf1 consists of sandy gravel to silty-sandy gravel. Overall, the Hf1 in this subregion contains a greater amount of sand (i.e., borehole log for 299-W22-69 described the top 14 m [46 ft] of sediments as a poorly sorted sand with less than 10 percent gravel) and displayed an interfingering of coarse gravel lenses. Driller's logs and geophysical log plots indicate there may be discontinuous finer grained lenses within the Hf1 beneath this subarea. This is illustrated in well 299-W19-7 and is shown as multiple increases and decreases in total gamma (Figure 4-33). The sand-dominated Hf2 consists of predominantly fine to coarse sand. Driller's logs and geophysical log plots indicate that there may be discontinuous coarse-grained lenses within the Hf2 in the central portion of the subregion.

Beneath the 216-S-9 Crib, contamination was detected in boreholes 299-W22-25 and 299-W22-26 from 9.4 to 20.7 m (31 to 68 ft) bgs and from 9.1 to 17.7 m (30 to 58 ft) bgs, respectively. Total gamma logs record this contamination as the elevated gamma log interval beginning at approximately 200 m (656 ft) elevation on cross sections L14-L14'and L15-L15'(Figures 4-35 and 4-36).

The top of the Hf2 unit generally dips to the southeast (PNNL-17913). Differentiating the Hanford subunits was possible using geophysical logging data but was sometimes complicated by the occurrence of radiological contamination, drilling methods, and the interfingering nature of the unit contacts.

4.7.3 Cold Creek Unit

The CCU underlies the Hanford formation and is locally divided into the CCUz and CCUc subunits. Both the CCUz and CCUc are laterally continuous throughout the subregion. The upper and lower contacts of these subunits were largely defined using the spectral and gross-gamma borehole geophysical log plots as shown in stratigraphic type logs (Figures 4-33 and 4-34). The CCUz is generally indicated by the occurrence of fine sand and clay, as noted on the driller's logs, and was described in the geologist-produced borehole log (well 299-W22-69) as a reddish brown sandy-silt with clay nodules in matrix up to 3 cm (1.2 in.).

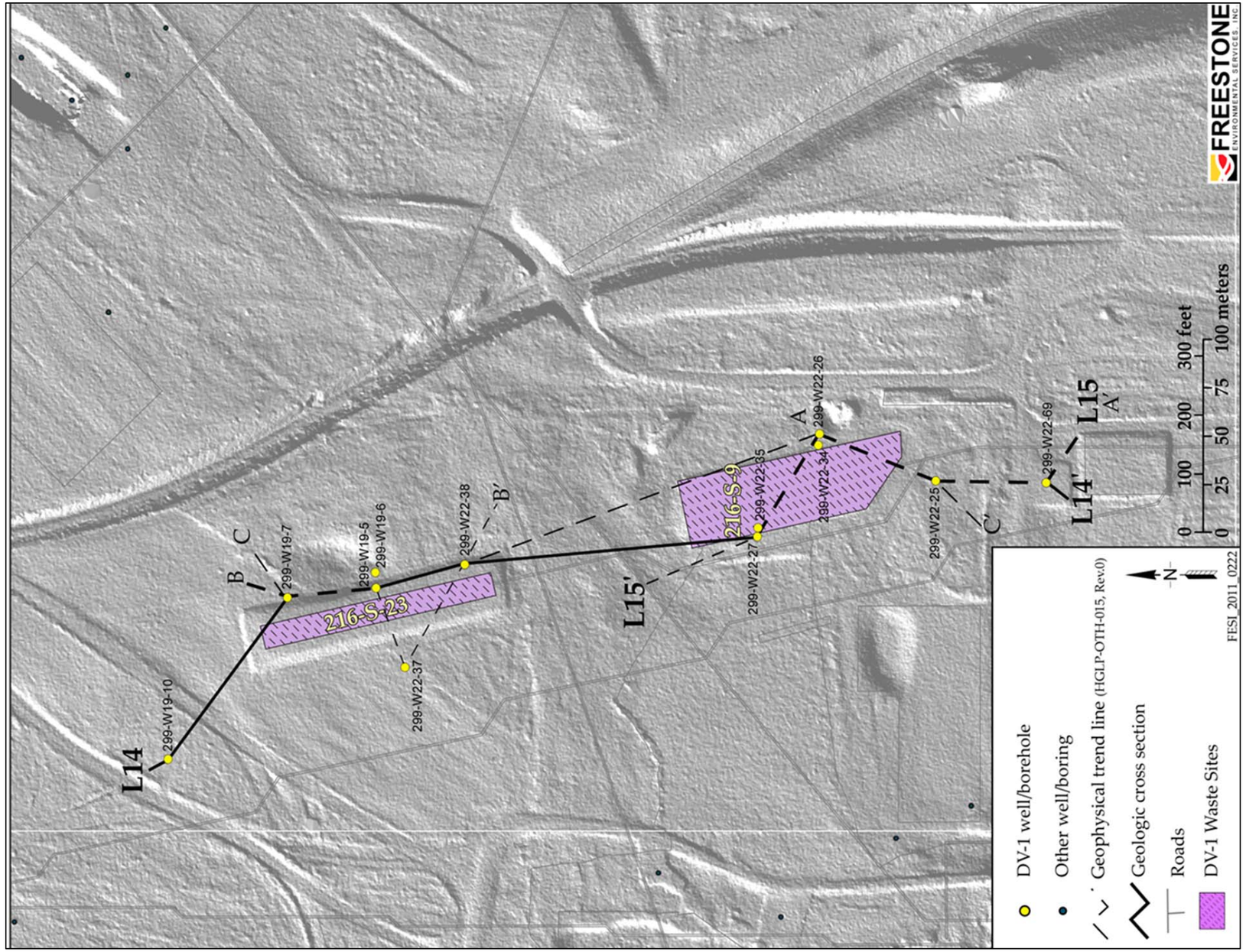

Figure 4-32. 216-S-9 and 216-S-23 Cribs Subregion Base Map and Cross Section Locations

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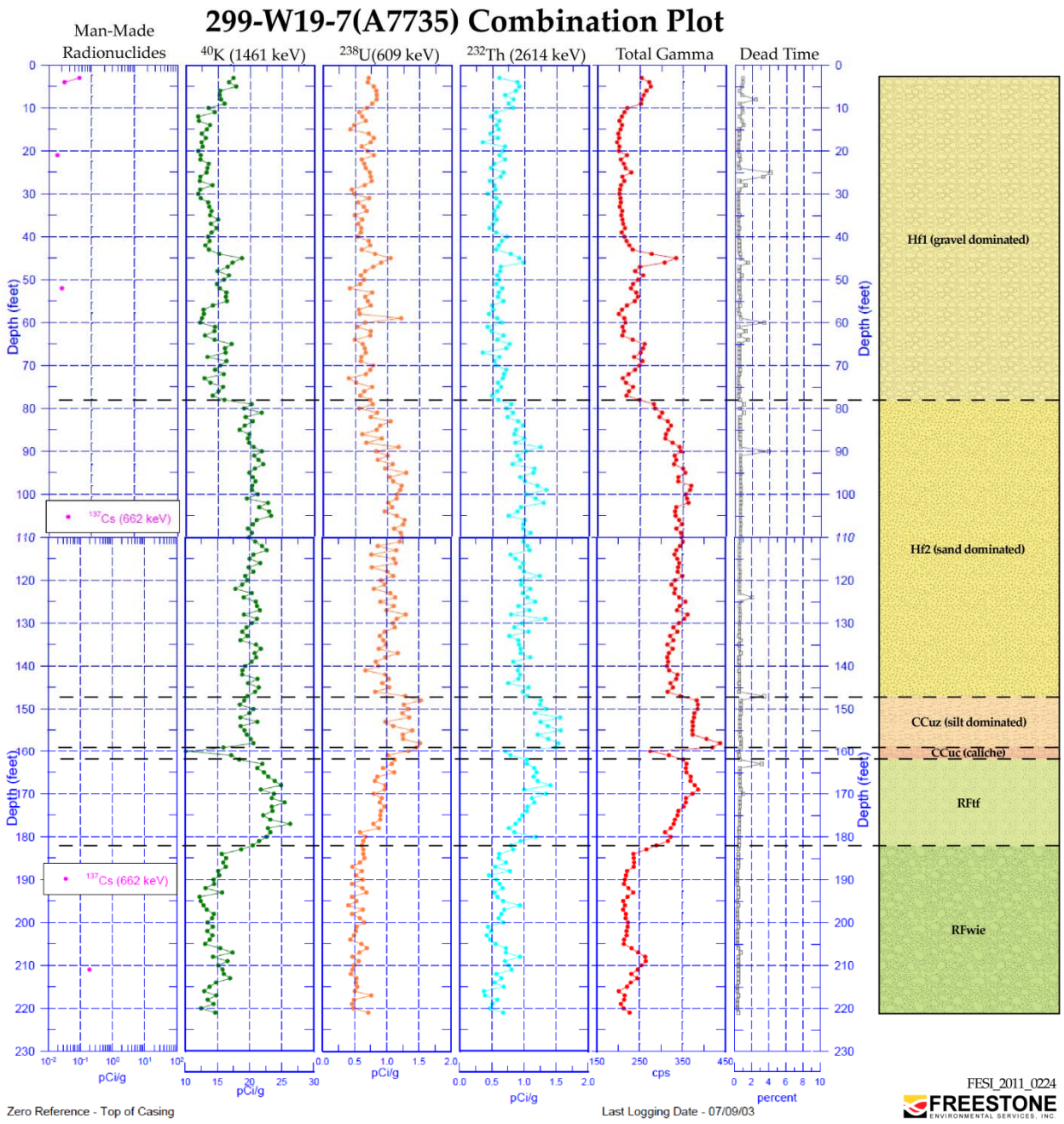

Figure 4-33. Stratigraphic Type Log for 299-W19-7

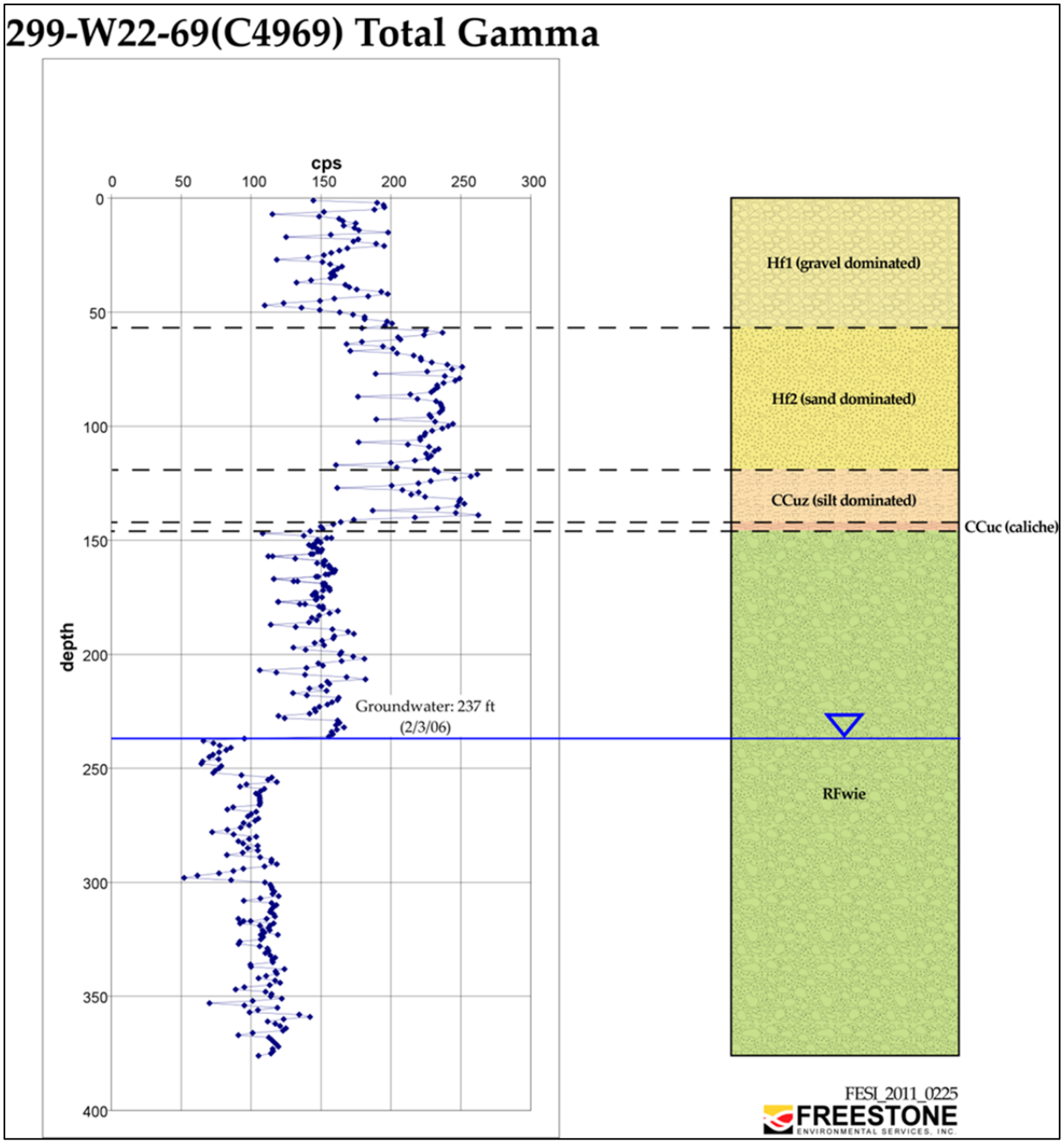

Figure 4-34. Stratigraphic Type Log for Well 299-W22-69

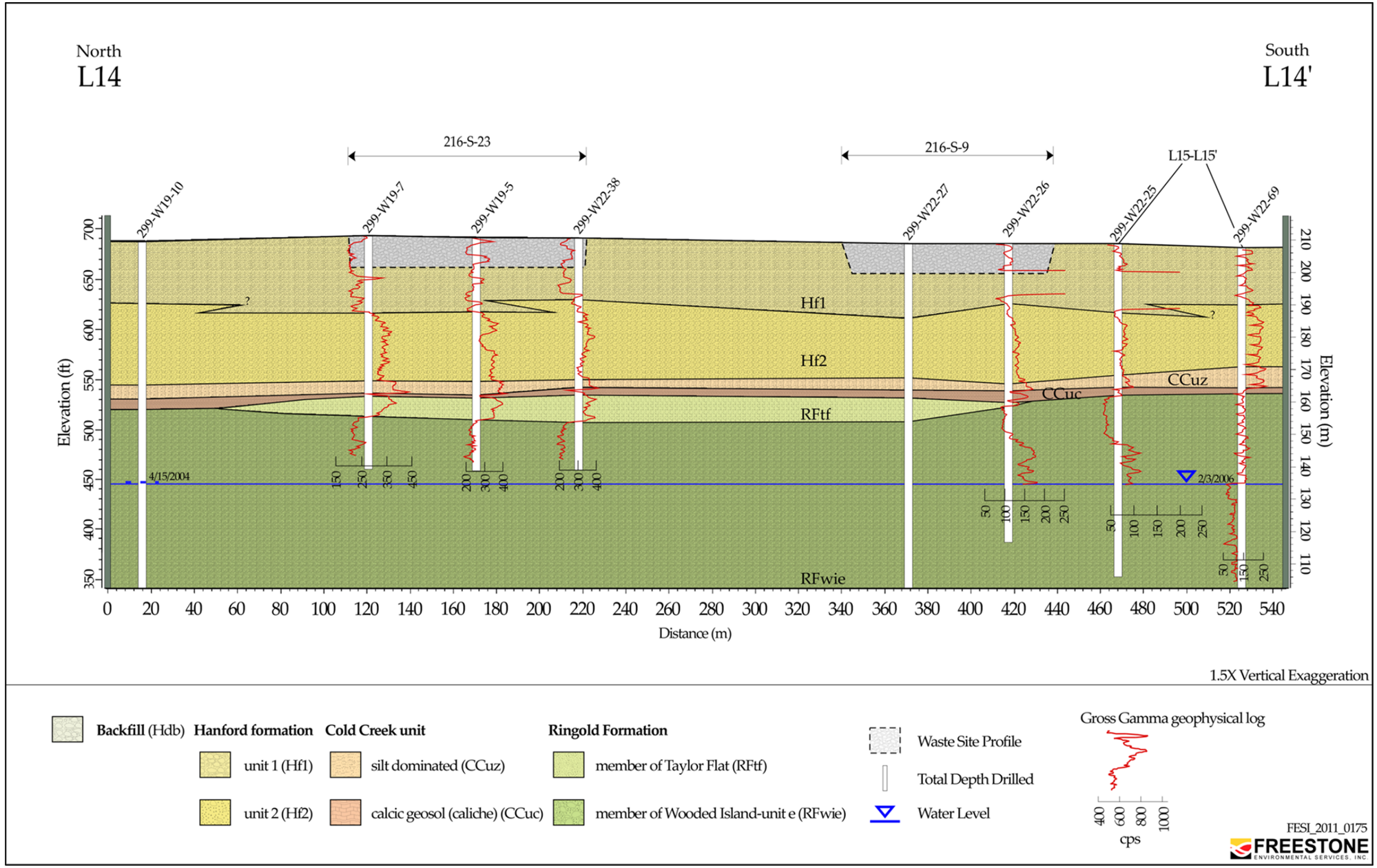

Figure 4-35. Geologic Cross Section L14-L14'

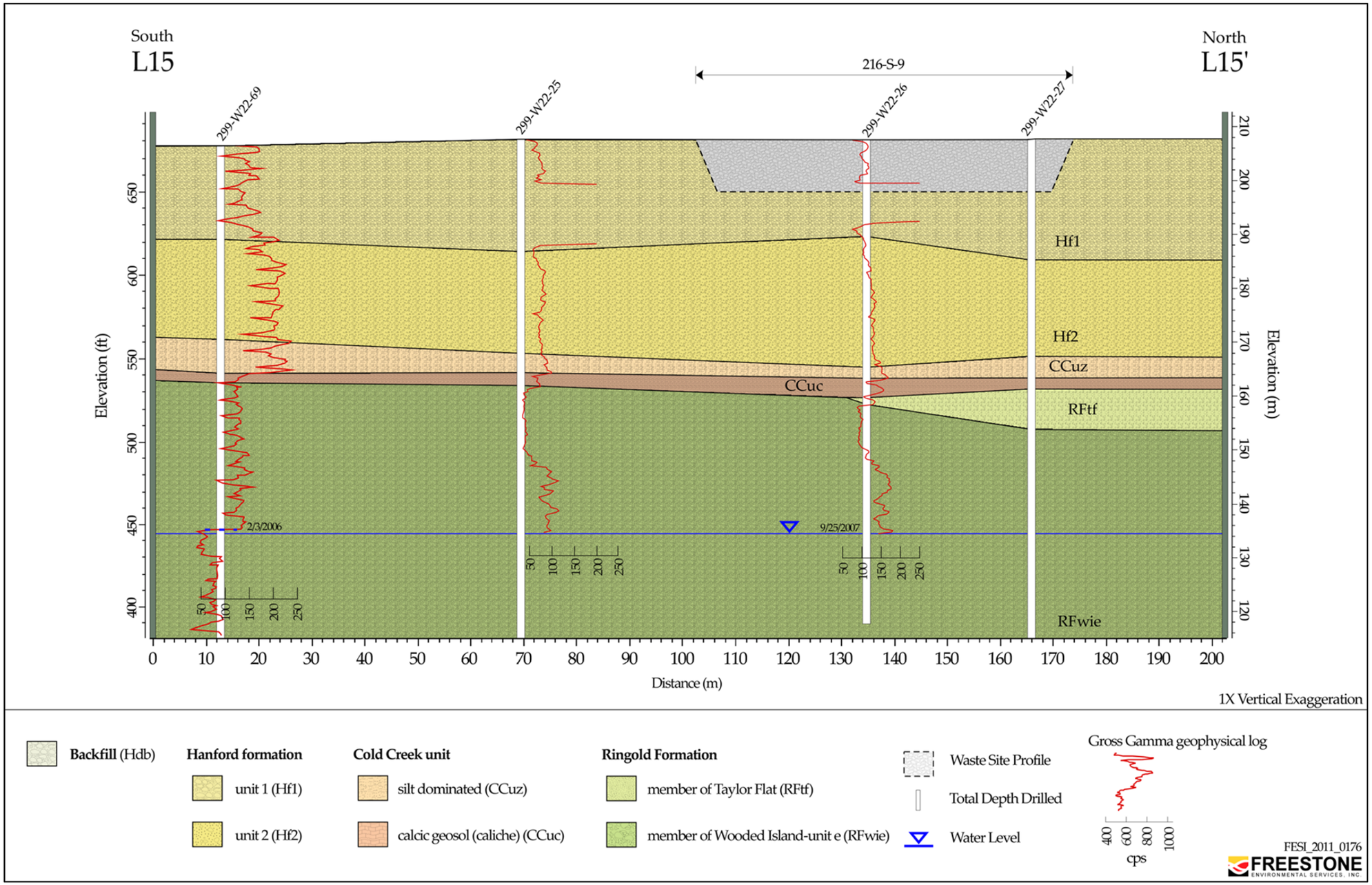

Figure 4-36. Geologic Cross Section L15-L15'

The CCUc is described in the geologist-produced borehole logs as a calcium carbonate-rich silty sand overlying an interval containing caliche nodules up to 10.2 cm (4 in). The base of the CCUc beneath the caliche layer consists of dark reddish-brown, silty-sandy gravel with gravel clasts up to 10.2 cm (4 in). The characteristic double decrease in potassium-40 that conforms with calcrete layers in most of the other subregions in the 200-DV-1 OU is not as present in this subregion. Spectral gamma logging geophysical logs from well 299-W19-7 show only a single, low signature of potassium-40 and thorium-232 (Figure 4-33). The existence of only a single calcrete zone, as compared to subregions to the north, suggests that either (1) the upper calcrete was eroded away and/or not deposited at this location prior to the deposition of the CCUz subunit, or (2) aggradation and accretion of soil deposits was much slower at this location so only a single pedogenic calcrete horizon developed.

The CCUz ranges in thickness from 2.1 to 6.4 m (7 to 21 ft), and CCUz ranges in thickness from 0.9 to 4.9 m (3 to 16 ft). Both subunits appear to dip gently to the north-northwest beneath the subregion.

4.7.4 Ringold Formation

The total thickness of the Ringold Formation was penetrated by two of the eight wells (299-W19-10 and 299-W22-27) evaluated for the subregion cross section development. Based on geologic descriptions in the subregion vicinity (PNNL-15955), the Ringold Formation is comprised of units RFtf, RFwie, RFlm, and RFwia.

The uppermost unit, RFtf, is predominately a well-sorted sand with minor silt described by driller's logs as a fine sand or sand and silt. In this subregion, the RFtf is not present beneath the entire area, and it ranges in thickness (where present) from 6.1 to 8.5 m (20 to 28 ft); the RFtf surface is relatively flat. The RFtf thickens substantially toward the south of 216-S-23 Crib and north of 216-S-9 Crib, then thins and disappears in the areas south, west, and north of the subregion.

The RFtf overlies the RFwie, which represents the lowermost Ringold Formation unit in the vadose zone. The contact between the RFtf and RFwie is distinct both in the geologist's borehole logs and in the geophysical logging plots. RFwie is described as well-rounded pebble to cobble gravel with a fine- to coarse-grained sand matrix. Gravel content is usually greater than 60 to 70 percent, poorly sorted, and iron oxide staining is common (PNNL-15955). The sediments in the RFwie are variably consolidated with calcium carbonate cementation. In wells 299-W19-10 and 299-W22-27, the RFwie is 87.9 and 81.7 m (288.5 and 268 ft) thick, respectively, and dips slightly to the southeast (PNNL-15955). The RFwie, RFlm, and RFwia comprise the suprabasalt aquifer system in this subregion. The RFlm and RFwia are not described in this report due to their occurrence in the saturated zone.

4.8 216-S-21 and 216-S-25 Cribs

The vadose zone underlying the 216-S-21 and 216-S-25 Cribs (Figure 4-37) is approximately 70.1 m (230 ft) thick. The suprabasalt aquifer system in this area is estimated to be approximately 105 m (344.5 ft) thick. Aquifer thickness is inferred from a regional top of basalt map (PNNL-17913) since none of the wells in this area were drilled to basalt. Groundwater generally flows to the east-northeast (DOE/RL-2010-11) beneath this subregion and is known to contain dissolved contaminants from past disposal facilities within the 200 West Area. Perched groundwater was not identified during review of borehole logs in the vicinity of the 216-S-21 and 216-S-25 Cribs.

The 216-S-21 and 216-S-25 Cribs are constructed in the near-surface Hanford formation sediments of the vadose zone. The bottom of the 216-S-21 and 216-S-25 Cribs lie within the gravel-dominated Hf1 at 6.7 and 3 m (22.1 and 10 ft) bgs, respectively.

A log based on the geophysical logging data from well 299-W23-8 and borehole log from well 299-W23-14 was generated to correlate stratigraphic contacts within this subregion (Figure 4-38). Well 299-W23-14 is the only well in this subregion with a geologist's borehole log and provides the best lithologic descriptions of the subsurface sediments. This well is included on a geologic cross section through the site (Figure 4-39).

Geologic information for this subregion is limited to the driller's logs, most of which are extremely old and were therefore used qualitatively. More quantitative data, which are used to interpret stratigraphy, are available in the ROCSAN database (in addition to the downhole geophysical logs). Cross sections depicting the geology of the subregion are shown in Figures 4-39 and 4-40. Detailed descriptions of the individual geologic units beneath the 216-S-21 and 216-S-25 Cribs are provided in the following subsections.

4.8.1 Holocene Deposits

Most of the recent (Holocene age), fine-grained (eolian) sediment has been removed or highly disturbed in this subregion. Several meters of backfill are present across the subregion above the Hanford formation, located within the construction areas of 216-S-21 and 216-S-25 Cribs. The backfill is native Hanford formation (gravelly sand) material that has been recovered from several borrow pits on the site (DOE/RL-2000-61). During crib construction, all natural layering/stratification was disrupted such that the backfill is rather homogeneous and featureless compared to the undisturbed Hf1.

4.8.2 Hanford Formation

The Hanford formation comprises the majority of the vadose zone sediment beneath the subregion, with a thickness of 37.8 m (124 ft). Both the Hf1 subunit (coarse-grained sandy gravel or gravel) and the Hf2 subunit (predominately sand) are present. The gravel-dominated Hf1 consists of poorly sorted sandy gravel to silty-sandy gravel. Overall, the Hf1 in this subregion is finer grained; the borehole log for well 299-W23-14 indicates that the gravel content was at or below 40 percent, predominately fine grained (less than 8 mm [0.31 in.]), and did not contain cobbles. The sand-dominated Hf2 consists of predominantly fine to very fine sand and silt based on driller's logs and geophysical logging data (Figure 4-38), indicating the presence of discontinuous gravel lenses, with occasional cobbles noted.

Beneath the 216-S-21 Crib, contamination was detected in boreholes 299-W23-63 and 299-W23-4 from ground surface to 15.5 m (0 to 51 ft) bgs and from 11.0 to 18.3 m (36 to 60 ft) bgs, respectively. Contamination from the SX Tank Farm was also noted in wells 299-W23-114 and 299-W23-108.

The top of the Hf2 unit generally dips to the south southeast (PNNL-17913).

4.8.3 Cold Creek Unit

The CCU underlies the Hanford formation and is locally divided into the CCUz and CCUc subunits. Both the CCUz and CCUc are laterally continuous throughout the subregion. The upper and lower contacts of these subunits were largely defined using the spectral and gross-gamma borehole geophysical log plots as shown in the stratigraphic type log (Figure 4-40). CCUz is generally indicated by the occurrence of heavy silt or brown sand and silt, as noted in driller's logs and a geologist borehole log for well 299-W23-14, as a dark yellowish-brown silt with iron staining in places.

