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Station # 12

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

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16. KEY

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1/2	1	Cog. Mgr. R. A. Carlson	RACarlson	12/15/93	H6-03	IRA Clearance (2)			H4-17	3	
1/2	1	QA ~~R.L. Hand~~ W.R. Thackaberry	W.R. Thackaberry		H4-16	Central Files (2)			L8-04	3	
		Safety				Lead Regulatory Agency Rep.				1/2	1
		Env.				D. Goswami	[signature]				

18.	19.	20.	21. DOE APPROVAL (if required)
B. E. Innis [signature] 12/15/93 Signature of EDT Originator / Date	Authorized Representative for Receiving Organization / Date	R.A. Carlson RACarlson 12/15/93 Cognizant/Project Engineer's Manager / Date	Ltr. No. [] Approved [] Approved w/comments [] Disapproved w/comments

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Date Release Required: 11-19-93

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Unclassified Category: UC-630

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New or novel (patentable) subject matter? [X] No [] Yes
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[] No [] Yes Disclosure No(s).

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Information conforms to all applicable requirements. The above information is certified to be correct.

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Transmit to DOE-HQ/Office of Scientific and Technical Information	[X]	[]

Author/Requestor (Printed/Signature) Date

B.E. Innis [signature] 12-15-93

Intended Audience

[] Internal [] Sponsor [X] External

Responsible Manager (Printed/Signature) Date

R.A. Carlson [signature] 12/17/93

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Part 1

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SUPPORTING DOCUMENT

1. Total Pages 65

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Description of Work for 200-UP-1 Characterization of Monitoring Wells

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WHC-SD-EN-AP-151

4. Rev No.

0

5. Key Words

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6. Author

Name: B.E. Innis / G.G. Kelty

Signature

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APPROVED FOR PUBLIC RELEASE

7. Abstract

Innis, B.E., and G.G. Kelty, *Description of Work for Characterization of 200-UP-1 Monitoring Wells*, WHC-SD-EN-AP-151, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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ACRONYMS

ALARA	as low as reasonably achievable
ASTM	American Society for Testing and Materials
BWIP	Basalt Waste Isolation Project
CERCLA	*Comprehensive Environmental Response Compensation and Liability Act of 1980*
DOW	Description of Work
Ecology	Washington State Department of Ecology
EFS	Environmental Field Services
EPA	U.S. Environmental Protection Agency
HEIS	Hanford Environmental Information System
IRM	interim remedial measures
PID	photoionization detector
RCRA	*Resource Conservation and Recovery Act of 1976*
RWP	radiation work permit
VOA	volatile organic analysis

CONTENTS

APPENDIXES:

FIGURES:

CONTENTS (Continued)

TABLES:

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1.0 SCOPE OF WORK

This description of work (DOW) details the field activities associated with the drilling, soil sampling, and construction of groundwater monitoring and dual-use wells in the 200-UP-1 Operable Unit (Tasks 2, 3, and 5 in the 200-UP-1 RI/FS Work Plan DOE/RL 1993a) and will serve as a field guide for those performing the work. It will be used in conjunction with the *Remedial Investigation/Feasibility Study Work Plan for the 200-UP-1 Groundwater Operable Unit* (DOE-RL 1993a, [LFI]) and *Site Characterization Manual* (WHC 1988a). Groundwater wells are being constructed to characterize the vertical and horizontal extent of the Uranium and ^{99}Tc plumes and to define aquifer properties such as hydraulic communication between aquifers and hydrostratigraphy. Some of these wells may be utilized for extraction purposes during the IRM phase anticipated at this operable unit and are being designed with a dual use in mind. These data will be used to optimize the Interim Remedial Measures (IRM) for the cleanup of these two plumes. The data will also be used with later Limited Field Investigation (LFI) data to perform a Qualitative Risk Assessment (QRA) for the operable unit. The locations for the proposed groundwater wells are presented in Figure 1. The contaminants of concern for the project are presented in Table 1.

1.1 PROPOSED ACTIVITIES

The following sections supply the general criteria and activities for proposed monitoring and dual-use well installation. Detailed data on waste volumes, contaminants, and system history are contained in the *U Plant Aggregate Area Management Study Report* (DOE/RL 1992) and the *200 West Groundwater Aggregate Area Management Study Report* (DOE/RL 1993b). Specific details for scope of work are contained in the *Remedial Investigation/Feasibility Study Work Plan for the 200-UP-1 Groundwater Operable Unit* (DOE-RL 1993a).

1.1.1 216-U-1, 216-U-2, and 216-U-17 Cribs

Five groundwater monitoring wells will be constructed to better define the horizontal and vertical extent of the uranium, ^{99}Tc, and nitrate plumes. Two of these wells (UP1-4 and UP1-7) will be designed as standard monitoring wells per the WHC-S-014 "Generic Well Specification." The other three wells (UP1-2, 3, and 6) will be designed as dual-use wells that may be utilized for extraction purposes during the IRM at this operable unit. These plumes are associated with waste discharges from U-Plant and are centered around the 216-U-1, 216-U-2 and 216-U-17 Cribs. The extent of the plumes is defined by the existing monitoring wells near the cribs, which supply limited plume definition to the north and east of the cribs. Vertical characterization of the plumes is also limited because of the lack of wells that monitor discrete vertical intervals. Well UP1-1, discussed in the work plan to be installed to the north if Well 299-W19-4 was not usable, will no longer be necessary. Recent vertical profiling samples have indicated that Well 299-W19-4 is usable for monitoring the upper unconfined aquifer. Also, data collected recently from Well 299-W19-4 indicate that the uranium and ^{99}Tc plumes have not moved that far north.

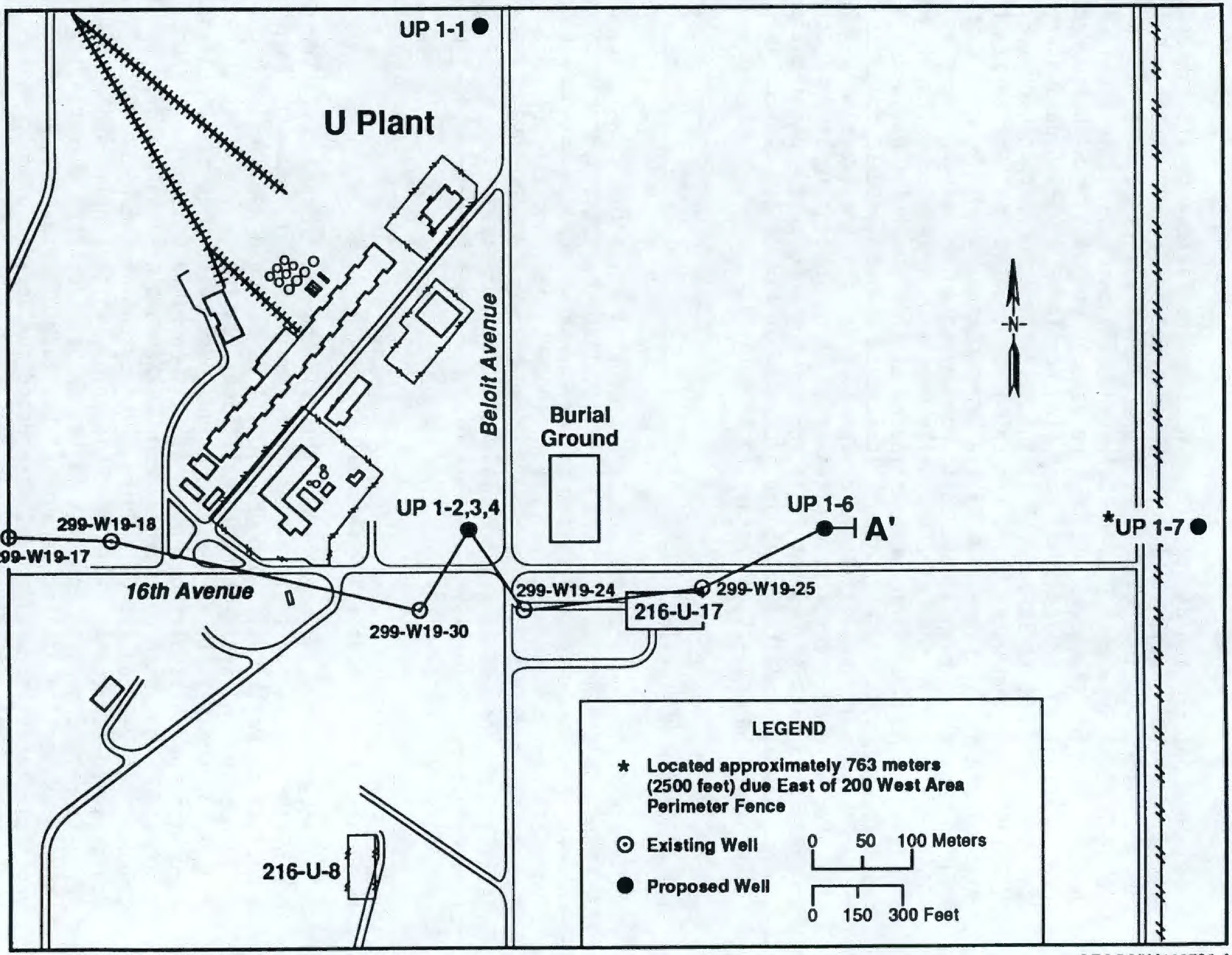

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Figure 1. Site Location and Cross Section Map.

Table 1. Analytical Methods for Target Analytes (Perched Water).
(sheet 1 of 3)

Analyte [a]	General Analytical Technique [b]	Water Analysis Method	Container and Volume [c]	Comments
Gross Alpha Gross Beta	Gas proportional	h	f	--
VOCs	GC/MS	CLP-VOAs	Gs 3 x 40mL	Gs 2X40 mL
Semi-Volatile Organic Contaminants	GC/MS	CLP Semi-VOAs	aG 3 x 2L	
All Identifiable and Quantifiable Isotopes	Gamma Spectrometry	h	f	
Total Uranium	Fluorometric	k	P/G 1L	
Iodine-129 Strontium-90 Technetium-99 [e]	Beta Counting	h	f	
Carbon-14	Beta Counting	h	G/P 1L	
Nitrate Nitrite	Colorimetric	353.2	P/G 300 mL	P/G 500 mL for Weston
Fluoride	Ion Chromatography	300	300 mL	G 500 mL for Weston
Americium-241 Curium-244 Neptunium-237 Plutonium-238 Plutonium-239/240 Uranium-234 [d] Uranium-235 [d] Uranium-238 [d]	Alpha Spectrometry	h	f	May also use gamma spectrometry

Table 1. Analytical Methods for Target Analytes (Perched Water).
(Sheet 2 of 3)

Analyte[a]	General Analytical Technique[b]	Water Analysis Method	Container and Volume[j]	Comments
Cyanide	Colorimetric	CLP-TAL	p 1000 mL	G 1000 mL
Tritium	Scintillation	h	Gs 250 mL	
Arsenic Selenium	Graphite Furnace Atomic Absorption	CLP-TAL	g	
Mercury	Cold Vapor Atomic Absorption	CLP-TAL	g	
Aluminum Antimony Barium Beryllium Cadmium Calcium Chromium Cobalt Copper Iron Lead Magnesium Manganese Mercury Nickel Potassium Silver Sodium Thallium Vanadium Zinc	ICP Analysis	CLP-TAL	g	– – – – P 500 mL Weston – – – –

G = Glass; P = Plastic; Gs = Glass septum w/zero headspace; aG = amber Glass
TBD = To Be Determined
M = method modified to include extraction from the solid medium, extraction method is matrix and laboratory-specific
Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA 1980a)
Test Methods for Evaluating Solid Waste (SW 846) Third Edition (EPA 1986)
Methods for Chemical Analysis of Water and Waste (EPA 1983)
Radionuclide Method for the Determination of Uranium in Soil and Air (EPA 1980b)

Table 1. Analytical Methods for Target Analytes (Perched Water). (sheet 3 of 3)

EML Procedures Manual (DOE/EML 1990)
Eastern Environmental Radiation Facility RadioChemistry Procedures Manual (EPA 1984)
High-Resolution Gamma-Ray Spectrometry of Water (ASTM 1985)

a/In addition to the analytes listed in this table, there are many progeny isotopes whose concentrations may be derived from known parent concentrations. Radionuclides related to U-238 include: Th-230, Bi-210, Bi-214, Po-214, and Po-218. Radionuclides related to U-235 include: Th-231, Tl-207, Pb-211, Pb-214, and Bi-211. Nb-93m is related to Zr-93. Pu-241 concentrations are inferred from Pu-238, Pu-239, and Pu-240. The radionuclides listed in parenthesis under the analyte column are measured as part of the analysis of the adjacent radionuclide.

b/The analytical techniques are listed in the order that they should be performed. Gross alpha, gross beta, and VOA analyses will always be done first. Gamma Spectrometry will be done next because it generally does not require destruction of any sample. Alpha spectrometry, Sr-90 and Tc-99 analyses will next be done if sufficient sample exists. The next priority is to perform ICP analyses. Approximately 2 lbs (1 kg) of material will be required to perform these primary analyses. If more sample exists, then several additional, secondary analyses may be performed. These are shown on the table below the ICP analysis. In borings, additional drive samples should be collected, if possible, to insure that all analyses can be run.

c/These analytical methods should be considered examples of possible analytical techniques to use. Individual labs may have other techniques developed for some analytes.

d/The uranium analyses will be conducted periodically to confirm the uranium concentrations calculated from the Pa-234m or Pa-231 analyses. Two samples from each deep boring and one sample from each test pit or shallow boring will undergo this confirmatory analysis. No uranium analyses will be done on surface soil or sediment samples.

e/Analytes that will be studied by beta counting are listed in the order that they should be analyzed. For instance, the Sr-90 analysis should be made first, followed by the Tc-99 analysis.

f/ All samples submitted for offsite radionuclide analysis will be placed in 9 P/G 1000 mL bottles.

g/ All samples submitted for CLP-Metals analysis will be placed in a P 1000 mL bottle.

h/ Analytical methods for radionuclide analysis are laboratory specific and by contract with WHC, must meet analytical requirements for level IV. (Examples of standard methods include ASTM D3549, ASTM D3865, ASTM D3972, ASTM D2334.)

i/ Samples collected for the 200-UP-1 Limited Field Investigation (LFI) activities that require analysis for kerosene will be analyzed at TMA by SW-846 method 8015. Kerosene is not listed in the SW-846 reference procedure as a compound that is included on the target list for 8015, Non-Halogenated Volatile Organics. Through its contract with WHC, TMA has adapted method 8015 to include kerosene as a target compound using its characteristic "fingerprint."

j/ Volumes listed are for TMA except where noted in comment column for split analysis where bottle size differs.

k/ This analysis will be run on site at 222-S lab, the procedure is lab specific and is on file and available for review at the lab.

l/ Technetium analysis will be run at an onsite lab as well as offsite, but only on the rapid turnaround samples necessary from well UP1-3 during its construction to determine whether to construct well UP1-4 in the well cluster. Analysis will still be by beta counting and bottle requirements are similar to the total uranium analysis requirements.

To better define the horizontal extent of the subject plumes, two wells will be installed in the upper unconfined aquifer. Well UP1-6, located slightly north and east of the 216-U-17 Crib, will be used to further delineate the uranium plume and the concentration ranges in the nitrate and ^{99}Tc plumes and will be designed as a dual-use well. Well UP1-7 will be located to the east of UP1-6 and will be used to define the boundaries of the uranium and ^{99}Tc plumes and to help track the nitrate plume.

To better define the vertical extent of the subject plumes, a three-well cluster site (UP1-2, 3, 4) will be constructed that will monitor the vertical distribution of contaminates within deeper portions of the unconfined and confined aquifers. The two wells from this cluster that are in the unconfined aquifer (UP1-2, 3) will also be designed as dual-use wells.

