DISTRIBUTION SHEET

To	From	Page 1 of 1
DISTRIBUTION	M. D. Sweeney	Date 22 March, 1995
Project Title/Work Order Interim Status Groundwater Monitoring Plan for the 216-B-63 Trench, Rev. 1		EDT No.
		ECN No. 618173

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
D. J. CARRELL	H6-22				X
D. W. FRITZ	H6-22				X
D. M. DAY	H6-22				X
A. K. MCDOWELL	R1-51	X			
M. D. SWEENEY	H6-06	(2)			
J. S. SCHMID	H6-06				X
W. R. THACKABERRY	H4-16	X			
B. A. WILLIAMS	H6-06				X
K. R. FECHT	H4-85	X			
L. C. SWANSON	H6-03	X			
J. RUGG	H4-86				X
CENTRAL FILES	~~L8-04~~ A3-88	(2)			
EPIC	~~H6-08~~ H6-08	(2)			
OSTI	~~L8-07~~ A3-36	(2)			

A-6000-135 (01/93) WEF067

COMPLETE

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN № 618173

Proj. ECN

2. ECN Category (mark one)

- Supplemental []
- Direct Revision [X]
- Change ECN []
- Temporary []
- Standby []
- Supersedure []
- Cancel/Void []

3. Originator's Name, Organization, MSIN, and Telephone No.
MD Sweeney, STS/HTS, H6-06, 373-0703 OM623

4. Date
March 22, 1995

5. Project Title/No./Work Order No.
Interim Status Groundwater Monitoring Plan for the 216-B-63 Trench
R4044

6. Bldg./Sys./Fac. No.
216-B-63 Trench

7. Approval Designator
QE

8. Document Numbers Changed by this ECN (includes sheet no. and rev.)
WHC-SD-EN-AP-165, Rev. 0

9. Related ECN No(s).
N/A

10. Related PO No.
N/A

11a. Modification Work
[] Yes (fill out Blk. 11b)
[X] No (NA Blks. 11b, 11c, 11d)

11b. Work Package No.
N/A

11c. Modification Work Complete
N/A
Cog. Engineer Signature & Date

11d. Restored to Original Condition (Temp. or Standby ECN only)
N/A
Cog. Engineer Signature & Date

12. Description of Change
Complete revision and replacement of this document.

13a. Justification (mark one)

Criteria Change []	Design Improvement []	Environmental [X]	
As-Found []	Facilitate Const. []	Const. Error/Omission []	Design Error/Omission []

13b. Justification Details
Reflects changes in sampling and analysis program and corrects errors in original document.

14. Distribution (include name, MSIN, and no. of copies)
See distribution sheet.

RELEASE STAMP
OFFICIAL RELEASE BY WHC 21
DATE JUN 13 1995
Sta. 21

A-7900-013-2 (06/94) GEF095

A-7900-013-1

ENGINEERING CHANGE NOTICE	Page 2 of 2	1. ECN (use no. from pg. 1) 618173

15. Design Verification Required	16. Cost Impact				17. Schedule Impact (days)	
	ENGINEERING		CONSTRUCTION			
[] Yes	Additional	[] $	Additional	[] $	Improvement	[]
[X] No	Savings	[] $	Savings	[] $	Delay	[]

18. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) that will be affected by the change described in Block 12. Enter the affected document number in Block 19.

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	Operational Safety Requirement	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

19. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
None		

20. Approvals

Signature	Date	Signature	Date
OPERATIONS AND ENGINEERING		ARCHITECT-ENGINEER	
Cog. Eng. M. D. Sweeney [signature]	3-24-95	PE	
Cog. Mgr. J. S. Schmid [signature]	~~4-5~~ 6/9/95	QA	
QA W. R. Thackeberry [signature] HA-16	4-5-95	Safety	
Safety		Design	
Environ. ~~D. W. Fritz~~ D. J. Carrell [signature] for DJC	4-13-95	Environ.	
Other [signature] / BRUCE A. WILLIAMS	6/9/95	Other	
		DEPARTMENT OF ENERGY	
		Signature or a Control Number that tracks the Approval Signature	
		ADDITIONAL	