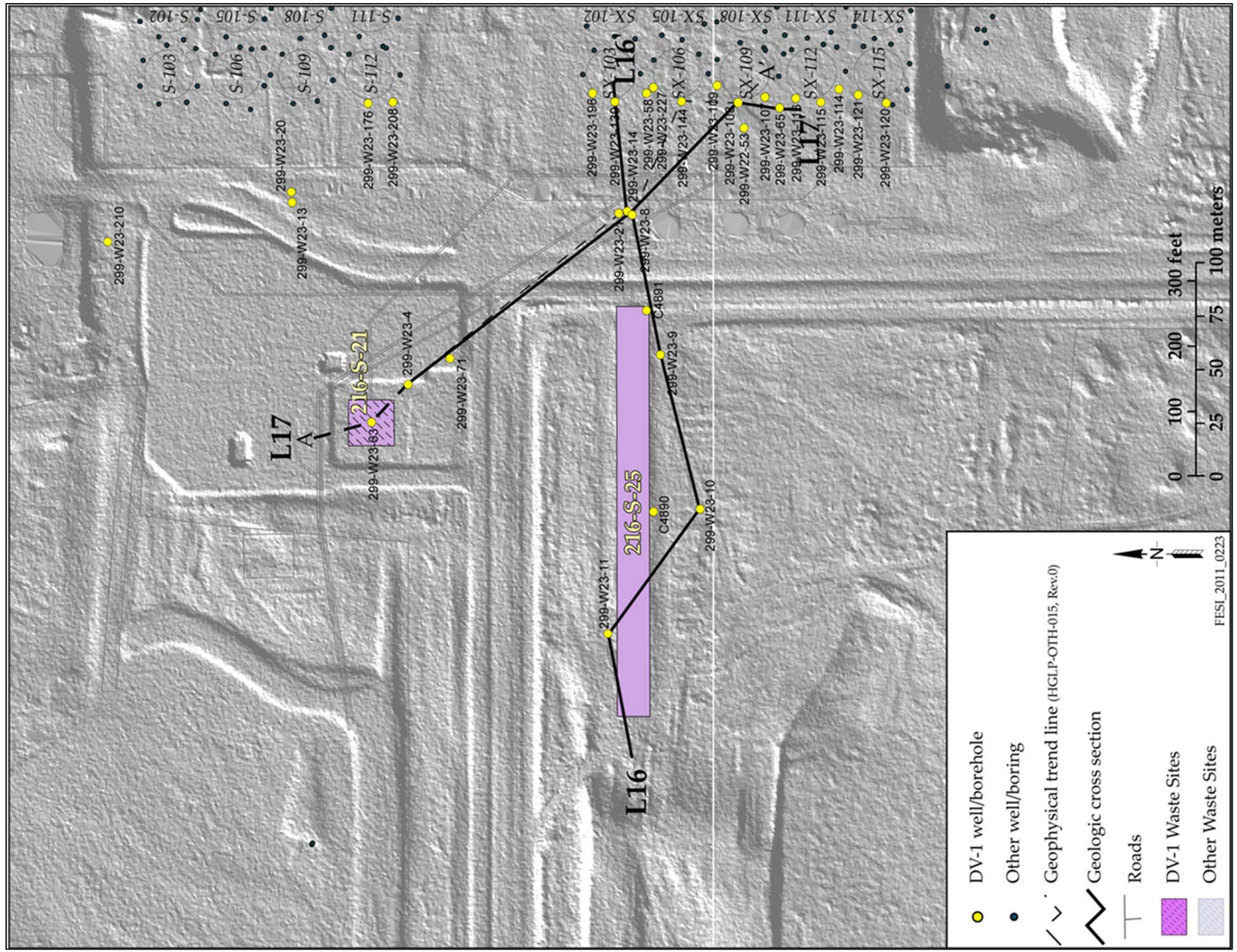

Figure 4-37. 216-S-21 and 216-S-25 Cribs Subregion Base Map and Cross Section Locations

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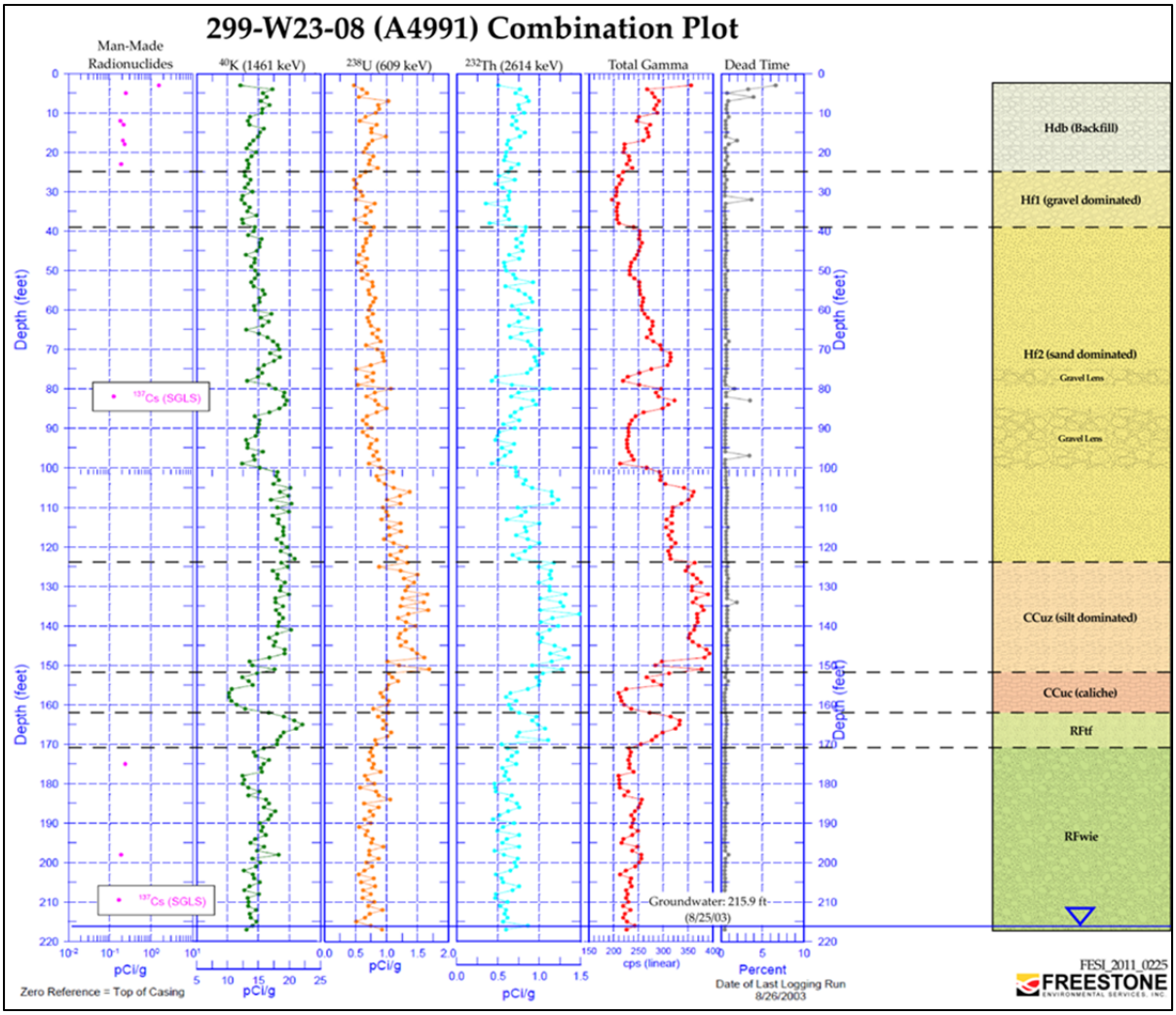

Figure 4-38. Stratigraphic Type Log for Well 299-W23-8

The CCUc is described as unconsolidated, light olive-brown, silty-sandy gravel in which the gravels were coated with calcium carbonate. The base of the CCUc beneath the calcium carbonate-rich layer consists of dark grayish-brown sand with a trace of gravel. The characteristic double decrease in potassium-40 that conform with two distinct calcrete layers in most of the other subregions in the 200-DV-1 OU is not present in this subregion. Geophysical logs from well 299-W23-8 indicate only a single calcrete interval (Figure 4-38).

The CCUz ranges in thickness from 7.3 to 10.4 m (24 to 34 ft), and the CCUc ranges in thickness from 1.5 to 3.7 m (5 to 12 ft). Both subunits are relatively horizontal beneath the subregion.

4.8.4 Ringold Formation

The total thickness of the Ringold Formation was not penetrated during drilling of the10 wells evaluated for the subregion cross section development. Based on geologic descriptions in the subregion vicinity (PNNL-15955), the Ringold Formation is comprised of units RFtf, RFwie, RFlm, and RFwia.

The RFtf is present beneath the 216-S-25 Crib, even though it is missing over much of the area to the north, south, and west (PNNL-17913). The RFtf maintains a uniform thickness of approximately 3 m (10 ft) and is relatively horizontal beneath the 216-S-25 Crib. The RFtf overlies the RFwie, which represents the lowermost Ringold Formation unit in the vadose zone. The contact between the RFtf and RFwie was sometimes difficult to distinguish from borehole or driller's logs due to the hard-tool, Becker hammer, or air-rotary drilling methods used in this area. Driller's logs described the RFwie formation as very tightly packed and containing silt and brown sand with 10.2 cm (4 in.) of gravel. The RFwie is described as well-rounded pebble to cobble gravel with a fine- to coarse-grained sand matrix. The sediments in the RFwie are variably consolidated with calcium carbonate cementation. The RFwie is estimated to be approximately 82 m (249.9 ft) thick; the upper boundary of RFwie dips slightly toward the south or southeast beneath the SX Tank Farm (PNNL-17913). The RFwie, RFlm, and RFwia comprise the suprabasalt aquifer system in this subregion. The RFlm and RFwia are not described in this report due to their occurrence in the saturated zone.

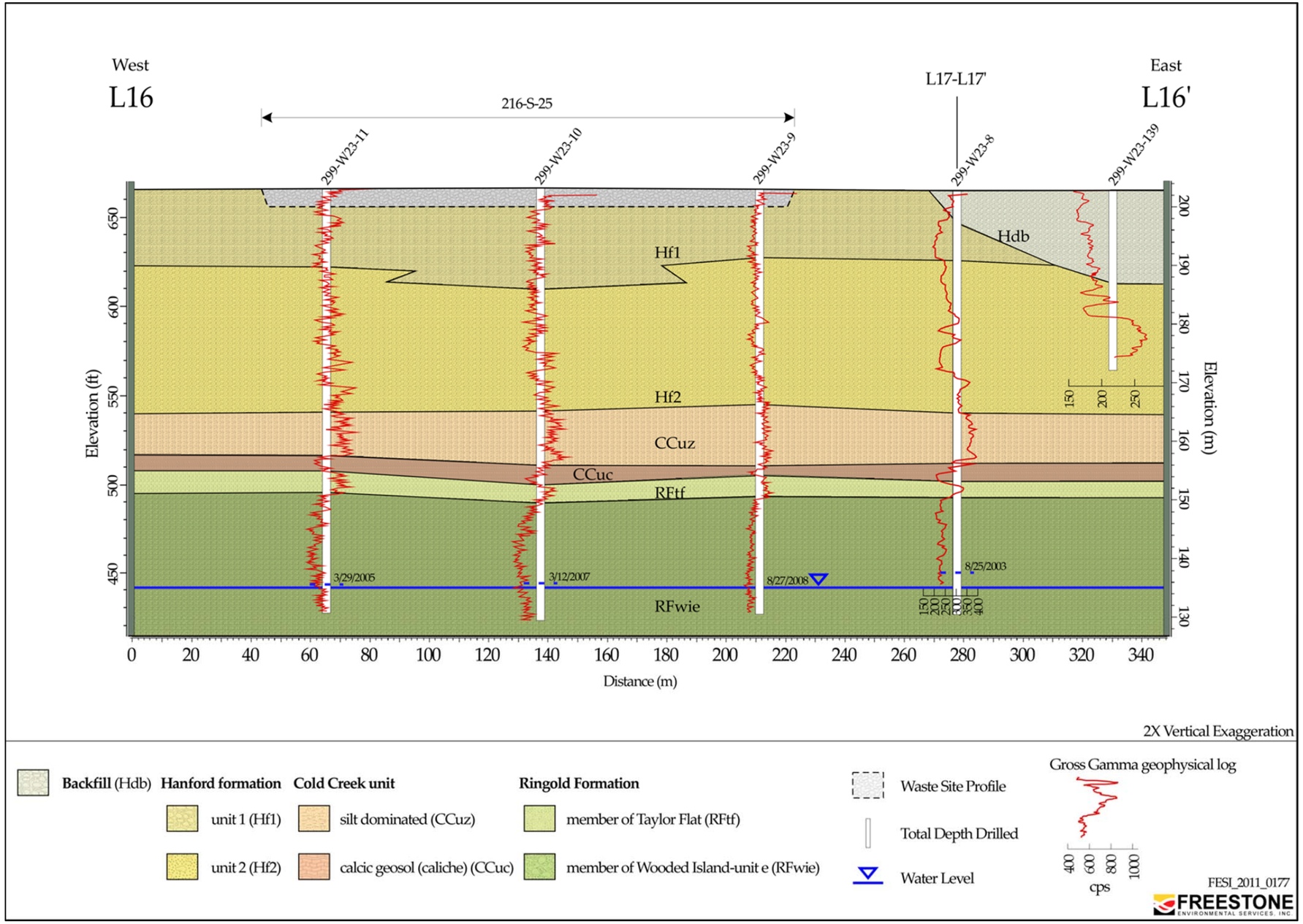

Figure 4-39. Geologic Cross Section L16-L16'

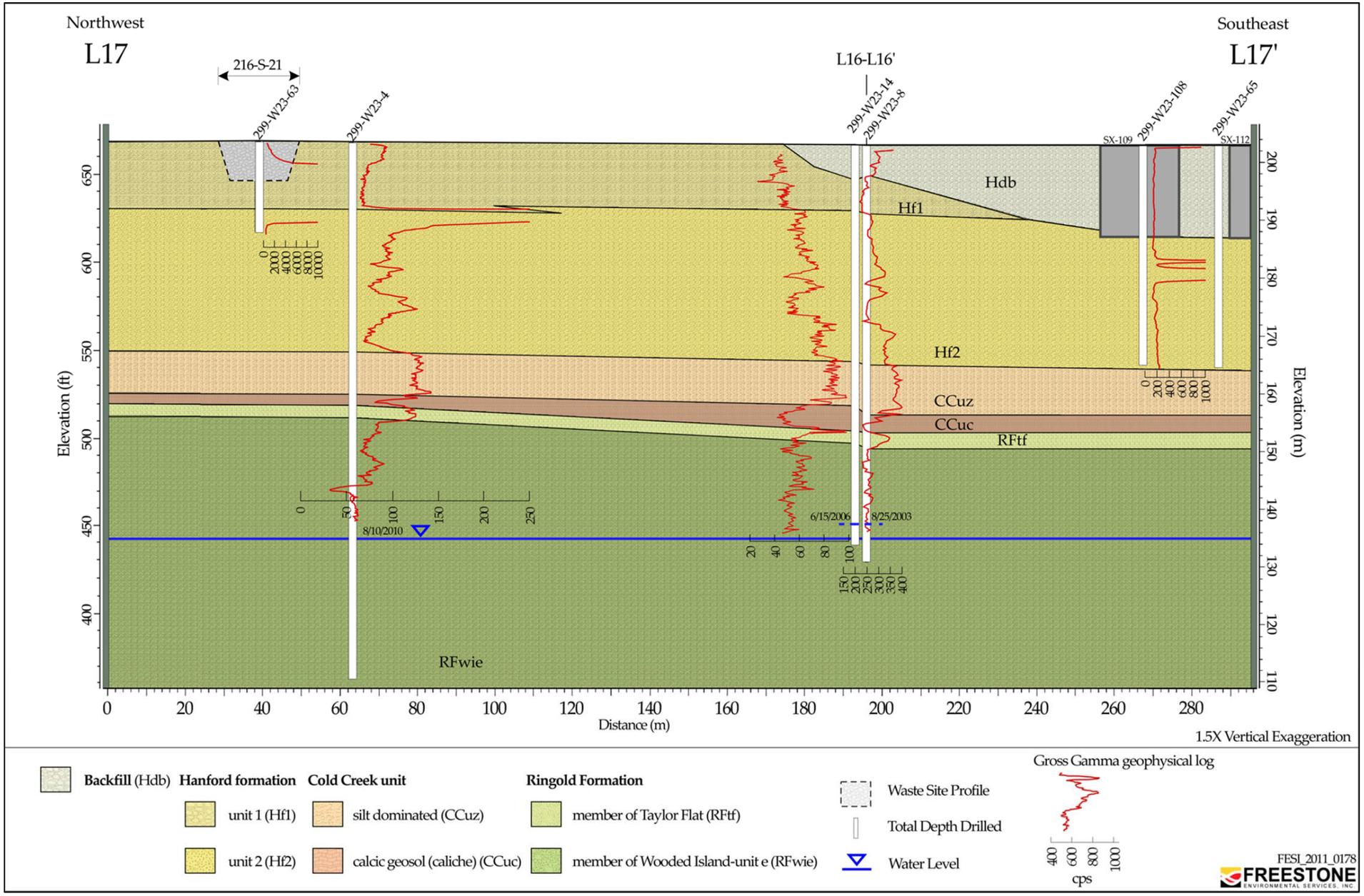

Figure 4-40. Geologic Cross Section L17-L17'

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Appendix A

Geophysical Logging Data and Stratigraphic Correlations

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A Geophysical Logging Data and Stratigraphic Correlations

This appendix provides correlations for 200-DV-1 Operable Unit wells with geophysical logging data available. All depths are shown in meters below ground surface; gross-gamma units are presented in counts per second.