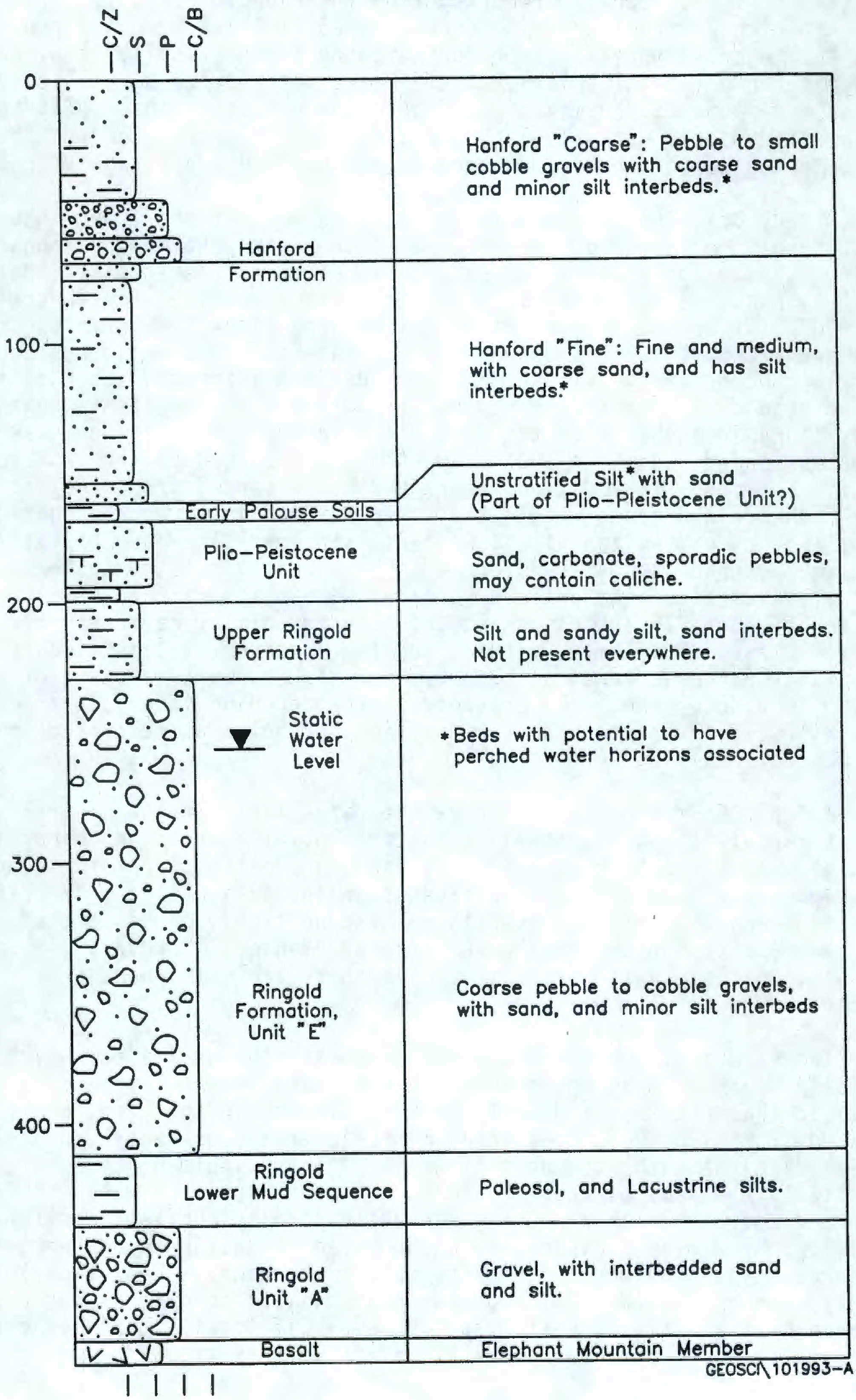
1.2 GENERAL SITE GEOLOGY AND HYDROLOGY

Suprabasalt sediments underlying the central UP-1 area include, from the surface downward, Holocene eolian sands, the Hanford formation, the early Palouse/Plio-Pleistocene interval, and the Ringold Formation. These strata overlie basalts of the Columbia River Basalt Group. The geology of this area is outlined in the following text. More detailed discussions of Hanford Site and 200 West Area geology can be found in Myers et al. (1979), Tallman et al. (1979, 1981), Reidel and Fecht (1981), DOE (1988), Delaney et al. (1991), Lindsey (1991), Lindsey et al. (1992), and Connelly et al. (1992). A generalized stratigraphic column for the 200-UP-1 Operable Unit is presented in Figure 2.

Holocene-aged deposits form the uppermost unit in the area. These deposits consist of eolian silt and sand that forms a thin (<10 ft), discontinuous sheet across the site.

The uppermost laterally continuous unit in the area is the Hanford formation. The Hanford formation consists of an upper gravelly interval (25 to 100 ft thick) and a lower, finer interval (10 to 100 ft thick). Stratified, open-framework, and largely uncemented granule-to-cobble gravel deposits typical of the gravel-dominated facies (see Lindsey et al. 1992) dominate the upper interval. Localized interbeds of the sand- and silt-dominated facies also may be present in the upper interval. Interstratified strata typical of both the sand-dominated and silt-dominated facies form the Touchet bed-like strata of the lower interval. Silt-rich horizons within the lower interval may be well compacted and partially cemented by calcium carbonate. The lower interval also may contain pebbly horizons up to 5 ft thick. Examination of recently drilled (FY 1993), closely spaced borehole geologic logs in the U-14 Ditch area and outcrops of analogous strata (at the White Bluffs several miles northeast of the operable unit) indicate that individual beds may be very discontinuous, commonly pinching out over a distance of a few hundred feet.

Figure 2. General Stratigraphic Section of the 200-UP1 Operable Unit.



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The Plio-Pleistocene/early Palouse interval consists of locally derived basaltic detritus, deposits reworked from the Ringold Formation, and calcium carbonate-rich paleosols ranging from 1 to 25 ft thick. In the central UP-2 area, the interval appears to be dominated by a mix of silt, sand, and gravel containing thin (<1-in. thick), calcium carbonate horizons, (caliche) coated clasts, and nodules. Examination of borehole geologic logs, split-tube samples, and Basalt Waste Isolation Project (BWIP) cores suggests that the well-cemented carbonate horizons may be discontinuous and highly fractured.

Recent drilling at the U-14 Ditch revealed that the lower interval of the Hanford formation and the Plio-Pleistocene/early Palouse carbonate horizons are commonly cross-cut by clastic dikes. Clastic dikes, described in detail by Black (1979), most commonly consist of vertical to subvertical layers of silt and sand that cut across bedding planes. The presence of these dikes coupled with the abundance of laterally discontinuous beds in the Plio-Pleistocene/early Palouse and lower Hanford intervals suggests that perched groundwater intervals may be of limited lateral extent. Again, recent observations in the area of the U-14 Ditch indicate this is the case; boreholes spaced less than 300 ft apart never reported perched water twice in the same horizon. In addition, where perched water was reported, it was found above fine-grained zones within the lower Hanford interval (Touchet-like beds), and not at the top of the Plio-Pleistocene. The lack of laterally extensive perched waters is inferred to be directly related to the absence of laterally extensive fine-grained horizons within the Hanford formation, the absence of laterally extensive and unfractured calcium carbonate horizons in the Plio-Pleistocene/early Palouse, and the presence of clastic dikes that potentially acted as vertical pathways for the downward movement of water within the vadose zone. The presence of the perching intervals as described above will define the methods for drilling boreholes as described in Section 3.2, General Drilling Activities.

Ringold Formation strata above the water table in the central UP-1 area consist largely of the partially cemented fluvial gravels and minor sands and silts of unit E. Interbedded fluvial sands and paleosols of the Ringold Formation upper unit also may be present in the area of the U-17 Crib. Cemented zones and silt layers within these units may cause perched conditions, although this has never been documented. However, with current data it is not clear if horizons such as these are continuous or discontinuous.

The saturated thickness of unit E beneath the UP-1 area, which is generally considered an unconfined aquifer, ranges from approximately 200 ft (61 m) in the northwest and west to 155 ft (47 m) in the east. Partially cemented fluvial gravels containing minor intercalated sandy and silty zones characterize the saturated part of unit E. These sediment types are essentially the same as those found in the unit above the water table. Well indurated and silt-rich zones that generate locally confined aquifer conditions have been occasionally encountered in unit E in the northern 200 West area. The presence of cemented zones in coreholes DH-7 (W19-10), DH-12 (W14-7), and DH-13A (W14-8A) suggests that similar conditions may occur in the southern half of the 200 West Area. However, if locally confined conditions occur, it is not clear how laterally extensive they are.

Silt-rich paleosols and lacustrine deposits of the lower mud unit underlie Ringold unit E throughout the UP-1 area. The top of the lower mud unit ranges from approximately 300 ft (91.5 m) above sea level in the eastern part of the area to 250 ft (76 m) in the west. Localized highs (near W18-22) and lows (near W19-10) may be present on this surface. The lower mud unit forms the base of the unconfined aquifer zone in the 200 West Area. No pathways through the lower mud unit into underlying units (such as erosional windows) are known to occur in the southern 200 West Area. Therefore all water-bearing geologic units occurring below the lower mud unit in the UP-1 area are considered confined aquifers.

Fluvial gravels similar to those that form unit E comprise the lowest unit in the Ringold Formation, unit A. Intercalated fluvial sand and mud-rich zones can be found in unit A. Unit A is present beneath the entire site and directly overlies basalt. This unit forms the lowest zone in the suprabasalt aquifer system beneath the 200 West Area and is considered a confined aquifer system.

2.0 GENERAL REQUIREMENTS

2.1 HEALTH AND SAFETY

All personnel working to this DOW will have completed the 40-hr Hazardous Waste Site Worker Training Program and will perform all work in accordance with the following:

- WHC-CM-7-7, *Environmental Investigations and Site Characterization Manual* (EII) (WHC 1988a)
- WHC-CM-7-5, *Environmental Compliance Manual* (WHC 1988b)
- WHC-CM-1-6, *Radiological Control Manual* (WHC 1993c)
- WHC-IP-0692, *Health Physics Procedures Manual* (WHC 1991)
- WHC-CM-4-11, *ALARA Program* (WHC 1988d)
- WHC-EP-0383, *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan* (WHC 1990)
- WHC-CM-4-3, *Industrial Safety Manual*, Vol. 1 through 4 (WHC 1987)
- Site-specific health and safety plan/radiation work permits/job safety analysis.

2.2 PREREQUISITES

The requirements and procedures applicable to the 200-UP-1 Operable Unit field activities are specified in the *Environmental Investigations and Site Characterization Manual* (WHC 1988a). Applicable EIIs include the following:

EII 1.1	"Hazardous Waste Site Entrance Requirements"
EII 1.5	"Field Logbooks"
EII 1.13	"Readiness Review"
EII 2.1	"Preparation of Hazardous Waste Operations" Permit
EII 3.2	"Calibration and Control of Monitoring Instruments"
EII 3.4	"Field Screening"
EII 4.3	"Control of CERCLA and Other Past-Practice Investigation Derived Waste"
EII 5.1	"Chain of Custody"
EII 5.2	"Soil and Sediment Sampling"
App. B	"Split-Spoon Sampling"
EII 5.4	"Field Decontamination of Drilling, Well Development, and Sampling Equipment"
EII 5.5	"1706 KE Laboratory Decontamination of RCRA/CERCLA Sampling Equipment"
EII 5.7A	"Hanford Geotechnical Sample Library Control"
EII 5.10	"Obtaining Sample Identification Numbers and Accessing HEIS Data"
EII 5.11	"Sample Packaging and Shipping"
EII 6.7	"Documentation of Well Drilling and Completion Operations"
EII 9.1	"Geologic Logging"
EII 11.1	"Geophysical Logging"

Each item on the checklist for tasks requiring no readiness review (EII 1.13, "Engineering and Geotechnology Readiness Review" [WHC 1988a]) will be signed and dated by the cognizant engineer or field team leader (FTL) prior to the start of work.

3.0 FIELD ACTIVITIES

The following sections detail the activities to be conducted for the drilling, sampling, analysis, and construction of groundwater wells in the UP-1 Operable Unit. Background information applicable to these activities is presented in DOE-RL (1993a), Section 5.1.3, LFI Field Activities and its subsections (excerpted and attached as appendix A to this document). For the locations of these proposed monitoring wells, see Figure 1 (Site Map) of this document. The primary contaminants of concern for the project include uranium, ^{99}Tc, and Nitrate to support decisions to be made on the Interim Remedial Measures (IRM) phase at this operable unit. Additional analyses will be performed for other radionuclides, VOCs, Semi-VOCs, and metals that are presented in more detail in Table 1.

3.1 CONTAMINANTS OF CONCERN

The primary contaminants of concern for the project include uranium, ^{99}Tc, and nitrate to support decisions to be made on the IRM phase at this operable unit. Additional analyses will be performed for other radionuclides, VOCs, semi-VOCs, and metals that are presented in more detail in Table 1.

3.2 SCREENING, BACKGROUND, AND BASELINE ACTIVITIES

All samples and cuttings will be field screened for radionuclides and for evidence of carbon tetrachloride, which is the indicator species for organics. Soil screening for carbon tetrachloride will be conducted using a photoionization detector (PID) equipped with an 11.7 eV lamp. Radionuclides will be screened by alpha and beta-gamma counting instruments. Field screening will be performed in accordance with EII 3.4, "Field Screening." The action level is twice background, as specified in DOE/RL (1993a), and is based on 95% confidence that anthropogenic species are identified. The action level for carbon tetrachloride screening is 5 ppm. All instruments will be used, maintained, and calibrated consistent with EII 3.2, "Calibration and Control of Monitoring Instruments," and EII 3.4, "Field Screening." The field geologist will record screening results on the borehole log (EII 9.1), "Geologic Logging" [WHC 1988a]).

Prior to start of drilling, a one-time background level for radiation will be established outside each drill site. The health physics technician (HPT) will select the appropriate location for the background survey. Instrument background will be measured holding the device less than 2.54 cm (1 in.) from soil excavated from a depth of 15.24 cm (6 in.). The field geologist will record the background levels on a field activity report per EII 6.7 (WHC 1988a).

A radiological baseline will be established at each drill site before drilling and after each borehole is completed. This activity will be performed to ensure that instrument background is defined at each site and that the drill pads are restored to pre-drilling radiological levels. Screening results will be recorded on the field activity report per EII 6.7 (WHC 1988a).

3.3 GENERAL DRILLING ACTIVITIES

The following sections describe the general drilling activities that will be conducted at each drill site. All drilling will be conducted utilizing the specifications and guidance presented in the *Washington Administrative Code* (WAC) 173-160 Part Three--"Resource Protection Wells," and the "Generic Well Specification," WHC-S-014. It should be noted that the requirements presented in the WAC in Section 173-160-500, Item 2 (No resource protection well shall interconnect saturated formations or aquifers) are not being violated when casing is carried through perching layers above the caliche layer. Previous drilling conducted in the area and the site conceptual model have shown that perching layers above the caliche layer are discontinuous and the water reported can be treated as a single hydrologic unit. No technical purpose would be served by attempting to seal individual silt or clay beds that occur in the lower fine-grained units of the Hanford formation (Touchet-like beds). The perching units expected are typically several centimeters to no more than 0.305 m (1 ft) thick and are laterally discontinuous (see Appendix B for cross sections). Layers thicker than 1.5 m (5 ft) are not expected; however, if they occur and perched water is reported, the Washington State Department of Ecology (Ecology) will be informed and an evaluation will be performed to determine if casing will be downsized.

In support of the 200-UP-1 Operable Unit field investigations, five borings will be drilled, sampled, and then converted to either standard monitoring or dual-use wells. The borings may be drilled using the cable-tool or other approved drilling method. The drilling operations will be conducted according to EII 6.7, "Resource Protection Well and Test Borehole Drilling," and EII 5.4, "Field Decontamination of Drilling, Well Development, and Sampling Equipment" (WHC 1988a). All waste will be handled according to EII 4.3, "Control of CERCLA and other Past-Practice Investigation Derived Waste" (WHC 1988a). Temporary casing will be used to minimize slough in the borehole and limit the transport of gross contamination if encountered. All boreholes will be constructed to ensure that 8-in. temporary casing is utilized in drilling to the screened interval.

Borings UP1-6 and UP1-7 will be constructed to monitor the top of the unconfined aquifer (saturated portion of Ringold unit E) and will be drilled in the following manner (Figure 3):

- Casing string #1. Large-diameter casing will be run to a minimum of 5.9 m (20 ft) below ground surface and will not be carried deeper than 12.2 m (40 ft). If radiological contamination is encountered, the casing will be carried to depth where contamination drops below 5000 cpm or to a depth of no greater than 12.2 m (40 ft).

- Casing string #2. Smaller diameter secondary casing will be telescoped through casing string #1 and carried to the top of the caliche layer or to the depth that the caliche layer is estimated to occur. If radiological contamination is encountered, casing will be carried to a point where contamination drops below established background levels for the site or to the top of the caliche layer, whichever occurs first.

- Casing string #3. Smaller diameter intermediate casing will then be telescoped through casing string #2 and carried to first reported water (Table 2). The borehole will be allowed to equilibrate for 1 hr to establish a static water level. The casing will then be advanced 30 ft below static water level and a soil sample will be obtained

Figure 3. Proposed Depths of Temporary Casing Strings With Generalized Stratigraphic Column.