RELEASE AUTHORIZATION

Document Number:	INTERIM-STATUS GROUNDWATER MONITORING PLAN FOR THE 216-B-63 TRENCH
Document Title:	WHC-SD-EN-AP-165, Rev. 1
Release Date:	5/4/95

This document was reviewed following the procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

Chris Willingham

C. Willingham 5/4/95

SUPPORTING DOCUMENT

1. Total Pages 77

2. Title

Interim-status Groundwater Monitoring Plan for the 216-B-63 Trench

3. Number

WHC-SD-EN-AP-165

4. Rev No.

1

5. Key Words

B-63 Trench, RCRA Groundwater Monitoring, 200 Area, Interim-Status

6. Author

Name: M. D. Sweeney

Signature

Organization/Charge Code STS/HTS/R4044 OM623

7. Abstract

This direct revision of the initial groundwater monitoring plan, under RCRA regulations in 40 CFR 265 Subpart F and WAC 173-300-400, for the 216-B-63 Trench. This interim-status facility is being sampled under detection monitioring criteria and this plan provides current program conditions and requirements.

8. RELEASE STAMP

OFFICIAL RELEASE 21
BY WHC
DATE JUN 13 1995
Sta. 21

RECORD OF REVISION	(1) Document Number WHC-SD-EN-AP-165	Page 1

(2) Title
Interim-status Groundwater Monitoring Plan for the 216-B-63 Trench

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
0	EDT-605142, 2/15/95		
1 RS	(7) Complete revision of this document ECN-	[signature]	[signature] 6/9/95

A-7320-005 (08/91) WEF168

CONTENTS

APPENDIX

LIST OF FIGURES

LIST OF TABLES

TERMS

AR	averaged replicate
CFR	*Code of Federal Regulations*
CRBG	Columbia River Basalt Group
CY	calendar year
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EII	environmental investigation instructions
EPA	U.S. Environmental Protection Agency
IP	(contamination) indicator parameters
LLBG-WMA 2	Low Level Burial Ground-Waste Management Area 2
LOQ	limit of quantitation
msl	mean sea level
NGVD	national geodetic vertical datum
OSHA	Occupational Safety and Health Administration
RCRA	*Resource Conservation and Recovery Act of 1976*
RL	U.S. Department of Energy, Richland Operations Office
SST	single-shell tank
TEGD	Technical Enforcement Guidance Document
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
WAC	*Washington Administrative Code*
WHC	Westinghouse Hanford Company

1.0 INTRODUCTION

This document outlines the groundwater monitoring plan for interim-status detection-level monitoring of the 216-B-63 Trench. This is a revision of the initial groundwater monitoring plan prepared for Westinghouse Hanford Company (WHC) by Bjornstad and Dudziak (1989).

The 216-B-63 Trench, located at the Hanford Site in south-central Washington State (Figure 1), is an open, unlined, earthen trench approximately 1.2 m (4 ft) wide at the bottom, 427 m (1,400 ft) long, and 3 m (10 ft) deep that received wastewater containing hazardous waste and radioactive materials from B Plant, located in the 200 East Area (Figure 2). Liquid effluent discharge to the 216-B-63 Trench began in March 1970 and ceased in February 1992. The trench is now managed by Waste Tank Operations.

The trench received liquid effluent from the B Plant chemical sewer. The effluent was a mixture of steam condensate and raw water; none of these waste streams is now designated as dangerous waste. However, documented hazardous discharges occurred from 1970 to October 1985 and consisted of aqueous sulfuric acid and sodium hydroxide solutions exceeding the pH limits of 2.0 and 12.5, respectively. Radioactive soils were dredged from the trench in August 1970. In 1985, physical controls, radiation monitors, and operating procedures were modified to avoid inadvertent discharge of chemicals or radioactive substances to the wastewater stream discharging to the 216-B-63 Trench.

1.1 PURPOSE

This plan presents a groundwater monitoring program that is capable of determining the impact of waste disposal at the 216-B-63 Trench on the quality of groundwater in the uppermost aquifer underlying the facility, as required in Title 40 *Code of Federal Regulations* (CFR) Part 265 Subpart F.