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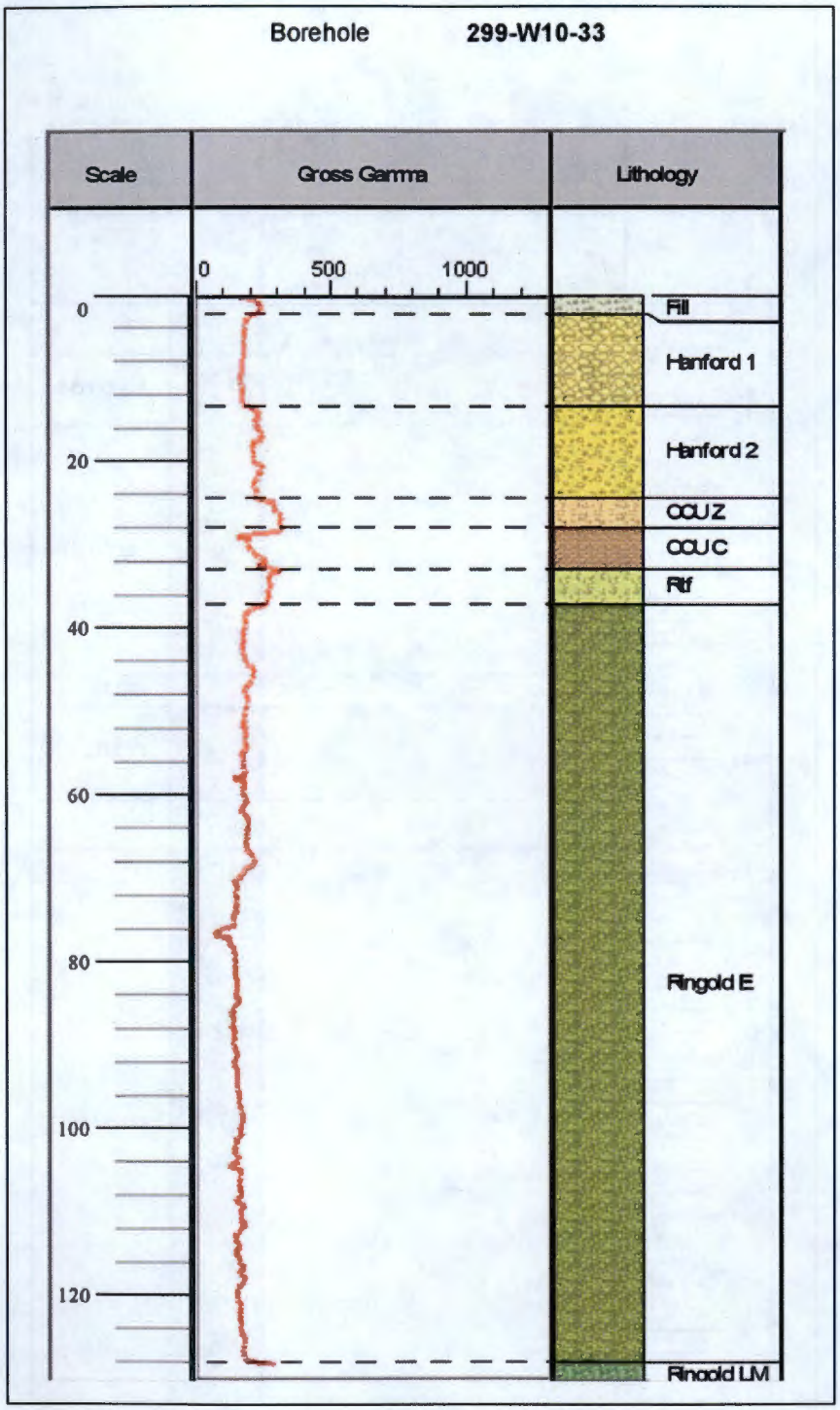
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299-W10-33
Scale
Gross Gamma
Lithology
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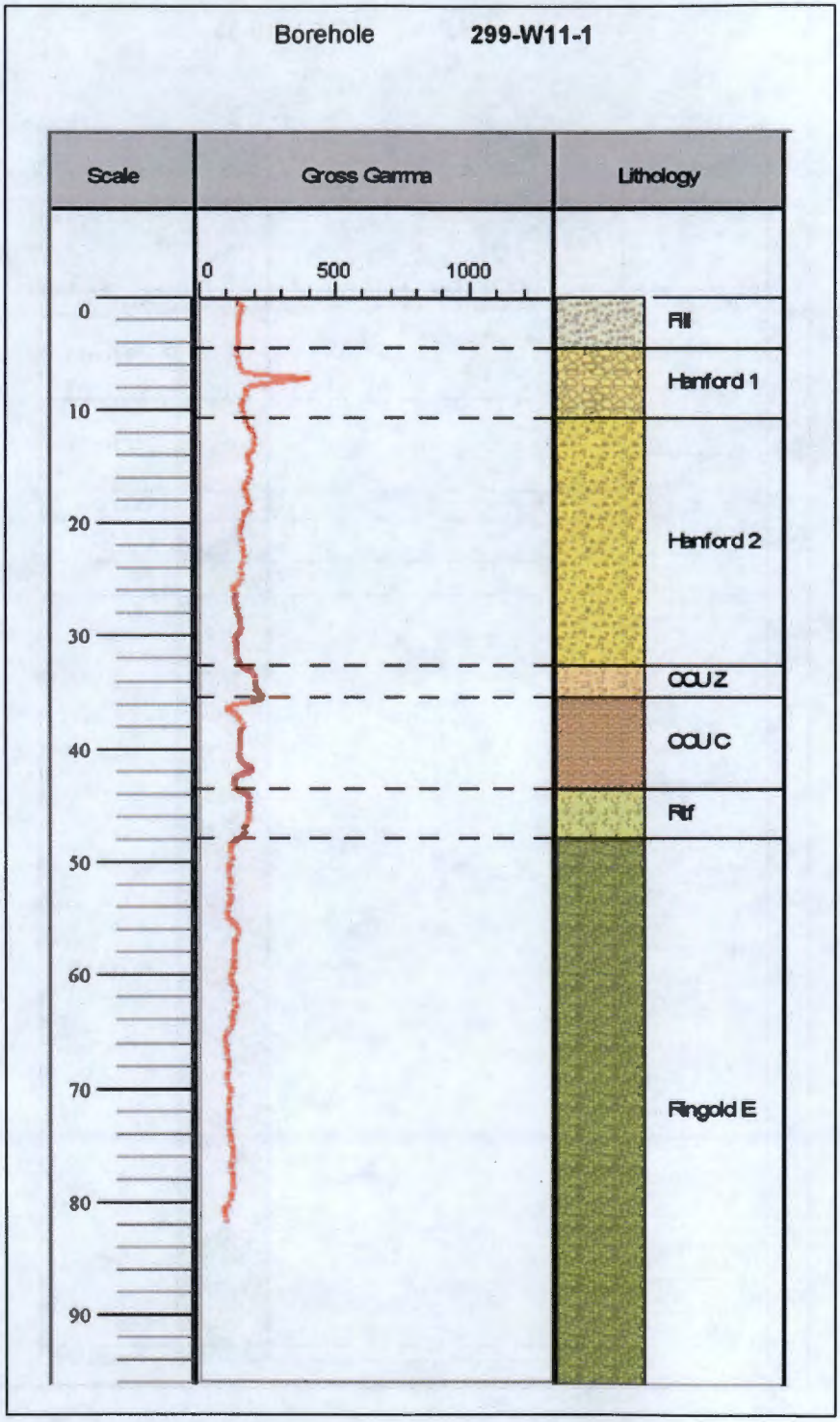
60
80
100
120
Fill
Hanford 1
Hanford 2
CCUZ
CCUC
Rtf
Ringold E
Ringold LM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Gross Gamma
Lithology
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Fill
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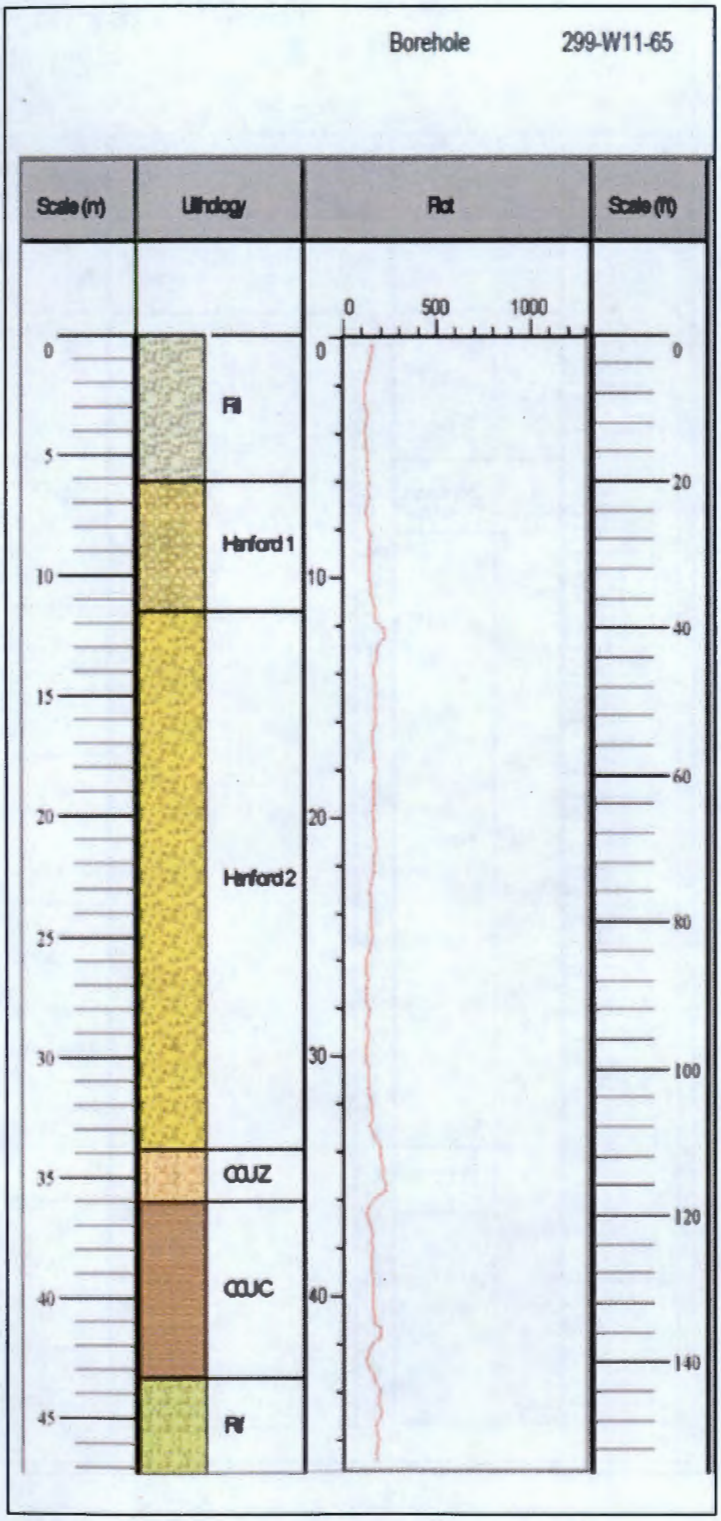
Hanford 2
CCU Z
CCU C
Rtf
Ringold E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299-W11-65
Scale (m)
Lithology
Plot
Scale (ft)
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500
1000
Fill
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Hanford 2
CCUZ
CCUC
Fill
0
5
10
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40
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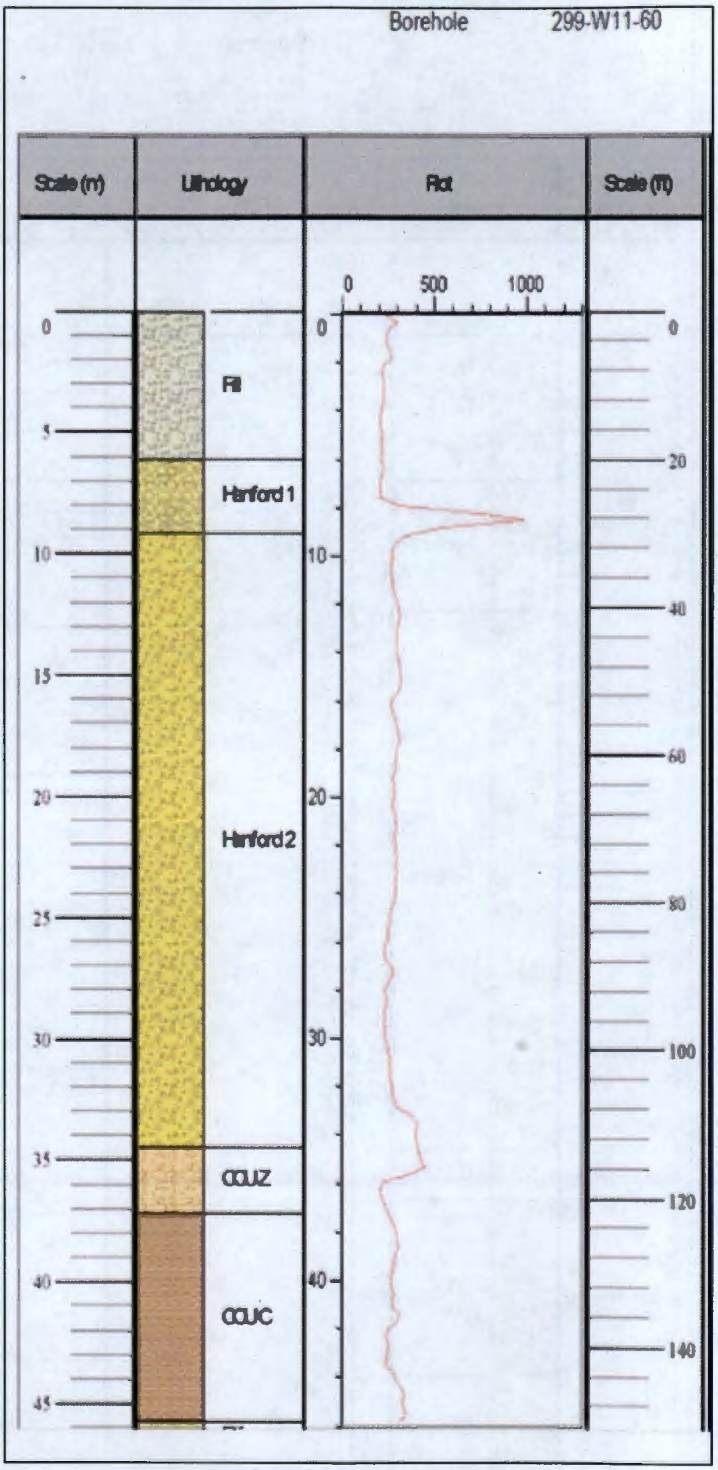
20
40
60
80
100
120
140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Scale (m)
Lithology
Rat
Scale (ft)
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500
1000
Fill
Hanford 1
Hanford 2
CCUZ
CCUC
0
5
10
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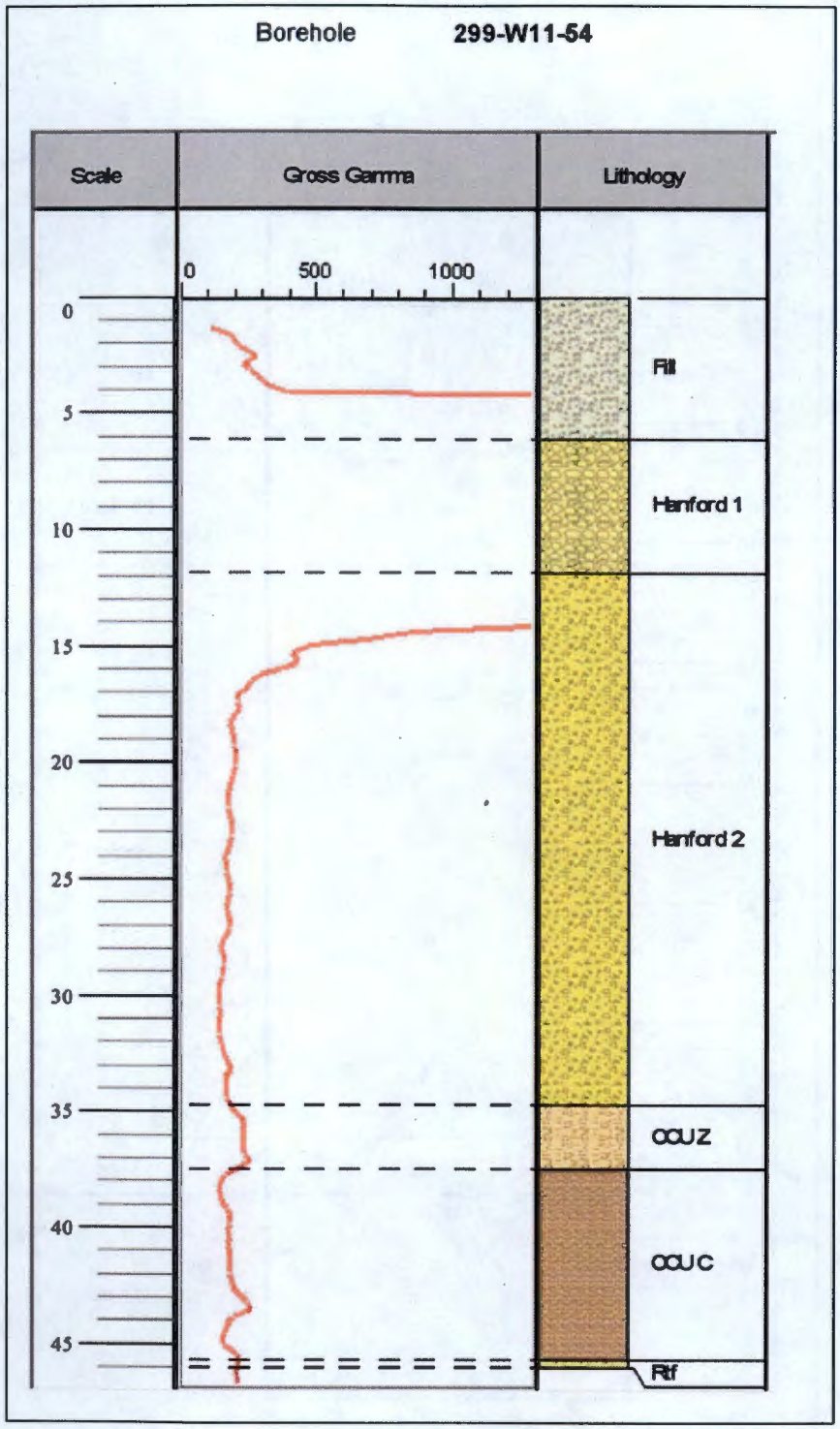
100
120
140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Scale
Gross Gamma
Lithology
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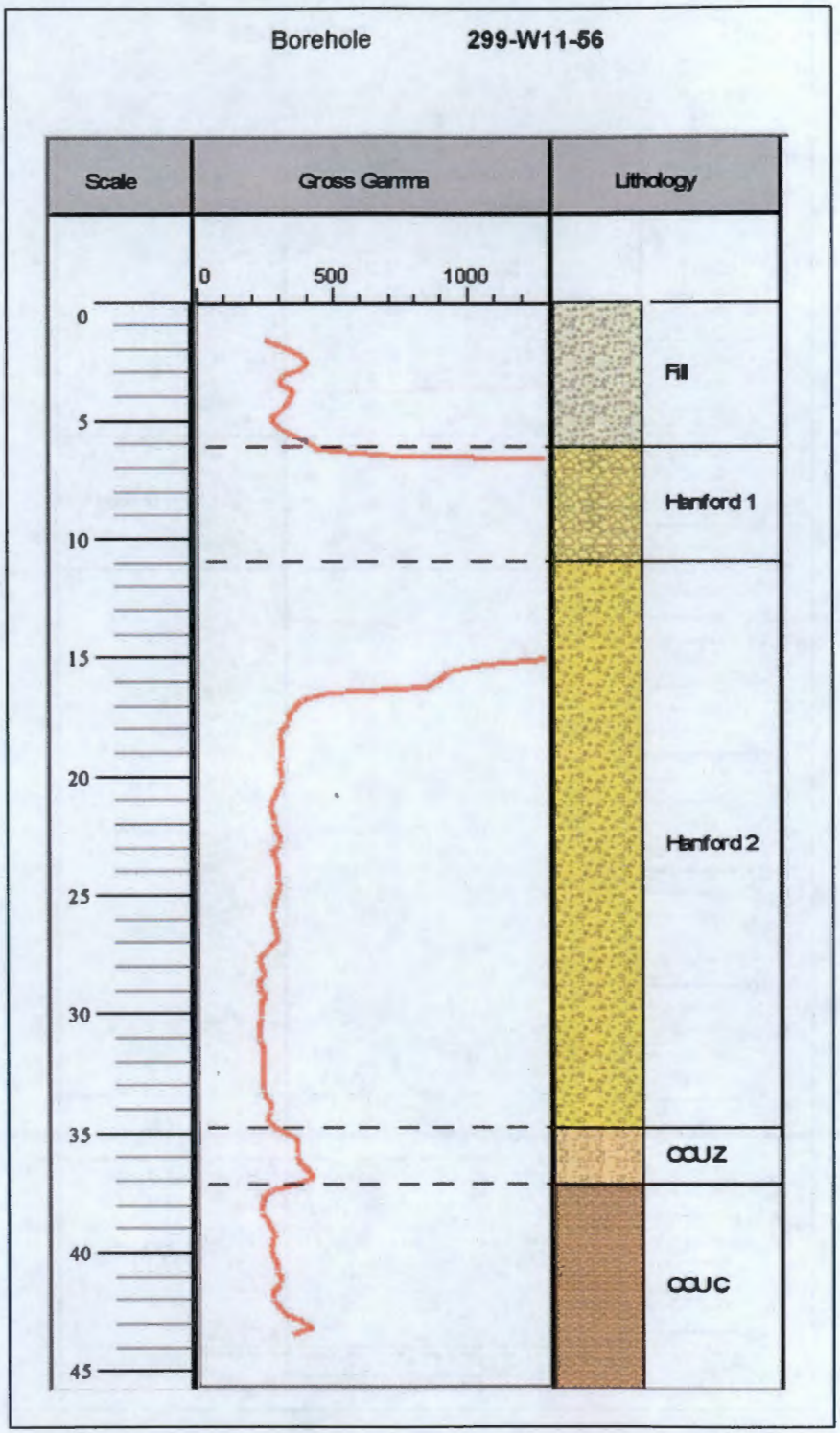
Fill
Hanford 1
Hanford 2
CCUZ
CCUC
Rtf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Gross Gamma
Lithology
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45
Fill
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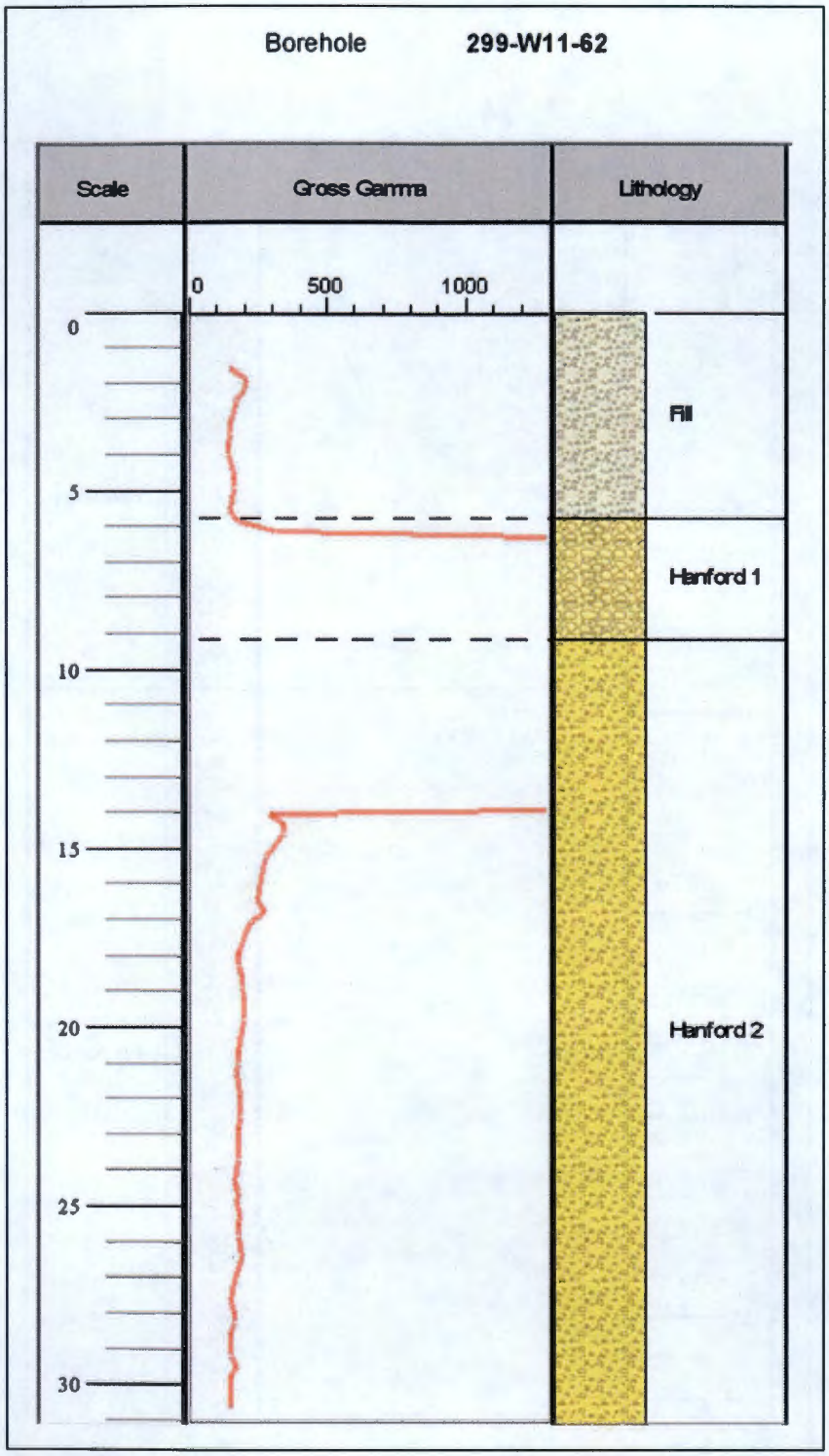
Hanford 2
CCUZ
CCUC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Scale
Gross Gamma
Lithology
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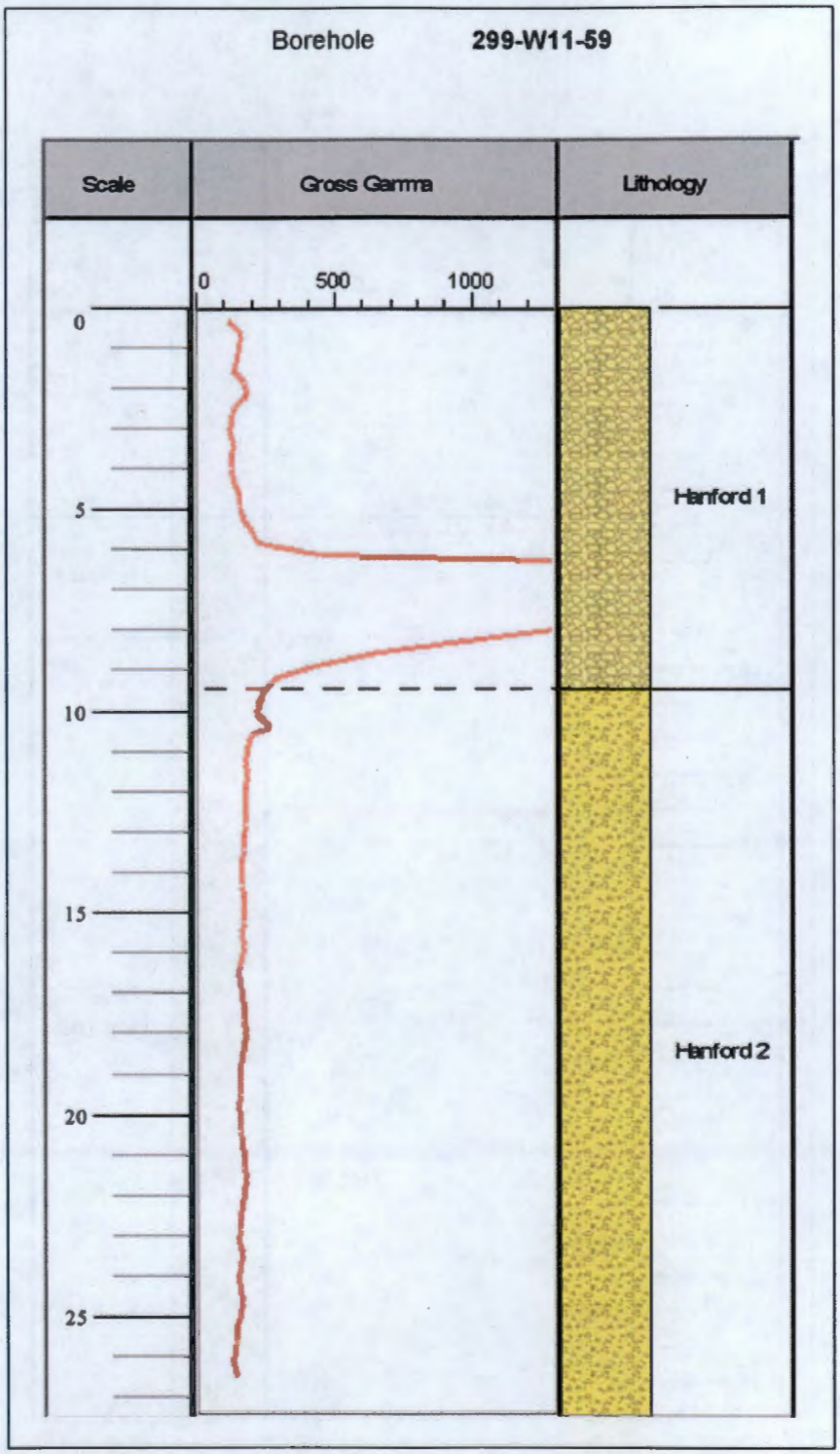
500
1000
0
5
10
15
20
25
30
Fill
Hanford 1
Hanford 2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Gross Gamma
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1000
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5
10
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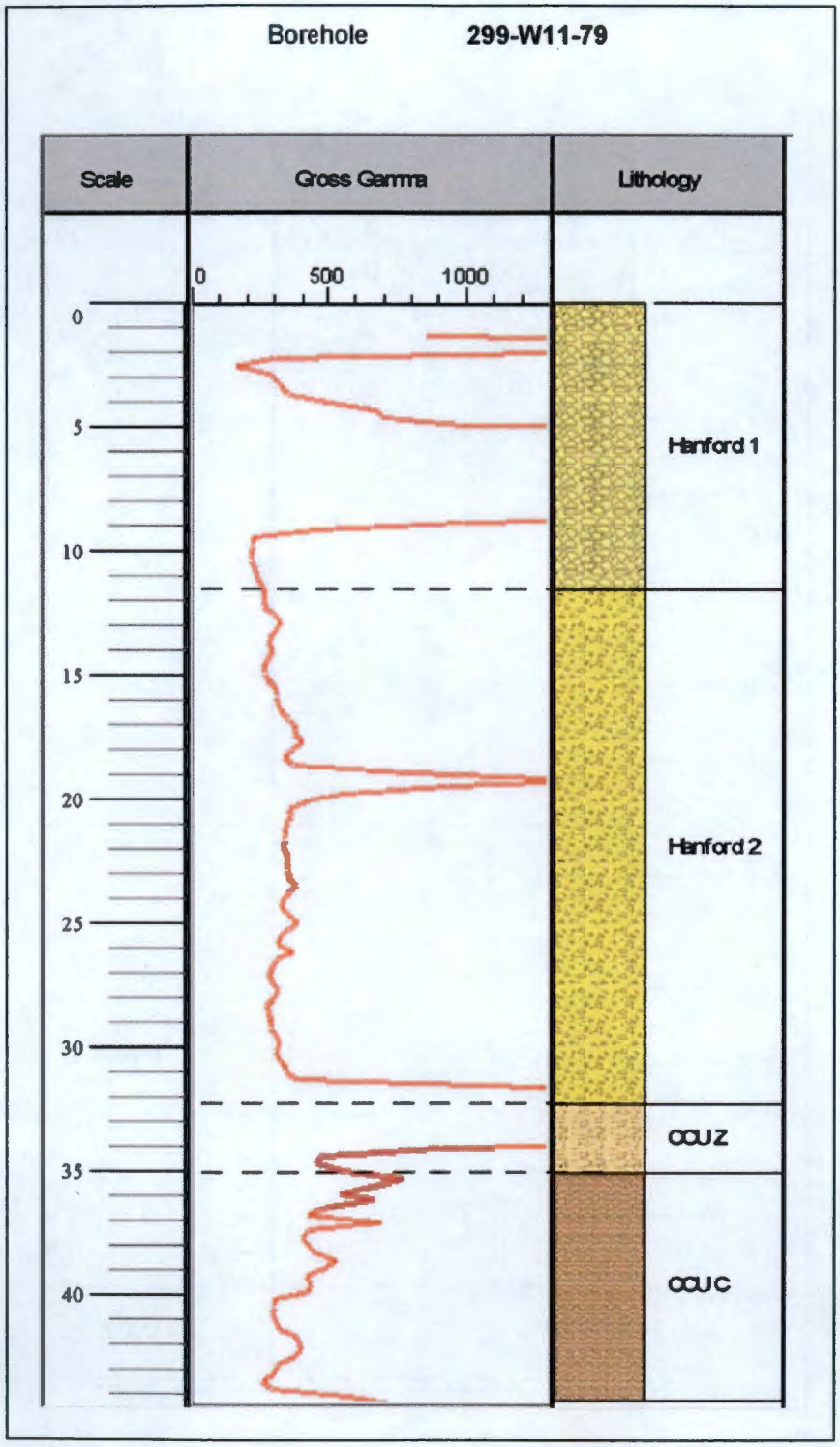
20
25
Hanford 1
Hanford 2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Scale
Gross Gamma
Lithology
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1000
0
5
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30
35
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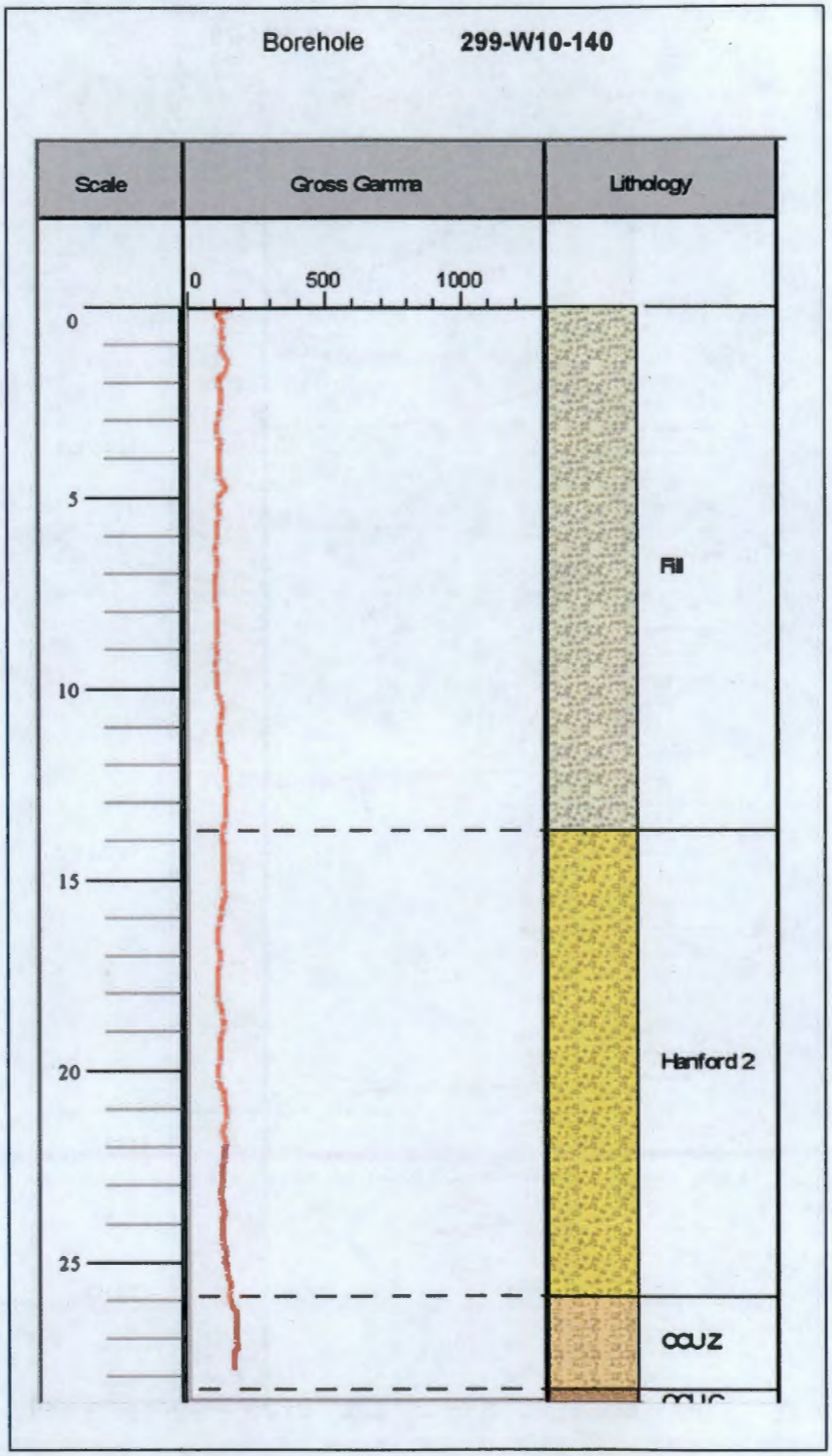
CCUC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Gross Gamma
Lithology
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1000
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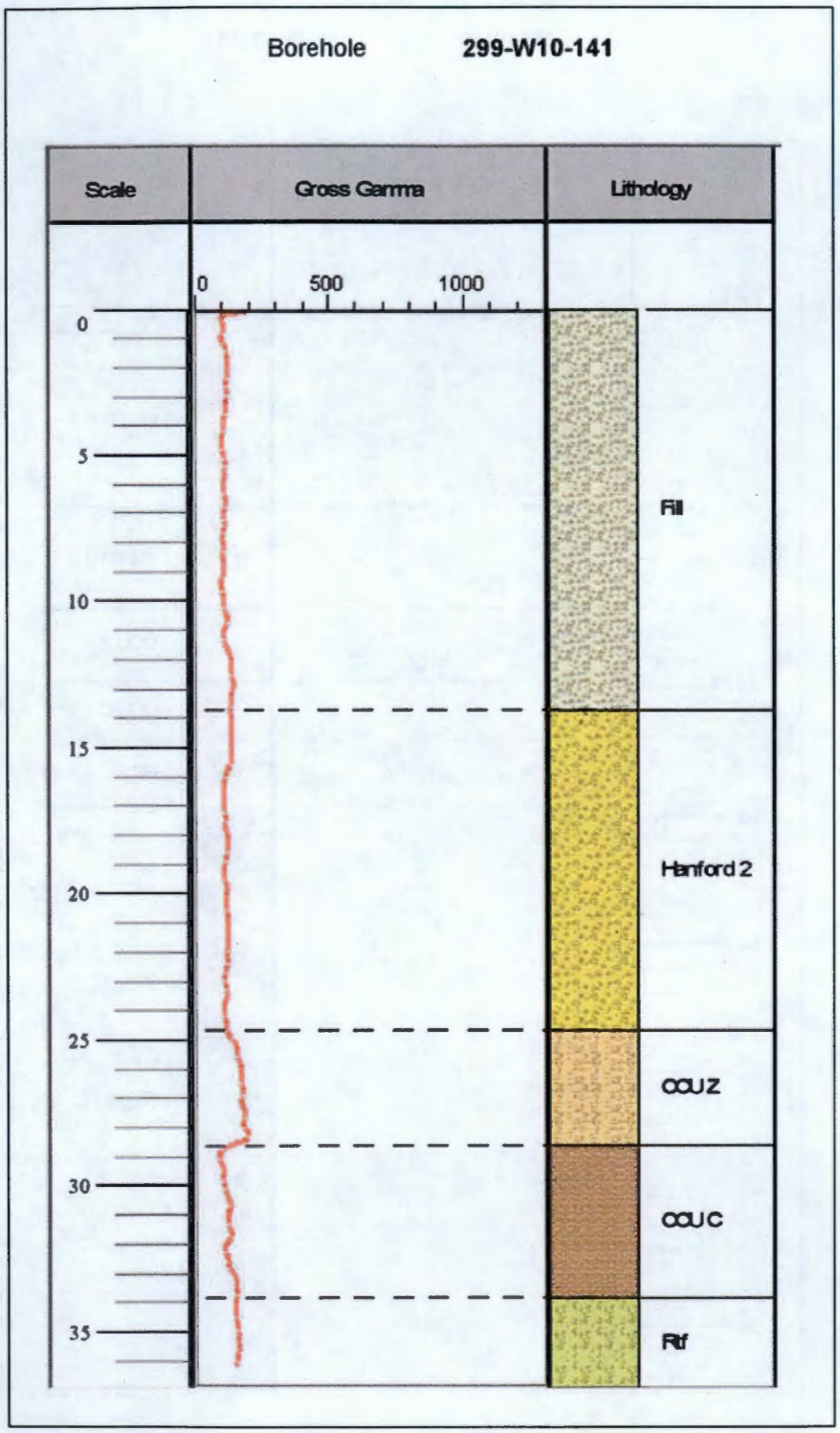
15
20
25
Fill
Hanford 2