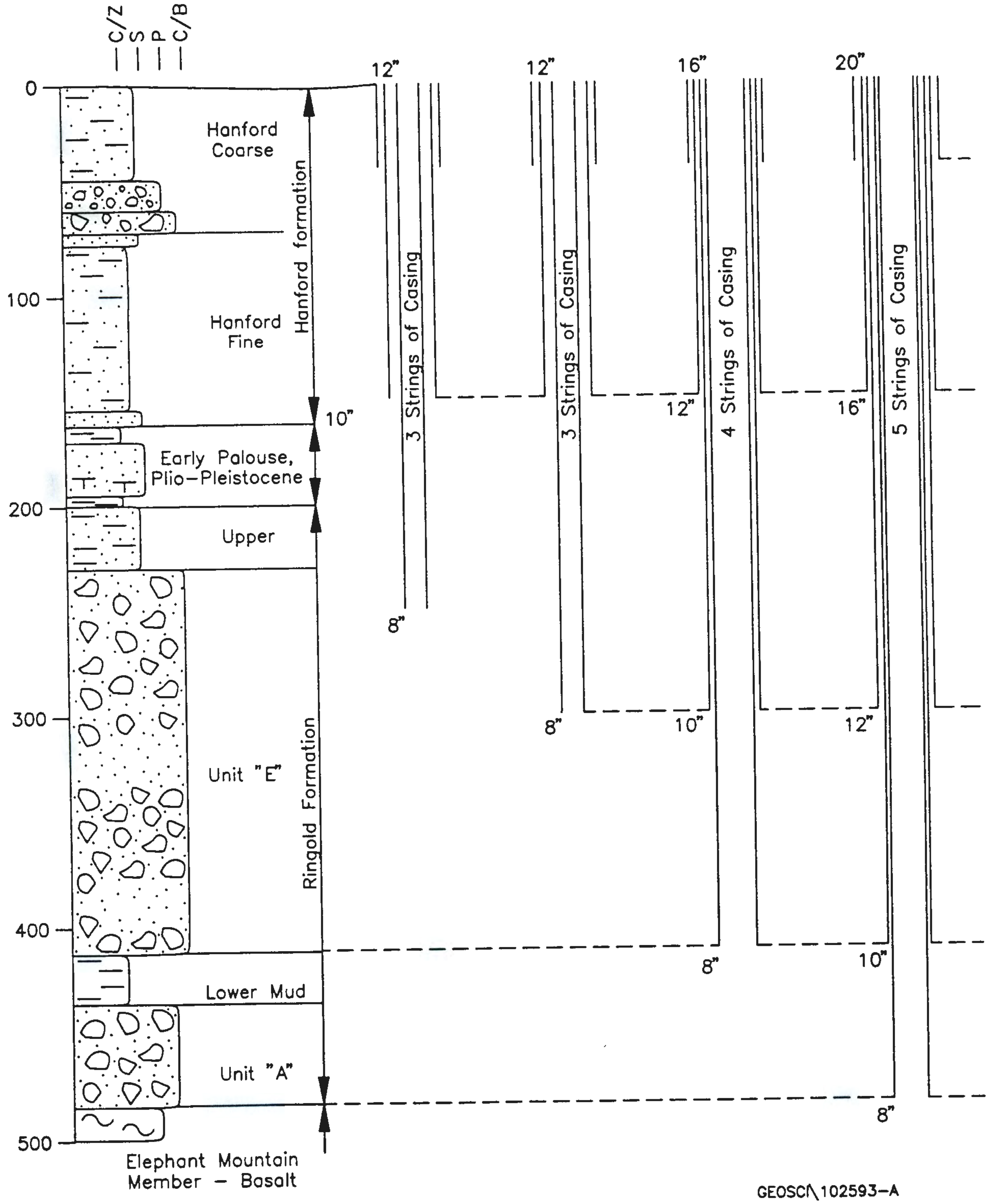

Table 2. Well Construction Parameters, 200 West, 200-UP-1

Well ID	Estimated Total Depth (ft)	Screen Length*	Water Level **	Depth Top Screen*	Depth Bottom Screen*	Interval Sand Pack*	Comments
UP1-1 (if built)	280	30	249	243	280	245-280	Top, Ringold "E" aquifer
UP1-2	330	10	238	320	330	317-330	
UP1-3	415	10	238	403	413	400-415	Bottom, Ringold "E" aquifer
UP1-4	485	10	238	475	485	470-485	Ringold "A" aquifer comment through lower mud sequence
UP1-6	275	30	243	238	275	242-275	Top, Ringold "E" aquifer
UP1-7	290	30	253	248	285	252-290	Top, Ringold "E" aquifer

*Estimated values.
**Water levels are approximately 1 year old; levels may have dropped since these were taken.

to determine the appropriate screen slot size and filter pack material for the monitoring well.

Boring UP1-2 will be constructed to monitor the middle of the unconfined aquifer and will be constructed predominantly as described above. The #3 casing, however, will be carried an additional 50 to 80 ft deeper to monitor the middle of the unconfined aquifer (Ringold unit E).

Boring UP1-3 will monitor the bottom of the unconfined aquifer (Ringold unit E). This boring will be drilled as described above; however, an additional fourth string of casing will be utilized (see Figure 3).

- Casing string #4. Smaller diameter casing will be telescoped through casing string #3 and then carried to the top of the lower mud sequence of the Ringold Formation. This material forms the confining unit between the unconfined and confined aquifers in the 200-UP-1 Operable unit.

Boring UP1-4 will be constructed to monitor the top of the confined aquifer (Ringold unit A). This boring will be drilled as described above; however, an additional fifth string of casing will be used (see Figure 3).

- Casing string #5. Smaller diameter casing will be telescoped through casing string #4 (set at top of lower mud) and carried to the top of basalt.

When perched water is reported above the caliche layer in all boreholes, drilling will stop and an initial baseline water level will be established. The amount of water in the borehole will be recorded on the borehole log and the field activity report. A water sample will then be obtained using a bailer. At least 0.305 m (1 ft) of water is required for water sampling. A water sample will not be obtained if less than 0.305 m (1 ft) of water is present. When taking a perched water sample, an attempt will be made to fill all the bottles specified in Table 1. If (within 1 hr of the start of the sampling event) sufficient water cannot be obtained to fill the bottle requirements specified, sampling will stop and drilling will continue. Casing would not be downsized at the perching layer, and drilling would continue to the next casing point.

When perched water is reported at the top of the caliche layer, drilling will stop and the amount of perched water will be determined using an electronic measuring tape. If water is present, the temporary casing should be backpulled from the top of the caliche layer at least 0.305 m (1 ft) to ensure that water can enter the casing. The borehole will then be allowed to equilibrate for 4 hr, and a baseline water level will be established. If sufficient water is available (per criteria in preceding paragraph) a sample will then be obtained.

When borehole UP1-3 reaches total depth, a packer and pump assembly will be installed to obtain a representative groundwater sample (in duplicate) for quick turnaround analyses mainly for uranium, ^{99}Tc, and VOCs. If significant contamination is found at this depth in the unconfined aquifer in Well UP1-3, drilling of UP1-4 may be delayed until discussions can be held with the regulators regarding the risks involved with drilling through the Ringold mud unit and creating a path for contaminants to enter the confined aquifer from the unconfined system above.

RLS gamma spectrometer logging will be conducted for all boreholes on each string of casing prior to downsizing and after reaching total depth (EII 11.1, "Geophysical Logging") (WHC 1988a).

The site geologist will record all activities on the field activity report per EII 6.7, "Activity Reports of Field Operations" (WHC 1988a). Items for entry will include borehole numbers, site location drawings, the names of site personnel, sampling types, and sampling intervals.

All boreholes will be logged according to EII 9.1, "Geologic Logging," (WHC 1988a). The geologic log will include the lithologic description, sample code, and depth; Hanford Environmental Information System (HEIS) numbers for each sample interval; borehole construction characteristics; screening results; and any general information the site geologist believes is pertinent to the characterization of the subsurface lithology. Each log sheet should contain no more than 20 ft of stratigraphic information.

3.4 MONITORING AND DUAL-USE WELLS

To support the groundwater characterization activities for the 200-UP-1 Operable Unit, five wells will be constructed. Wells UP1-6 and UP1-7 will be constructed as single wellsites that will monitor the top of the unconfined aquifer of unit E of the Ringold Formation. Wells UP1-2, UP1-3, and UP1-4 will be constructed as a three-well cluster site that will monitor the middle and bottom of the unconfined aquifer within Ringold unit E and the top of the confined aquifer of Ringold unit A. The locations for wellsites are presented in Figure 1. Table 2 and Appendix B present the estimated target drill depths for each well.

3.4.1 Design Specifications for Monitoring and Dual-Use Wells

This section delineates well design criteria and specifications required for the installation of monitoring and dual-use wells. General construction specifications and criteria for the drilling and construction of groundwater wells on the Hanford Site are provided in the WHC-S-014, Generic Well Specification. The WHC-S-014 supplies the design and construction standards necessary for the installation of monitoring wells capable of providing quality groundwater samples for the *Resource Conservation and Recovery Act* (RCRA) and *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) groundwater monitoring and past-practice site investigation programs. In addition, specifications delineated in WHC-S-014 reflect the required well-drilling and construction practices detailed in the WAC-173-160 and WAC-173-162.

Although the WHC-S-014 focuses on drilling and installation of RCRA/CERCLA standard groundwater monitoring wells, many of the general specifications and requirements delineated in the WHC-S-014 will also generally apply to the drilling and installation of wells designed for a dual use of monitoring and/or extraction. Divergence in guidance occurs in those sections of the WHC-S-014 detailing the well screen and sand selection criteria and well development requirements. These differences are minor changes to the guidance presented in the WHC-S-014 and will not require an Engineering Change Notice (ECN) to the specification. Special instructions for the construction of the dual-use well are presented below. Significant design or structural changes that occur in the field will be documented on a field change authorization form.

3.4.2 Screen and Filter Pack Selection for Monitoring Wells

Groundwater monitoring wells on the Hanford Site are designed to limit the hydraulic efficiency between the well and the aquifer to reduce the amount of purgewater generated. This is achieved by designing a screen slot size and filter pack combination that allows the minimum amount of water for sampling while restricting the amount of fine-grained material to the well. Limited well development is also performed to ensure that only minor amounts of fines are drawn into the filter pack and well.

Boreholes UP1-4 and UP1-7 will be constructed as groundwater monitoring wells. When the target depth for each screened interval is reached (see Table 2), a split-spoon sample will be obtained and a sieve analysis performed. A screen and filter pack combination will then be selected that precludes approximately 90% of the formation fines from the well (typically either a 10- or 20-slot screen and 20-40 or 16-20 filter pack sand respectively). After completing each well, limited development will be performed. When a sieve analysis cannot be performed, a 10-slot screen and 20-40 sand will be used.

3.4.3 Screen and Filter Pack Selection for Dual-Use Wells

Extraction wells are constructed to achieve the greatest level of hydraulic efficiency between the well and the aquifer. This is performed by using larger screen slots and filter pack than used on groundwater monitoring wells. Extraction wells are also more thoroughly developed than monitoring wells and thus require the removal of larger amounts of fines and possibly purgewater. Extraction wells may also require a larger diameter casing to provide higher pumping rates without damage to the sand pack and well screen.

Boreholes UP1-2, UP1-3, and UP1-6 will be constructed as dual-use wells. A 6-in. stainless steel casing will be installed to allow for the potential higher production rates expected from these wells if utilized for extraction purposes in the future. When the target depth for the screened interval is reached (see Table 2), a split-spoon sample will be obtained and a sieve analysis performed. An evaluation will then be conducted by the project hydrogeologist to select a screen and filter pack size to maximize hydraulic communication between the well and aquifer. The screen and filter pack selected should retain approximately 60% to 80% of the formation fines. The selection should ensure an entrance velocity at the well screen of <0.1 ft/s assuming an inflow rate of 25 gal/min/ft. After completing the well, extensive well development will be performed. Water generated during this development process will be managed per EII 10.3 "Purgewater Management" (WHC 1988a). It is estimated that the monitoring/extraction well will require either 20- to 30-slot screen and 16-20 or 8-12 filter pack.

3.5 AQUIFER TESTING

Groundwater monitoring and dual-use wells will be slug tested after each well is completed. Slug testing will be conducted in accordance with EII 10.1, "Aquifer Testing." Additional slug interference testing will be conducted on Well UP1-4, where observation wells are available. Slug interference test procedures are presented in Appendix C.

All other aquifer testing to be performed for this operable unit will be delineated in an aquifer test plan to be issued at a later date.

Slug Interference testing will be conducted on monitoring Well UP1-4 and will follow a drill and test sequence. Wells UP1-2 and UP1-3 will be drilled and completed prior to the start of UP1-4. Wells UP1-2 and UP1-3 will then be used as observation wells for the test. The length and slot size of telescoping screen used in the slug interference test will be selected by the test hydrogeologist after completing wells UP1-2 and UP1-3. The lithology encountered and physical testing properties collected from UP1-2 and UP1-3 will help determine the telescoping screen size and proper intervals tested on monitoring Well UP1-4. The following steps will be performed for the slug interference test:

1. Drill borehole UP1-4 to about the same screened interval depth as Well UP1-2. Place 12-in. (30.5 cm) telescoping screen across the same screened interval as Well UP1-2. Back pull temporary 12-in. casing to expose the telescoping screen to the formation. Swab or surge block develop UP1-4 to remove residual drill cuttings and minor amounts of formation fines. The test hydrogeologist will determine when development is complete.

2. Conduct slug interference testing as specified in Appendix C. The test hydrogeologist will evaluate test results and determine if additional testing will be performed. If test results are acceptable, the test hydrogeologist will release the well for further drilling.

3. Remove the telescoping screen and advance the borehole to the same screened interval as monitoring Well UP1-3.

4. Repeat steps 1 and 2 using 10-in. telescoping screen. If test results are acceptable, the test hydrogeologist will release the well for further drilling. The borehole will then be advanced through the lower mud to the target depth.

3.6 WATER AND SOIL SAMPLING

3.6.1 Water Sampling

Perched water samples will be collected from boreholes per criteria discussed in section 3.2 and EII 5.8, "Groundwater Sampling" (WHC 1988c) and will be analyzed for the analytes presented in Table 1.

A groundwater sample (in duplicate) will be obtained when Well UP1-3 reaches total depth to determine if contamination is present at this depth in the unconfined aquifer. These samples will be analyzed onsite mainly for total uranium, ^{99}Tc, and VOCs. For sample volumes required for these analyses, please see Table 1 of this document. This sample will be obtained using a single packer and pump assembly installed in the temporary well casing. This will require a smaller purge volume to be pumped before a representative sample can be obtained from the final depth interval.

3.6.2 General Sampling Requirements

Chemical/Radiological, physical, and archive samples will be collected from boreholes UP1-3, UP1-4, UP1-6, and UP1-7. Chemical/Radiological samples will not be taken from boreholes UP1-2. This boring is in a cluster site with Well UP1-3 and UP1-4, where all applicable chemical samples for this area will be obtained. Physical properties samples will be collected only from the planned screened interval of UP1-2 to obtain sand pack design criteria. Chemical/Radiological samples will be obtained using the split-spoon sampler in accordance with EII 5.2, Table 4 and Appendix B. If insufficient samples are obtained to satisfy the required analysis, the split spoon can be redriven. The chemical portion of the sample will take precedence over physical samples, which take precedence over archive samples. The drive barrel can be used to obtain type-A physical properties and archive samples when insufficient samples are obtained with the split spoon. An entry will be made in the borehole log identifying the sampling method using codes presented in Table 3.

3.6.3 Geologic and Archive Sampling

All material removed from a borehole will be identified and described by the geologist and summarized on the Borehole Log. Geologic samples for archive storage will be collected and described every 5 ft, at significant changes of lithology as determined by the field geologist, and from all other sampling points. Proposed sampling intervals and expected subsurface lithology are presented in Table 4 and in Appendix B.

The archive sample is to provide the geotechnical library with material from sampling intervals and to supply a representative physical record of the lithologies encountered during excavation activities. The field geologist shall archive only nonradioactive material. The field geologist will submit archive samples per EII 5.7A, "Hanford Geotechnical Sample Library Control" (WHC 1988d). Each archive sample will be labeled with the appropriate sample

Table 3. Sampling Codes.

Sample Type	Sample Type Designation	Purpose of Sample
Archive	AR	Provide samples for future data needs.
Physical	PH	Provide material for determination of physical characteristics of vadose zone.
Chemical	CH	Provide material for chemical analysis to determine contaminant inventory and extent of contamination in the vadose zone.

Table 4. Proposed Sampling Intervals.