1.2 OBJECTIVES

This plan is being revised to meet the following objectives.

- Revise the initial groundwater monitoring system so that it can indicate any hazardous constituents that may have migrated from the site to groundwater
- Revise the initial hydrogeologic characterization plan to incorporate the most recent site information.

This revised groundwater monitoring plan presents an overview of the 216-B-63 Trench, the waste characteristics, the geology and hydrology of the area, the background and indicator evaluation (detection) groundwater monitoring program, and an outline of a groundwater quality assessment (compliance) program.

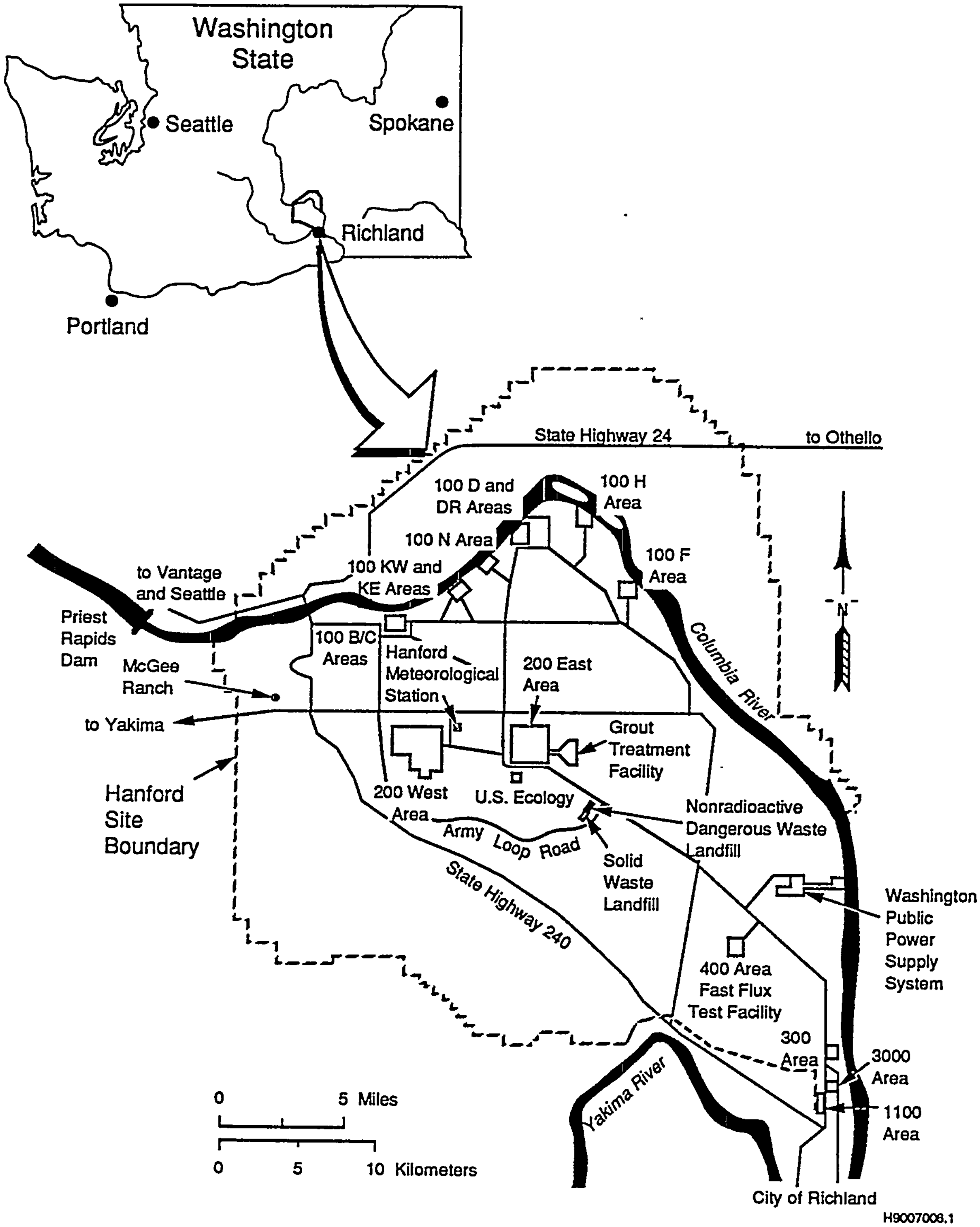


Figure 1. Location of the Hanford Site and Various Landmarks.