CCUZ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Gross Gamma
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1000
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25
30
35
Fill
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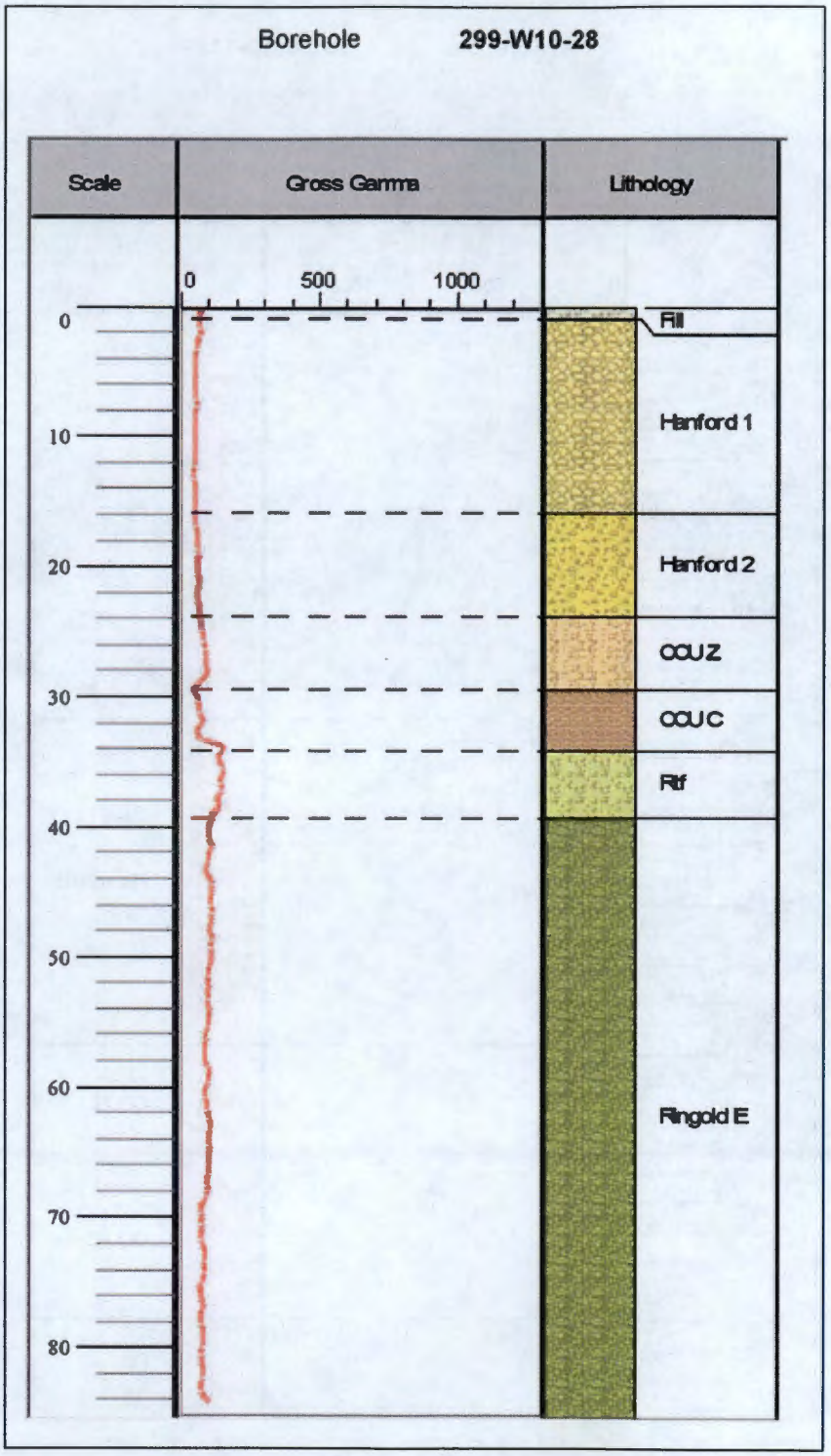
CCUZ
CCUC
Rtf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Gross Gamma
Lithology
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1000
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30
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60
70
80
Fill
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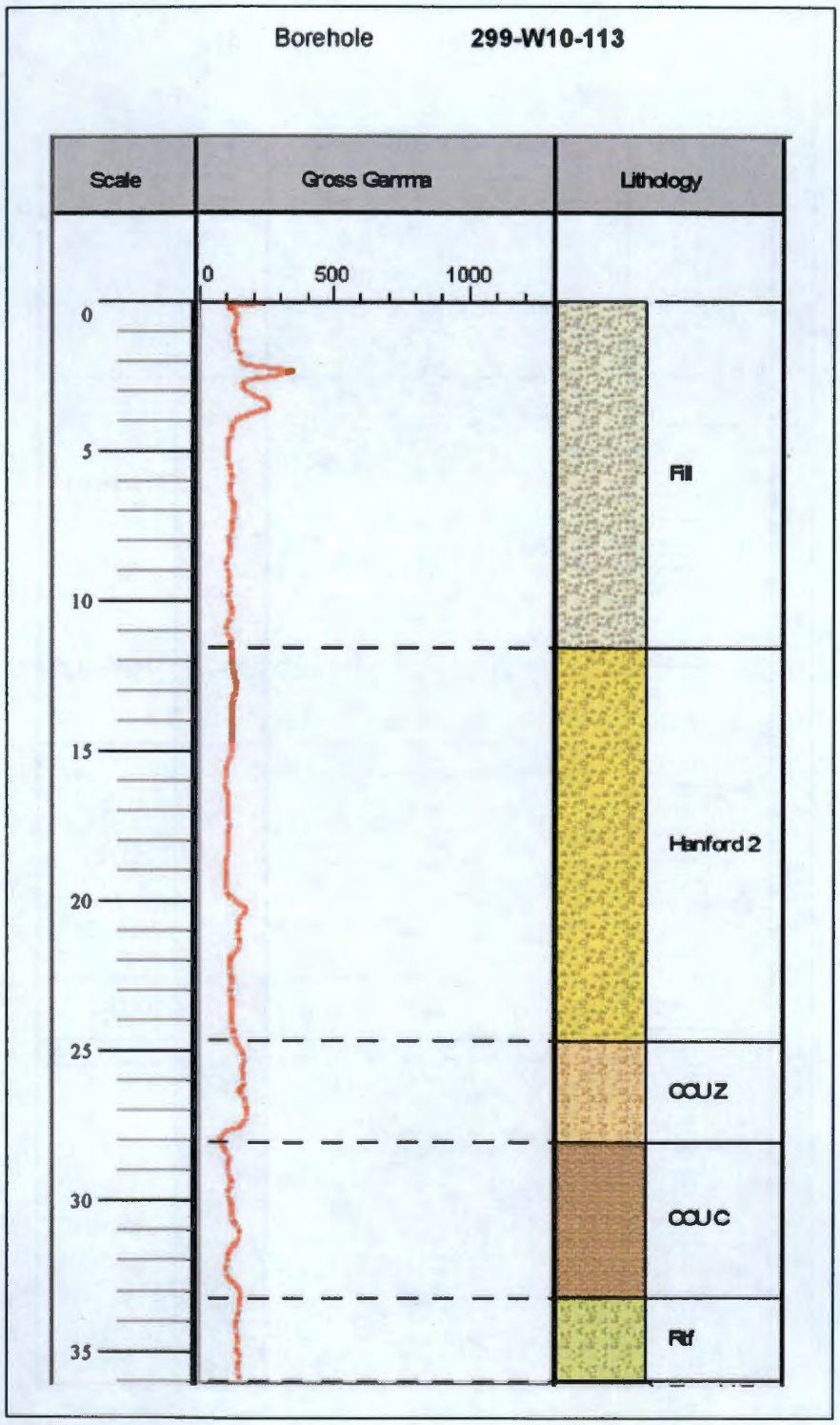
Hanford 2
CCUZ
CCUC
Rtf
Ringold E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Gross Gamma
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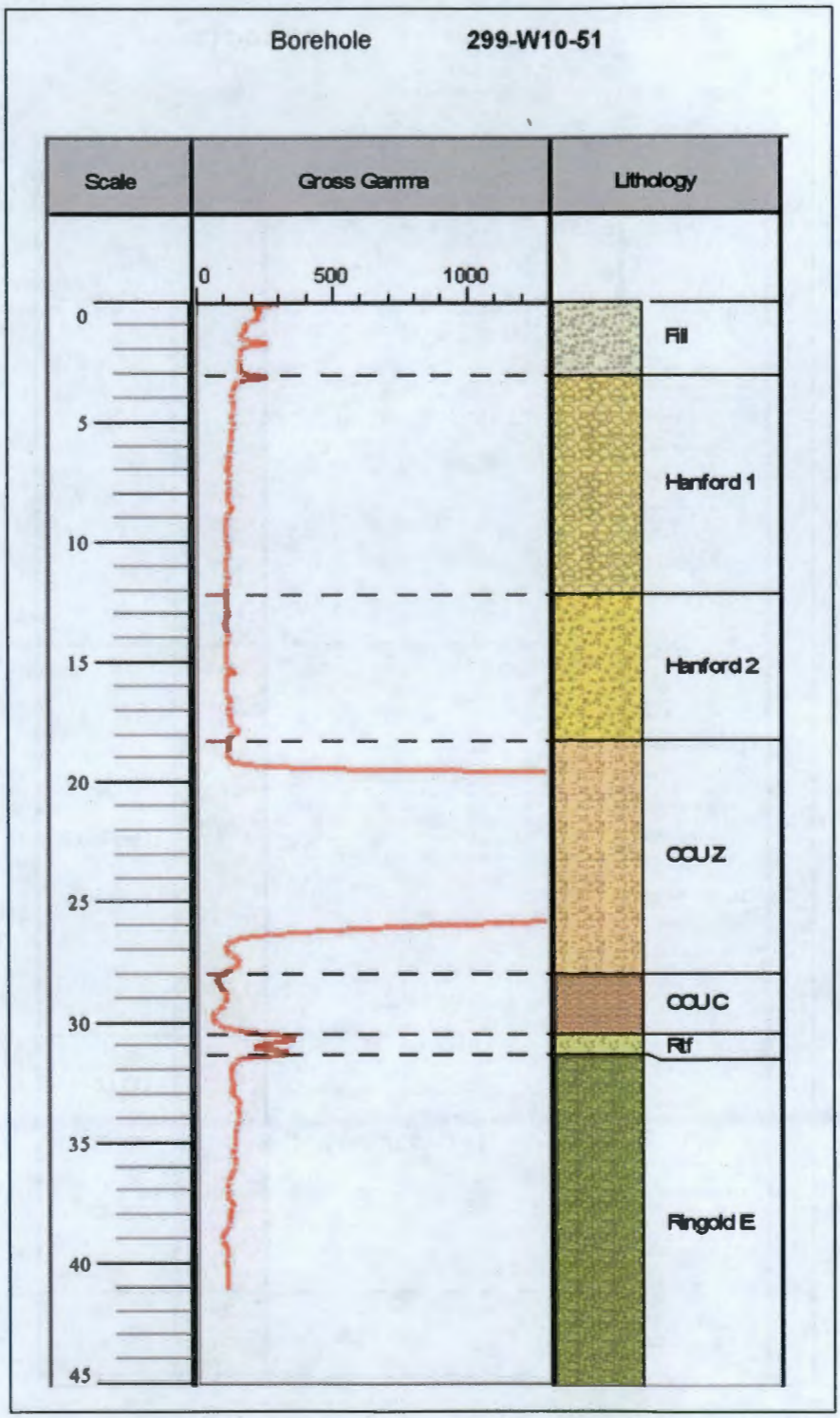
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Gross Gamma
Lithology
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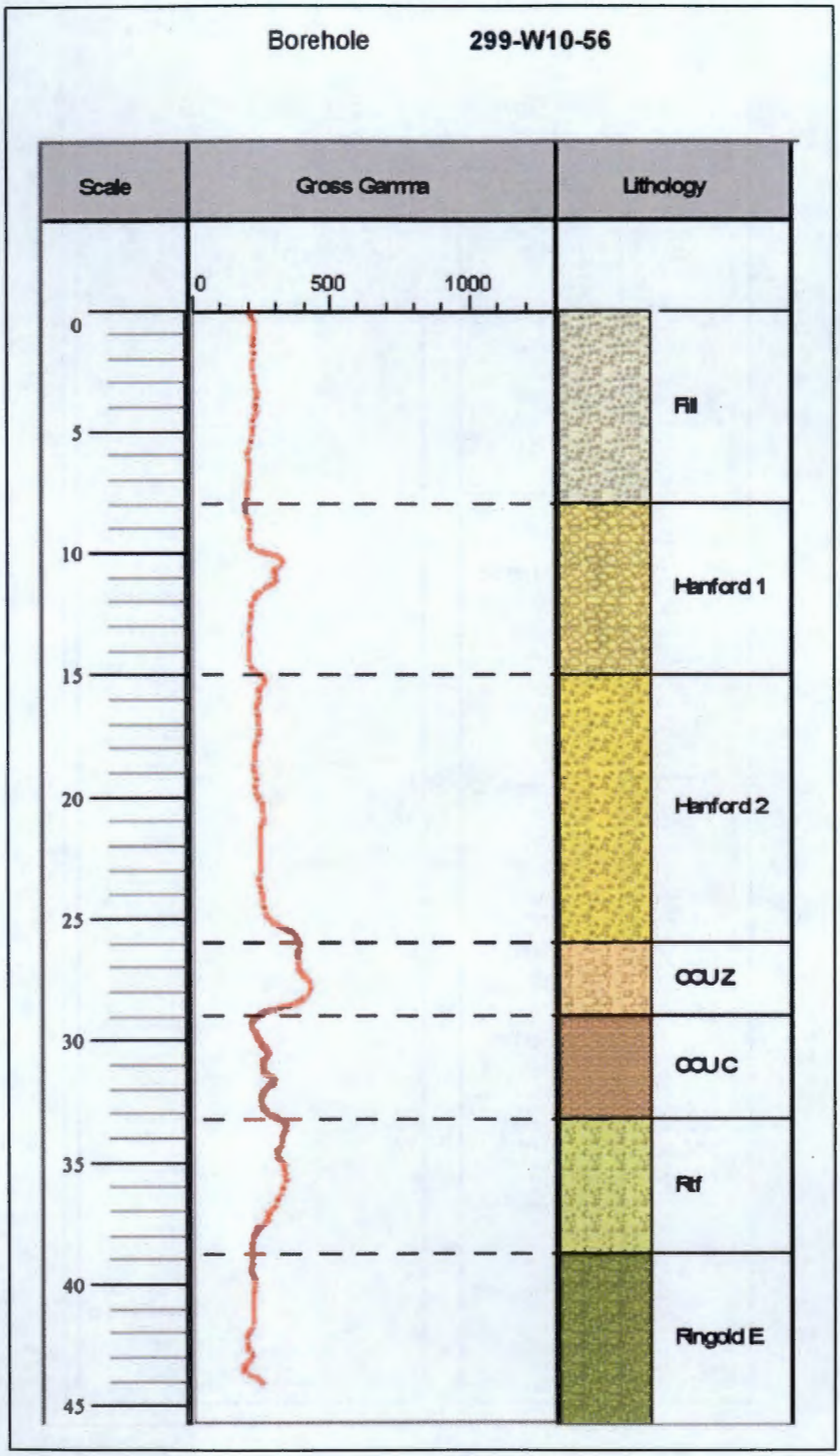
CCUC
Rtf
Ringold E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Hanford 2
CCUZ
CCUC
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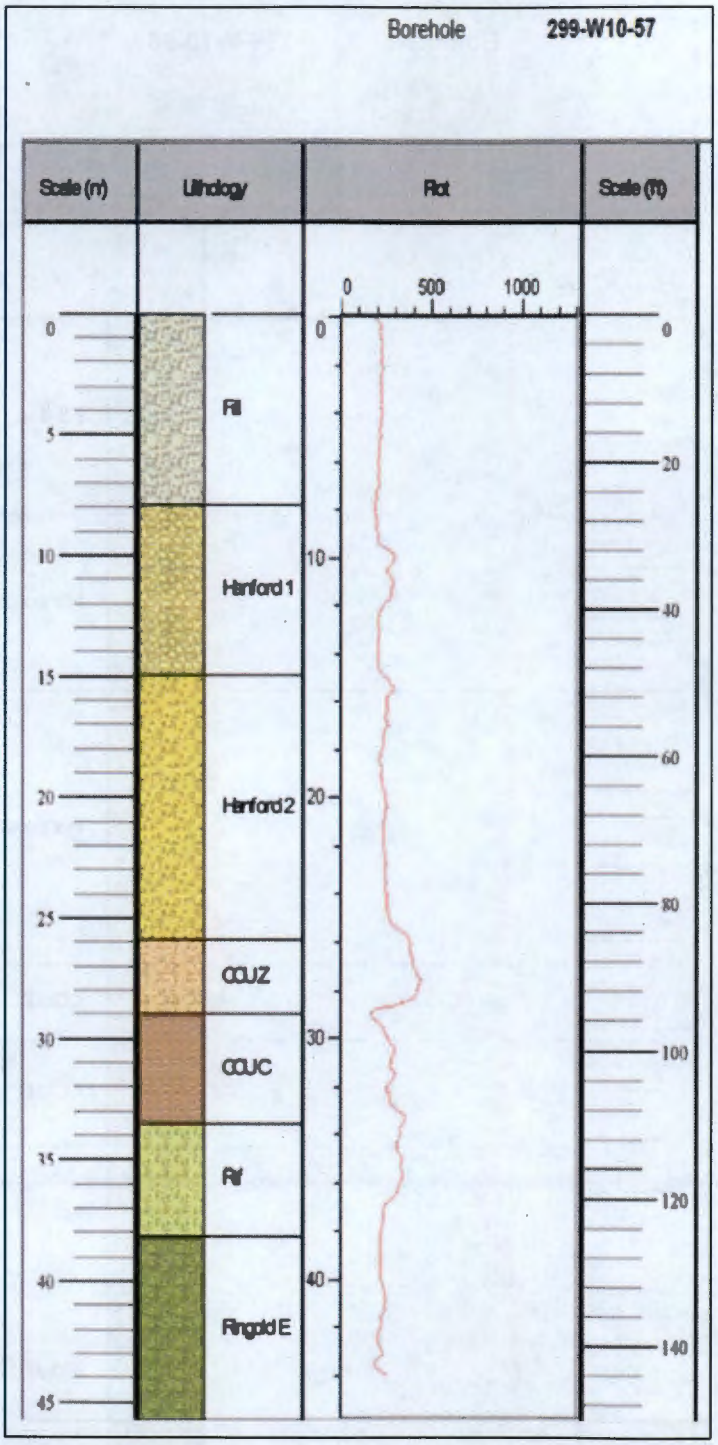
Ringold E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Lithology
Rot
Scale (ft)
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1000
Fill
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Hanford 2
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CCUC
Rif
Ringold E
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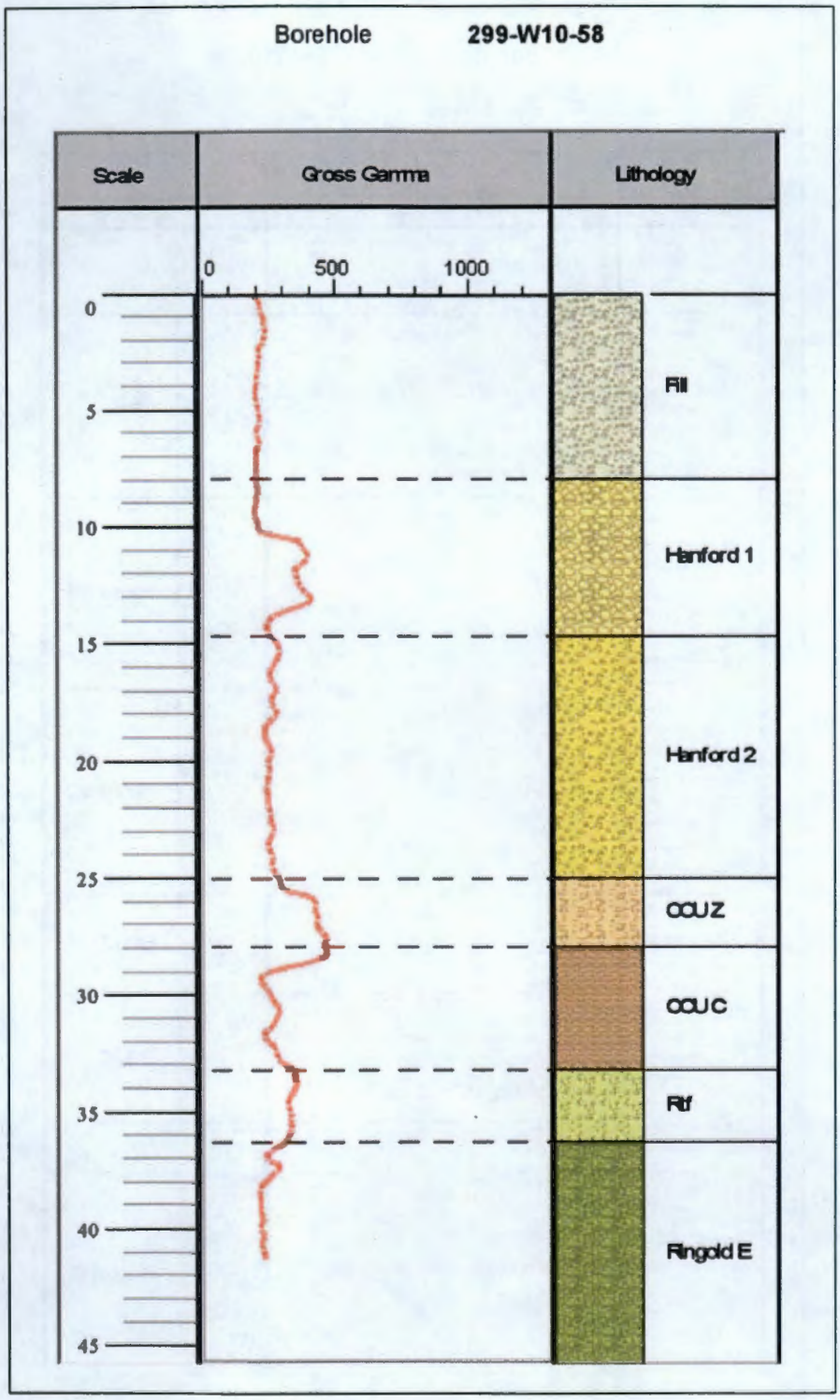
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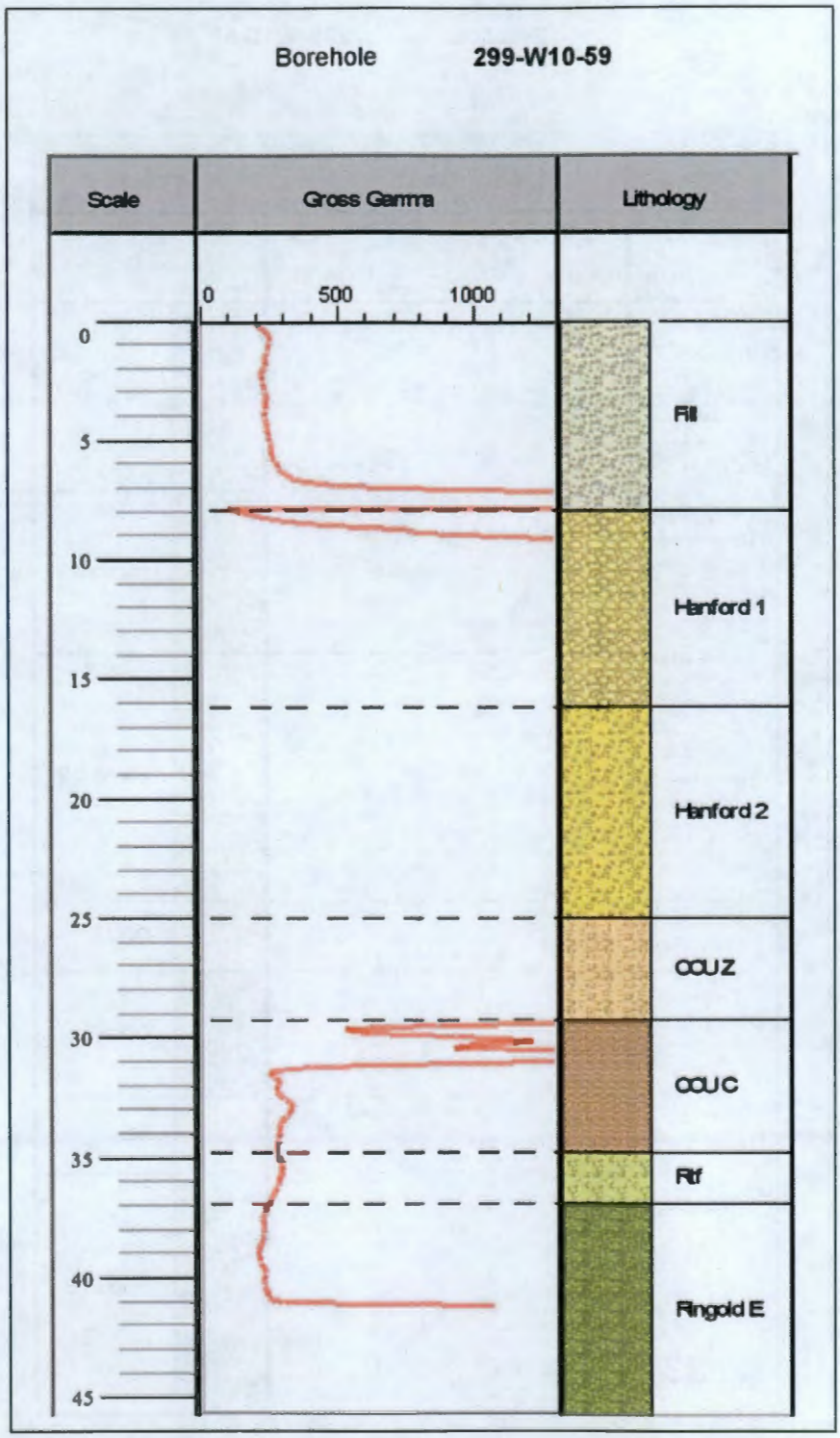
Hanford 2
CCUZ
CCUC
Rtf
Ringold E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Hanford 2
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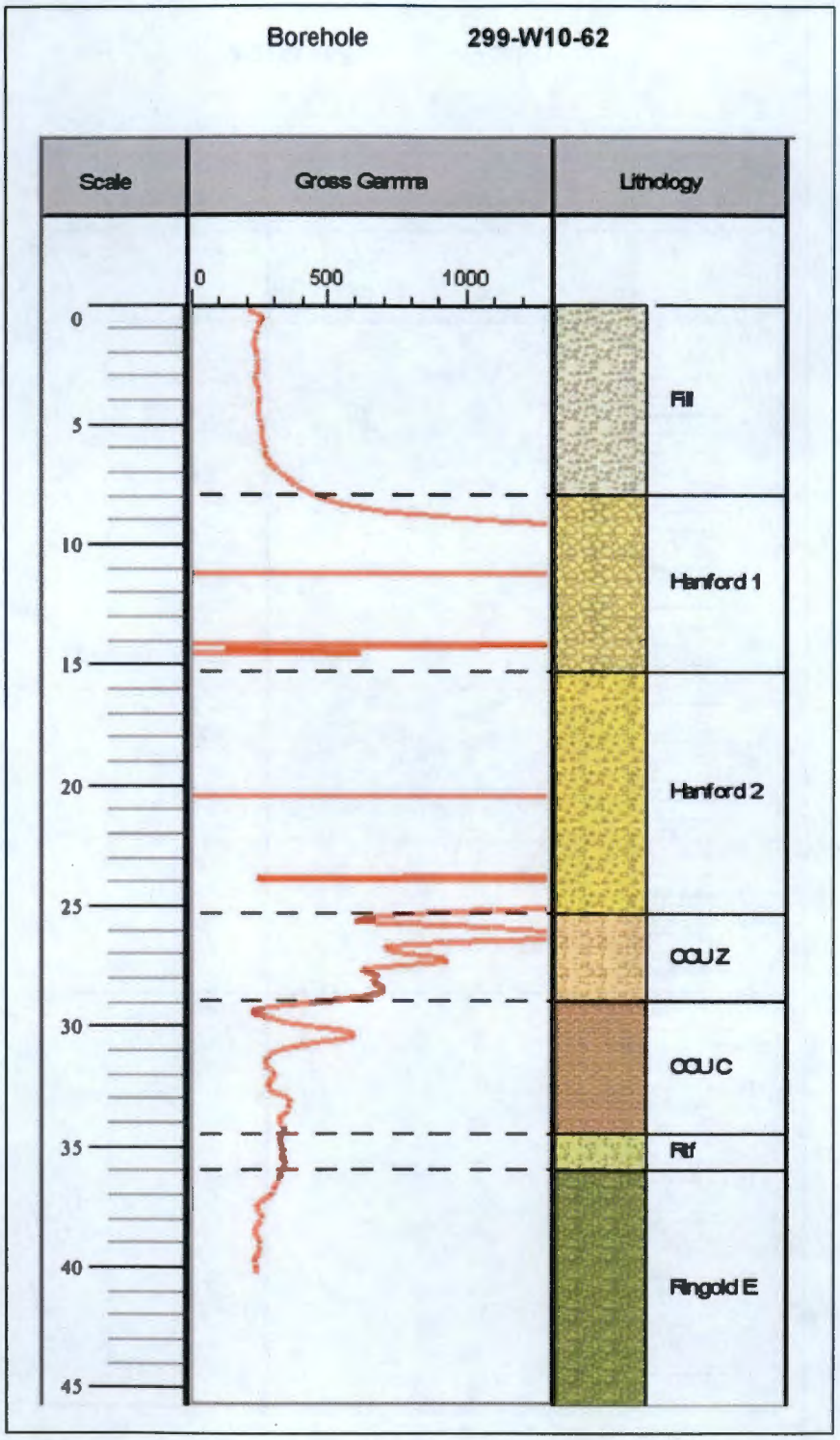
Ringold E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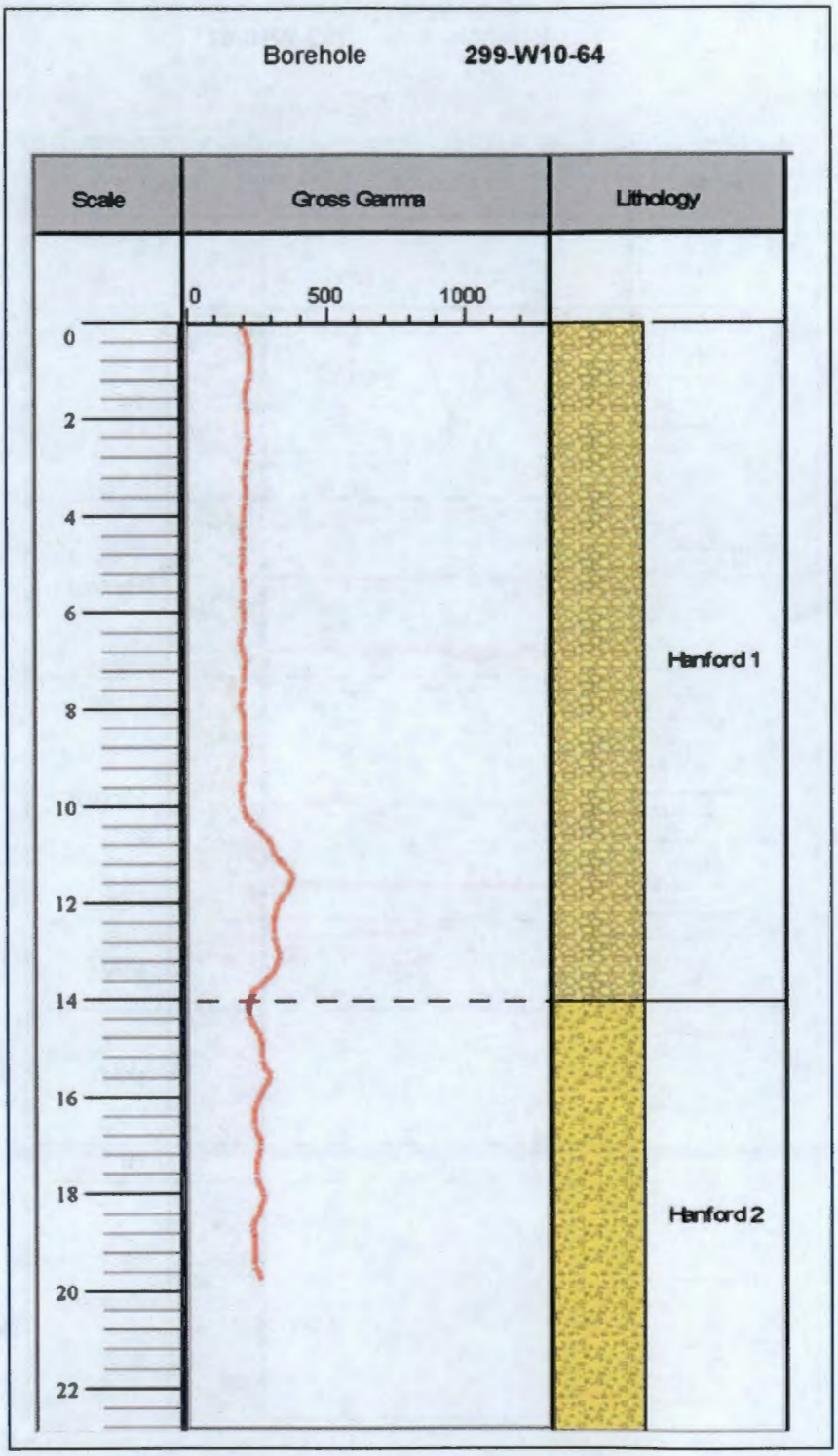
Hanford 2
CCUZ
CCUC
Rif
Ringold E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22
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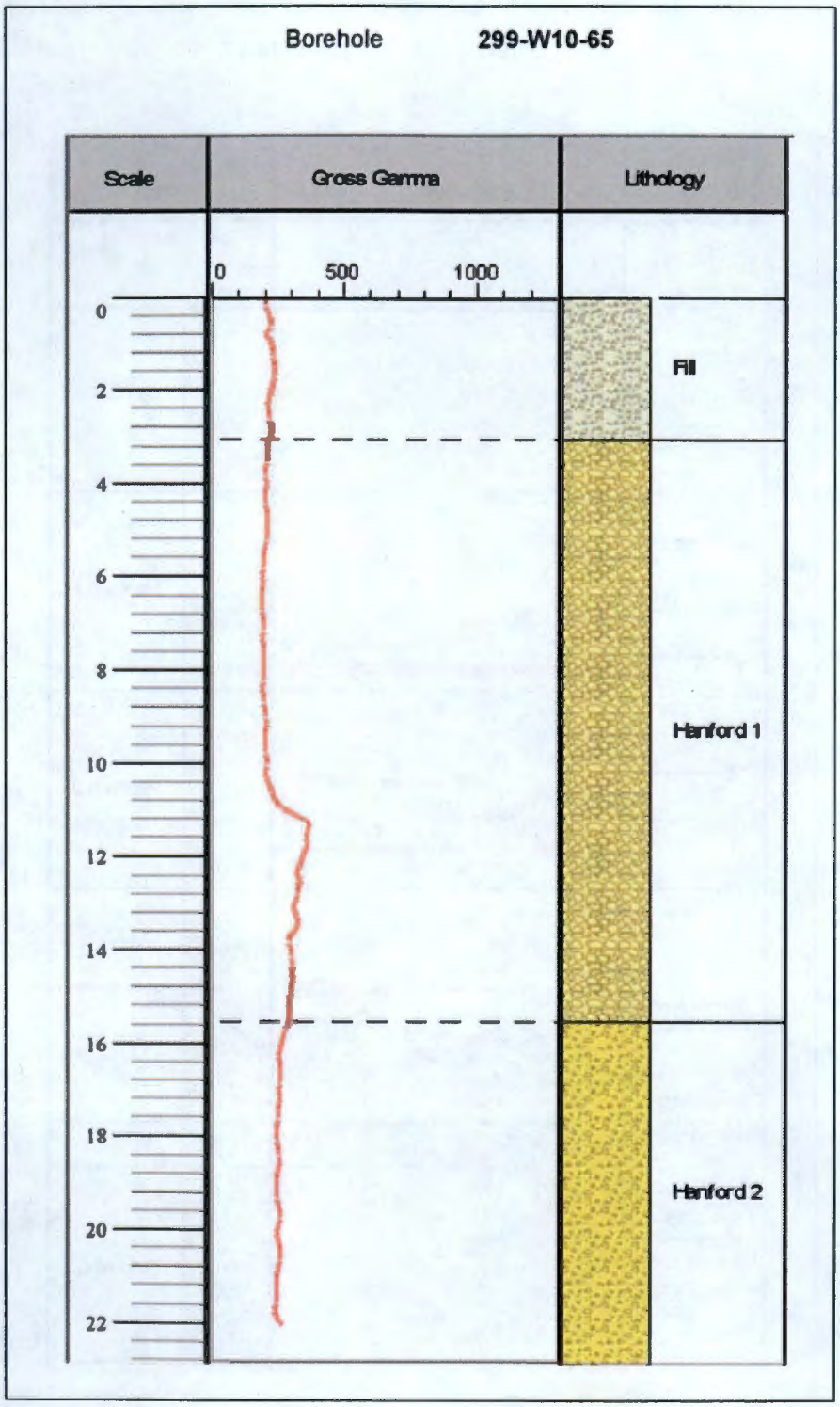
Hanford 2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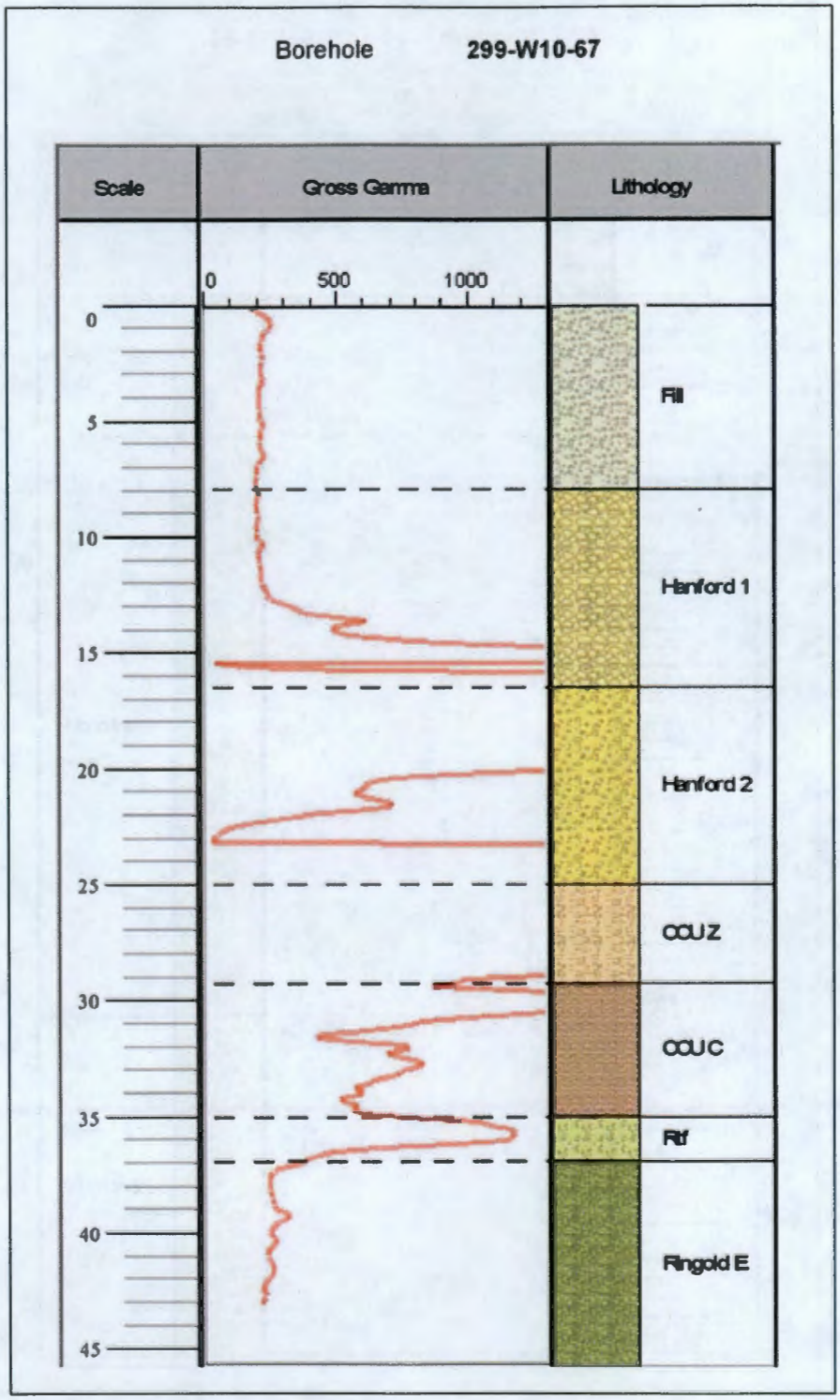
Hanford 2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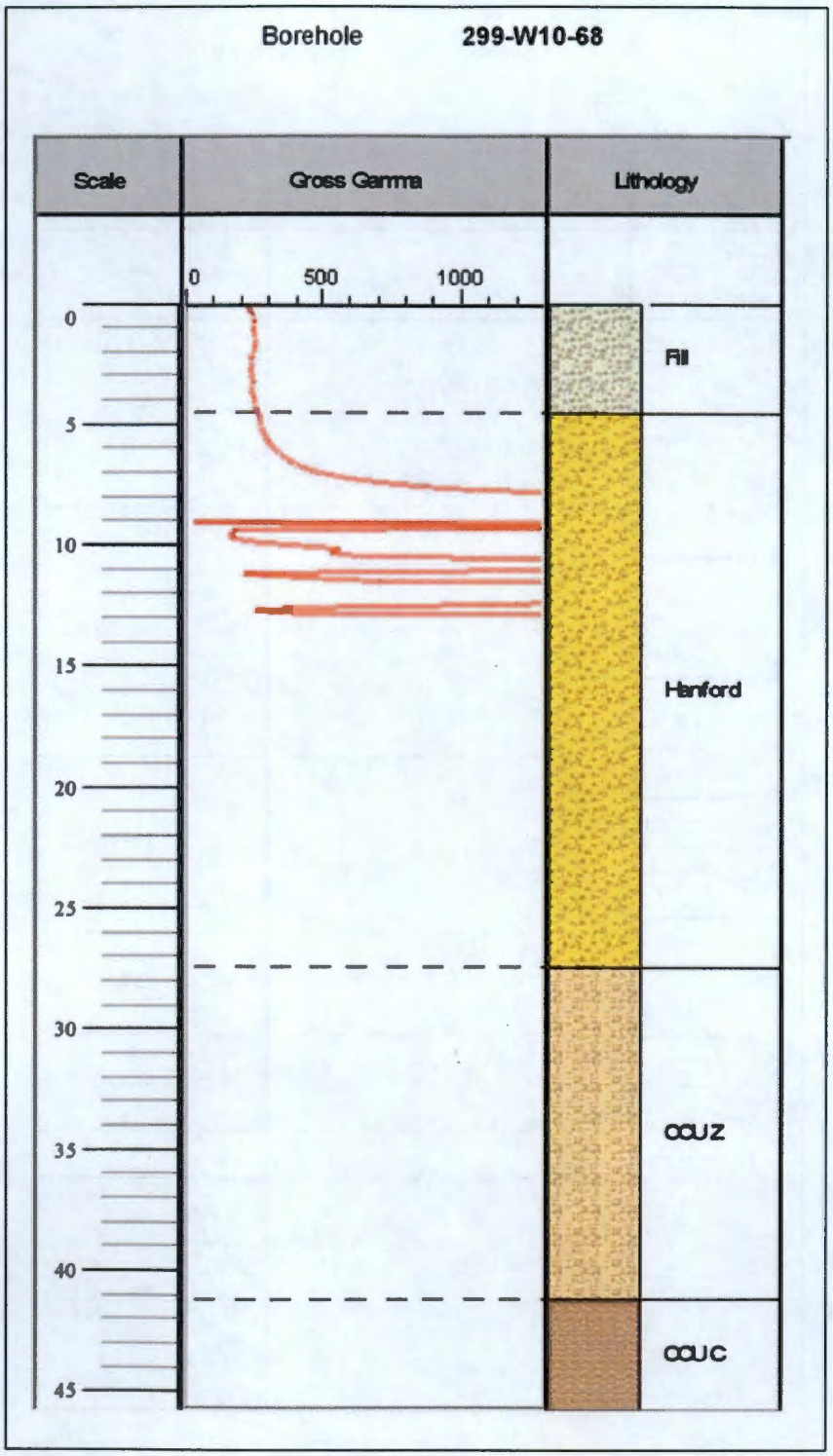
Hanford 2
CCUZ
CCUC
Rtf
Ringold E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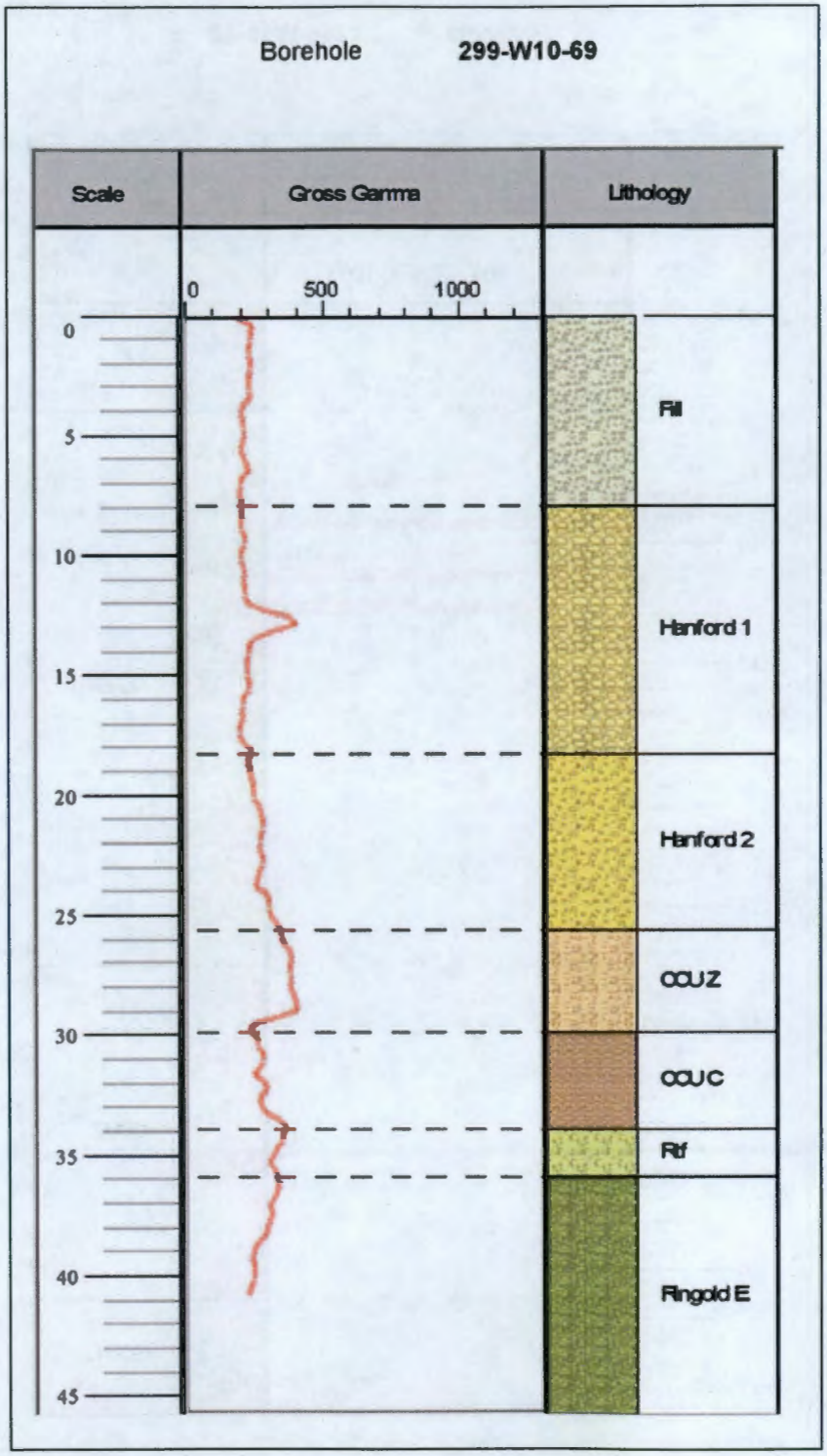
Hanford
CCUZ
CCUC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Hanford 2
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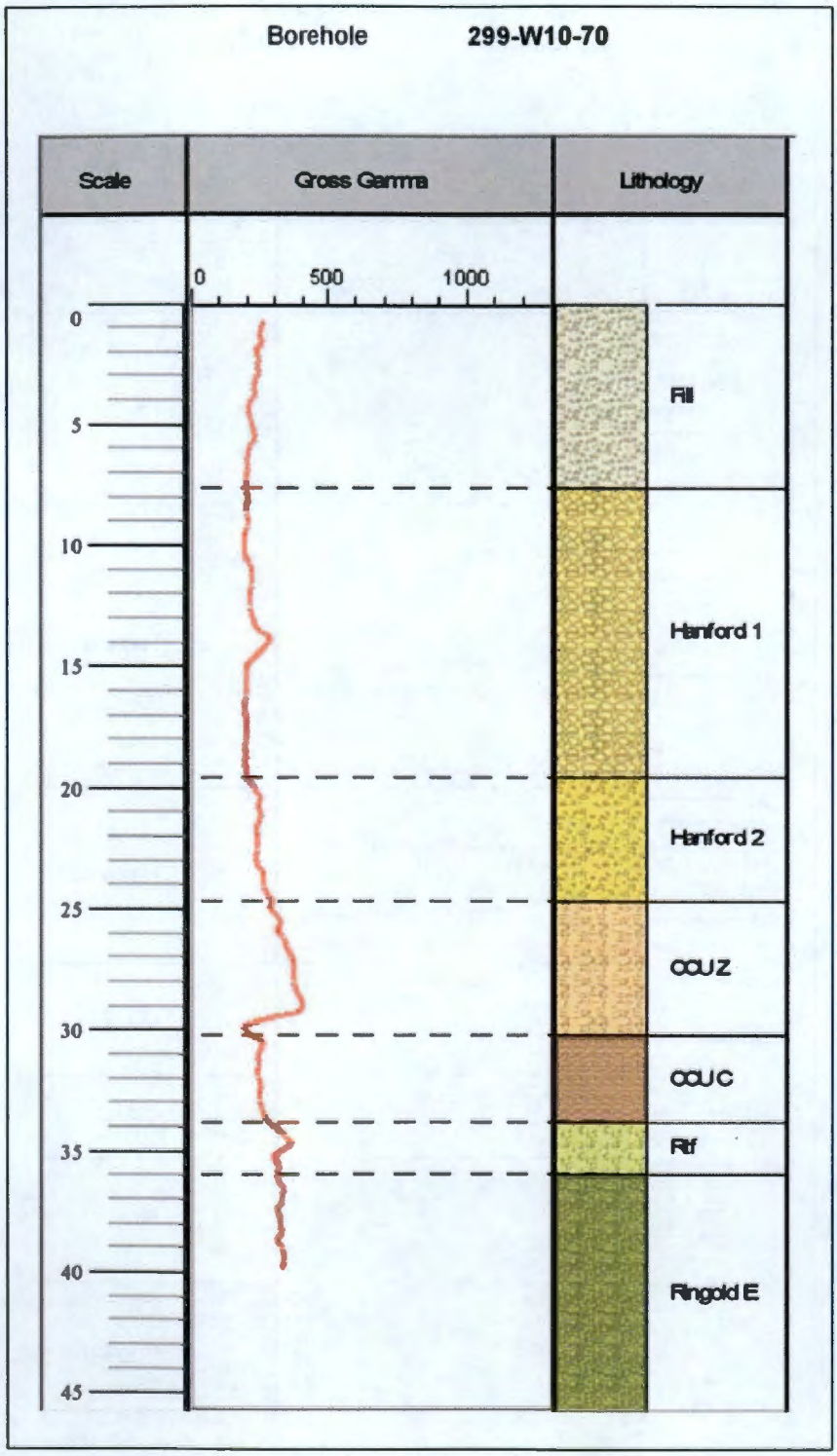
CCUC
Rtf
Ringold E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Hanford 2
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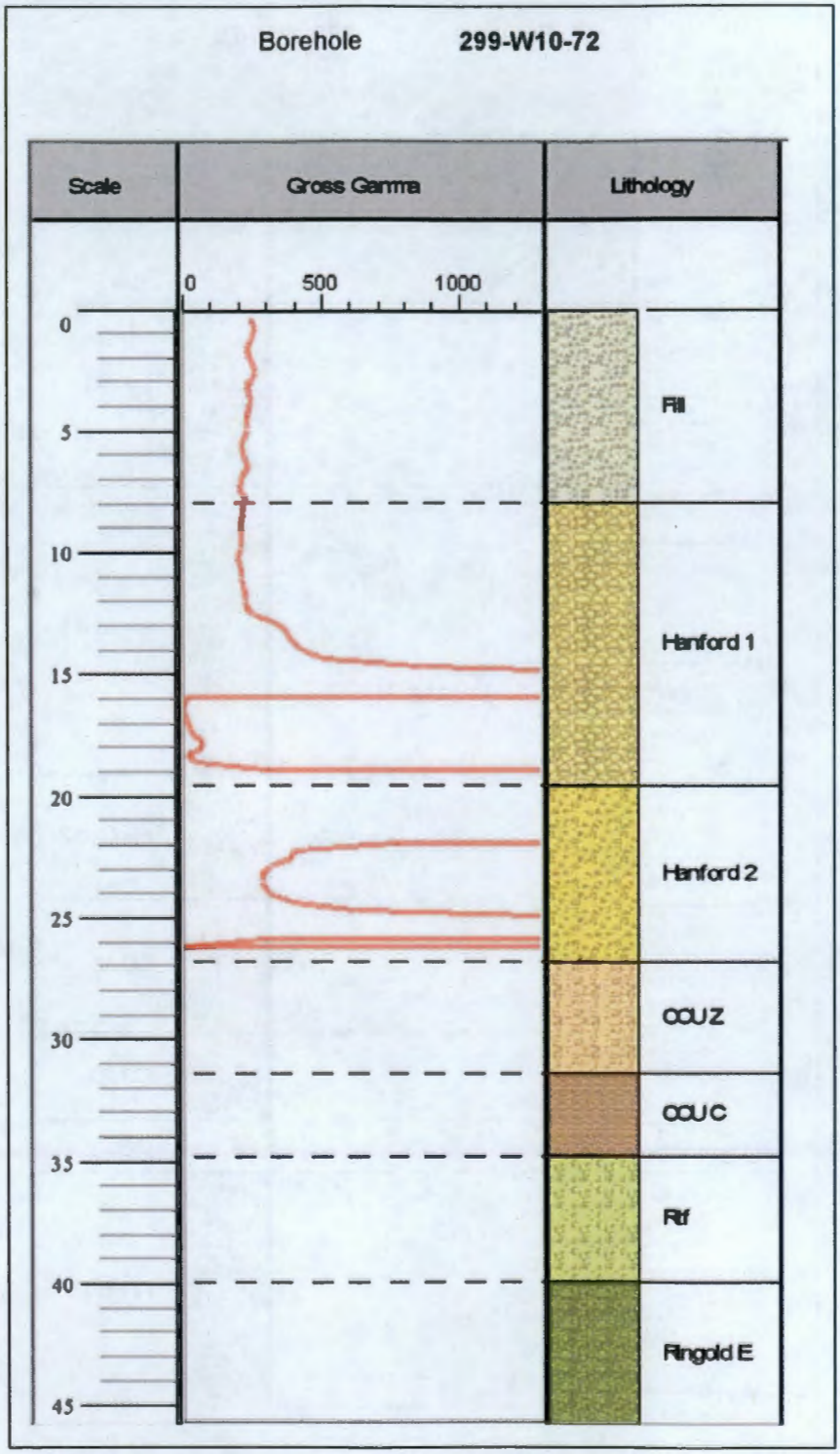
Rtf
Ringold E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Hanford 2