Borehole	UP1-1 (if built)	Borehole	UP1-2	Borehole	UP1-3
Chem Sample Approx. Depth (Ft)	Phys. Sample Approx. Depth (Ft)	Chem Sample Approx. Depth (Ft)	Phys. Sample Approx. Depth (Ft)	Chem Sample Approx. Depth (Ft)	Phys. Sample Approx. Depth (Ft)
176	178		297	162	164
188	190			170	172
245	247			NA	238
260	262			245	247
				297	NA
				NA	350
				405	407
Total: 4	Total: 4	Total: 0	Total: 1	Total: 0	Total: 1
Caliche layer at ~180-190 ft		Caliche layer at ~162-190 ft		Caliche layer at ~162-190 ft	

Borehole	UP1-4	Borehole	UP1-6	Borehole	UP1-7
Chem Sample Approx. Depth (ft)	Phys. Sample Approx. Depth (ft)	Chem Sample Approx. Depth (ft)	Phys. Sample Approx. Depth (ft)	Chem Sample Approx. Depth (ft)	Phys. Sample Approx. Depth (ft)
NA	420	158	160	NA	216
450	452	182	184	218	220
NA	470	230	232	NA	245
		250	252	265	267
Total: 1	Total: 3	Total: 4	Total: 4	Total: 2	Total: 3
Caliche layer at ~160-170 ft		Caliche layer at ~180-190 ft		Caliche layer at ~200-210 ft	

depth interval (to the nearest foot), date, and time the sample was obtained. Chain of Custody documentation as detailed in EII 5.1, "Chain of Custody" (WHC 1988d) will be prepared by the site geologist. Splits of samples will be labeled, placed in a plastic bag, and given to the HPT for survey and release evaluation. Each archive interval will be logged in the field logbook and the borehole log. Container requirements for archive samples are presented in Table 5.

3.6.4 Analytical Soil Sampling

Analytical samples will be collected as specified in EII 5.2, "Soil and Sediment Sampling." Packaging and shipping requirements for samples transported offsite shall be selected on the basis of total activity values and the preservation requirements applicable to the parameters of interest, as described in EII 5.11, "Sampling Packaging and Shipping" (WHC 1988a).

This DOW presents only general guidance for obtaining samples. Due to the variability occurring in the field, the site geologist will need to use professional judgment to determine the appropriate intervals for obtaining samples. The approximate sampling depths for each borehole are presented in Table 4 and Appendix B. Field screening will be used to ensure that the most contaminated material from each sampling interval is submitted for analysis. This will involve screening the ends of the split spoon after the drive head and shoe are removed. If radiological contamination does not exceed the criteria established in the Radiation Work Permit (RWP) for placement in the glove box, the split spoon will be opened and the liners surveyed. If an interval is identified (i.e., silt layer in a predominantly gravel unit) that is more contaminated than surrounding material, it will be separated from adjacent liners and a sample will be obtained. If insufficient material is present to satisfy all the bottle requirements for analysis, a composite sample will be obtained by mixing material from above and below the contaminated interval. If radiological contamination exceeds the criteria established in the RWP, the split spoon will be opened in the glove box. Accurate screening of the sample cannot be performed outside the glovebox because of shielding.

Field screening will also be used to monitor drill cuttings obtained with the drive barrel and to identify alternate sampling points not presented in this DOW. For example, if a contaminated zone occurs (i.e., silt layer in a predominantly gravel unit) before a designated sampling point, a sample will be obtained. When the designated sampling point is encountered, if screening indicates lower contamination than at the previous sampling point, no sample will be obtained. If screening indicates that contamination is greater than the previous sampling point, a sample will be obtained, and the previous sample (if it has not been shipped to the lab already) would be discarded as drilling waste.

All samples shall have a representative portion submitted to the 222-S Laboratory for total activity analysis. This will be utilized for sample preshipment characterization. Chemical and radiological samples with a total activity of less than the established lab criteria will be analyzed at an offsite laboratory. Those samples exceeding the lab criteria will be routed to a designated onsite laboratory for analysis. Onsite and offsite laboratories will be identified prior to initiating field activities and will be mutually

Table 5. Physical Sample Bottle Requirements.

Analyses	Drive Barrel	Split Spoon
Archive	2 mason jars or 1 bag+	1-2 liners
Type A, Analyses		
Sieving* (Gel-07)	1 mason jar or 1 bag+	2 liners
Moisture content* (Gel-14)	1 moisture tin or 1 mason jar+	Combine analyses with above liners
Calcium carbonate* (Gel-19)	Combine analyses with above samples	Combine analyses with above liners
Type B, Analyses		
Bulk density/Porosity* (Gel-16)	Not taken	2 liners
Particle size distribution* (Gel-07)	1 moisture tin and 3 mason jars or 1 moisture tin and 1 bag+	Combine analyses with above liners
Soil pH/Eh	Combine analyses with above samples	Combine analyses with above liners
Cation exchange capacity	Combine analyses with above samples	Combine analyses with above liners
Calcium carbonate* (Gel-19)	Combine analyses with above samples	Combine analyses with above liners
Organic carbon content	Combine analyses with above samples	Combine analyses with above liners
Type C, Analyses		
Bulk density/Porosity* (Gel-16)	Not taken	2 liners
Vertical hydraulic cond.	Not taken	Combine analyses with above liners
Particle size distribution* (Gel-07)	1 mason jar or 1 bag+	Combine analyses with above liners
Moisture content* (Gel-14)	1 moisture tin	Combine analyses with above liners
HPT release	1 small plastic bag	1 plastic bag

*=Westinghouse Hanford Company Geotechnical Engineering Lab method procedure number (Gel-#)

+=Container type dependent upon size of material sampled.

acceptable to Hanford Analytical Services Management (HASM) and the cognizant engineer.

Samples collected for physical analysis and unconditionally released by the HPT as nonradioactive will be submitted to the Geotechnical Engineering Cold Laboratory. Radioactive physical samples that do not exceed 25 mrem will be submitted to the Geotechnical Engineering Hot Laboratory. Samples exceeding 25 mrem will be stored at a temporary radioactive storage area until it is determined if they will be analyzed. Physical samples not tested will be disposed of as waste. All sample containers will be labeled with applicable borehole number, sampling date, time, depth interval to the nearest foot (physical samples only), HEIS number, requested analysis, and the sampler's initials.

3.6.4.1 Physical Property Analysis. Three suites of physical property analyses (Types A, B, and C) are proposed for the various hydrostratigraphic units in the 200-UP-1 Operable Unit. A summary of the proposed sampling intervals is presented in Table 4 and Appendix B. An additional description for physical sampling is presented in Section 5.1.3.3.2 of the Work Plan (DOE-RL 1993a).

Type A analyses will be performed on the early Palouse soils, Plio-Pleistocene Unit, and the unsaturated portions of the Ringold unit E gravels. Type A analyses will include the following:

- Moisture content
- Soil pH/Eh
- $CaCO_3$ content
- Particle size distribution.

Type B analysis will be performed on saturated portions of the Ringold units E and A. Type B analyses will include the following:

- Bulk density
- $CaCO_3$ content
- Particle size distribution
- Porosity
- Soil pH/Eh
- Cation exchange capacity
- Organic carbon content.

Type C analysis will be collected from the Ringold lower mud unit and will include the following:

- Bulk density
- Particle size distribution
- Moisture content
- Vertical hydraulic conductivity.

Chain of Custody documentation will be prepared by the site geologist for each day's sampling. The project geologist will supply HEIS numbers for physical samples to the site geologist at the beginning of borehole activities. Container requirements for physical samples are contingent on the size of material being sampled. Sample container requirements are presented in

Table 5. Material larger than 7.62 cm (3 in.) will be removed from cuttings collected with the drive barrel/split spoon before placing in the sample container. Analyses requested for samples collected with the drive barrel will be limited to tests that can be performed on disturbed material (Table 6). The applicable WHC Geotechnical Engineering Lab (GEL) numbers presented below will be requested on the sampling and analysis request form. Physical samples will be analyzed using the following American Society for Testing and Materials (ASTM) methods:

- Bulk density/Porosity (GEL-16)
- Particle size distribution (ASTM D422-63) (Gel-07)
- Moisture content (ASTM D2216) (Gel-14)
- $CaCO_3$ Content (Gel-19)
- Soil pH/Eh
- Cation exchange capacity
- Organic Carbon content.

3.6.4.2 Chemical and Radiological Analysis. Soil samples for characterizing chemical and radiological contaminants will be collected from each boring at the early Palouse soils, the Plio-Pleistocene Unit, just above the water table, at appropriate intervals within the saturated zone, and from each screened interval. Additional samples may be collected if any contamination or perched water is encountered. A summary of the proposed chemical analytical methods is presented in Table 1. The approximate sampling intervals are presented in Table 4 and Appendix B.

Chain of custody documentation will be prepared by the Environmental Field Services (EFS) sampling scientist. Container and volume requirements for chemical and radiological samples are presented in Table 1. The laboratory will use existing Level IV CLP methods. Level V CLP methods for radionuclide analysis and Level III analysis for anions will be used as approved in laboratory contracts. Samples will be analyzed for constituents as specified in Table 1.

If full sample volume requirements cannot be met, the volume obtained will be recorded in the sampling scientist's logbook per EII 1.5, "Field Logbook" (WHC 1988a) and analyzed in the following order:

1. Radionuclides
2. Volatiles
3. Semivolatiles
4. Target analyte list
5. Anions.

4.0 QUALITY ASSURANCE/QUALITY CONTROL REQUIREMENTS

Internal quality control samples shall be collected at each facility by the sampling scientist as specified in *Quality Assurance Project Plan*, (DOE-RL 1993, Appendix A) with the revisions as outlined below. The sampling shall be documented in the sampling logbook per EII 1.5, "Field Logbooks" (WHC 1988a).

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Table 6. Analytical Methods for Target Analytes (Soils). (sheet 1 of 3)

Analyte [a]	General Analytical Technique [b]	Soil and Sediment Analysis Method	Container and Volume	Comments
Gross Alpha Gross Beta	Gas proportional	h	f	
VOCs	GC/MS	CLP-VOAs	Gs 250 ml	
Semi-Volatile Organic Contaminants	GC/MS	CLP Semi-VOAs	aG 250 ml	
Nitrate Nitrite	Ion Chromatography	300	G 125 ml	
Cyanide	Colorimetric	CLP-TAL	G 125 ml	
Fluoride	Ion Chromatography	300	G 125 ml	
All Identifiable and Quantifiable Isotopes	Gamma Spectrometry	h	f	
Iodine-129 Strontium-90 Technetium-99	Beta Counting	h	f	
Americium-241 Curium-244 Neptunium-237 Plutonium-238 Plutonium-239/240 Uranium-234 [d] Uranium-238 [d] Uranium-234 [d]	Alpha Spectrometry	h	f	

Table 6. Analytical Methods for Target Analytes (Soils). (sheet 2 of 3)

Analyte[a]	General Analytical Technique[b]	Soil and Sediment Analysis Method	Container and Volume	Comments
Aluminum Antimony Barium Beryllium Cadmium Calcium Chromium Cobalt Copper Iron Lead Magnesium Manganese Nickel Potassium Silver Sodium Thallium Vanadium Zinc	ICP Analysis	CLP-TAL	g	
Arsenic Selenium	GFAA	CLP-TAL	g	
Mercury	Cold Vapor Atomic Absorption	CLP-Metals	g	

G = Glass; P = Plastic; Gs = Glass septum w/zero headspace; aG = amber Glass
TBD = To Be Determined
M = method modified to include extraction from the solid medium, extraction method is matrix and laboratory-specific
Prescribed Procedures for Measurement of Radioactivity in Drinking Water (EPA 1980a)
Test Methods for Evaluating Solid Waste (SW 846) Third Edition (EPA 1986)
Methods for Chemical Analysis of Water and Waste (EPA 1983)
Radionuclide Method for the Determination of Uranium in Soil and Air (EPA 1980b)
EML Procedures Manual (DOE/EML 1990)

Table 6. Analytical Methods for target Analytes (Soils). (sheet 3 of 3)

<u>Eastern Environmental Radiation Facility RadioChemistry Procedures Manual</u> (EPA 1984)
<u>High-Resolution Gamma-Ray Spectrometry of Water</u> (ASTM 1985)

a/In addition to the analytes listed in this table, there are many progeny isotopes whose concentrations may be derived from known parent concentrations. Radionuclides related to U-238 include: Th-230, Bi-210, Bi-214, Po-214, and Po-218. Radionuclides related to U-235 include: Th-231, Tl-207, Pb-211, Pb-214, and Bi-211. Nb-93m is related to Zr-93. Pu-241 concentrations are inferred from Pu-238, Pu-239, and Pu-240. The radionuclides listed in parenthesis under the analyte column are measured as part of the analysis of the adjacent radionuclide.

b/The analytical techniques are listed in the order that they should be performed. Gross alpha, gross beta, and VOA analyses will always be done first. Gamma Spectrometry will be done next because it generally does not require destruction of any sample. Alpha spectrometry, Sr-90 and Tc-99 analyses will next be done if sufficient sample exists. The next priority is to perform ICP analyses. Approximately 2 lbs (1 kg) of material will be required to perform these primary analyses. If more sample exists, then several additional, secondary analyses may be performed. These are shown on the table below the ICP analysis. In borings, additional drive samples should be collected, if possible, to insure that all analyses can be run.

c/These analytical methods should be considered examples of possible analytical techniques to use. Individual labs may have other techniques developed for some analytes.

d/The uranium analyses will be conducted periodically to confirm the uranium concentrations calculated from the Pa-234m or Pa-231 analyses. Two samples from each deep boring and one sample from each test pit or shallow boring will undergo this confirmatory analysis. No uranium analyses will be done on surface soil or sediment samples.

e/Analytes that will be studied by beta counting are listed in the order that they should be analyzed. For instance, the Sr-90 analysis should be made first, followed by the Tc-99 analysis.

f/ All samples submitted for radionuclide analysis will be placed in a P/G 750 ml bottle.

g/ All samples submitted for CLP-Metals analysis will be placed in a P/G 250 ml bottle.

h/ Analytical methods for radionuclide analysis are laboratory specific and by contract with WHC, must meet analytical requirements for level IV. (Examples of standard methods include ASTM D3549, ASTM D3865, ASTM D3972, ASTM D2334.)

i/ Samples collected for the 200-UP-2 Limited Field Investigation (LFI) activities that require analysis for kerosene will be analyzed at TMA by SW-846 method 8015. Kerosene is not listed in the SW-846 reference procedure as a compound that is included on the target list for 8015, Non-Halogenated Volatile Organics. Through its contract with WHC, TMA has adapted method 8015 to include kerosene as a target compound using its characteristic "fingerprint."

- Field Duplicate Samples. A minimum of one duplicate per sampled borehole or one duplicate for every 20 samples shall be collected, whichever is greater. Duplicate samples shall be retrieved from the same sampling location using the same equipment and sampling technique and shall be placed in two sets of identically prepared and preserved containers. All field duplicates shall be analyzed independently to provide an indication of the reproducibility of sampling and/or analysis techniques.

- Split samples. At the direction of the cognizant engineer, and if a laboratory is designated, split samples shall be collected at the same frequency as duplicate samples.

- Field Blanks. Field blanks shall consist of pure deionized water or silica sand (depending on the medium being collected) and transferred into clean sample containers at the site. Field blanks are used as a check on environmental contamination and shall be collected for each borehole, or one for every 20 samples, whichever is greater.

- Equipment Rinsate Blanks. Equipment rinsate blanks consist of pure deionized water or silica sand (depending on the medium being collected) that is run through decontaminated sampling equipment and placed in clean sample containers. Equipment blanks are used to verify the adequacy of sampling equipment decontamination procedures and shall be collected at the same frequency as field duplicate samples where applicable.

- Volatile organic analysis (VOA) trip blanks. The VOA trip blanks consist of pure deionized water or silica sand (depending on the medium being sampled) added to clean sample containers under controlled conditions and accompanying each batch of coolers shipped to the analytical facility. Trip blanks shall be shipped unopened to the laboratory and are prepared as a check on possible contamination originating from container preparation methods, shipment, handling, storage, or site conditions. The trip blank shall be analyzed for volatile organic compounds from EPA's target compound list.

5.0 SCHEDULE

The following schedule is for drilling in the 200-UP-1 Operable Unit for 1994 (assuming the availability of two drill rigs). This schedule is subject to change, and the operable unit coordinator should be contacted for the current status. An agreement Activity Notification Form will be issued at least 5 days before the start of field work.

Well Number	Drilling Dates
UP1-2	Early February -- Mid March
UP1-3	Early February -- Late March
UP1-4	Mid March -- Late May
UP1-7	Late May -- Late June
UP1-6	Late March -- Early May.

6.0 ALARA CONSIDERATIONS AND CHANGES TO THE DESCRIPTION OF WORK

All boreholes will be drilled utilizing the guidance of the As Low As Reasonably Achievable (ALARA) program.

Minor changes to this DOW, such as a change in sampling methods, analyzing different parameters, using different analytical methods, or significantly changing the sampling interval, will be submitted on the attached form (Attachment 1) and kept on file with the operable unit coordinator. Copies will be submitted to the regulatory agencies and the appropriate field personnel within 10 working days of the occurrence.

Any major changes to this document such as a revision of the target analyte list or well completion depths will require regulator approval.

7.0 REFERENCES

Black, R.F., 1979, *Clastic Dikes of the Pasco Basin, Southeastern Washington*, RHO-BWI-C-64, Rockwell Hanford Operations, Richland, Washington.

Connelly, M.P., B.H. Ford, J.W. Lindberg, S.J. Trent, C.D. Delaney, and J.V. Borghese (PNL), 1992, *Hydrogeologic Model for the 200 East Groundwater Aggregate Area*, WHC-SD-EN-TI-019, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Delaney, C.D., K.A. Lindsey, and S.P. Reidel, 1991, *Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports*, WHC-SD-ER-TI-003, Westinghouse Hanford Company, Richland, Washington.