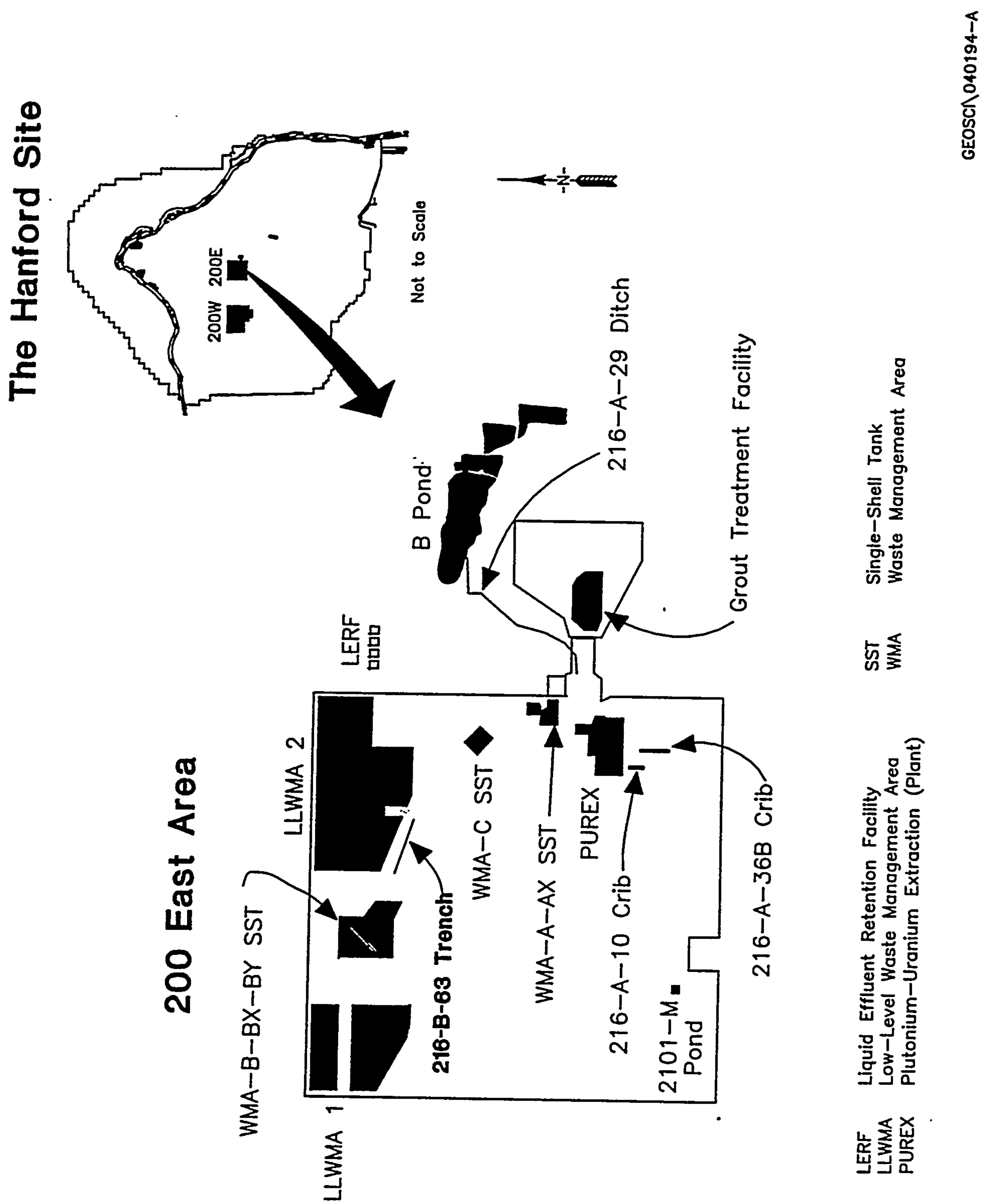


Figure 2. Location of the 216-B-63 Trench.