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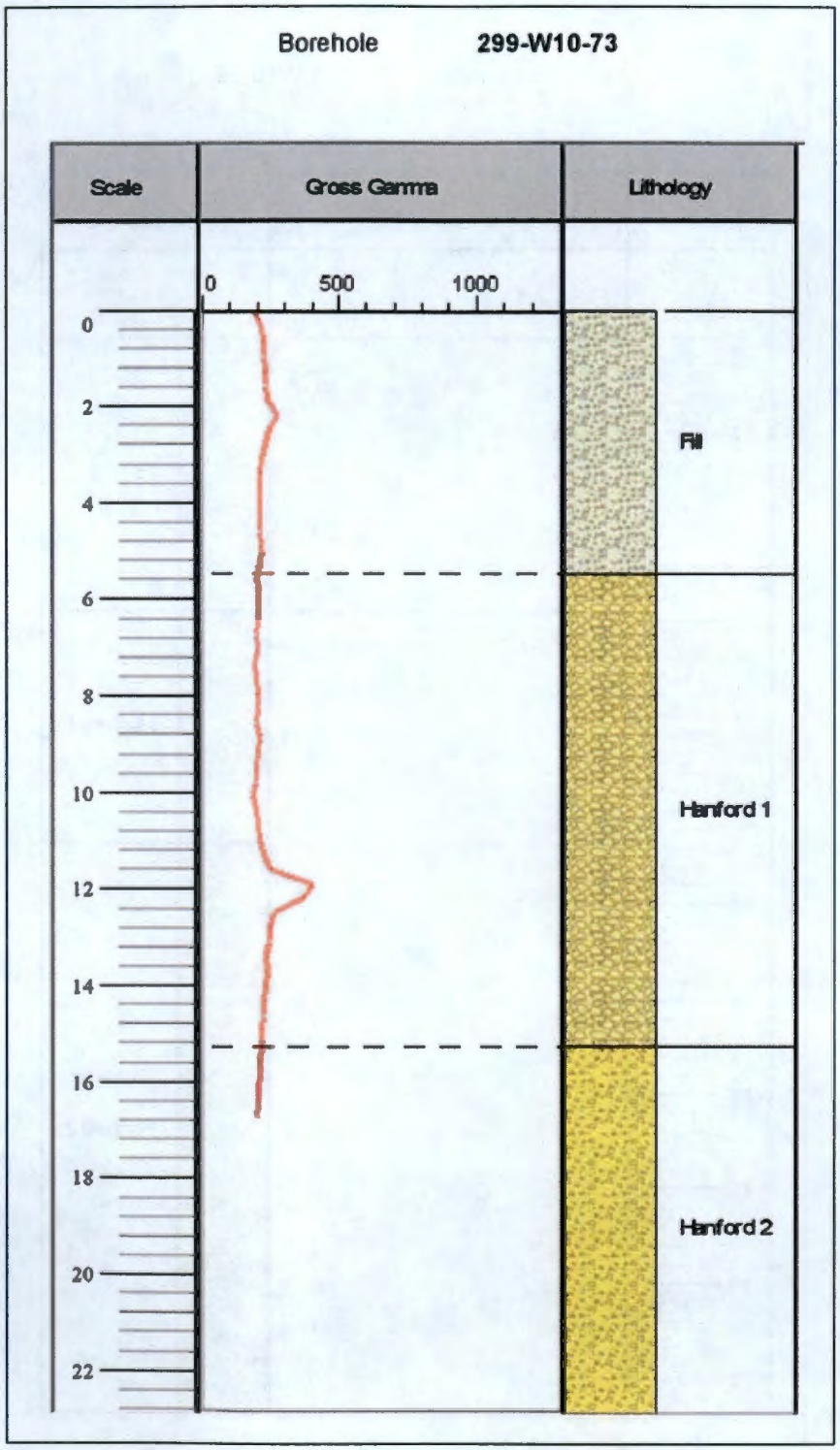
CCUC
Rif
Ringold E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22
Fill
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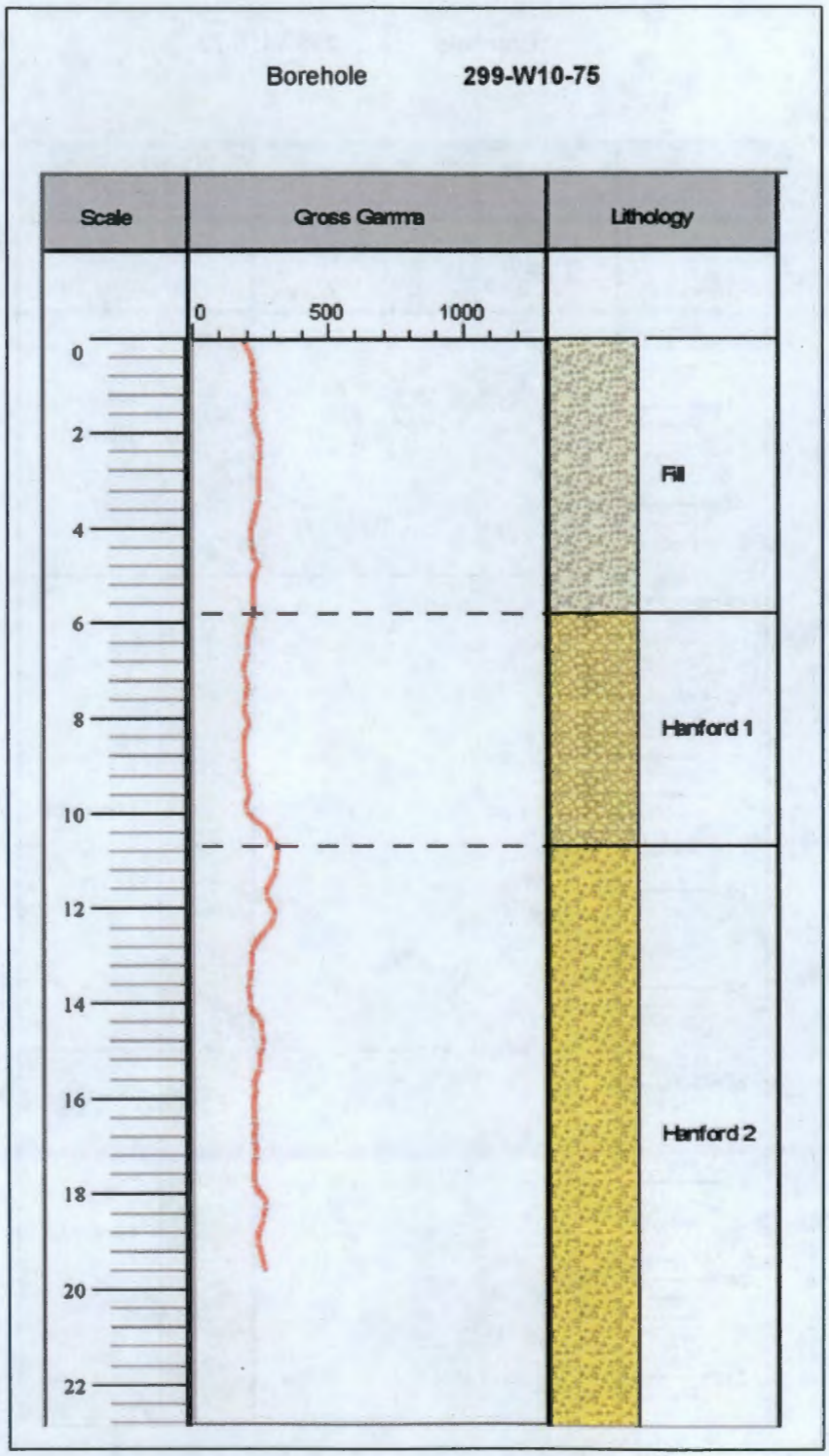
Hanford 2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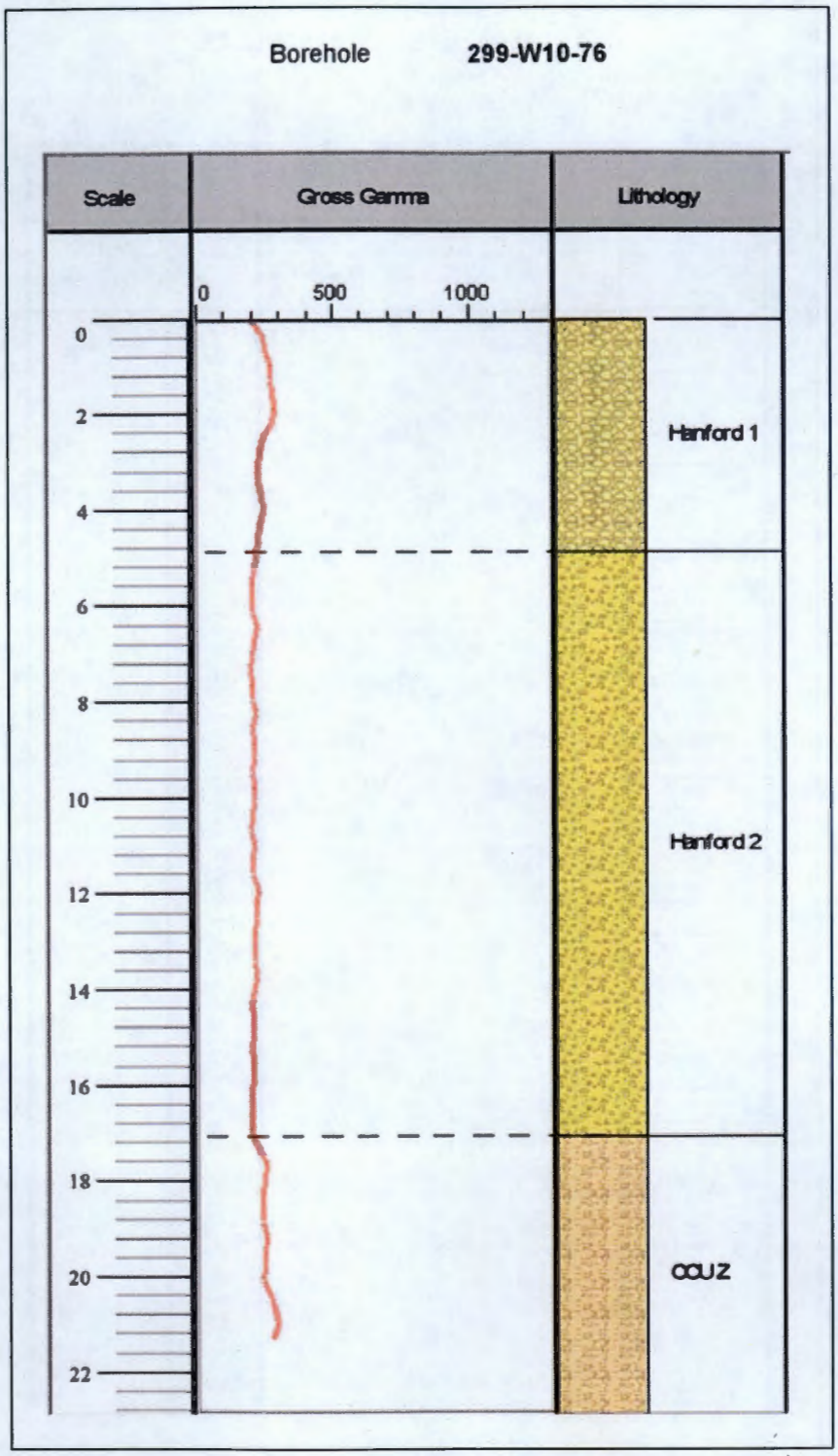
Hanford 2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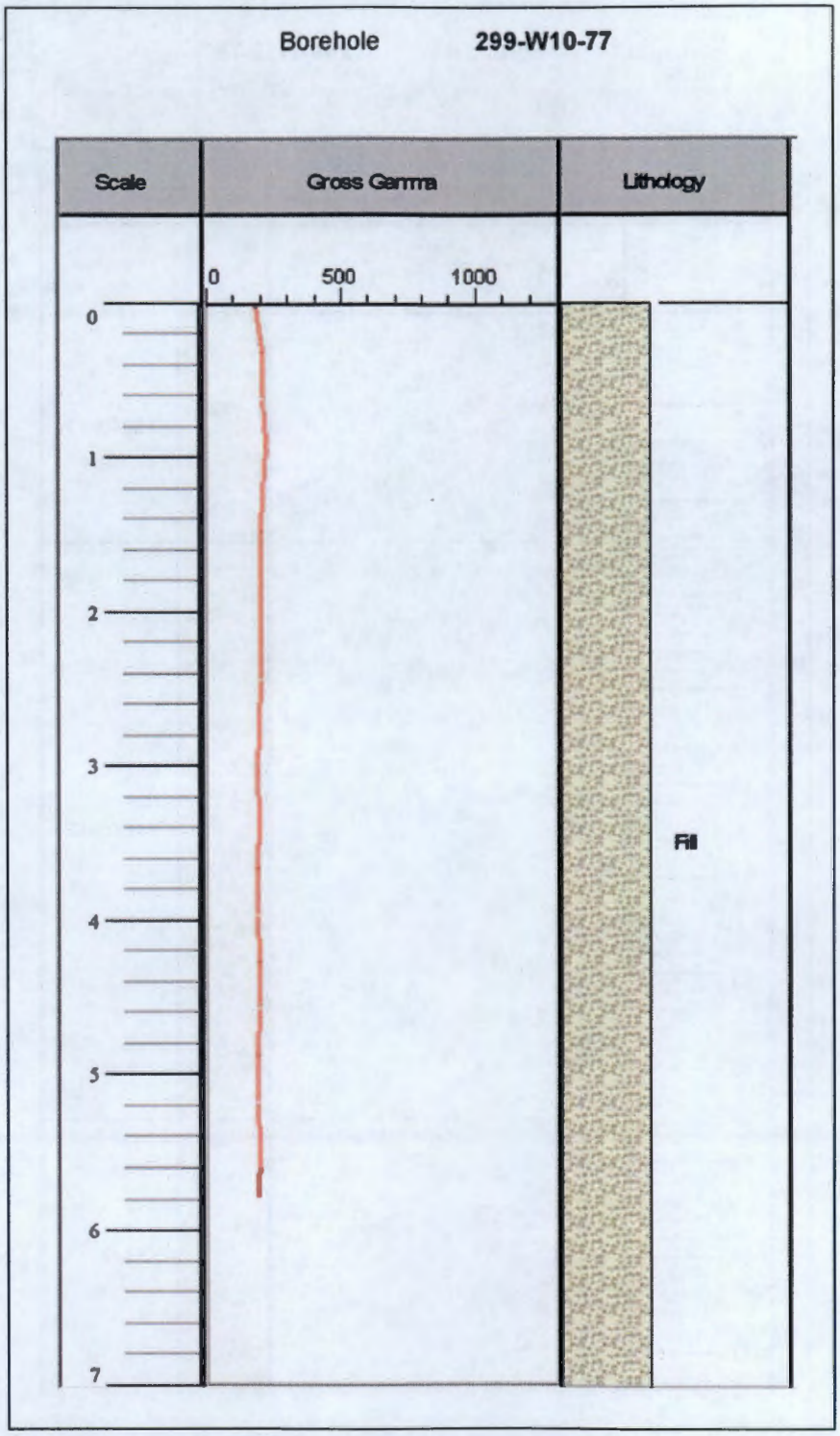
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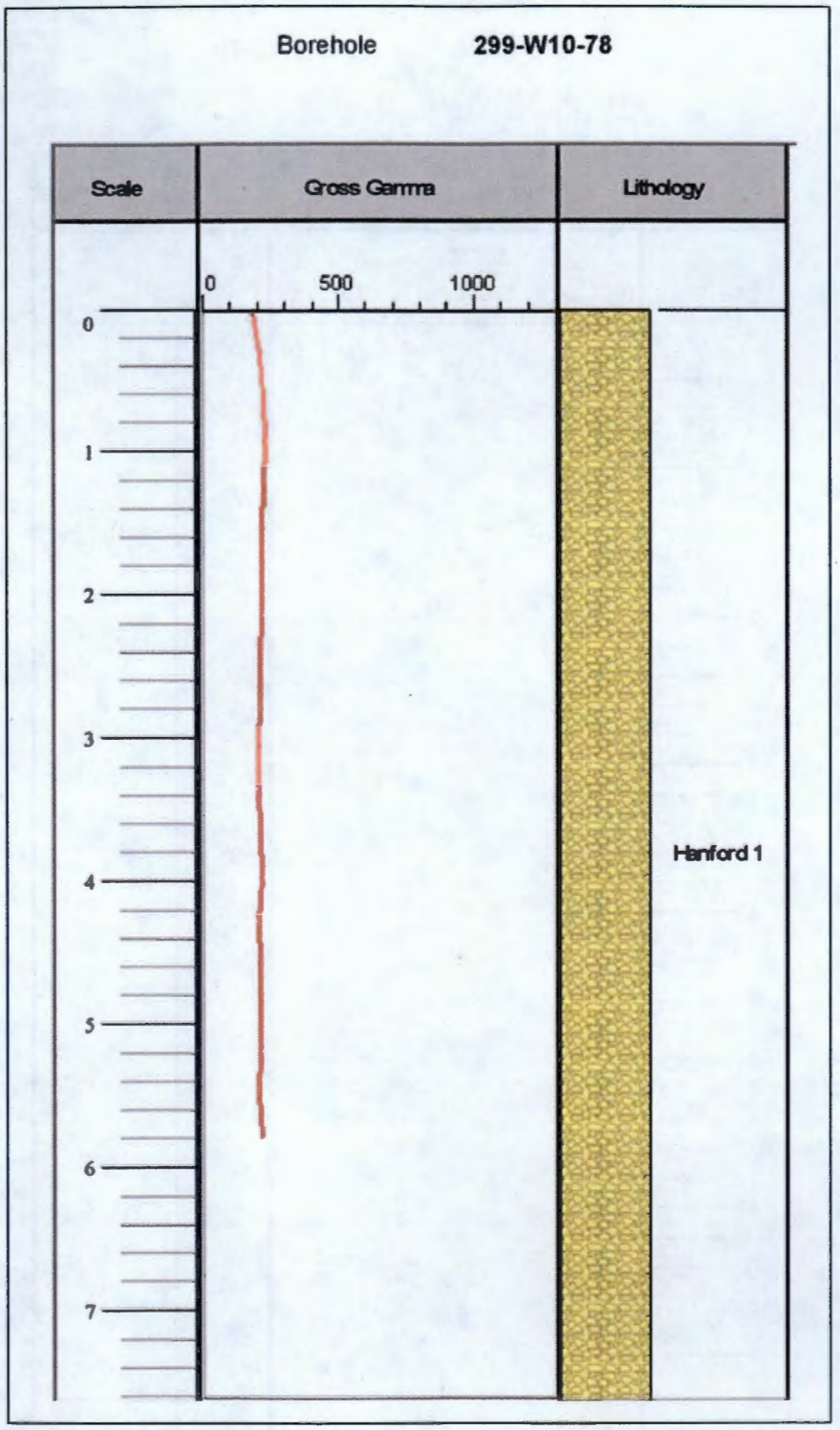
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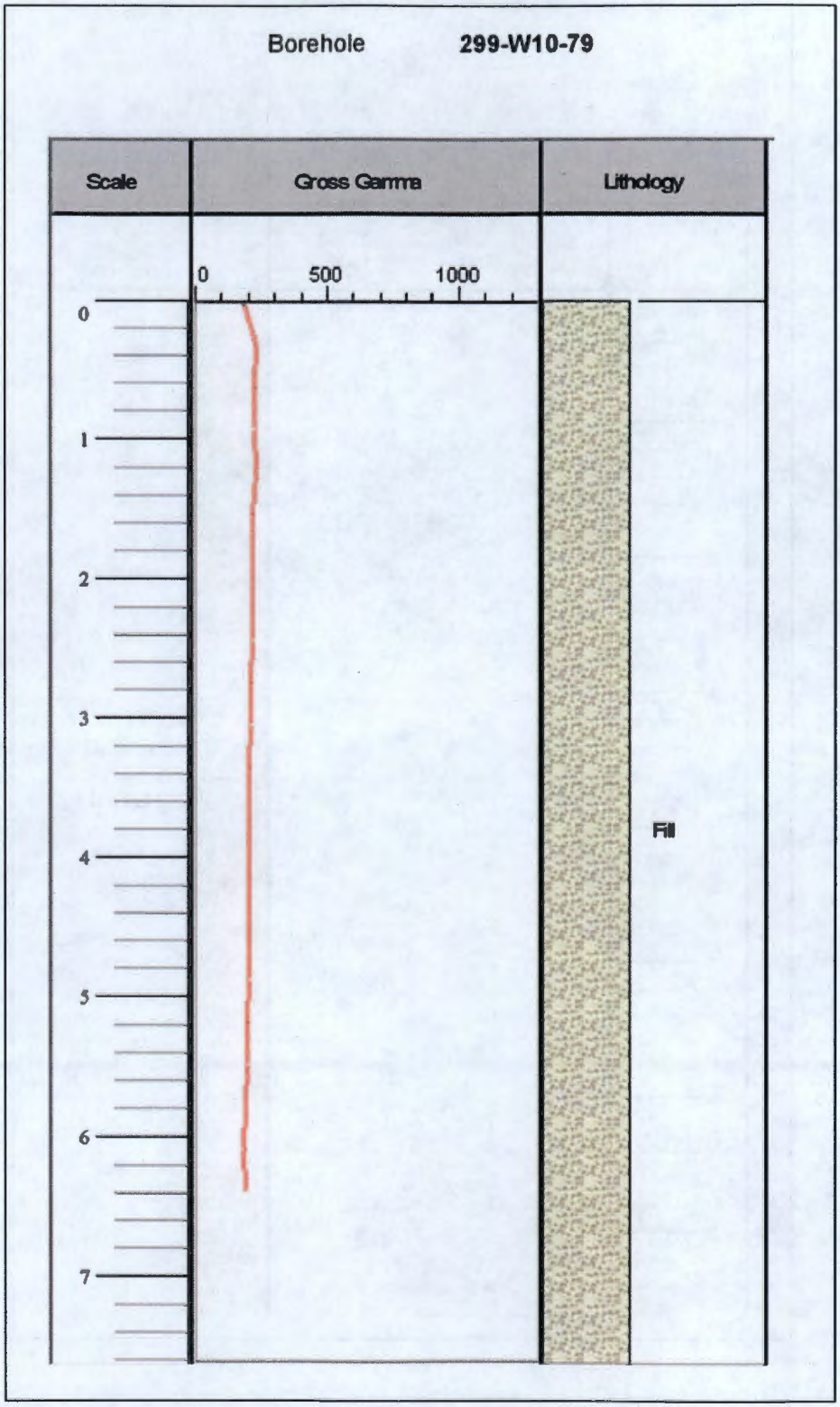
Hanford 1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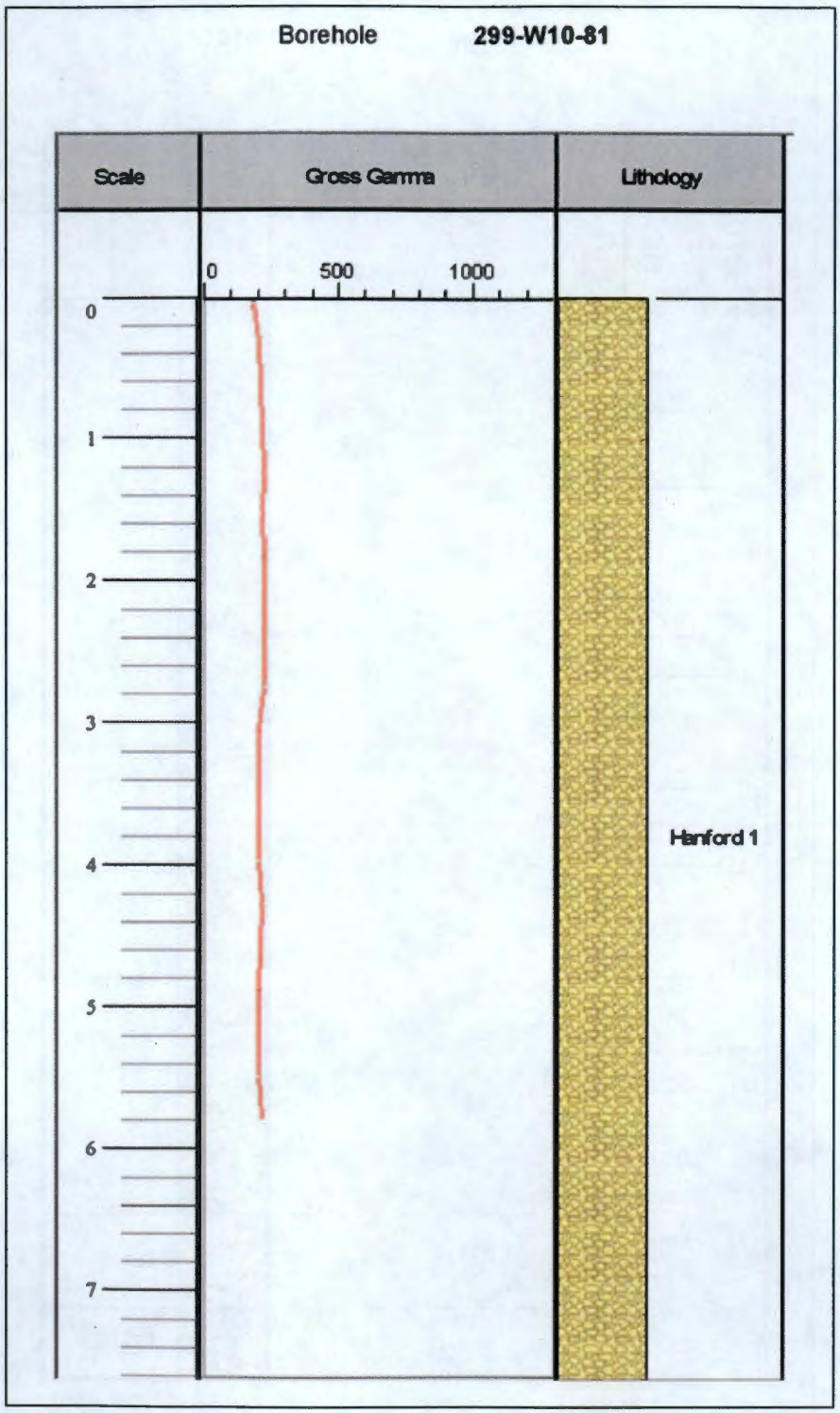
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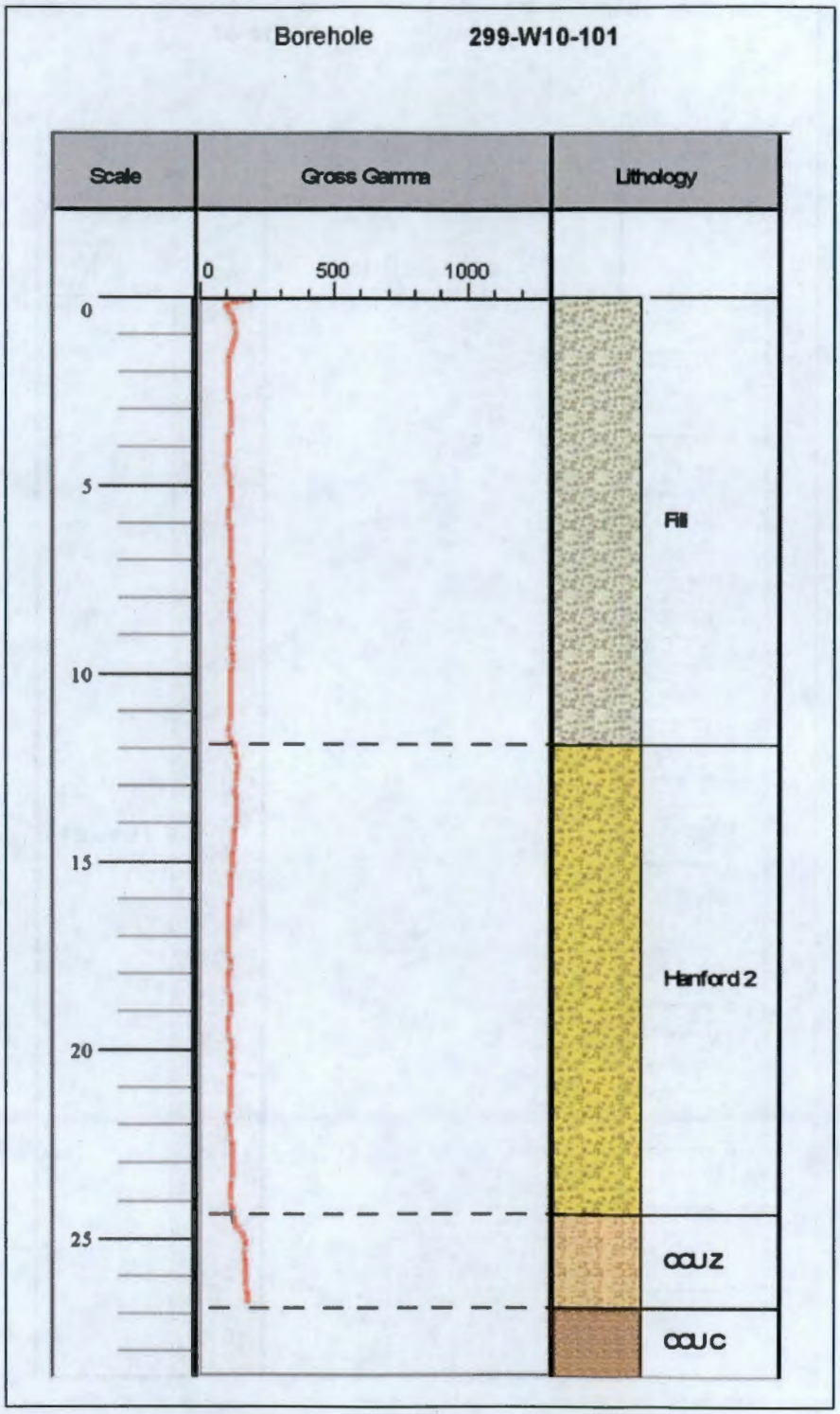
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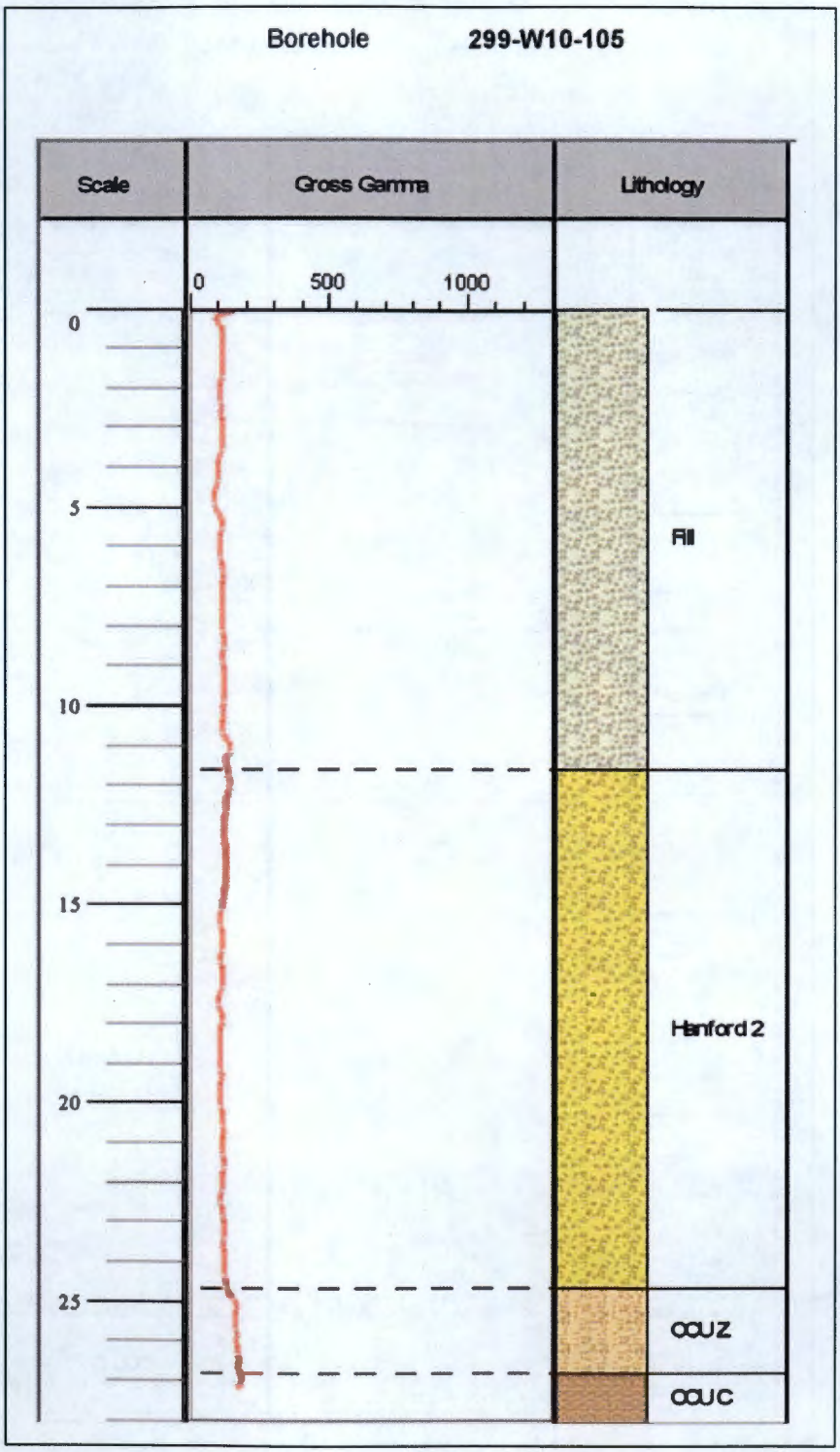
CCUC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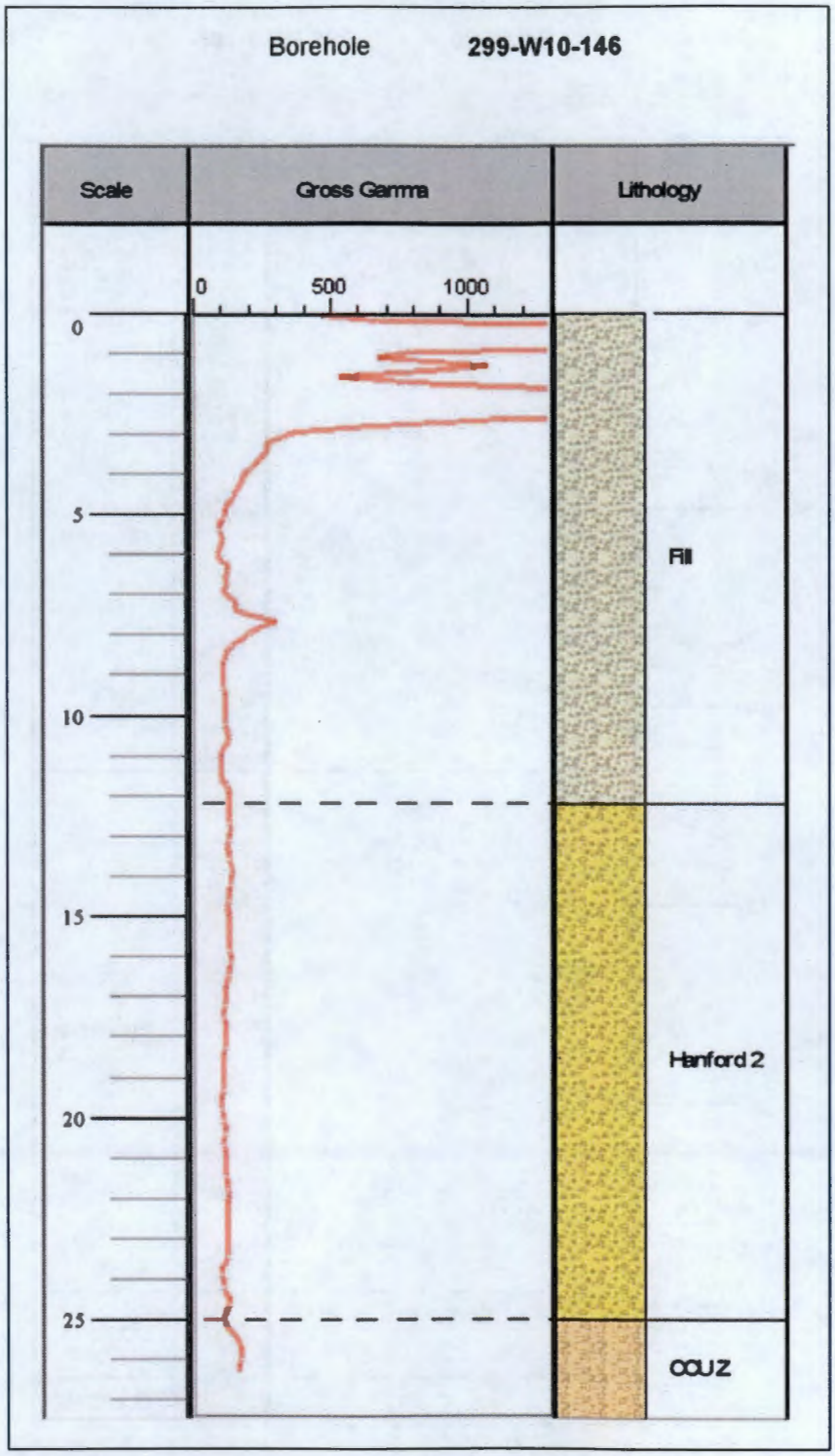
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Gross Gamma
Lithology
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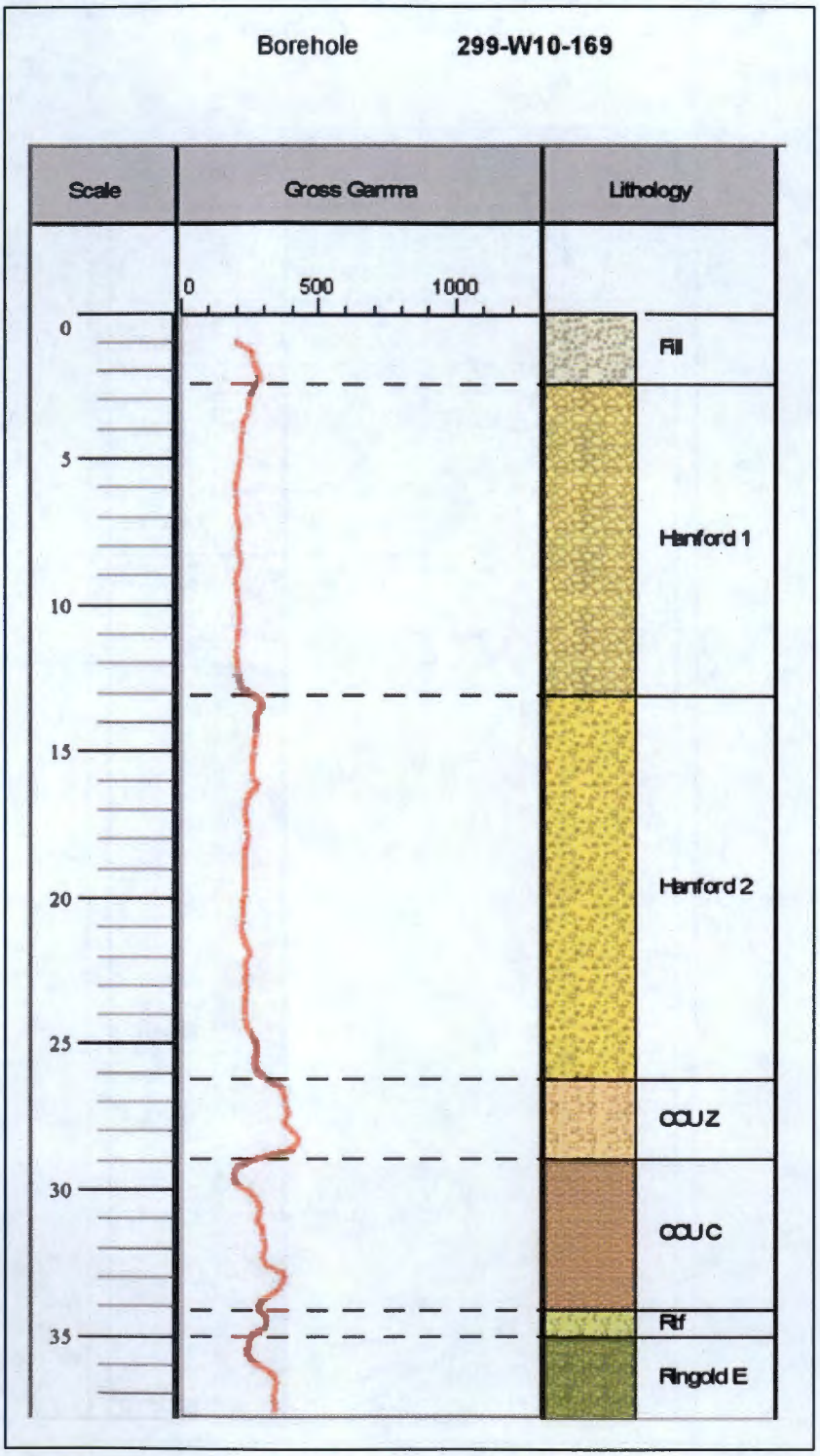
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Gross Gamma
Lithology
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15
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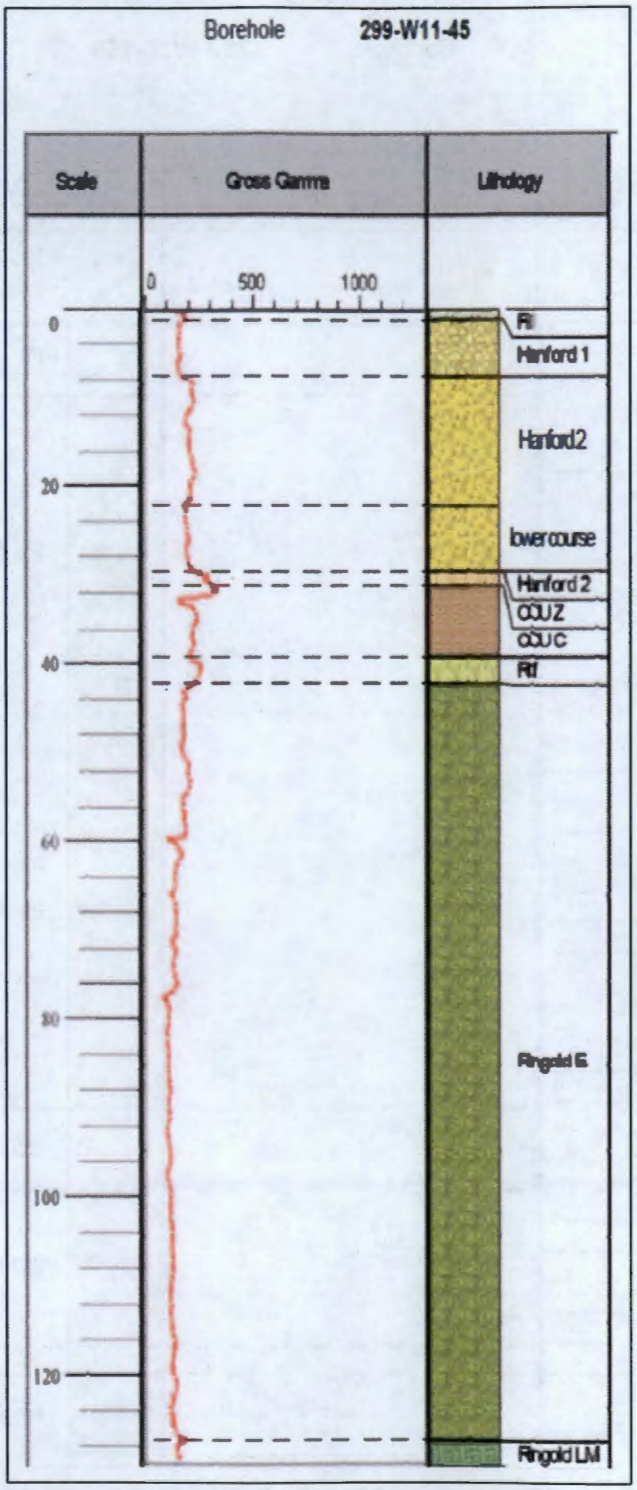
CCUC
Rtf
Ringold E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Scale
Gross Gamma
Lithology
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500
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0
20
40
60
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Fill
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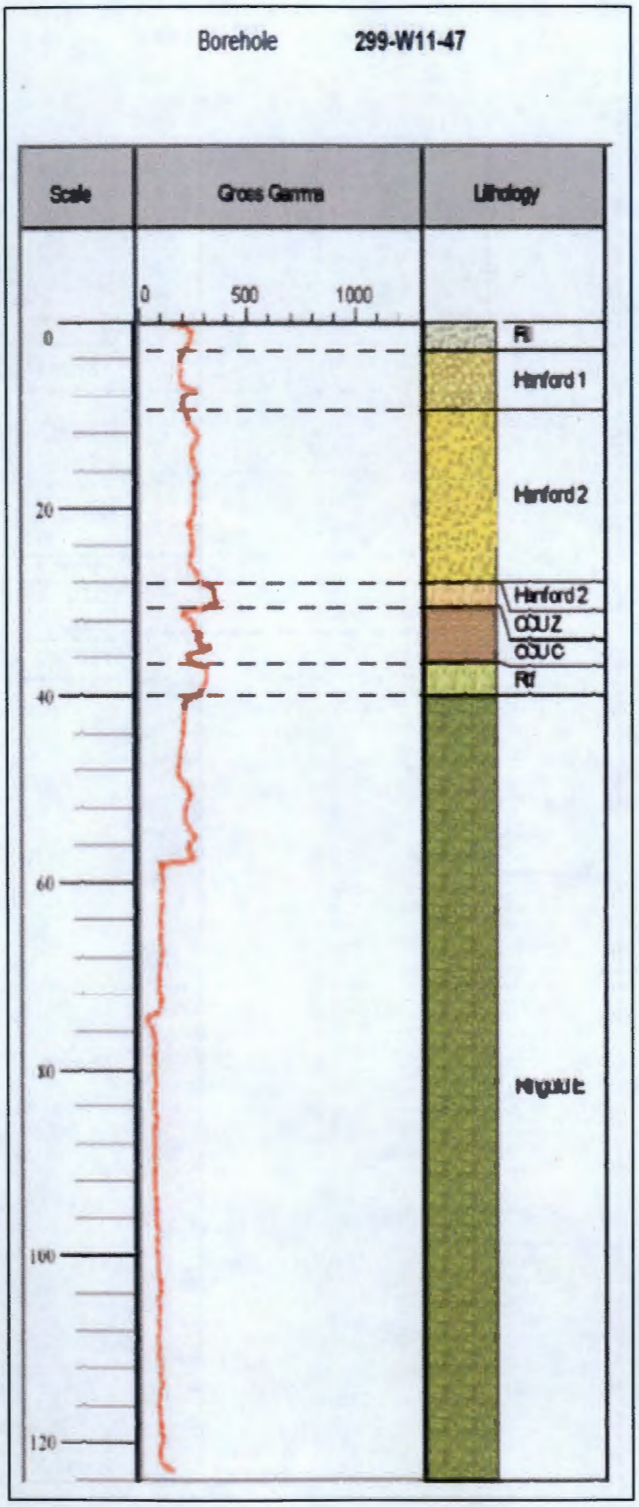
Hanford2
lowercourse
Hanford 2
CCUZ
CCUC
Fill
Ringold E
Ringold LM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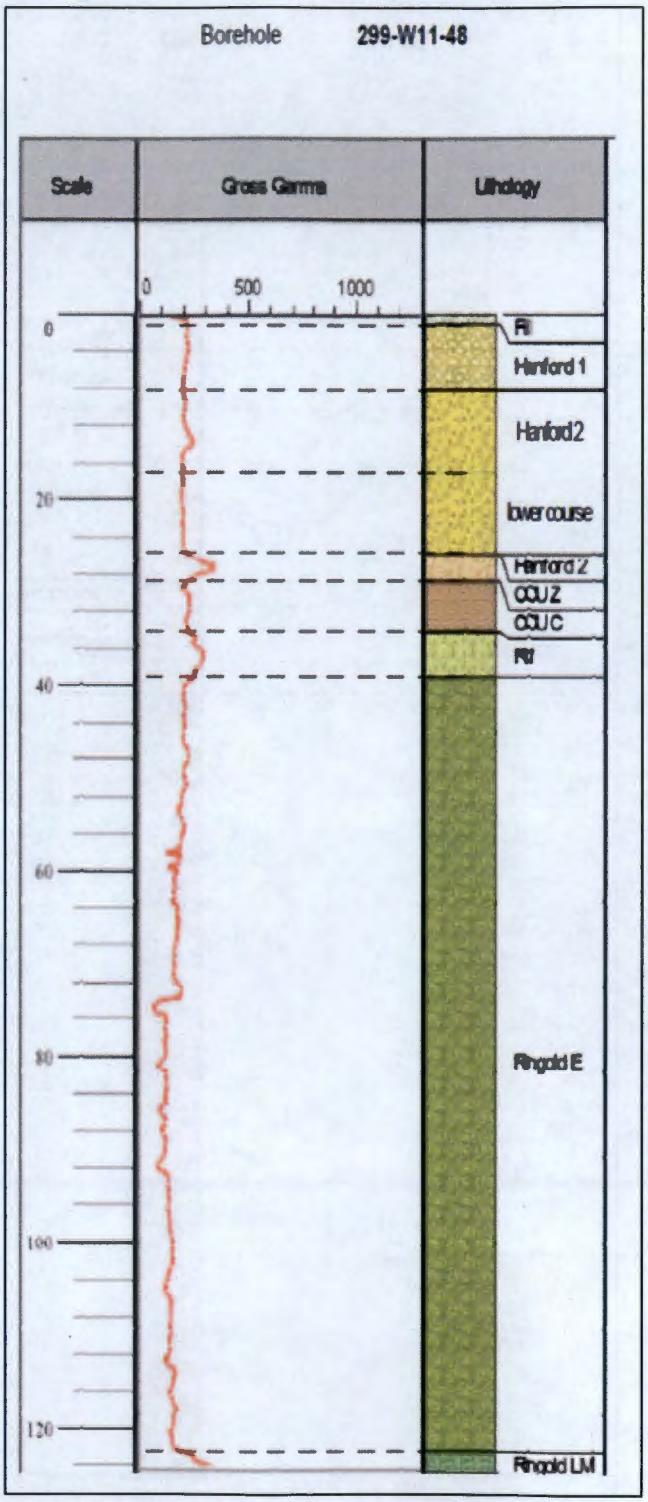
Hanford 2
Hanford 2
CCUZ
CCUC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Scale
Gross Gamma
Lithology
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20
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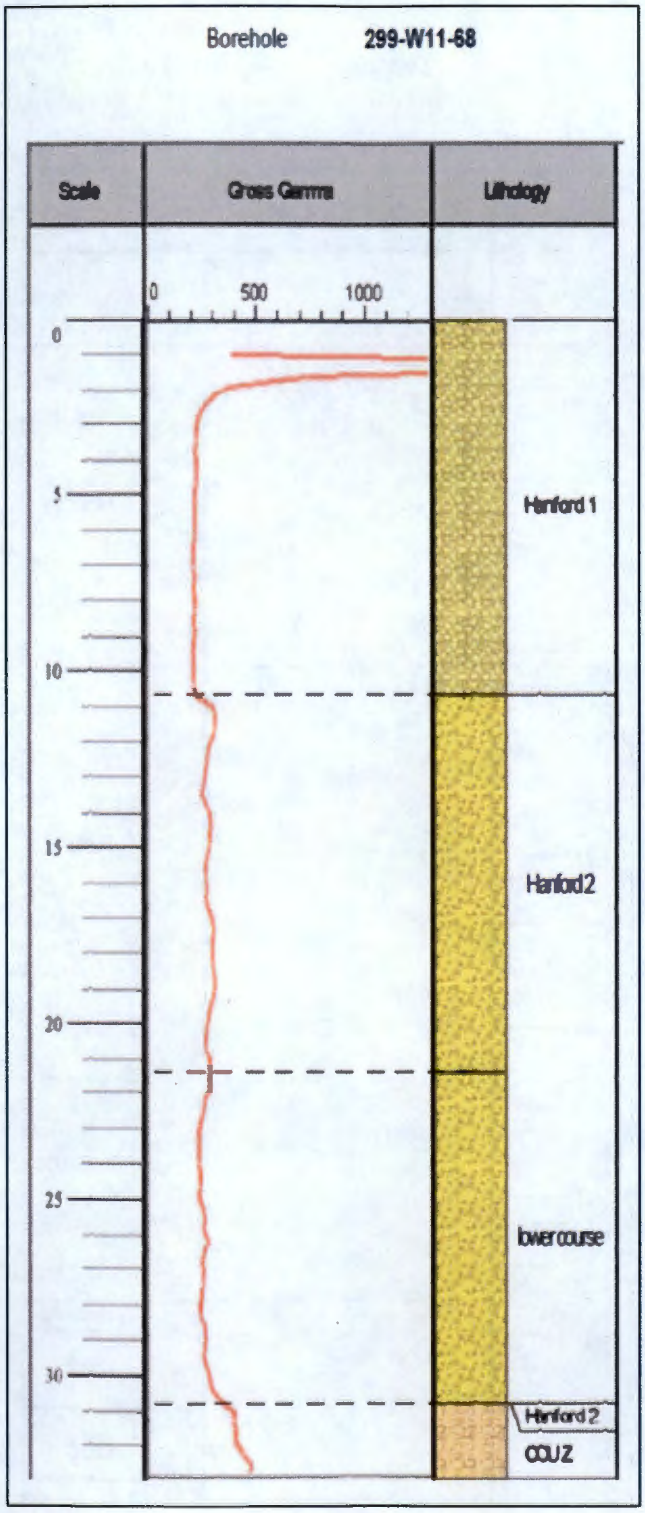
Hanford2
lower cause
Hanford 2
CCU Z
CCU C
Rif
Ringold E
Ringold LM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Scale
Gross Gamma
Lithology
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25
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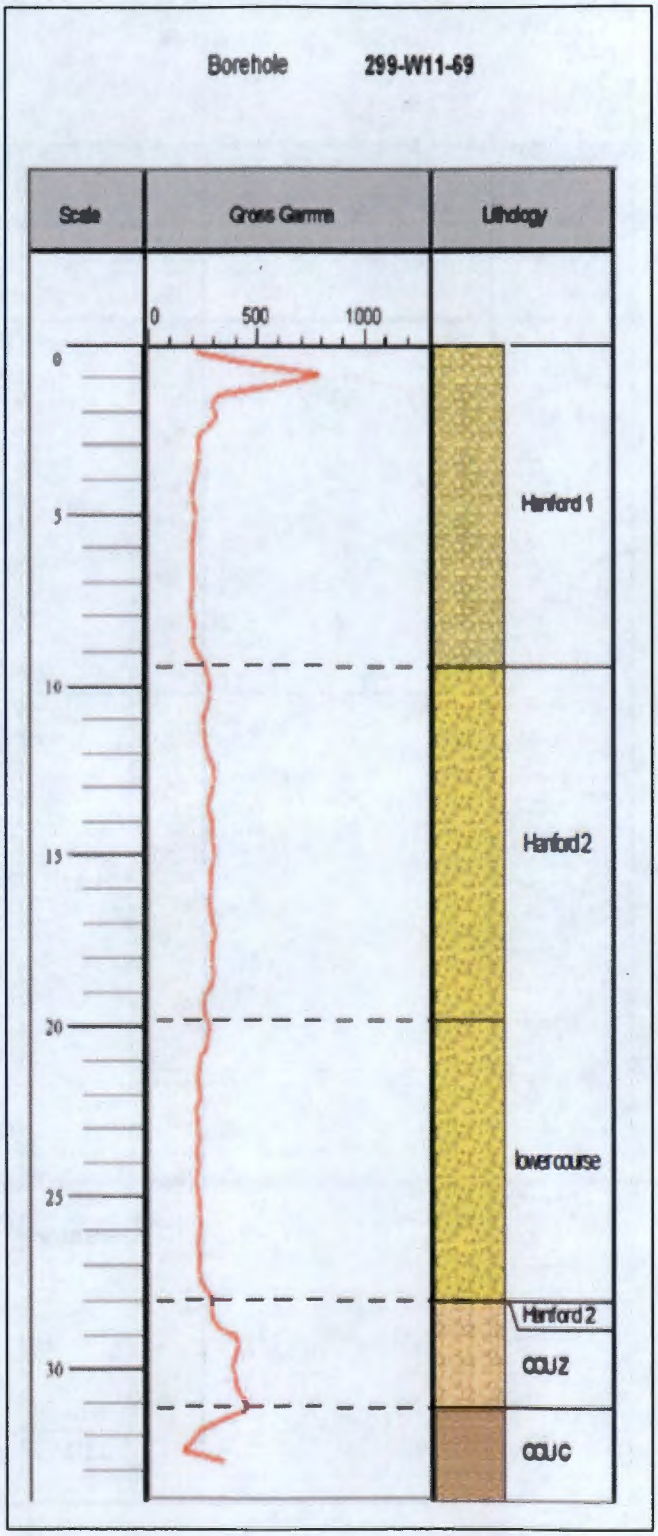
Hanford 2
lower coarse
Hanford 2
CCUZ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Scale
Gross Gamma
Lithology
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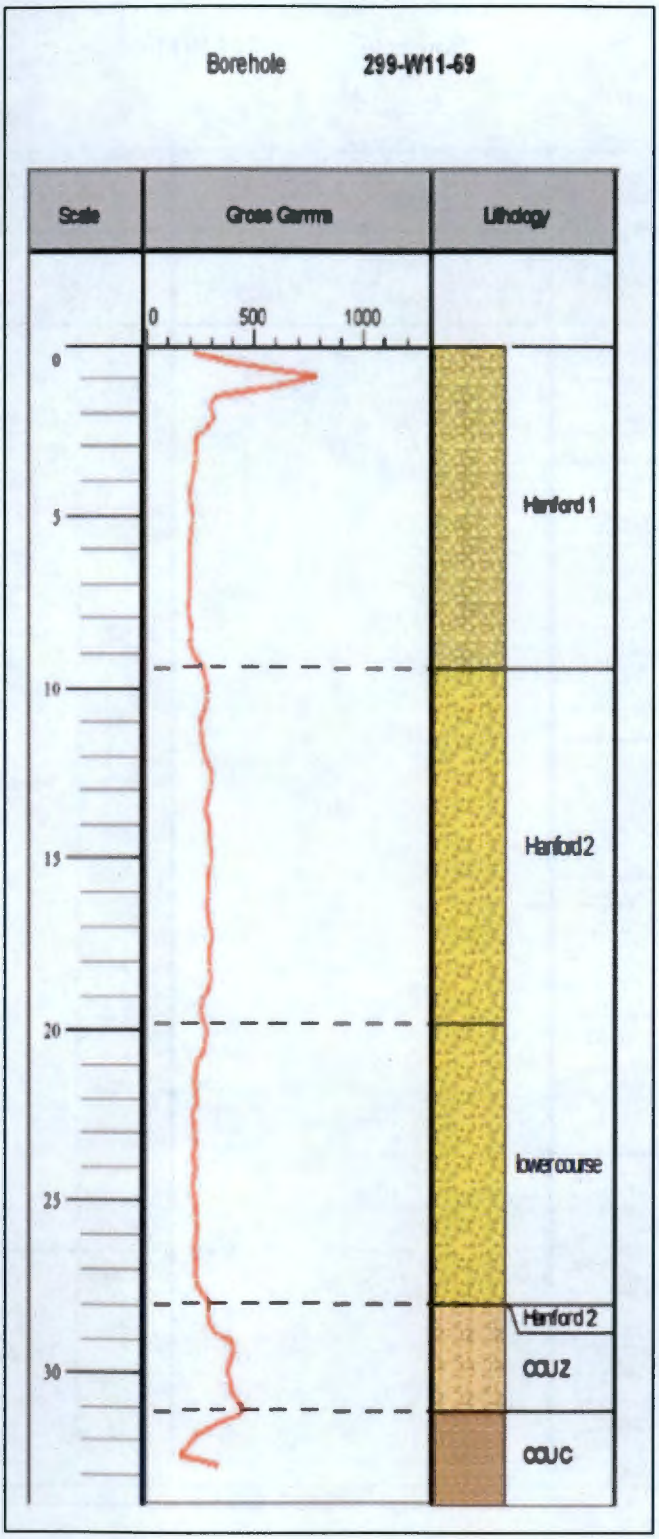
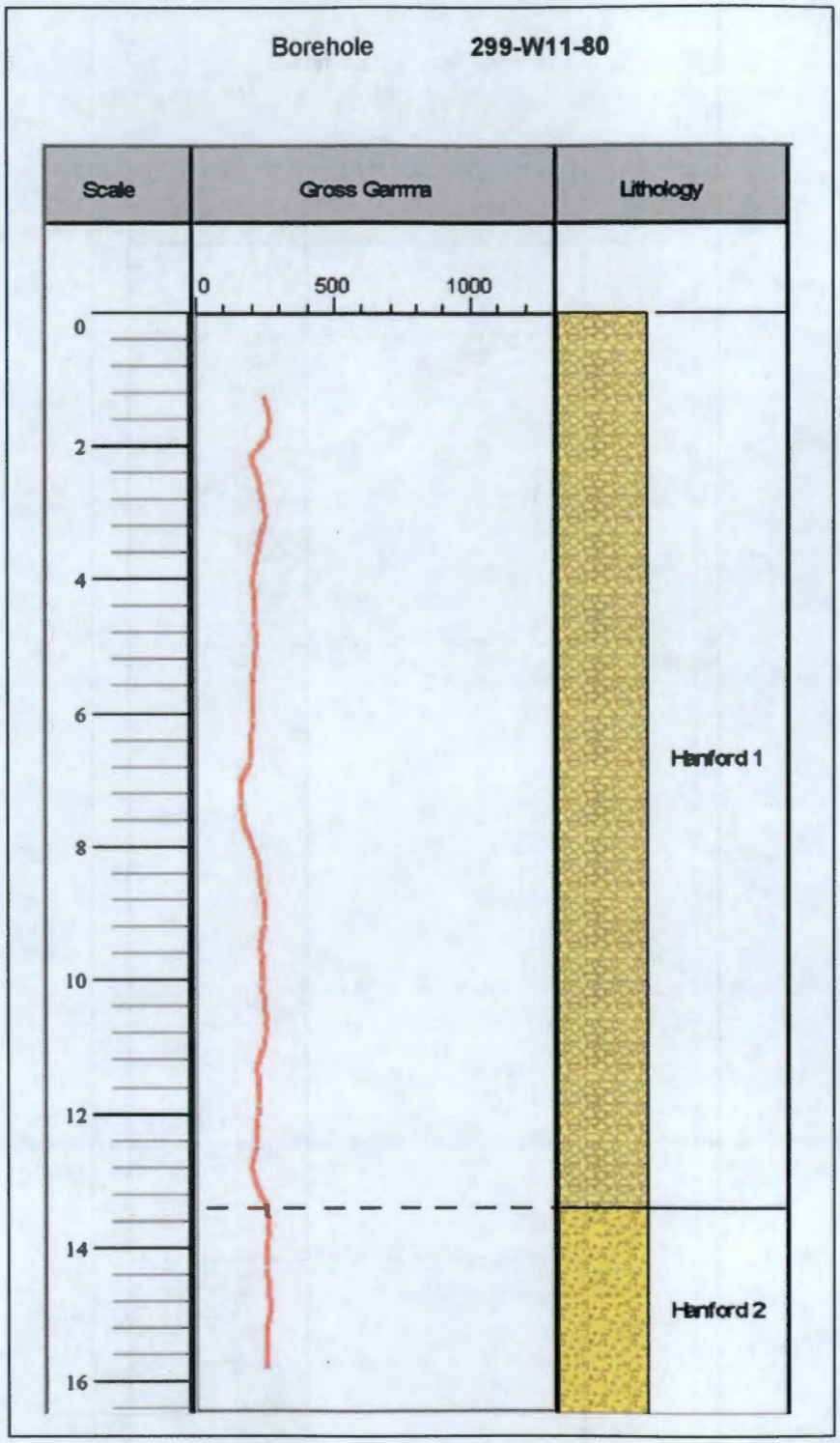
500
1000
0
5
10
15
20
25
30
Hanford 1
Hanford 2
lower cobble
Hanford 2
CCU 2
CCU C