DOE, 1988, *Site Characterization Plan, Reference Repository Location, Hanford Site, Washington, Consultation Draft*, DOE/RW-0164, U.S. Department of Energy, Washington, D.C.

DOE-RL, 1992, *U-Plant Source Aggregate Area Management Study*. DOE/RL-91-52, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1993a, 200-UP-1 *Remedial Investigation/Feasibility Work Plan*, DOE/RL-92-76 Rev.0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL 1993b, *200 West Groundwater Aggregate Area Management Study Report*, DOE/RL-92-16, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

EPA, 1987, *Data Quality Objectives for Remedial Response Activities*, EPA/540/G-87 003, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1988, *USEPA Contract Laboratory Program Statement of Work for Inorganic Analysis*, Sample Management Office, U.S. Environmental Protection Agency, Washington, D.C.

Lindal, P.C., 1984, *Determination of Inorganic Ions in Aqueous and Solid Samples of Ion Chromatography*, EPA.00/4-84, Argonne National Laboratory, Argonne, Illinois.

Lindsey, K.A., 1991, *Revised Stratigraphy for the Ringold Formation, Hanford Site, South-Central Washington*, WHC-SD-EN-EE-004, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K.A., M. P. Connelly, and B.N. Bjornstad, 1992, *Geologic Setting of the 200 West Area: An Update*, WHC-SD-EN-TI-008, Westinghouse Hanford Company, Richland, Washington.

Myers, C.W., S.M. Price, J.A. Caggiano, M.P. Cochran, W.J. Czimer, N.J. Davidson, R.C. Edwards, K.R. Fecht, G.E. Holmes, M.G. Jones, J.R. Kunk, R.D. Landon, R.K. Ledgerwood, J.T. Lillie, P.E. Long, T.H. Mitchell, E.H. Price, S.P. Reidel, and A.M. Tallman, 1979, *Geologic Studies of the Columbia Plateau--A Status Report: Richland, Washington*, RHO-BWI-ST-4, Rockwell Hanford Operations, Richland, Washington.

Reidel, S.P., and K.R. Fecht, 1981, "Wanapum and Saddle Mountains Basalts of the Cold Creek Syncline Area," *Subsurface Geology of the Cold Creek Syncline*, RHO-BWI-ST-14, C.W. Myers and S.M. Price (eds.), Rockwell Hanford Operations, Richland, Washington.

Tallman, A.M., K.R. Fecht, M.J. Marratt, and G.V. Last, 1979, *Geology of the Separations Areas, Hanford Site, South-Central Washington*, RHO-ST-23, Rockwell Hanford Operations, Richland, Washington.

Tallman, A.M., J.T. Lillie, and K.R. Fecht, 1981, "Suprabasalt Sediments of the Cold Creek Syncline Area," in *Subsurface Geology of the Cold Creek Syncline*, C.W. Myers and S.M. Price (eds), RHO-BWI-ST-14, Rockwell Hanford Operations, Richland, Washington.

WHC, 1987, *Industrial Safety Manual*, WHC-CM-4-3, Vol. 1 through 3, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988a, *Environmental Investigations and Site Characterization Manual*, WHC-CM-7-7, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988b, *Environmental Compliance Manual*, WHC-CM-7-5, Westinghouse Hanford Company, Richland, Washington.

WHC, 1988c, WHC-CM-1-6, *Radiological Control Manual*, WHC-CM-1-6 (WHC 1993c), Westinghouse Hanford Company, Richland, Washington.

WHC, 1988d, *ALARA Program*, WHC-CM-4-11, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990, *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan*, WHC-EP-0383, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991, *Health Physics Procedures Manual*, WHC-IP-0692, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX A

EXCERPTED SECTIONS FROM WORK PLAN

The following pages are excerpted from *Remedial Investigation/Feasibility Study Work Plan*, DOE/RL-92-76, Rev. 0 U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Permits and Hazardous Waste Operating Permits (EII 2.2, "Occupational Health Monitoring"[WHC 1988]) is planned to be performed prior to the start of any sampling activity. All personnel entering the job site will fulfill the minimum requirements for entry as discussed in EII 1.1., "Hazardous Waste Site Entry Requirements" (WHC 1988).

An as-low-as-reasonably-achievable (ALARA) plan that addresses the potential radiation exposure of task personnel during field tasks is planned to be completed prior to the commencement of field operations. Guidance on such assessments is found in WHC-CM-4-11 as referenced in EII 2.3, "Administration of Radiation Surveys to Support Environmental Characterization Work on the Hanford Site" (WHC 1988). A Radiation Dose Assessment evaluation may be performed for the anticipated soil samples and upon its completion may be used in conjunction with estimates of sample size and duration of exposure to prepare an ALARA plan.

5.1.2.9 Community Relations (Subtask 1j). Community relations activities are planned to be conducted in accordance with the Community Relations Plan for the Hanford Site (Ecology et al. 1989). All community relations activities associated with the 200-UP-1 Groundwater Operable Unit will be conducted under this overall Hanford Site Community Relations Plan.

5.1.3 Limited Field Investigation Field Activities (Tasks 2 to 6)

This section describes the proposed field activities to be performed for the LFI. The field activities are designed to accomplish the following tasks: source characterization (Task 2), geologic investigation (Task 3), vadose zone investigation (Task 4), groundwater investigation (Task 5), and air investigation (Task 6). These tasks are described in Section 5.1.1. Section 5.1.3 recommends specific activities to be conducted for the LFI, although final determination of field activities will be made through issuance of DOWs. Several DOWs will be required and will likely address the following topics:

- Accelerated vertical contaminant profiling (*Description of Work for the 200-UP-1 Groundwater Contaminant Vertical Profiling Activity* [WHC 1993b])--Indicates the locations, methodology, and analytical methods for the vertical contaminant profiling

- Soil sampling, monitoring well installation, groundwater sampling, and geophysical surveys--Identifies locations, frequencies, methodologies, and analytical methods for the subject field activities

- Aquifer testing, including accelerated 1993 aquifer testing (*Description of Work for the 200-UP-1 Aquifer Testing Activity* [WHC 1993c])--Identifies the locations, methodology, and analyses for aquifer tests.

Section 5.1.3.1 discusses the locations and frequencies of each activity, and is subdivided by waste management unit and unplanned release. The protocols and procedures for each type of field activity are described in

Section 5.1.3.2. Section 5.1.3.3 describes the laboratory analyses that each sample will undergo.

5.1.3.1 Sampling Locations and Frequencies. The following sections describe the recommended field activity for each data collection category.

5.1.3.1.1 Well Condition and Survey Assessment. Existing resource protection wells within the 200-UP-1 Groundwater Operable Unit should be used whenever possible to provide hydrogeologic and chemical information to support IRM/LFI activities. The suitability of wells used for these purposes should be assessed as part of the 200-UP-1 Groundwater Operable Unit Remedial Investigation/Feasibility Study. As a strategy to complete this assessment, information from an ongoing Westinghouse Hanford Environmental Field Services well remediation program should be incorporated, as available, to guide field activities and data analysis efforts.

Well remediation at the Hanford Site is currently implemented on a well-by-well basis as driven by specific requirements of individual site programs and characterization activities. Criteria for assessing the fitness-for-use of individual wells are described in EII 6.6 (WHC 1988). The intent of remediation is to bring wells constructed prior to incorporation of current Washington State well construction standards (Chapter 173-160 WAC) in line with new well regulations and current Hanford Site well construction practices. The objective is to remediate wells with documented deficiencies so that they may be used for resource protection wells or for other purposes where feasible. Generally, all pre-1987 wells are considered to be suspect.

For the purpose of the 200-UP-1 Groundwater Operable Unit, compliance status of existing wells under EII 6.6. and Chapter 173-160 WAC should first be reviewed during planned work plan activities. Based on results of this review a list of wells requiring further remediation should be prepared based on the intended purpose for groundwater sampling or water elevation measurements. Wells with high potential for transporting contaminants along poor or nonexistent annular seals should be given priority for remediation. Remediation efforts should be considered on a case-by-case basis. Remediation options include perforation and grout injection to create an annular seal. These wells should not be used for groundwater sampling unless it can be demonstrated that the deficiency is unlikely to affect analytical results. The wells may also be acceptable for other purposes such as water level elevation measurements or aquifer testing. Wells presenting a high risk for providing vertical pathways for contaminant transport will be scheduled for abandonment according to procedures in EII 6.7 (WHC 1988). As discussed in Section 4.2.6.4 (Existing Well Quality), it is recommended that the well fitness-for-use and survey quality evaluation be completed in a prioritized manner. Initial priority should be given to wells listed in Table 5-2 since sampling and analysis results of groundwater samples from these wells will be used to determine the disposition of the LFI constituents and further define the extent of IRM constituents. Operable unit wells with detected LFI/IRM constituents should then be evaluated, followed by the remaining 200-series wells, and lastly the remaining 600-series wells.

An additional component of the well suitability assessment is the verification of existing wellhead elevation and location surveys. Questions of survey accuracy are generally restricted to older (pre-1987) wells. Wells that are currently scheduled for resurvey are indicated in Table 5-2. Resurvey of existing wells should be staged in a similar manner to that described above for fitness-for-use.

In many cases, well construction records of older wells (1950's) are missing or incomplete. When available, completion records of existing wells would be reviewed to identify wells for which the screened interval is unknown or uncertain. In such cases, wells should be visually inspected with a downhole camera, as necessary, to determine screened intervals. In addition, continued dissipation of elevated water table levels in areas of mounding may lead to wells screened across the water table to go dry in such locations. Wells for which recent water level records indicate that the screen may become stranded above the water table should be identified as part of the proposed work plan effort, and monitoring of water levels should occur on a quarterly basis to verify that such wells would be permanently stranded rather than temporarily stranded because of seasonal fluctuations in the water table. Stranded wells in locations that are considered critical to water quality monitoring and water level elevation determination should then be recommended for replacement.

5.1.3.1.2 Borings and New Well Installation. Thirteen proposed new wells, UP1-1 through UP1-13, may be installed at eight locations as part of this work plan. The installation of these wells will meet the requirements of WAC 173-160, WAC 173-162, and Revised Code of Washington (RCW) 18.104 with the guidance of the Environmental Compliance Support Organization. The location of the proposed new wells are shown on Figure 4-2. The estimated depth and screen interval and the primary DQO for each well is summarized in Table 5-4. A graphical representation of each well showing the well depth, approximate depth of the lithologic units encountered, and sampling intervals is presented on Figures 5-1 through 5-8. In cases where more than one well at a location will be installed, only soil from the deepest well in each assemblage will be sampled during drilling (unless a well screen interval sample is needed). This approach is adopted to expedite drilling, with the understanding that wells are located sufficiently close so that stratigraphic variations are negligible. The purpose of these wells is to help further characterize contaminant plumes and groundwater flow in the 200-UP-1 Groundwater Operable Unit. Plans for new well installations will be finalized in a DOW.

Five wells (UP1-1, if required, -6, -7, -12, and -13) should be installed to better delineate the horizontal extent of the plumes in the 200-UP-1 Groundwater Operable Unit. These wells will be screened in the upper 10 m (30 ft) of the uppermost aquifer. The reason for screening the upper 10 m (30 ft) is to ensure that the water table will be intersected by the screen, even if water levels continue to fall in accordance with the recent trend. Samples collected during drilling will be used to analyze the physical and chemical properties of the vadose and saturated zones. Sampling recommendations are discussed in Section 5.1.3.3 and shown on Figures 5-1 through 5-5. If the Vertical Profiling Test Program (WHC 1993b) demonstrates that Well 299-W19-4 is suitable for sampling the top of the uppermost aquifer, Well UP1-1 may not be installed.

Four wells, UP1-2 (if needed), -3, -4, and -5, will be installed in a cluster adjacent to Well 299-W19-24. Well 299-W19-24 is screened from 72 to 77 m (235 to 255 ft) across the top of the uppermost aquifer. The current depth to the top of the uppermost aquifer in Well 299-W19-24 is 73 m (238 ft). Well UP1-2 should be screened from 98 to 101 m (320 to 330 ft). Well UP1-3 should be screened at the bottom of the uppermost aquifer at the base of Ringold Unit E. Well UP1-4 should be screened in the confined aquifer in Ringold Unit A. Well UP1-5 should be screened in the confined aquifer in the Rattlesnake Ridge interbed. This well will not be installed until after operable unit IRM activities are completed. In order to expedite drilling, samples will be collected during drilling of Well UP1-4 and from the depth of the screened interval in the other wells. The samples will be used to analyze the physical and chemical properties of the vadose and saturated zones. Sampling recommendations are discussed in Section 5.1.3.3 and shown on Figure 5-6. These four wells will provide data on the vertical extent of the uranium and ^{99}Tc plumes, groundwater flow, and the underlying stratigraphy.

Well UP1-8 should be installed adjacent to Well 299-W23-14. Well 299-W23-14 is screened from 59 to 66 m (193 to 215 ft) across the top of the uppermost aquifer. The current depth to the top of the uppermost aquifer in Well 299-W23-14 is 61 m (200 ft). Well UP1-8 will be screened in the confined portion of the uppermost aquifer in Ringold Unit A. Samples collected during drilling will be used to analyze the physical and chemical properties of the vadose and saturated zones. Sampling recommendations are discussed in Section 5.3.3 and shown on Figure 5-8.

Three wells, UP1-9, -10, and -11, should be installed in a cluster adjacent to Well 299-W22-20. The current depth to the top of the uppermost aquifer in Well 299-W22-20 is 67 m (219 ft). Well UP1-9 will be screened from 91 to 94 m (300 to 310 ft). Well UP1-10 will be screened at the bottom of the uppermost aquifer at the base of Ringold Unit E. Well UP1-11 will be screened in the confined portion of the uppermost aquifer in Ringold Unit A. In order to expedite drilling, samples will be collected during drilling of Well UP1-13 and at the depth of screened intervals in the other wells. The samples will be used to analyze the physical and chemical properties of the vadose and saturated zones. Sampling recommendations are discussed in Section 5.3.3 and shown on Figure 5-9. These three wells will provide data on the vertical extent of the chromium, nitrate, carbon tetrachloride, chloroform, and trichloroethylene plumes, as well as provide data to assist determination of groundwater flow and refine knowledge of stratigraphy.

5.1.3.1.3 Soil Vapor Sampling. Because large volumes of volatile chemicals were not disposed of in waste management units overlying the 200-UP-1 Groundwater Operable Unit, no soil vapor sampling is planned for the 200-UP-1 Groundwater Operable Unit investigation. Low concentrations of volatile organics in groundwater and information from process and disposal records indicate that testing for vapors in the vadose zone is not warranted because of the unlikelihood of a positive result. Soil vapor sampling may be used in the 200-ZP-1 Groundwater Operable Unit investigation and in the source operable unit investigations.

5.1.3.1.4 Groundwater Sampling. Many of the existing wells in the 200-UP-1 Groundwater Operable Unit, and all the new wells to be installed, should be sampled and analyzed for appropriate constituents. Before groundwater sampling begins, the historical analytical data should be reviewed carefully. Upon completion of this review, changes in the recommended sampling requirements will be made, if needed. Table 5-2 summarizes the recommended sampling requirements (analytes in each well).

In all these wells, the sampling should be begun on a quarterly basis for one year. Subsequently, sampling will be continued according to need based on the results during the first year of sampling.

Unfiltered samples for inorganics are required to support the QRA. It is anticipated that wells being sampled may produce turbid samples containing suspended solids. Such materials likely originate from aquifer soils in the immediate vicinity of the well, rather than representing transported residues from disposed wastes. Because the sediment contains inorganic compounds, samples collected for inorganic analysis will be analyzed for both dissolved (filtered) and total (unfiltered) concentrations.

5.1.3.1.5 Water Level Measurements. To support work plan activities for the operable unit, it is recommended that static water levels in existing groundwater wells located in the 200-UP-1 Groundwater Operable Unit will be monitored on a quarterly basis throughout the duration of field and analytical activities discussed in the work plan. Wells to be monitored should include all new wells and wells identified on Plates 1a and 1b. Monitoring should incorporate measurements from wells installed as part of the current work plan, and measurements from groundwater monitoring efforts and aquifer testing will also be included.

Water level elevations are currently measured for many of the 200-UP-1 Groundwater Operable Unit wells. These measurements are obtained as part of on-going site-wide monitoring programs from RCRA, CERCLA, and Hanford Operational Groundwater Monitoring Network programs. These programs and the wells included within each program are discussed in Section 2.8 of the *200 West Groundwater AAMSR*. Many of these wells are monitored on a quarterly basis at a minimum. The proposed monitoring efforts for the 200-UP-1 Groundwater Operable Unit should, to a large extent, use groundwater elevation data obtained from these programs to optimize the use of this information. Wells within the operable unit that are not currently included in these programs will be identified and incorporated into the monitoring network. Wells scheduled for abandonment will be checked, and wells installed for other programs will be added to the monitoring network for the 200-UP-1 Groundwater Work Plan as needed.