The plan for the monitoring program is based on groundwater monitoring requirements for *Resource Conservation and Recovery Act of 1976* (RCRA) interim-status facilities. The applicable monitoring requirements are described in 40 CFR 265 Subpart F and *Washington Administrative Code* (WAC) 173-303-400; WAC-173-303-400(3)(a) refers to 40 CFR 265 Subpart F for interim-status groundwater monitoring regulations.

2.0 BACKGROUND

The Hanford Site is a U.S. Department of Energy (DOE) nuclear materials facility that, in the past, included operating nuclear reactors, storing and reprocessing spent nuclear fuel, and managing radioactive and dangerous wastes. Present activities primarily involve managing radioactive, dangerous, and extremely dangerous waste. The fuel reprocessing and radioactive waste management facilities are in the 200 East and 200 West Areas and are currently operated by WHC. More than 45 years of operations in these areas have resulted in the storage, disposal, and release of radioactive and/or hazardous wastes. Groundwater contamination plumes resulting from these releases pass beneath the 216-B-63 Trench and affect the background water quality for the site (Johnson 1993).

2.1 FACILITY DESCRIPTION

2.1.1 Location and Physical Description

The Hanford Site is approximately 270 km (170 mi) southeast of Seattle and 200 km (125 mi) southwest of Spokane, Washington (Figure 1). The 216-B-63 Trench is centrally located on the Hanford Site in the 200 East Area (Figure 2).

The 216-B-63 Trench is an open, unlined constructed earthen trench, approximately 1.2 m (4 ft) wide at the bottom, 427 m (1,400 ft) long, and 3 m (10 ft) deep. Figure 3 details the configuration of the trench, along with the location of nearby wells and the trench boundary. The trench is closed at the east end and does not convey effluent to any other facilities. The trench is located within the perimeter fencing of the 200 East Area and has been in service since 1970. All discharge to the trench is located within the perimeter fencing of the 200 East Area. The trench is located northeast of B Plant and originates approximately 366 m (1,200 ft) east of Baltimore Avenue (DOE-RL 1987).

The B Plant chemical sewer discharges to the 216-B-63 Trench through a 38-cm (15-in.)-diameter vitrified clay pipe. The first 3 m (10 ft) of trench from the point of influent is lined with gravel (5-cm [2-in.]-minimum size, 0.3-m [1-ft]-minimum depth) for erosion control (DOE-RL 1987).