Borehole
299-W11-69
Scale
Gross Gamma
Lithology
0
500
1000
0
5
10
15
20
25
30
Hanford 1
Hanford 2
lower course
Hanford 2
CCUZ
CCUC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Scale
Gross Gamma
Lithology
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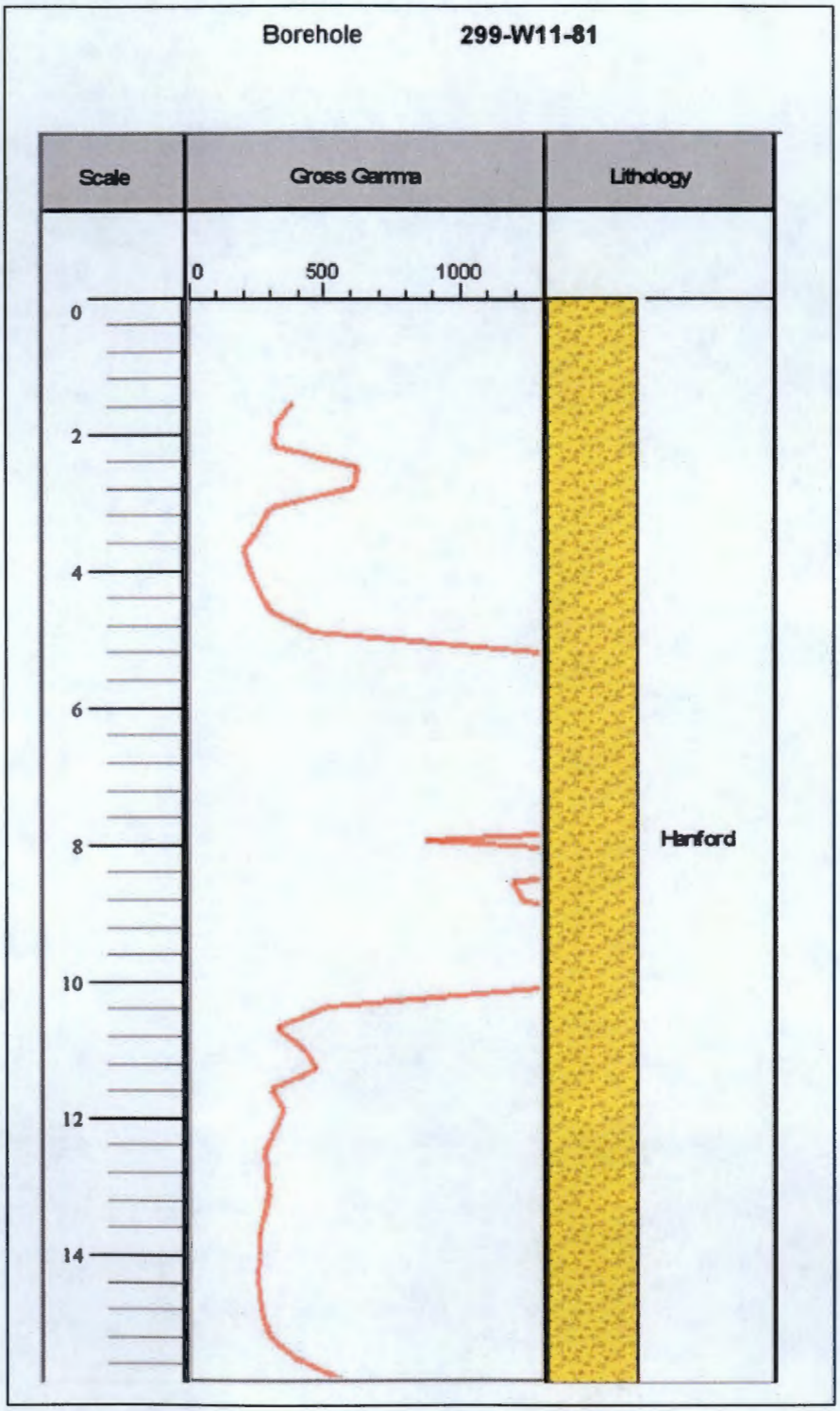
500
1000
0
2
4
6
8
10
12
14
16
Hanford 1
Hanford 2