5.1.3.1.6 Geophysical Surveys. Subsurface geophysics are recommended to be run in nine of the new well boreholes and on four existing wells. The locations of these wells are shown on Figure 5-9. Only the deepest new well at a location will be surveyed with the assumption that variability over the close spacing is negligible. The list of wells and methods will be finalized in a DOW.

Geophysical surveys of the new wells should be performed as each casing string reaches its maximum depth to avoid surveying portions of boreholes through two casings and intervening grout. Gross gamma logging will be performed in Wells UP1-1 (if installed), -4, -5 (from the base of the Ringold Unit A through the Rattlesnake Ridge interbed), -6, -7, -8, -11, -12, and -13 in advance of the placement of casings. The RLS spectral gamma surveys will be conducted on these new wells following well installation. Although running both gross gamma logging and RLS spectral gamma logging in the new wells may be redundant, it is recommended that both techniques be used because of various limitations in both types of logging. These limitations include the length of time for running RLS logs, the length of the specialized cable for the RLS detector is not long enough to log the deepest new wells, and the inability of gross gamma logging to detect uranium. In addition gross gamma logging could save time by identifying intervals that would saturate an unshielded RLS detector, and gross gamma logs are more readily correlated with other wells in the area because of the historically more extensive use of gross gamma logging.

Gross gamma logging also should be conducted in Wells 299-W22-2 and 299-W22-30. These two wells monitor the 216-S-1 and 216-S-2 Cribs. Previous gross gamma logging of these well has shown elevated gross gamma levels throughout the vadose zone to the water table. These wells have not been logged since 1980. The new logs will be compared with the old logs to see if any appreciable changes have occurred in gross gamma levels in these wells.

The RLS spectral gamma logging should be conducted in four existing wells. The four existing wells are Wells 299-W22-2 and 299-W22-30, which monitor the 216-S-1 and 216-S-2 Cribs, 299-W22-25 which monitors the 216-S-9 Crib, and 299-W22-13, which monitors the 216-S-7 Crib. This logging should be coordinated with any future investigations of the S Plant Source Aggregate Area. The spectral gamma logs will provide information on the radionuclides responsible for the elevated gross gamma in these wells in the vadose zone immediately above the water table.

The 200-UP-2 Source Operable Unit field investigation calls for spectral gamma logging in eight existing monitoring wells and five new borings. The existing wells are Wells 299-W19-3, 299-19-9, 299-19-11, 299-W19-69, 299-W19-70, 299-W19-71, 299-W22-62, and 299-W22-75. Spectral gamma logging will be conducted during spring 1993 at Wells 299-W19-9, 299-W19-11, 299-W19-70, and 299-W22-75 as part of the *200 West Groundwater AAMSR* screening study (WHC 1991). The new borings that will be logged will be located near the 216-U-1, 216-U-2, and 216-U-8 Cribs, 216-U-4 Reverse Well, and 216-U-4A French Drain.

5.1.3.1.7 Aquifer Tests. The proposed aquifer tests to gather data on hydraulic properties data are based on the data needs and DQOs discussed in Section 4.2.3. Aquifer tests were conducted in 1993 for accelerated field activities and are planned along with other LFI activities following new well installation. Table 5-3 summarizes the recommended aquifer testing program for the 200-UP-1 Groundwater Operable Unit. The table identifies wells to be tested for the unconfined portion of the uppermost aquifer (Ringold Unit E gravels), the confined portion of the uppermost aquifer (Ringold Unit A gravels), and the Rattlesnake Ridge interbed confined aquifer using a variety of testing methods. The wells identified for deeper aquifer tests should be installed as nested completions that will also be used to collect groundwater samples for chemical analysis and collect water level elevation data (see Sections 5.1.3.1.2 and 5.1.3.1.4). The Rattlesnake Ridge interbed well is planned to be installed following completion of operable unit IRM activities.

Proposed testing methods listed in Table 5-3 include slug, slug interference, constant rate drawdown/recovery pumping tests, and short term pressure buildup tests. Section 4.2.3 discusses the rationale, application, and the advantages and limitations for each type of test and their variations. Specific information regarding the anticipated screen intervals in the test wells, observation wells for each test, and methods of data analysis are presented in Table 5-3. Final determination of the scope and methodology of this field activity is planned in a follow-on DOW.

5.1.3.2 Protocols and Procedures.

5.1.3.2.1 Well Condition and Survey Assessment. To complete the operable unit well condition and survey assessment, a record search should initially be conducted to gather well completion and survey data for existing wells within the operable unit. Wells for which the depth of screen intervals is uncertain or unknown would be identified and assessed by use of a downhole camera. Wells for which survey data are uncertain or unknown will be recommended for resurvey using a licensed professional surveyor familiar with the Hanford Site. Vertical and horizontal measurements will be referenced to U.S. Geological Survey/National Geodetic Survey bench marks or other permanent reference points. As discussed in Section 5.1.3.1.1, this effort is intended to incorporate available information from well compliance status and remedial assessment work planned by Westinghouse Hanford in 1993/1994.

5.1.3.2.2 Soil Borings/Sampling. Thirteen proposed boreholes may be drilled during the 200-UP-1 Groundwater Operable Unit field investigation. The general locations of these well borings are discussed in Section 5.1.3.1.2 and shown on Figure 4-2. The depths and geologic units to which the well borings will extend are shown in Table 5-4. Schematic diagrams showing stratigraphic units, depth of well screen, and sampling intervals of the borings are shown on Figures 5-1 through 5-8.

Drilling. The suggested drilling technique used on the boreholes should be air rotary with a downhole hammer or one of other acceptable technologies, with selection of the method to be made in a DOW. Drilling operations will be conducted according to EII 6.7, "Resource Protection Well and Test Borehole Drilling," and EII 5.4, "Field Decontamination of Drilling, Well Development and Sampling Equipment" (WHC 1988). Drilling cuttings will be managed according to EII 4.2, "Interim Control of Unknown, Suspected Hazardous and Mixed Waste" and EII 4.3, "Control of CERCLA and Other Past-Practice Investigation Derived Waste" (WHC 1988). As drilling proceeds, the well-site geologist will complete the borehole geologic log in accordance with EII 9.1, "Geologic Logging" (WHC 1988).

Temporary casing will be advanced along with drilling. Casings will be telescoped through the various aquifers, perched water, if encountered, and intervals of contamination to prevent cross contamination. The approximate casing sizes to be used will likely be 20, 25, 30, and 40 cm (8, 10, 12, and 16 in.) casings. For the five plume delineation well borings and the three boreholes to Ringold Unit A, UP1-1, -4, -6, -7, -8, -11, -12, and -13, gross gamma logging will be performed whenever the casing is telescoped. Gross gamma logging will also be performed in the UP1-5 well boring. The survey procedures are outlined in Section 5.3.2.4. Each telescoped casing, when its total depth has been achieved, will be cut and left in place so that it extends about 0.2 m (0.5 ft) above the next larger diameter casing.

Sampling. The split-spoon and/or core sampler should be the primary device for collecting soil samples for chemical and physical analyses during drilling. Recommended intervals for collecting chemical and physical samples are shown on Figures 5-1 through 5-8 and the analyses are discussed in Section 5.1.3.3. Archive samples will be collected at 3 m (10 ft) intervals from cuttings. All depths will be recorded to the nearest 0.025 m (0.10 ft). Sample intervals may be extended by driving the sampler a second time if an insufficient sample is collected during the first attempt. If samples cannot be obtained due to lithologic conditions, material from the drive barrel or sediment trap will be collected. At locations where multiple wells will be installed, samples will be collected from the deepest well and from the depths of the screened interval in the shallower wells.

Chemical samples will be collected and handled in accordance with EII 5.1, "Chain of Custody" (WHC 1988) and EII 5.2, "Soil and Sediment Sampling" (WHC 1988). Chemical samples will be collected with a split-spoon and/or core sampler with stainless steel liners. The sampler and liners will be decontaminated before use according to EII 5.5, "1706 KE Laboratory Decontamination of Resource Conservation and Recovery Act/Comprehensive Environmental Response, Compensation, and Liability Act (RCRA/CERCLA) Sampling Equipment" (WHC 1988). Prior to sampling, slough in the borehole will be removed to the greatest extent possible. Sampling personnel will transfer samples from the sample liners to the appropriate sample containers and preserve them in accordance with the EPA guidelines set forth in *Test Methods for Evaluating Solid Wastes* (EPA 1986). All chemical samples will be geologically logged by the well-site geologist. Chemical samples will be labeled with the appropriate Hanford Environmental Information System (HEIS) number to accommodate sample tracking and data entry into the HEIS.

All samples and cuttings will be field screened for organic volatiles and radionuclides. Volatiles will be screened by a qualified technician using an organic vapor monitor. Radionuclides will be screened by alpha and gamma counting instruments. All instruments will be used, maintained, and calibrated in a manner consistent with EII 3.2, "Calibration and Control of Monitoring Instruments" (WHC 1988), and EII 3.4, "Field Screening" (WHC 1988). The field geologist will record screening results in the borehole log (EII 9.1, "Geologic Logging" [WHC 1988]). If contamination is indicated by field screening or perched water is encountered, additional chemical samples will be collected for analyses as described in Section 5.1.3.3.

Physical samples will be collected by the same procedures as for chemical samples. Portions of physical samples that have been unconditionally radiologically released will be sent to an existing storage facility to be archived. Contaminated samples will be sent to a long-term storage facility if one is available. If one is not available, such samples will not be retained. The nonradioactive samples will be archived according to EII 5.7A, "Hanford Geotechnical Sample Library Control" (WHC 1988).

5.1.3.2.3 Well Completion. Wells will be completed according to procedures outlined in EII 6.8, "Well Completion" (WHC 1988). The design of wells will be as described in "Generic Specifications - Groundwater Monitoring Wells" (WHC 1991). In general, wells will be constructed of 10 cm (4 in.) inner diameter 304 stainless steel, joint threaded casing, and wire-wrap well screen. The screen slot and pack sand size will be determined from the results of sieve analysis.

5.1.3.2.4 Groundwater Sampling. Groundwater sampling should be carried out under the guidance of EII 5.8, "Groundwater Sampling" (WHC 1988). The only modification will be the measurement of Eh (by probe) simultaneously with the measurements for the other parameters (temperature, pH, and specific conductivity) at the time of sampling (i.e., after purging is complete).

5.1.3.2.5 Geophysical Surveys. Subsurface geophysics should be run in the five plume delineation well boreholes (UP1-1, -6, -7, -12, and -13) and the three Ringold Unit A well boreholes (UP1-4, -8, and -11) as each casing string reaches its maximum depth. Subsurface geophysics will also be run in well borehole UP1-5 from the base of Ringold Unit A through the Rattlesnake Ridge interbed. Boreholes will be logged according to EII 11.1, "Geophysical Survey Work" (WHC 1988).

In addition to the new well boreholes schedule for surveying, subsurface geophysics will be run in four existing wells (Figure 5-9). Wells 299-W22-2 and 299-W22-30 will be logged for gross gamma. The RLS spectral gamma logs will be run in Wells 299-W22-2, 299-W22-30, 299-W22-25, and 299-W22-13. The RLS spectral logging will be done in other wells within the 200-UP-1 Groundwater Operable Unit as part of the 200-UP-2 Source Operable Unit field investigation and as part of the 200 Area AAMSR screening study (WHC 1991).

5.1.3.2.6 Water Level Measurements. Groundwater levels should be measured in accordance with procedures and protocols described in EII 10.2 (WHC 1988). All observations, water levels, well depths, and other measurements will be obtained using a pre-determined reference point and will be recorded in the field notebook. Groundwater level measurements will be compared with previous measurements from the same well for consistency. If the measurements differ by more than 0.15 m (0.5 ft), depth to groundwater will be remeasured for verification. Necessary repairs and concerns associated with the condition of the well will also be identified and recorded in a field notebook.

5.1.3.2.7 Aquifer Testing. The proposed approach for aquifer testing outlined in Table 5-3 includes both single well tests and slug and pumping tests with observation wells. As an initial strategy, the single well pumping tests are planned to be completed for the aquifers identified during installation of the proposed well clusters listed in Table 5-3. Single well slug tests should be performed first, followed by pumping tests for applicable hydrostratigraphic units. A step drawdown test will be required to determine the optimal pumping rate for the longer term (constant discharge/recovery) pumping tests.

Slug interference and pumping tests with observation wells must be staged to use observation wells with temporary screens in the hydrostratigraphic unit being tested. Following completion of testing, the observation well would continue to be advanced to its target final completion depth. An example is the slug interference test proposed for Well UP1-3 (deep unconfined portion of the uppermost aquifer). This test should use a temporary screen for Well UP1-4 for an observation well in the same hydrostratigraphic unit as Well UP1-3 is being advanced to its target final completion depth in the Ringold Unit A gravels (confined aquifer). The projected final screen depths for the proposed testing wells are listed in Table 5-4.

Specific details regarding the staging of drilling for this testing program, and other details such as well diameter and screen design specification data, pump types, and other logistical constraints should be provided in follow-on DOW documents for aquifer testing. Testing will also be conducted in accordance with procedures and protocol described for slug tests and constant discharge/recovery tests in EII 10.1 (WHC 1988). The DOW testing plans should include contingency arrangements for containing, testing, and disposing contaminated discharge water during pumping tests, if encountered.

5.1.3.2.8 Air Sampling. There are four high-volume air samplers stationed within the 200-UP-1 Groundwater Operable Unit. The samplers contain filters, which collect particles entrained in the air. The sample filters are exchanged weekly and saved to be analyzed quarterly. The air sampling effort is an on-going activity that is independent of the other activities described in this work plan. However, during the field work at the 200-UP-1 Groundwater Operable Unit the air sampling results will be monitored more closely to see if the other field activities are impacting air quality. This monitoring will involve reviewing the data that are being generated by the on-going program to see if field operations have in any way impacted the local air quality. Air sampling will also be performed for carbon tetrachloride and other VOCs during the drilling process called for in drilling DOWs.

5.1.3.3 Laboratory Analysis. Vadose and saturated zone soil samples and groundwater samples will be submitted for chemical and radionuclide analysis, as discussed in Sections 5.1.3.1.2 and 5.1.3.1.4. Vadose and saturated zone soil samples will be sent to the laboratory for physical analyses as discussed in Section 5.1.3.3.2.

5.1.3.3.1 Chemical and Radionuclide Analyses. Table QAPjP-1 (Appendix A) lists the target analytes for the 200-UP-1 Groundwater Operable Unit and specifies the method of analysis. Chemical and radionuclide analyses will include the following for soil and water:

- Volatile organics

- Semivolatile organics
- Inorganics
- Radionuclides
- Common ions, alkalinity, total organic carbon (TOC), total dissolved solid (TDS), total suspended solid (TSS) (water only).

For soil, these analyses are recommended for the early "Palouse" soils, Plio-Pleistocene Unit, just above the water table, and from the depth of the screen interval for each well. If either unexpected soil contamination or perched water is encountered during drilling, then the supervising field engineer/scientist can decide to collect unscheduled samples for analysis. For groundwater, these analyses will vary according to well, as indicated in Table 5-2.

Detection levels for groundwater analyses will follow method standards for the analyses indicated in the QAPjP except where MCL and 4% DCGs and the QRA require lower levels. Detection limits necessary to support the QRA are shown in Table 5-5 and are derived based on a target 1E-6 risk level and groundwater ingestion. Where possible, analytical methods will be selected to meet these DQOs. In order to satisfy some of these requirements, the Low-level Contract Laboratory Program (CLP) Statements of Work (SOWs) for both organics (volatiles) and inorganics will be followed.

5.1.3.3.2 Physical Analyses. Three suites of proposed analyses (labeled as Type A to Type C) are identified below to distinguish between analyses appropriate for each hydrostratigraphic unit. A summary of the type of analyses selected for each unit is presented in Table 5-6. The recommended types of analyses and approximate depths where they should be collected are shown on schematic well diagrams on Figures 5-1 through 5-8.

Type A analyses will include the following:

- Moisture content
- Soil pH/Eh
- $CaCO_3$ content.

The Type A analyses are recommended for the early "Palouse" soils, Plio-Pleistocene Unit, and unsaturated portions of the Ringold Unit E gravels.

Type B analyses will include the following:

- Grain and cement mineralogy
- Bulk density
- Particle size distribution
- Porosity
- Soil pH/Eh
- Cation exchange capacity
- $CaCO_3$ content
- Organic carbon content.

An initial use of the borehole geologic data will be to verify that the anticipated screen intervals for well installations listed in Table 5-4 are acceptable. It is expected that many of the screen horizons may be adjusted slightly based on the local stratigraphy.