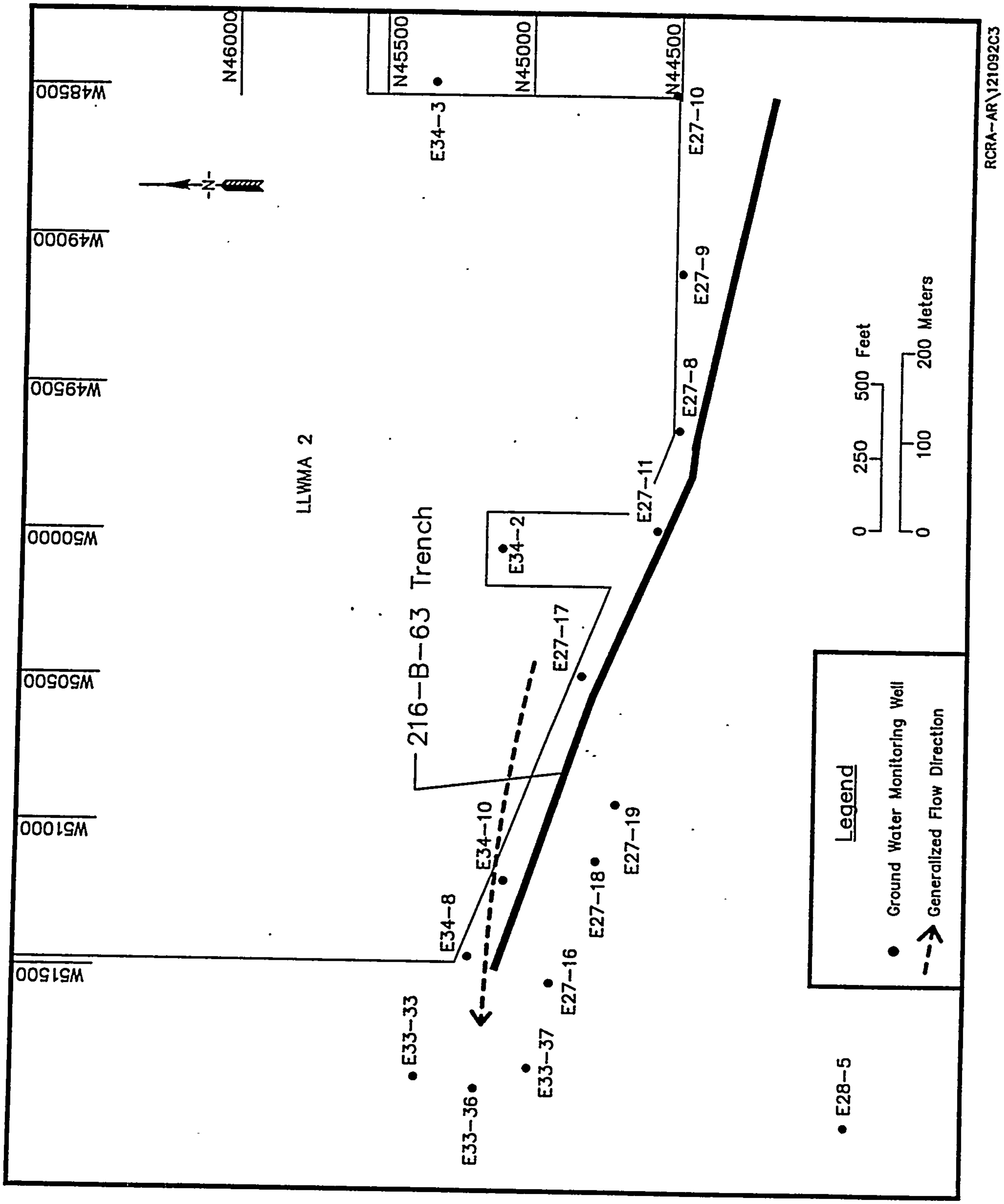


Figure 3. Map of 216-B-63 Trench Site Showing Location of Trench and Wells.

2.1.2 History of Operations

The 216-B-63 Trench received chemical sewer effluents from B Plant, which includes a separations building (221-B) and an attached service building (271-B). All effluent infiltrates into the soil along the course of the trench (DOE-RL 1987).

Average discharges into the 216-B-63 Trench ranged from 3.8×10^5 to 1.4×10^6 L/day (1.0×10^4 to 3.8×10^5 gal/day) during normal operations. The sources contributing to the B Plant chemical sewer are listed in Table 1. Floor drains, funnel drains, and the tank overflow/drain and heating and cooling coils in the 225-B (Encapsulation Facility portion of B Plant) were formerly discharged into the chemical sewer.

This facility is shut down and no longer produces waste. All the aforementioned drains and discharges have been covered or plugged (DOE-RL 1987).

Since 1984, a number of physical and administrative controls have been instituted at B Plant to prevent inadvertent release of regulated chemicals to the 216-B-63 Trench. Administrative controls consist of revisions to operating procedures and institution of in-line neutralization for demineralizer effluent from the 217-B Building (DOE-RL 1987).

2.1.3 Waste Characteristics

Waste streams generated by B Plant that were routed to the chemical sewer were predominantly composed of water. The water source for B Plant chemical sewer consisted of 70 percent steam condensate and 30 percent untreated Columbia River raw water. Some hazardous chemical discharges did manage to enter the waste stream through the B Plant demineralizers (DOE-RL 1987).