Borehole 299-W11-81
Scale
Gross Gamma
Lithology
0
500
1000
0
2
4
6
8
10
12
14
Hanford

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Appendix B

Lithologic Contacts Data Table

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B Lithologic Contacts Data Table

The lithologic contacts data table provided in this appendix presents all contact depths in measurements of feet below ground surface.

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Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
T-Complex Wells																							
299-W11-56	A7298	150.0	218.06500	Top of casing, north edge, stamped	HEIS	X	—	—	X	—	NP	36	NP	114	122	ETD	—	—	—	—	216-T-3, 216-T-6	L2-L2'	Lower coarse unit (61 ft bgs) removed 4/28/2011.
299-W11-62	A7304	102.0	218.05800	Top of casing, north edge, stamped	HEIS	X	—	—	X	—	19	30	NP	ETD	—	—	—	—	—	—	216-T-3, 216-T-6	L2-L2'	Black sand 23 to 31 ft bgs. Lower coarse unit (60 ft bgs) removed 4/28/2011.
299-W11-59	A7301	90.0	216.51401	Top of casing, north edge, stamped	HEIS	X	—	—	X	—	0	31	NP	ETD	—	—	—	—	—	—	216-T-3, 216-T-6	L2-L2'	Fine gray sand 21 to 24 ft bgs. Lower coarse unit (79 ft bgs) removed 4/28/2011.
299-W11-79	A7321	150.0	217.57300	Top of casing, north edge, stamped	HEIS	X	—	—	X	—	0	38	NP	106	115	NP	—	—	—	—	216-T-3, 216-T-6	L2-L2'	—
299-W10-146	A7236	90.0	206.76800	—	—	—	—	—	X	X	NP	40	NP	82	90	—	—	—	—	—	216-T-14, 216-T-17	L10-L10'	—
299-W11-25B	C4669	408.0	209.74600	Disc_Z	—	X	X	X	—	X	4	34	63	89	98	119	130	406	—	—	216-T-14, 216-T-17	L10-L10' and type log	—
299-W15-763	C3339	257.6	202.175	—	—	—	X	X	—	—	8	40.5	NP	94	101.5	NP	117	—	—	—	216-T-19	L11-L11'	Silty layer 40.5 to 42.5 and 65.5 to 66 ft bgs. Silt stringers at 49, 50, 69 (clastic dike?), 89, and 92 ft bgs.
299-W15-65	A7366	25.0	202.912	—	—	X	—	—	—	—	0	ETD	—	—	—	—	—	—	—	—	216-T-19	L11-L11'	—
299-W14-52	A7336	28.0	203.076	—	—	X	—	—	—	—	0	ETD	—	—	—	—	—	—	—	—	216-T-19	L11-L11'	—
299-W15-4	A4929	217	203	—	—	Gamma	—	X	X	X	1	41	NP	91	105	NP	122	—	—	—	216-T-19	L11-L11'	—
299-W15-210	A7808	101.0	207.173	—	—	X	—	—	X	—	11	30	71*	—	—	—	—	—	—	—	216-T-21, 216-T-25	L12-L12'	Silt lenses at 44 ft bgs (8 in. thick) and 49 ft bgs (6 in. thick). *H3 at 71 ft bgs.

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
299-W15-209	A7507	50.2	207.43201	—	—	X	—	—	X	—	12	32	ETD	—	—	—	—	—	—	—	216-T-21, 216-T-25	L12-L12'	—
299-W15-80	A7381	167.0	207.9	—	—	X	—	—	X	—	13.5	40	70*	116.0	121.0	135.5	142.5	—	—	—	216-T-21, 216-T-25	L12-L12'	Perched water at 112 ft bgs (10/12/1953). *H3 at 70 ft bgs.
299-W15-211	A7509	102.0	206.9	—	—	X	—	—	X	—	10.0	35	54*	—	—	—	—	—	—	—	216-T-21, 216-T-25	L12-L12' and L13-L13'	*H3 at 54 ft bgs.
299-W15-43	C3955	347.0	206.77699	Disc_Z	—	X	X	X	—	—	25	40	91*	111	117	131	147	—	—	—	216-T-21, 216-T-25	L13-L13' and type log	*H3 at 91 ft bgs.
299-W15-40	B8550	265.8	205.06	—	—	X	X	XX	—	X	0	67	NP	98	109	123	132	—	—	—	216-T-21, 216-T-25	L13-L13'	Perched water at 215 ft bgs (9/3/1998).
299-W11-1	A7275	314.5	216.54401	Top of casing, north edge, stamped	HEIS	X	—	X	X	X	15	35	NP	107	116	143	157	—	—	—	216-T-3, 216-T-6	L1-L1'	Fine sand 20 to 28 ft bgs. Lower coarse unit (85 ft bgs) removed 4/28/2011.
299-W11-7	A4910	315.0	217.10800	Top of casing, north edge, stamped	HEIS	Gamma	—	X	X	X	16	36	NP	110	130	145	165	ETD	—	—	216-T-3, 216-T-6	L1-L1'	Silt stringers 33 to 58 ft bgs. Lower coarse unit (90 ft bgs) removed 4/28/2011.
299-W11-65	A7307	160.0	216.30099	Top of casing, north edge, stamped	HEIS	X	—	—	X	X	20	34	NP	111	118	142	ETD	—	—	—	216-T-3, 216-T-6	L1-L1' and type log	Sand 38 to 43 ft bgs. Lower coarse unit (75 ft bgs) removed 4/28/2011.
299-W11-60	A7302	150.0	217.67999	Top of casing, north edge, stamped	HEIS	X	—	—	X	—	20	30	NP	113	122	150	—	—	—	—	216-T-3, 216-T-6	L2-L2'	Fine black sand 20 to 30 ft bgs. Lower coarse unit (60 ft bgs) removed 4/28/2011.
299-W11-54	A7296	150.0	218.15100	Top of casing, north edge, stamped	HEIS	X	—	—	x	—	20	39	NP	114	123	150	—	—	—	—	216-T-3, 216-T-6	L2-L2' and type log	Lower coarse unit (60 ft bgs) removed 4/28/2011.
299-W10-56	A7146	150	205.84300	—	HEIS	Gamma	—	—	X	—	20	39	NP	85	95	109	127	ETD	—	—	216-T-5, 216-T-7, 216-T-32	L3-L3'	Sand layer 32 to 37 ft bgs.