On a broader scale, the information will be used to further evaluate the lateral extent and thicknesses of geologic and hydrostratigraphic units presented on Figure 2-1. A key feature of this evaluation is the determination of the thickness and hydrologic properties of the Ringold lower mud unit and Ringold Unit A gravels at the locations of deep wells UP1-4/5, UP1-8, and UP1-11. This information is an important factor affecting the interpretation of aquifer testing data from the confined zones.

Additional data from vadose zone soil samples are expected to provide more-detailed delineation of the lateral thickness variability for the Plio-Pleistocene unit, early "Palouse" soil, and finer grained zones of the Hanford formation (potential perching layers). The vadose zone data will be useful for conducting of source area environmental assessment, evaluating potential future contributions to groundwater contamination, and developing and remediation work plans.

Information on subsurface conditions will be obtained from the geologist logs, grab samples, split-spoon samples, or core samples as specified in individual DOWs.

5.1.4.2 Aquifer Properties and Groundwater Flow Characterization. Aquifer properties will be evaluated through samples collected during borings, geophysical surveys, and aquifer tests proposed for the work plan. Soil samples will provide detailed lithologic information, and soil testing will quantify many of the soil characteristics needed for a complete hydrogeologic evaluation. Geophysical surveys will help refine stratigraphic interpretations.

Data from aquifer tests described in Section 5.1.3.1.7 will be analyzed using a variety of potential methods listed in Table 5-3. The analytical methods will be selected based on several criteria including:

- The overall quality and representativeness of the data obtained from the aquifer testing
- Appropriateness of the analytical method for hydrogeologic conditions encountered
- The intended application of data.

Aquifer testing data will be used to assess vertical anisotropy and possible leakage between the unconfined portion of the uppermost aquifer (Ringold Unit E), and the confined portion of the uppermost aquifer (Ringold Unit A). Water level elevation data obtained from 200-UP-1 Groundwater Operable Unit wells will allow for more detailed characterization of groundwater flow and horizontal/vertical hydraulic gradients. The data will also be used to assess possible perturbations in groundwater, flow and gradients induced by changes in volume of effluent from 200 West Area discharge sources.

Aquifer test and water level elevation data obtained during proposed work plan field activities are also intended to support groundwater flow modeling activities. As an example, results of the aquifer test data analysis are useful for supplementing previous testing data from the unconfined portion of the uppermost aquifer (Ringold Unit E) described by Connelly et. al. (1992). The previous data were used to develop a hydrogeologic model of the unconfined aquifer for the 200 West Area, and were summarized in Section 3.5 of the *200 West Groundwater AAMSR*. Similar to the recommended 1993 shallow aquifer testing using existing operable unit wells (Section 4.2.1), results of proposed work plan aquifer testing should help support groundwater modeling studies by Westinghouse Hanford to evaluate remedial technologies related to the IRM.

An additional aspect of groundwater flow characterization is the identification of wells with potential to become dry due to falling water table elevations. As discussed in Section 5.3.1.1, wells in critical monitoring locations with potential for becoming stranded should be replaced with deeper installations if sampling is to be continued. To complete this evaluation, historic water table elevation records will be reviewed and extrapolated to predict locations where well screens will become stranded. The evaluation will use verified well screen and survey data.

5.1.4.3 Plume Delineation. Groundwater chemical data collected during the field sampling program discussed in Section 5.1.3.1.4.2 will be assessed to further delineate the extent of LFI constituent plumes (and LFI portions of IRM plumes) of concern in the 200-UP-1 Groundwater Operable Unit. The sampling program includes existing wells specified for each constituent, and new wells installed in areas that currently have sparse well coverage. As discussed in Section 5.1.3.1.4.2, the proposed locations and depths of the new wells were selected to provide data for assessing both the vertical and lateral extent of the constituent plumes.

A significant component of the plume delineation effort will involve comparison of the sampling data collected with existing groundwater chemical information. As part of this comparison, a detailed assessment of the overall quality of the historical analytical data is planned to evaluate analytical quality control, differing sampling and analytical methods, detection limits, and verification of "single detections." Other factors such as the potential influence of well construction materials on analytical results will also be considered (e.g., chromium contribution to groundwater from carbon steel well casings). The description of time variation trends of plume constituents in Section 3.1 (through April 1992) provides initial background information for the purposes of comparing changes in plume configurations over time.

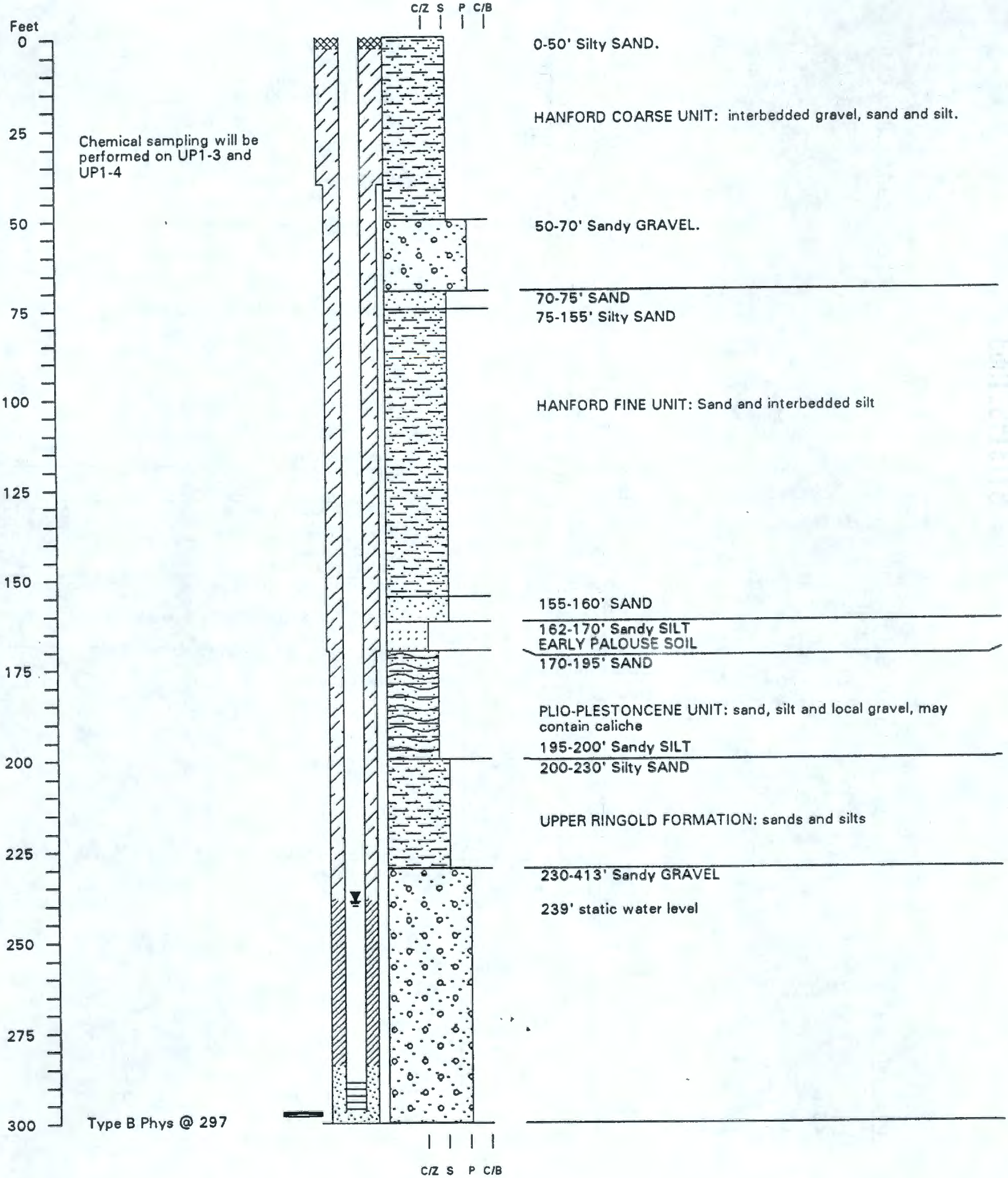
5.1.4.4 Contaminant Characteristics and Transport. Another objective during the analysis of groundwater chemical data is to further assess contaminant transport characteristics. This assessment provides additional understanding of plume migration patterns over time, and information for operable unit remedial alternatives. Transport characterization is intended to primarily

APPENDIX B

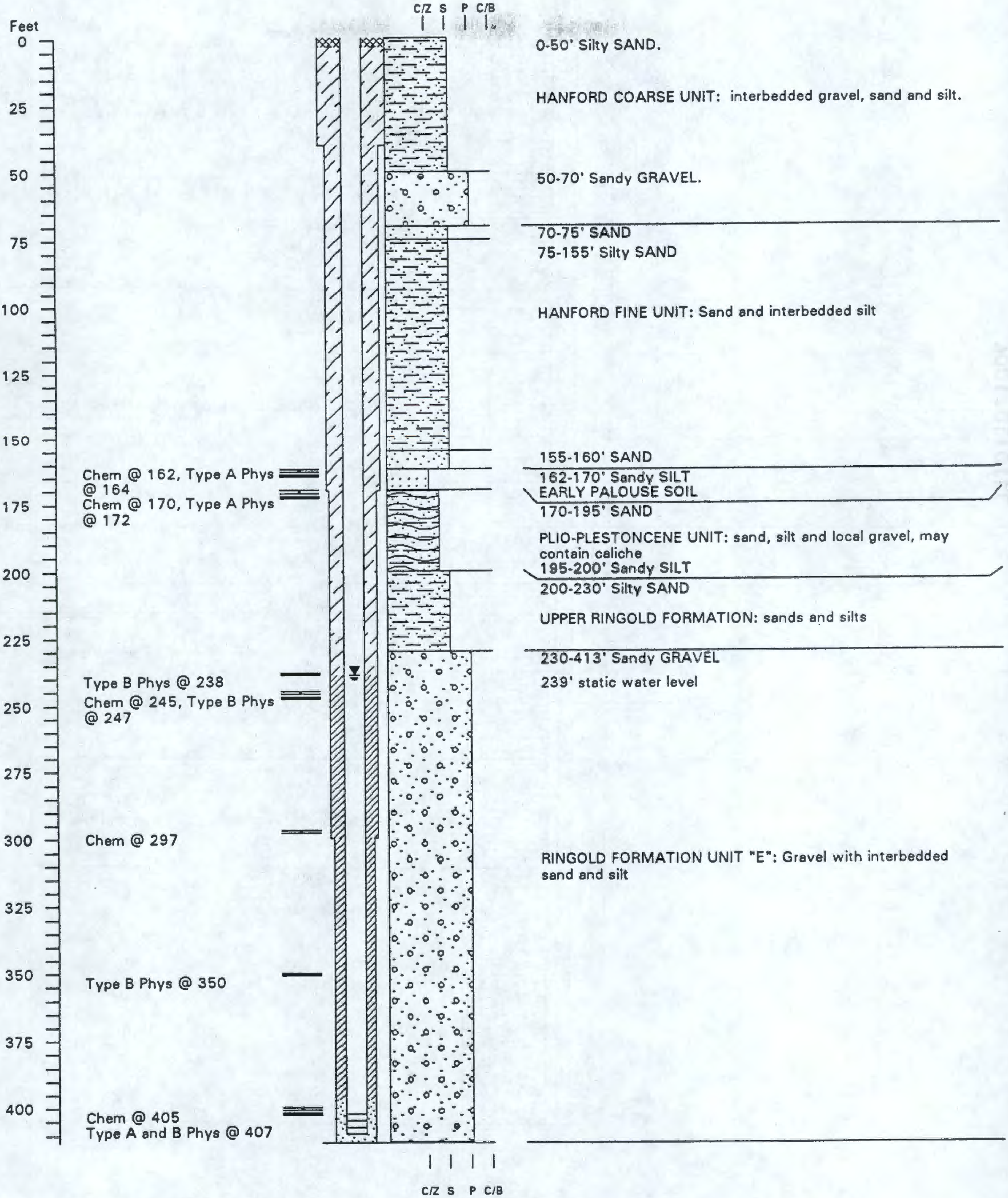
GEOLOGIC SAMPLING

(All stratigraphic information and sampling points are approximated; sample points are subject to the professional judgment of the Site Geologist)

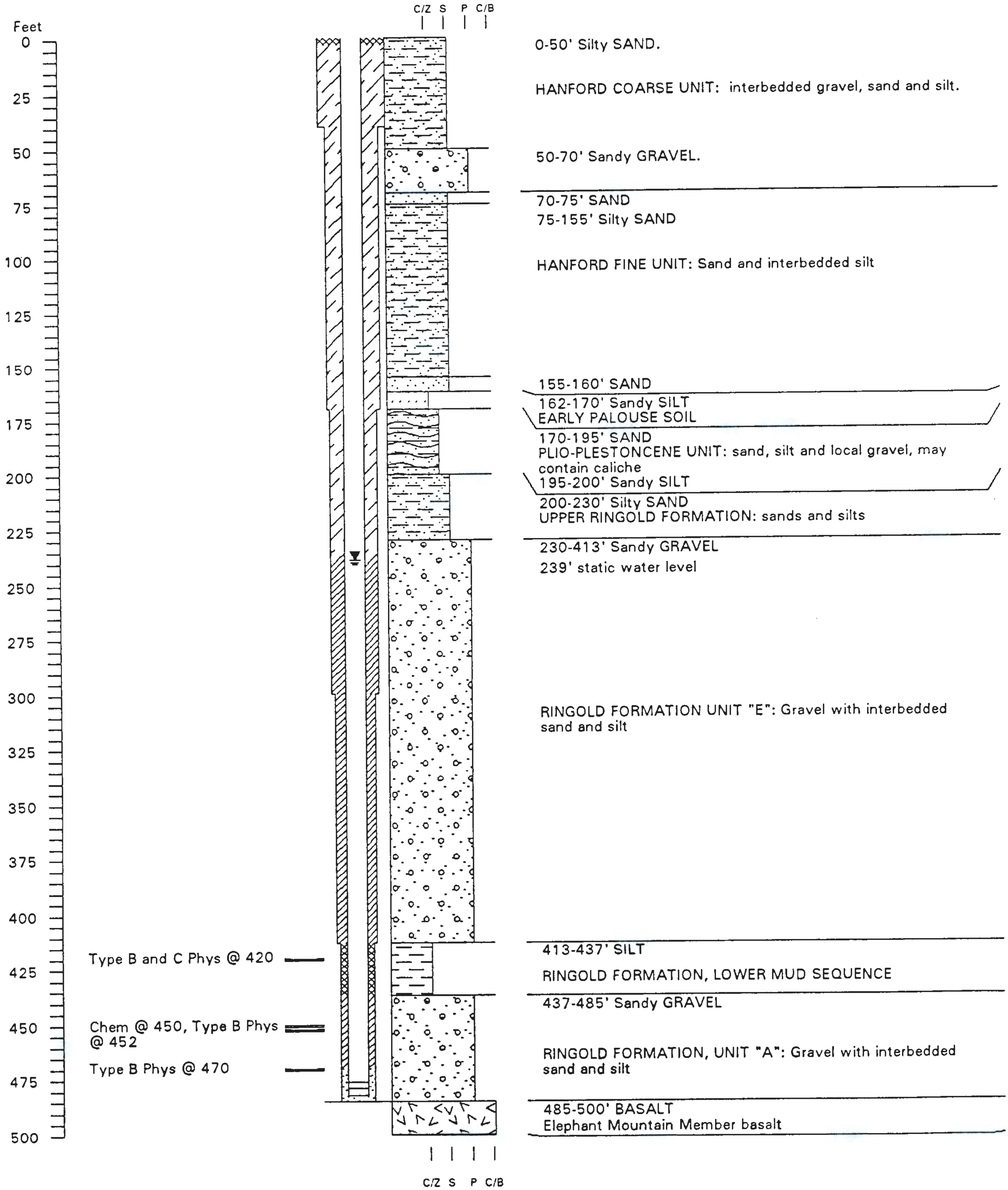
UP1-2


C/Z S P C/B
Feet
0
25
50
75
100
125
150
175
200
225
250
275
300
Chemical sampling will be performed on UP1-3 and UP1-4
Type B Phys @ 297
0-50' Silty SAND.
HANFORD COARSE UNIT: interbedded gravel, sand and silt.
50-70' Sandy GRAVEL.
70-75' SAND
75-155' Silty SAND
HANFORD FINE UNIT: Sand and interbedded silt
155-160' SAND
162-170' Sandy SILT
EARLY PALOUSE SOIL
170-195' SAND
PLIO-PLESTONCENE UNIT: sand, silt and local gravel, may contain caliche
195-200' Sandy SILT
200-230' Silty SAND
UPPER RINGOLD FORMATION: sands and silts
230-413' Sandy GRAVEL
239' static water level
C/Z S P C/B

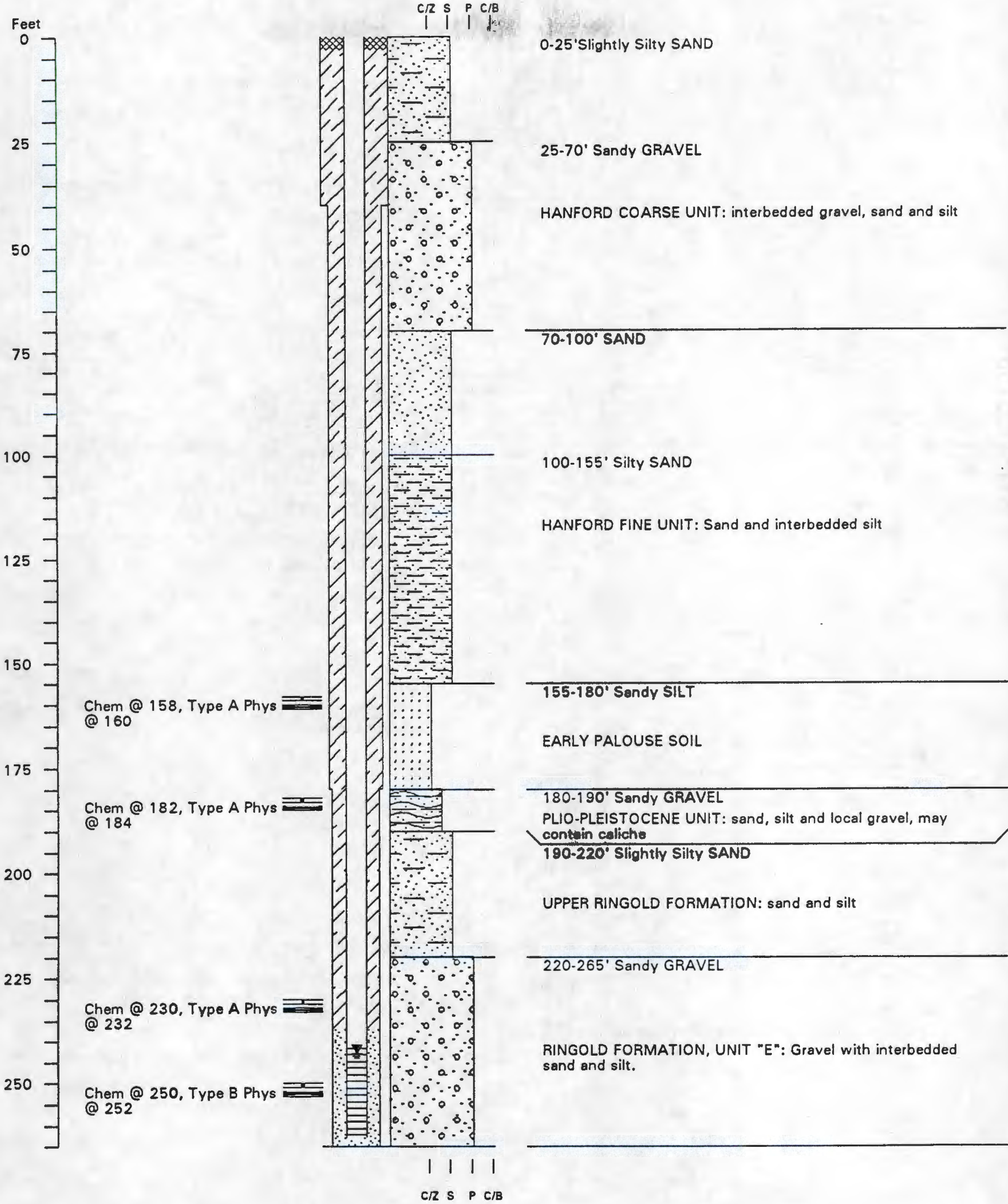
UP1-3


C/Z S P C/B
Feet
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
Chem @ 162, Type A Phys @ 164
Chem @ 170, Type A Phys @ 172
Type B Phys @ 238
Chem @ 245, Type B Phys @ 247
Chem @ 297
Type B Phys @ 350
Chem @ 405
Type A and B Phys @ 407
0-50' Silty SAND.
HANFORD COARSE UNIT: interbedded gravel, sand and silt.
50-70' Sandy GRAVEL.
70-75' SAND
75-155' Silty SAND
HANFORD FINE UNIT: Sand and interbedded silt
155-160' SAND
162-170' Sandy SILT
EARLY PALOUSE SOIL
170-195' SAND
PLIO-PLESTONCENE UNIT: sand, silt and local gravel, may contain caliche
195-200' Sandy SILT
200-230' Silty SAND
UPPER RINGOLD FORMATION: sands and silts
230-413' Sandy GRAVEL
239' static water level
RINGOLD FORMATION UNIT "E": Gravel with interbedded sand and silt
C/Z S P C/B

UP1-4


C/Z S P C/B
Feet
0
25
50
75
100
125
150
175
200
225
250
275
300
325
350
375
400
425
450
475
500
0-50' Silty SAND.
HANFORD COARSE UNIT: interbedded gravel, sand and silt.
50-70' Sandy GRAVEL.
70-75' SAND
75-155' Silty SAND
HANFORD FINE UNIT: Sand and interbedded silt
155-160' SAND
162-170' Sandy SILT
EARLY PALOUSE SOIL
170-195' SAND
PLIO-PLESTONCENE UNIT: sand, silt and local gravel, may contain caliche
195-200' Sandy SILT
200-230' Silty SAND
UPPER RINGOLD FORMATION: sands and silts
230-413' Sandy GRAVEL
239' static water level
RINGOLD FORMATION UNIT "E": Gravel with interbedded sand and silt
413-437' SILT
RINGOLD FORMATION, LOWER MUD SEQUENCE
437-485' Sandy GRAVEL
RINGOLD FORMATION, UNIT "A": Gravel with interbedded sand and silt
485-500' BASALT
Elephant Mountain Member basalt
Type B and C Phys @ 420
Chem @ 450, Type B Phys @ 452
Type B Phys @ 470
C/Z S P C/B

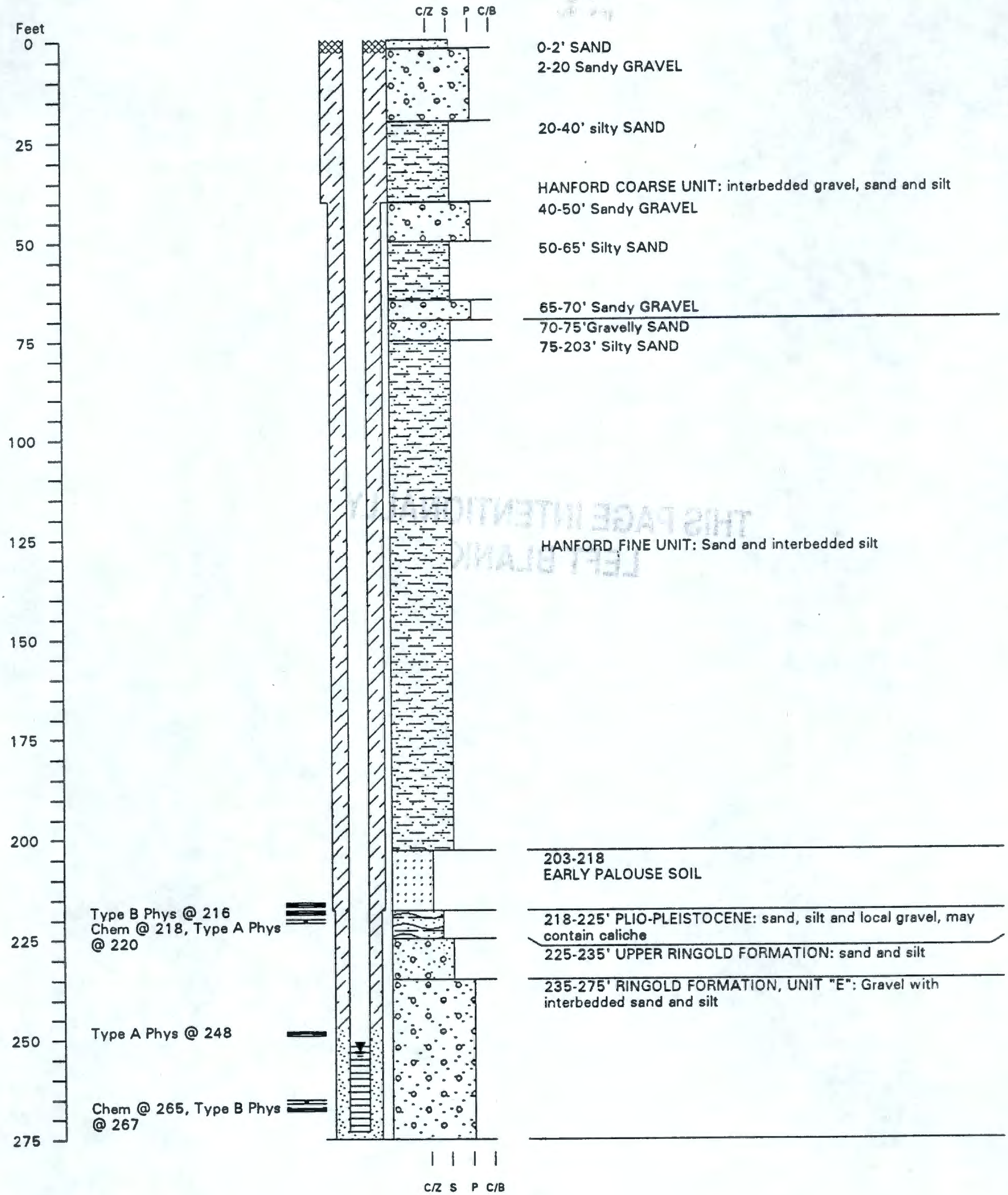
UP1-6



C/Z S P C/B
Feet
0
25
50
75
100
125
150
175
200
225
250
0-25'Slightly Silty SAND
25-70' Sandy GRAVEL
HANFORD COARSE UNIT: interbedded gravel, sand and silt
70-100' SAND
100-155' Silty SAND
HANFORD FINE UNIT: Sand and interbedded silt
155-180' Sandy SILT
EARLY PALOUSE SOIL
180-190' Sandy GRAVEL
PLIO-PLEISTOCENE UNIT: sand, silt and local gravel, may contain caliche
190-220' Slightly Silty SAND
UPPER RINGOLD FORMATION: sand and silt
220-265' Sandy GRAVEL
RINGOLD FORMATION, UNIT "E": Gravel with interbedded sand and silt.
Chem @ 158, Type A Phys @ 160
Chem @ 182, Type A Phys @ 184
Chem @ 230, Type A Phys @ 232
Chem @ 250, Type B Phys @ 252
C/Z S P C/B

9413146.1566

UP1-7



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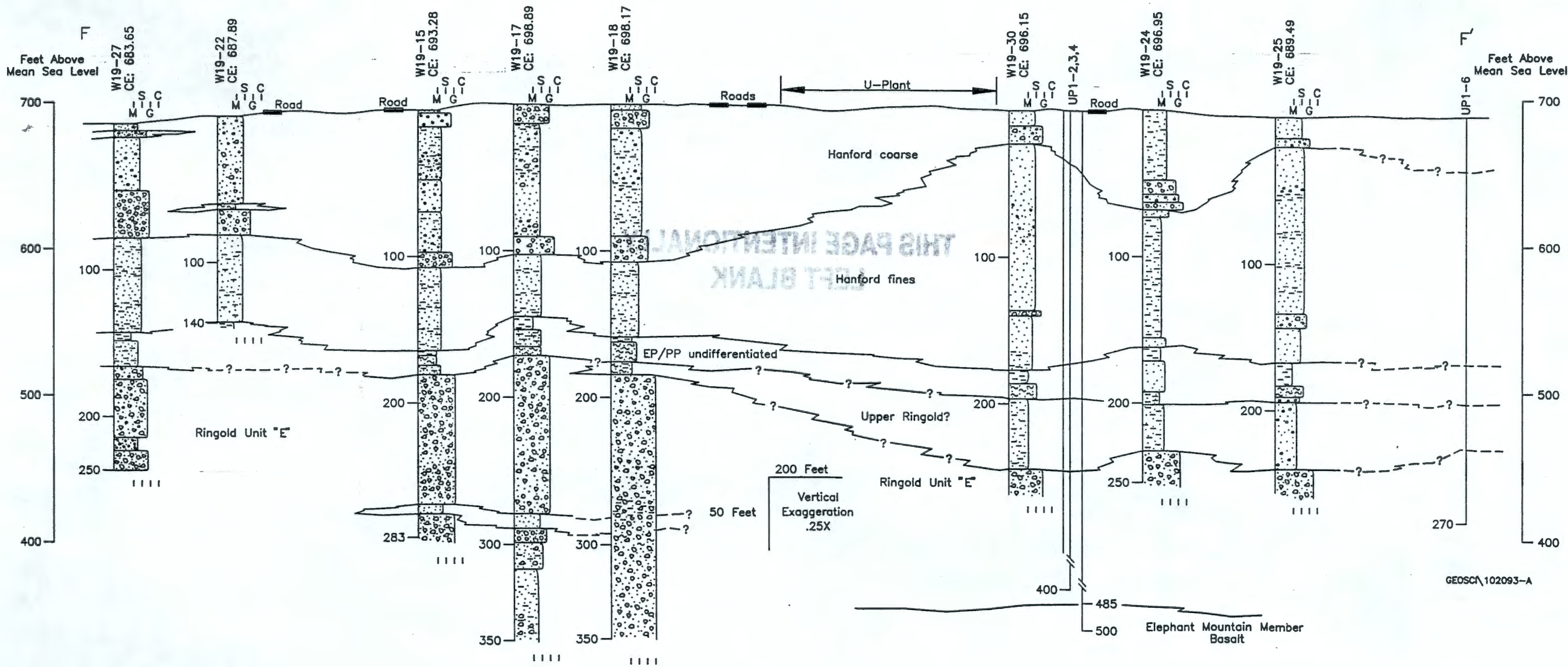

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APPENDIX C

SLUG INTERFERENCE PROCEDURE

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Prerequisite

1. Before installing any calibrated test equipment, verify and record that the equipment will remain in calibration over the period of the test.

2. Pre-test monitoring of water-levels at each well must start at least 1 day before the field testing begins to establish water-level trends (although a longer period is optimum). A barometric pressure transducer must be used to monitor atmospheric pressure changes over the same period of time. Both transducers must be set to the same recording rate and time (a maximum of 1 hour intervals).

Procedure

1. Install an inflatable packer on a working string in the observation well as close as possible to the top of the well screen. The packer generally should not be seated inside the well screen, but may be if the screen is a louvered or bridge slot type. The packer must be set below the top of the water table. Note: The test can still be conducted even if a packer is not set (e.g., testing a well with a wire wrap screen that transects the water table), although this is not the preferred method. Install the observation well transducer within the screened interval of the well.

2. Begin baseline monitoring of water levels and barometric pressures at the observation well(s) at 10-minute intervals.

3. Make up the wellhead assembly to the stress well.

4. Install two pressure transducers in the screen section of the stress well: one at the maximum depth that the water level will be depressed, and the other above the water table. An electric tape may be placed at or below the lower transducer as a check to ensure that the water level is not depressed into the well screen. Begin baseline monitoring with the transducer at 10-minute intervals.

5. Connect the gas line from the gas cylinder to the wellhead assembly and make sure the ball valves are closed. An inert type of gas such as nitrogen must be used.

6. Set the transducer recording rates to 1 minute for both the observation well and stress well. Make sure that the transducers in both the stress and observation wells are recording at the same rate and at the same time.

7. Pressure the well casing by opening the valve on the gas cylinder, thereby depressing the water level in the well to near the top of the well screen (maximizing the volume displaced), but not below the screen top. The well should be pressurized until the pressure reading on both transducers is about the same. If the water level drops below the electric tape, the tape will no longer buzz when tested. This indicates that the water level has dropped into the screen, and the test must be abandoned (the test can be restarted after the water level restabilizes).

8. Hold the water level at this elevation until the transducers indicate the formation has restabilized (i.e., the pressure readings are relatively constant).

9. Reset the transducer recording rates to the most rapid recording rate (less than one second is preferred), making sure that the transducers in the stress and observation wells are synchronized.

10. Open the ball valve on the wellhead assembly to instantaneously release the pressure in the casing, and monitor the water level recovery in both the stress well and the observation wells until they return to static.

11. Repeat the process of pressurizing and depressurizing as many times as desired. At least two cycles are recommended.

<u>Variations in Stress Well Configuration</u>

A. If the stress well has a double screen section, and the upper screen section will be tested, an inflatable packer on a working string must be installed in the blank casing section between the screens. Placement of the packer will isolate the two screen sections. The wellhead assembly is constructed to allow access to the lower screen section but still allow pressurization and depressurization of the upper screen interval (annular space).

Using this configuration, a third transducer should be installed through the working string to monitor water level changes in the lower screen section. The recording rate and recording times must be synchronized with the transducer in the upper screen.

B. If in a double screened well the lower screen section is to be tested, the same packer and transducer configuration can be used as for Variation A above. However, the working string is pressurized and then depressurized instead of the annular space.