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
299-W10-57	A7147	150	205.87399	—	HEIS	Gamma	—	—	X	—	26	49	NP	85	95	110	125	ETD	—	—	216-T-5, 216-T-7, 216-T-32	L3-L3'	Sand layer 30 to 39 ft bgs.
299-W10-64	A7154	75	205.93201	—	HEIS	Gamma	—	—	X	—	0	46	ETD	—	—	—	—	—	—	—	216-T-5, 216-T-7, 216-T-32	L3-L3'	Sand layer within Hf2, 35 to 45 ft bgs.
299-W10-65	A7155	75	205.87000	—	HEIS	Gamma	—	—	X	—	10	51	ETD	—	—	—	—	—	—	—	216-T-5, 216-T-7, 216-T-32	L3-L3'	Sand layer 24 to 29 ft bgs.
299-W10-3	A4897	239.0	205.763	—	—	—	—	X	X	—	26	40	NP	88	98	117	136	ETD	—	—	216-T-5, 216-T-7, 216-T-32	L3-L3'	Fine sand 37 to 52 ft bgs.
299-W10-140	A7230	94.0	205.805	—	—	—	—	—	X	—	NP	45	NP	85	93	—	—	—	—	—	216-T-5, 216-T-7, 216-T-32	L3-L3' and L4-4'	Fine sand 45 to 50 ft bgs.
299-W10-141	A7231	121.0	205.799	—	—	—	—	—	X	—	NP	45	NP	81	94	111	—	—	—	—	216-T-5, 216-T-7, 216-T-32	L3-L3' and L4-4'	Sand layer 45 to 49 ft bgs.
299-W10-1	A7136	305.0	207.459	—	—	Gamma	—	—	X	—	1	49	—	77	95	111	142	—	—	—	216-T-5, 216-T-7, 216-T-32	L3-L3'	Sand layer 20 to 25 ft bgs.
299-W10-58	A7148	150	205.90800	—	HEIS	Gamma	—	—	X	—	26	48	NP	82	91.5	109	119	ETD	—	—	216-T-5, 216-T-7, 216-T-32	L3-L3' and L5-L5'	Sand layer 35 to 44 ft bgs.
299-W10-28	C3400	279.0	206.10001	Disc_Z	—	X	X	X	—	—	3	52	NP	78	96.5	112	129	—	—	—	216-T-5, 216-T-7, 216-T-32	L3-L3' and type log	Sand layer 3-14 and 24-27.5 ft bgs
299-W10-33	C5855	425.0	205.17599	Disc_Z	—	X	X	X	—	X	8	44	NP	80	92	108	122	420	ETD	—	216-T-5, 216-T-7, 216-T-32	L3-L3' and type log	—
299-W10-70	A7160	150	206.02299	Top of casing, north edge, stamped	HEIS	X	—	—	X	—	25	64	NP	81	99	111	118	—	—	—	216-T-5, 216-T-7, 216-T-32	L4-L4'	Sand layer 43 to 49 ft bgs.
299-W10-79	A7169	25	205.93600	—	HEIS	X	—	—	X	—	NP	ETD	—	—	—	—	—	—	—	—	216-T-5, 216-T-7, 216-T-32	L4-L4'	—

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
299-W10-59	A7149	150	205.54700	—	HEIS	Gamma	—	—	X	—	26	53	NP	82	96	114	212	—	—	—	216-T-5, 216-T-7, 216-T-32	L4-L4'	—
299-W10-62	A7152	150	205.63499	—	HEIS	Gamma	—	—	X	—	26	50	NP	83	95	113	118	—	—	—	216-T-5, 216-T-7, 216-T-32	L4-L4'	—
299-W10-67	A7157	150	205.62801	—	HEIS	Gamma	—	—	—	—	26	54	NP	82	96	115	121	—	—	—	216-T-5, 216-T-7, 216-T-32	L4-L4'	—
299-W10-77	A7167	23	205.85600	—	HEIS	X	—	—	X	—	NP	ETD	—	—	—	—	—	—	—	—	216-T-5, 216-T-7, 216-T-32	L4-L4' and L5-L5'	—
299-W10-69	A7159	150	205.91100	Top of casing, north edge, stamped	HEIS	X	—	—	X	—	26	60	NP	84	98	111.2	117.8	—	—	—	216-T-5, 216-T-7, 216-T-32	L4-L4' and L5-L5'	Sand layer 41 to 48 ft bgs.
299-W10-73	A7163	75	205.87399	—	HEIS	X	—	—	X	—	18	50	ETD	—	—	—	—	—	—	—	216-T-5, 216-T-7, 216-T-32	L5-L5'	Fine sand 36 to 40 ft bgs.
299-W10-72	A7162	150	205.92900	Top of casing, north edge, stamped	HEIS	X	—	—	X	—	26	64	NP	88	103	114	131	—	—	—	216-T-5, 216-T-7, 216-T-32	L5-L5'	—
299-W10-113	A7203	118.1	205.72701	—	HEIS	—	—	—	X	X	NP	38	NP	81	92	109	118	—	—	—	216-T-5, 216-T-7, 216-T-32	L5-L5'	—
299-W10-2	A4896	230.0	206.579	—	—	—	—	X	X	—	7	63	NP	81	97	113	127	—	—	—	216-T-5, 216-T-7, 216-T-32	L5-L5'	Perched water at 86 ft bgs (11/13/1951).
299-W10-196	A7274	176.0	206.351	—	—	—	X	X	X	—	NP	38	NP	82	92	109.0	124	—	—	—	216-T-14, 216-T-17	L5-L5' and L10-L10'	Perched water at 109 ft bgs (2/16/1993).
299-W11-69	A7311	110.5	213.188	—	—	X	—	—	X	—	0	31	65	92	102	ETD	—	—	—	—	216-T-14, 216-T-17	L6-L6'	—
299-W11-45	C4948	427.0	212.88400	Disc_Z	—	X	X	X	—	—	4	25	73	97	102	129	138	418?	—	—	216-T-14, 216-T-17	L6-L6'	—
299-W11-48	C5243	409.0	208.89700	Disc_Z	—	X	X	X	—	X	4	27	56.5	84.5	94	112	128	401.5	—	—	216-T-14, 216-T-17	L6-L6'	Rc at 305 ft bgs?

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top Hf2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
299-W10-22	A9890	300.0	208.954	—	—	—	X	X	X	—	1	34	54	84	94	112	145	ETD	—	—	216-T-14, 216-T-17	L6-L6'	Perched water at 67 ft bgs (8/12/1994).
299-W11-68	A7310	108	213.711	—	—	X			X	—	0	35	70	101	ETD	—	—	—	—	—	216-T-14, 216-T-17	L6-L6', L7-L7' and L10-L10'	—
299-W11-80	A7322	54	214.58701	—	—	X			X	—	0	44	ETD	—	—	—	—	—	—	—	216-T-14, 216-T-17	L7-L7'	—
299-W11-28	A4908	247.4	211.355	—	—	—	X	X	—	X	8	38	70	91	104	125	139	—	—	—	216-T-14, 216-T-17	L7-L7'	Perched water at 197.9 ft bgs (10/30/1991).
299-W11-47	C4990	405.5	209.65500	Disc_Z	—	X	X	X	—	—	10	31	70	92	100	120	131	406.5	—	—	216-T-14, 216-T-17	L7-L7' and type log	—
C4175	C4175	227.5	204.92999	Brass survey marker	HEIS	X	X	XX	—	—	10.5	31	NP	90.5	97	114	120.5	—	—	—	216-T-18, 216-T-26	L8-L8' and L9-L9' and type log	Volcanic ash at 27 ft bgs? Silt stringer 176 ft bgs.
299-W14-18	C3396	218.5	204.26300	Disc_Z	—	X	X	X	—	X	13	34	NP	88.5	100	111	118	—	—	—	216-T-18, 216-T-26	L8-L8'	Used borehole log. Rc at 159? Silt stringer at 37 and 51 ft bgs.
299-W14-16	C3120	265.0	205.36800	Disc_Z	—	—	X	X	—	—	13.5	34	NP	89	99	113	122	—	—	—	216-T-18, 216-T-26	L8-L8'	—
299-W14-4	A7330	205.0	205.814	—	—	X	—	—	X	X	0	36	NP	91	101	118	124	—	—	—	216-T-18, 216-T-26	L8-L8'	Rc at 147 ft bgs? Silt stringer at 39 ft bgs.
299-W14-3	A7329	270.0	205.792	—	—	X	—	—	X	X	0	35	NP	92	99	115	122	—	—	—	216-T-18, 216-T-26	L8-L8'	Rc at 178 ft bgs?
299-W10-26	B8548	262.0	204.673	—	—	X	X	XX	—	X	0	44	NP	89	97	110	117	—	—	—	216-T-18, 216-T-26	L8-L8'	—
299-W14-20	C7018	439.0	204.39900	—	—	X	X	X	—	—	14	36	NP	88	98	114	125	407	430	—	216-T-18, 216-T-26	L9-L9'	CCUc picked based on KUT.
299-W14-11	C4668	349.0	204.38300	Disc_Z	—	X	X	X	—	X	9	33	NP	91	98	117	125	—	—	—	216-T-18, 216-T-26	L9-L9'	—
299-W14-62	A7346	68.0	206.024	—	—	X	—	—	X	—	0	31	ETD	—	—	—	—	—	—	—	216-T-18, 216-T-26	L9-L9'	—
299-W11-82	A7324	70.0	206.558	—	—	X	—	—	—	—	0	37	ETD	—	—	—	—	—	—	—	216-T-18, 216-T-26	L9-L9'	—
299-W11-70	A7312	150.0	206.321	—	—	X	—	—	—	—	0	35	NP	89	100	119	126	—	—	—	216-T-18, 216-T-26	L9-L9'	—

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
299-W14-2	A7328	223.0	205.789	—	—	X	—	—	—	X	0	32	NP	91	96	117	125	—	—	—	216-T-18, 216-T-26	L9-L9'	—
C3102	C3102	227.0	205.48199	Disc_Z	—	X	X	X	—	—	10	35.2	NP	91	99	116	121	—	—	—	216-T-18, 216-T-26	L9-L9' and type log	Silt layers (clastic dike?) 81 to 87 ft bgs and 174 to 175 ft bgs. Stringers at 44 and 67 ft bgs.
299-W15-41	B8815	238.0	202.78799	Disc_Z	—	X	X	X	—	X	5.5	44	NP	94	103	117	120	—	—	—	216-T-19	type log	—
299-W15-64	A7365	189.0	203.817		—	X	—	—	—	—	15	44	NP	102	110	NP	117	—	—	—	216-T-19	type log	—
299-W15-225	C7017	461.0	204.84599	Disc_Z	—	X	X	X	—	—	9	55	NP	103	111	124	133	410.5	458	—	216-T-21, 216-T-25	type log	—
299-W15-212	A7510	100.0	207.3	—	—	X	—	—	X	—	14	29	71*	—	—	—	—	—	—	—	216-T-21, 216-T-25	L12-L12'	Added to cross section 3/9/2011. *H3 at 71 ft bgs.
299-W14-51	A7335	80.0	203.45799	Top of casing, north edge, stamped	HEIS	X	—	X	X	—	0	40	ETD	—	—	—	—	—	—	—	216-T-19	L11-L11'	Added to cross section 3/18/2011.
299-W15-66	A7367	80.0	203.439	—	—	X	—	—	X	—	0	47	ETD	—	—	—	—	—	—	—	216-T-19	L11-L11'	Added to cross section 3/18/2011. Silt stringer at 58 and 63 ft bgs.
S-Complex Wells																							
299-W22-25	A7846	335.0	208.568	Top of casing, north edge, stamped X	HEIS	X	—	X	X	—	0	70	NP	133	145	NP	153	—	—	—	216-S-9, 216-S-23	L14-L14' and L15-L15'	Cemented gravels 217 to 222 ft bgs (per driller's log and KUT plot). Sand top 35 ft of Hf1.
299-W22-26	A4968	300.0	208.379	Top of casing, north edge, stamped X	HEIS	X	—	X	X	—	0	60	NP	141	148	160	164	—	—	—	216-S-9, 216-S-23	L15-L15'	Sand top 20 ft of Hf1. Contamination in sand/gravel within Hf1.
299-W22-27	A7847	572.0	208.53	Top of casing (assumed)	HEIS	—	—	X	X	X	0	75	NP	135	148	155	180	448	505	559	216-S-9, 216-S-23	L14-L14'	—

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
299-W22-69	C4969	376.0	207.26700	Disc_Z	—	X	X	X	—	X	0	58	NP	120	141	NP	147	—	—	—	216-S-9, 216-S-23	L14-L14', L15-L15' and type log	—
299-W19-5	A7734	235	210.53	Top of casing, north edge, stamped	HEIS	X	—	X	X	—	0	75	NP	145	159	162	184	—	—	—	216-S-23, 216-S-9	L14-L14'	Sand layer 18 to 26, 41 to 46 (per driller's logs), and 65 to 68 ft bgs per geophysical logs.
299-W19-7	A7735	235	211.07	Top of casing, north edge, stamped	HEIS	X	—	X	X	—	0	78	NP	147	159	162	182	—	—	—	216-S-23, 216-S-9	L14-L14' and type log	Sand 44 to 46 ft bgs (damp per driller's log). Cemented sand 145 to 147 ft bgs (per driller's log).
299-W19-10	A7738	573.00	209.35	Top of casing, north edge, stamped	HEIS	—	—	X	X	X	0	63	NP	145	159	NP	169.5	458	485	556	216-S-23, 216-S-9	L14-L14'	—
299-W22-38	A7857	233.00	210.28	—	HEIS	X	—	X	X	X	0	62	NP	143	150	158	186	—	—	—	216-S-23, 216-S-9	L14-L14'	Sand top 20 ft of Hf1. Sand 46 to 51 ft bgs, possible silt 102 to 105 ft bgs.
299-W23-11	A4980	235.00	202.71	Disc_Z	HEIS	Gamma	—	X	X	X	10	43	NP	124	148	157	169	—	—	—	216-S-21, 216-S-25	L16-L16'	—
299-W23-14	A4983	224.40	202.54	Disc_Z	HEIS	X	X	X	—	X	20	37	NP	122	147	161	168	—	—	—	216-S-21, 216-S-25	L17-L17' and type log (composite geophysical and borehole logs; wells are 9 ft apart)	Gravel lens 80 to 100 ft bgs.

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
299-W23-8	A4991	235.0	202.53	Corrected to ground surface (3 ft stick up)	—	X		X	X	X	17	39	NP	124	152	162	171	—	—	—	216-S-21, 216-S-25	L17-L17', L16-L16' and type log (composite geophysical and borehole logs; wells are 9 ft apart)	Gravel lenses at 75 to79 ft bgs and 85 to 100 ft bgs.
299-W23-4	A4987	300.0	202.99899	—	—	X		X	X	X	0	38	NP	118	142	148	155	—	—	—	216-S-21, 216-S-25	L17-L17'	Only very old gamma log. Contacts are highly questionable.
299-W23-63	A7899	51.0	203.13	Top of casing, north edge, stamped	HEIS	X	—	—	—	—	22	38	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	L17-L17'	In tank farm; a great deal of contamination.
299-W23-9	A7883	235.0	202.74	Disc_Z	HEIS	Gamma	—	X	X	X	10	38	NP	120	154	159	171	—	—	—	216-S-21, 216-S-25	L16-L16'	—
299-W23-10	A7884	235.0	202.82	Disc_Z	HEIS	Gamma	—	X	X	X	10	56	NP	124	154	165	175	—	—	—	216-S-21, 216-S-25	L16-L16'	—
299-W23-65	A7901	125.0	202.54	Top of casing, north edge, stamped	HEIS	—	—	X	X	X	NP	52	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	L17-L17'	Gravel lens 78 to 92 ft bgs.
299-W23-108	A7944	130.0	202.56	Top of casing, north edge, stamped	HEIS	X	—	X	X	X	NP	52	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	L17-L17'	Gravel lens 75 to 90 ft bgs.
299-W23-139	A7975	100.0	202.60	Top of casing, north edge, stamped	HEIS	X	—	X	X	X	NP	52	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	L16-L16'	—
299-W22-21	—	—	—	—	—	Gamma	—	X	X	—	0	77	NP	120	152	175	200	—	—	—	216-S-13	L18-L18'	—
299-W22-86	C4971	350.0	—	—	—	X	X	X	—	X	0	60	NP	126	157	171	185	—	—	—	219-S-13	L18-L18'	—

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
ERDF Wells																							
699-36-66B	C6219	338.0	220.452	Disc_Z	—	X	X	X	—	—	0	40	NP	NP	NP	255	264	—	—	—	ERDF	L5-L5' and L4-L4'	—
699-37-66	C5704	340.8	221.197	Disc_Z	—	X	X	X	—	—	0	50	NP	NP	NP	NP	258	—	—	—	ERDF	L5-L5'	—
699-35-66B	A5453	—	219.11	Disc_Z	—	X	X	X	—	—	NP	0	NP	NP	NP	NP	245	—	—	—	ERDF	L5-L5'	—
299-W22-88	C4978	—	213.137	Disc_Z	—	X	X	X	—	—	0	30	NP	167	194	227	260	438	—	—	ERDF	L4-L4'	—
299-W21-1	A4963	—	214.14400	Top of casing, north edge, stamped	HEIS	X	—	X	—	X	0	22	NP	175	197	231	255	—	—	—	ERDF	L4-L4'	—
699-36-63A	A5455	—	227.081	Disc_Z	—	—	X	X	—	—	0	17	NP	NP	NP	NP	265	—	—	—	ERDF	L4-L4'	—
699-36-58A	A8571	360.0	225.43100	Top of casing, north edge, stamped	HEIS	—	X	X	—	X	0	34	NP	NP	NP	NP	312	—	—	—	ERDF	L4-L4'	—
699-36-61B	A8573	568.0	229.38400	Top of casing, north edge, stamped	HEIS	—	—	X	—	X	NP	0	NP	NP	NP	NP	310	398	476	—	ERDF	L3-L3' and L4-4'	—
699-38-61	A5464	—	227.361	Disc_Z	—	—	X	X	—	—	0	57	NP	NP	NP	NP	330	—	—	—	ERDF	L3-L3'	—
699-35-61A	A5456	—	220.929	Disc_Z	—	X	X	X	—	—	NP	0	NP	NP	NP	NP	273	—	—	—	ERDF	L3-L3'	—
699-34-61	A5463	345.1	220.92	Disc_Z	—	X	X	X	—	—	0	35	NP	NP	NP	NP	265	—	—	—	ERDF	L3-L3'	—
699-38-70C	C4256	419.0	225.933	Disc_Z	—	X	X	X	—	—	0	45	NP	191	196	221	250	—	—	—	ERDF	L2-L2'	—
699-38-68A	A9516	307.0	218.21	Disc_Z	—	—	X	X	—	—	NP	0	NP	172	215	230	245	—	—	—	ERDF	L2-L2'	—
699-37-68	B2732	297.0	217.8	Disc_Z	—	—	X	X	—	—	NP	0	NP	183	189	225	241	—	—	—	ERDF	L2-L2'	—
699-35-68A	A5452	—	218.735	Disc_Z	—	X	X	X	—	—	6	17	NP	188	200	231	247	—	—	—	ERDF	L2-L2'	—
699-36-67	B2733	—	218.959	Disc_Z	—	—	X	X	—	—	NP	0	NP	190	202	237	255	—	—	—	ERDF	L2-L2' and L4-L4'	—
699-38-70B	C4236	478.5	221.821	Disc_Z	—	X	X	X	—	X	0	32	NP	170	190	225	255	449	457	—	ERDF	L1-L1'	—

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
699-38-70	A5149	413.0	217.70399	Top of casing, north edge, stamped	HEIS	—	—	X	—	X	0	30	NP	170	185	235	260	395	—	—	ERDF	L1-L1'	—
699-36-70B	C4299	427.0	214.492	Disc_Z	—	X	X	X	—	X	0	46	NP	167	193	230	250	420	—	—	ERDF	L1-L1'	—
699-35-70	A5140	325.0	212.32600	Top of casing, north edge, stamped	HEIS	X	—	X	—	X	5	33	NP	165	211	248	270	—	—	—	ERDF	L1-L1'	—
699-36-70A	A9901	440.0	215.227	Disc_Z	—	—	X	X	—	X	0	30	NP	176	204	239	255	432	—	—	ERDF	L1-L1' and L4-L4'	—
Not Vetted by 200-DV-1 Working Group																							
299-W10-16	A4893	220.0	206.162	—	—	—	X	X	X	—	5	44	NP	84	96	114	129	ETD	—	—	216-T-5, 216-T-7, 216-T-32	L3-L3'	Removed from cross section 3/25/2011.
299-W10-76	A7166	75	206.02299	—	HEIS	X	—	—	—	—	0	16	NP	56	ETD	—	—	—	—	—	216-T-5, 216-T-7, 216-T-32	—	—
299-W10-78	A7168	25	205.96001	—	HEIS	X	—	—	—	—	0	ETD	—	—	—	—	—	—	—	—	216-T-5, 216-T-7, 216-T-32	—	—
299-W10-81	A7171	23	205.83000	—	HEIS	X	—	—	—	—	0	ETD	—	—	—	—	—	—	—	—	216-T-5, 216-T-7, 216-T-32	—	—
299-W10-68	A7158	150	205.50999	—	HEIS	X	—	—	X	—	15 undif.	15 undif.	NP	90	135	—	—	—	—	—	216-T-5, 216-T-7, 216-T-32	—	—
299-W10-75	A7165	75	205.90800	—	HEIS	X	—	—	—	—	19	35	ETD	—	—	—	—	—	—	—	216-T-5, 216-T-7, 216-T-32	—	Silt layer within Hf2, 35 to 41 ft bgs.
299-W10-51	A7141	148	205.73500	—	HEIS	X	—	—	—	—	10	40	NP	60	92	100	103	ETD	—	—	216-T-5, 216-T-7, 216-T-32	—	—
299-W10-169	A7252, C5694	124	—	—	—	X	—	—	—	—	8	43	NP	86	95	112	115	ETD	—	—	216-T-14, 216-T-17	—	—

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
299-W11-81	A7323	52	—	—	—	X	—	—	—	—	0	?	ETD	—	—	—	—	—	—	—	216-T-14, 216-T-17	—	A great deal of contamination. Unable to discern Hf1/Hf2.
299-W11-22A	A9794	248?	—	—	—	X	—	—	—	—	0	40	NP	118	131	NP	140	?	—	—	216-T-14, 216-T-17	—	A great deal of contamination.
299-W11-39	C3117	280.0	209.88499	Disc_Z	—	X	X	X	—	X	3	34	NP	89	98	119	130	—	—	—	216-T-14, 216-T-17	—	—
299-W10-101	A7191	—	—	—	—	X	—	—	X	X	NP	39	NP	80	88	—	—	—	—	—	216-T-14, 216-T-17	—	—
299-W10-105	A7195	—	—	—	—	X	—	—	—	X	NP	38	NP	81	88	—	—	—	—	—	216-T-14, 216-T-17	—	—
299-W11-27	A4907	—	—	—	—	X	—	—	—	X	8	38	NP	83	95	118	125	—	—	—	216-T-14, 216-T-17	—	—
299-W10-27	C3125	268.7	204.89900	Disc_Z	—	—	X	X	—	X	4	44	NP	89	98	113	125	—	—	—	216-T-18, 216-T-26	—	—
299-W14-1	A4913	240.0	—	—	—	X	—	—	—	X	5	29	NP	88	96	119	124	—	—	—	216-T-18, 216-T-26	—	—
299-W14-5	—	240.0	—	—	—	—	—	X	X	X	10	29	NP	80	99	NP	120	—	—	—	216-T-19	—	—
299-W22-63	A7870	149.7	208.64101	Top of casing, north edge, stamped	HEIS	X	—	—	—	—	0	60	ETD	—	—	—	—	—	—	—	216-S-21	—	Contact based on K plot.
299-W15-22	A4925	—	—	—	—	X	—	X	—	X	0	47	NP	102	110	120	126	—	—	—	216-T-21, 216-T-25	—	—
299-W15-44	C3956	340.4	204.16800	Disc_Z	—	X	X	X	—	—	0	35	NP	101	108	NP	124	—	—	—	216-T-21, 216-T-25	—	—
299-W15-73	A7374	—	—	—	—	—	—	—	—	X	0	42	NP	102	111	120	128	—	—	—	216-T-21, 216-T-25	—	—
299-W15-81	A7382	117.0	—	—	—	X	—	—	—	—	12	33	83	113	ETD	—	—	—	—	—	216-T-21, 216-T-25	—	—
699-33-74	C4973	350.0	205.4	Disc_Z	—	X	X	X	—	—	NP	15	177.0	196.0	203.0	216.0	221.0	—	—	—	216-S-14	—	—
299-W10-52	A7142	148.0	205.887	—	—	X	—	—	—	—	0	40	NP	82	93	113	212.0	—	—	—	216-T-5, 216-T-7, 216-T-32	—	—

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	H2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
C6412	C6412	96.0	205.38	—	—	X	—	—	—	—	13	28	NP	87	ETD	—	—	—	—	—	216-T-18, 216-T-26	—	Silt layer 28 to 32 ft bgs.
299-W10-24	B8546	432.5	209.725	—	—	X	—	—	—	—	7	42	56	83	94	117	128.0	—	—	—	216-T-14, 216-T-17	—	—
299-W14-53	A7337	100.0	206.089	—	—	X	—	—	—	—	10	53	NP	92	101	112	123.0	—	—	—	216-T-18, 216-T-26	—	—
C6410	C6410	95.9	205.2	—	—	X	—	—	—	—	13	27	NP	86	ETD	—	—	—	—	—	216-T-18, 216-T-26	—	Silt layer 27 to 40 ft bgs?
299-W10-168	A7251	122.0	205.653	—	—	X	—	—	—	—	0	35	NP	83	92.5	107	122.0	—	—	—	216-T-5, 216-T-7, 216-T-32	—	Silt stringer at 49 ft bgs.
C4105	C4105	131.0	—	—	—	X	—	—	—	—	0	36	NP	80.5	92.5	105	118.0	—	—	—	216-T-5, 216-T-7, 216-T-32	—	—
C6411	C6411	96.0	205.26	—	—	X	—	—	—	—	15	27	NP	88	ETD	—	—	—	—	—	216-T-18, 216-T-26	—	Silt layer 27 to 32 ft bgs?
C4104	C4104	126.0	—	—	—	X	—	—	—	—	Could be backfill or Hf1	40.0	NP	80.5	92.5	104	120.7	—	—	—	216-T-5, 216-T-7, 216-T-32	—	—
299-W15-74	A7375	150.0	204.454	—	—	X	—	—	—	—	0	40	NP	94	108	120	131	—	—	—	216-T-21, 216-T-25	—	—
299-W15-110	A7409	100.0	204.852	—	—	X	—	—	—	—	0	50	NP	98	ETD	—	—	—	—	—	216-T-21, 216-T-25	—	—
299-W15-111	A7410	100.0	204.651	—	—	X	—	—	—	—	4	48	NP	89	ETD	—	—	—	—	—	216-T-21, 216-T-25	—	—
299-W15-129	A7428	100.0	205.183	—	—	X	—	—	—	—	9	49	NP	ETD	—	—	—	—	—	—	216-T-21, 216-T-25	—	—
299-W15-131	A7430	100.0	204.844	—	—	X	—	—	—	—	18	48	NP	ETD	—	—	—	—	—	—	216-T-21, 216-T-25	—	—
299-W15-135	A7434	100.0	204.995	—	—	X	—	—	—	—	3	49	NP	98	ETD	—	—	—	—	—	216-T-21, 216-T-25	—	—
299-W15-137	A7436	100.0	204.796	—	—	X	—	—	—	—	4	48	NP	99	ETD	—	—	—	—	—	216-T-21, 216-T-25	—	—
299-W15-154	A7452	105.0	205.192	—	—	X	—	—	—	—	2	50	NP	ETD	—	—	—	—	—	—	216-T-21, 216-T-25	—	—

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
299-W15-156	A7454	105.0	204.832	—	—	X	—	—	—	—	6	48	NP	ETD	—	—	—	—	—	—	216-T-21, 216-T-25	—	—
299-W15-179	A7477	100.0	205.21	—	—	X	—	—	—	—	2	48	NP	ETD	—	—	—	—	—	—	216-T-21, 216-T-25	—	—
299-W15-180	A7478	100.0	204.542	—	—	X	—	—	—	—	0	46	NP	95	ETD	—	—	—	—	—	216-T-21, 216-T-25	—	—
299-W23-109	A7945	75.0	202.56	Top of casing, north edge, stamped	HEIS	—	—	X	X	X	51	—	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W23-58	A7894	101.0	202.73	Top of casing, north edge, stamped	HEIS	X	—	X	X	X	52	87	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W23-20	C3112	260	203.095	Top of casing, stamped X	HEIS	—	X	X	—	—	0	36	NP	117	130?	NP?	169	—	—	—	216-S-21, 216-S-25	—	—
299-W23-13	A4982	143.0	203.255	—	—	—	—	—	—	X	10	45	NP	123	140	NP	151	—	—	—	216-S-21, 216-S-25	—	—
299-W22-37	A7856	335	210.54	Top of casing, north edge, stamped	HEIS	X	—	X	X	—	0	73	NP	—	—	—	—	—	—	—	216-S-23, 216-S-9	—	Sand 42 to 48 ft bgs. Alternating sand/silt layers in Hf1 (thick and interlacing).
299-W23-114	A7950	75.0	202.54	Top of casing, north edge, stamped	HEIS	—	—	X	X	X	51	—	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W23-115	A7951	75.0	202.58	Top of casing, north edge, stamped	HEIS	—	—	X	X	X	51	—	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
299-W23-121	A7957	125.0	202.49	Top of casing, north edge, stamped	HEIS	—	—	X	X	X	53	91	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W23-144	A7980	100.0	202.59	Top of casing, north edge, stamped	HEIS	—	—	X	X	X	53	84	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W23-176	A8012	100.0	203.18	Top of casing, north edge, stamped	HEIS	X	—	—	X	—	50	71	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W23-196	A8032	100.0	202.59	Top of casing, north edge, stamped	HEIS	X	—	X	X	—	50	85	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W23-208	A8044	105.0	203.11	Top of casing, north edge, stamped	—	X	—	—	X	—	50	75	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W23-21	C3113	—	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W19-6	A4959	—	—	—	—	Gamma	—	X	X	—	—	—	—	—	—	—	—	—	—	—	216-S-23, 216-S-9	—	—
299-W22-34	A7853	—	207.845	Top of casing, north edge, stamped X	HEIS	Gamma	—	X	X	—	—	—	—	—	—	—	—	—	—	—	216-S-9, 216-S-23	—	—
299-W22-35	A7854	—	209.521	Top of casing, north edge, stamped X	HEIS	Gamma	—	X	X	—	—	—	—	—	—	—	—	—	—	—	216-S-9, 216-S-23	—	—

Table B-1. FESI 200-DV-1 Operable Unit Lithologic Contact Picks

Well Name	Well ID	Total Depth (ft bgs)	Elevation (m)	Type	Source	Geophysical Log	Borehole Log	As-Built	Driller's Log	PNNL (06-30-2010)	Top Hf1 (ft bgs)	Top H2 (ft bgs)	Hf2-Lower Coarse (ft bgs)	Top CCUz (ft bgs)	Top CCUc (ft bgs)	Top RFtf (ft bgs)	Top RFwie (ft bgs)	Top RFlm (ft bgs)	Top RFwia (ft bgs)	Basalt (ft bgs)	Waste Site/Area	Cross Section	Notes
299-W23-210	A8045	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W22-53	A7860	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W23-107	A7943	—	—	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W23-116	A7952	—	—	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W23-120	A7956	—	—	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W23-227	A8054	—	—	—	—	—	—	X	X	—	—	—	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
299-W23-71	A7907	—	—	—	—	—	—	—	X	—	—	—	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
C4890	C4890	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—
C4891	C4891	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	216-S-21, 216-S-25	—	—

bgs = below ground surface
CCU = Cold Creek unit
CCUc = Cold Creek unit – calcic geosol
CCUz = Cold Creek unit – silt-dominated
ERDF = Environmental Restoration Disposal Facility
ETD = estimated total depth
HEIS = Hanford Environmental Information System
Hf1 = Hanford formation unit 1
Hf2 = Hanford formation unit 2
ID = identification
NP = not present
PNNL = Pacific Northwest National Laboratory
RFlm = Ringold Formation lower mud unit
RFtf = Ringold Formation member of Taylor Flat
RFwia = Ringold Formation member of Wooded Island – unit A
RFwie = Ringold Formation member of Wooded Island – unit E

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