The regeneration solutions from the B Plant demineralizers consisted of aqueous sulfuric acid and sodium hydroxide. These waste streams were not treated and some of the resulting effluents exceeded the 2.0 and 12.5 pH controls set by current RCRA standards. The corrosive discharges were routine and occurred from 1970 to October 1985 (DOE-RL 1987).

Results of samples taken from the B Plant chemical sewer are shown in Table 2. The preliminary results of the data tend to support the conclusion that the effluents at the time of sampling would not be considered dangerous waste as defined in WAC-173-303.

2.2 GEOLOGY

2.2.1 Regional Geologic Setting

The Hanford Site lies within the Columbia Plateau, which is underlain by a thick sequence of tholeiitic basalt flows called the Columbia River Basalt Group (CRBG) (Swanson et al. 1979). These flows have been folded and faulted,

Table 1. B Plant Chemical Sewer Sources.

Steam	Source
Floor, funnel, sink drains	221-B pipe and operating gallery (separation building) 271-B aqueous makeup area (service building) 271-B compressor room 217-B Demineralized Water Unit Building 225-BC Compressor Building 276-B Organic Makeup Building 224-B Building
Steam condensate	221-B pipe and operating gallery (chemical makeup tank farm) 211-B station steam supply SN-172 ammonia tank heating coil Various steam trace lines
Steam condensate and/or cooling water	TK-101. -102 aqueous makeup tank heating and cooling coils (211-B) HEDTA[a] tank heating and cooling coils (211-B) TK-SF-121, -122 tanks heating and cooling coils (211-B) Various heating, ventilating and air conditioning systems
Tank overflow and drain effluent	221-B scale tanks 211-B aqueous makeup tanks 271-B aqueous makeup tanks TK-H-317 resin fluidizing tank (271-B) 211-B ammonia pump basin 217-B tanks[b] 276-B tanks TK-CS-1, -2 tanks (212-B cask station) 224-B hot water tank 2902-B water tank
Sump effluent	211-B electrical gallery
Cooling water	211-B electrical gallery instrument air compressor
Rain water	Outdoor drain near 224-B Building (storage building)

[a]Trisodium hydroxyethylethylene-diaminetriacetic acid
[b]Includes neutralized demineralizer recharge effluent

Table 2. 216-B-63 Trench Preliminary Analytical Data from B Plant Sewerage. (2 sheets)

Analyte	Data (first sample, 9/12/85)	Data (second sample 4/9/86)	Analyte	Data (first sample, 9/12/85)	Data (second sample, 4/9/86)
Aluminum	<150	500	Vanadium	<5	<5
Silver	<10	<10	Zinc	12.0	420
Barium	28	120	Chlorine	1,100	1,400
Beryllium	<5	<5	CN	17	10
Calcium	17,000	170,000	Fluorine	1,500	2,800
Cadmium	2	<2	NO_3	530	<500
Chromium	<10	<10	PO_4	<1,000	<1,000
Copper	10	89	Sulfur	<1,000	<1,000
Iron	160	1,700	SO_4	10,000	2,900,000
Mercury	<0.1	1.3	Acetone	<10	<10
Potassium	1,200	6,600	Butyraldehyde	12	<10
Magnesium	3,600	48,000	Chloroform	<10	<10
Manganese	14	44	Phenol	<10	<10
NH_4	<20	<50	Alkanes	<10	13
Sodium	150,000	410,000	Amount (L/mo)	20,000,000	38,000,000
Nickel	<10	<10	pH	11.6	2.28
Osmium	<300	<300	Temperature (°C)	24	15
Lead	30		Alpha activity (pCi/L)	0.37	0.31
Antimony	<100	<100	Beta activity (pCi/L)	15	51
Tin	<300		Conductivity (μS/cm)	1,200	
Strontium	<300	670	Total organic carbon	1,800	2,800
Uranium	0.51	4.6			

Table 2. 216-B-63 Trench Preliminary Analytical Data from B Plant Sewerage. (2 sheets)

Analyte	Data (third sample, 4/15/86)	Data (fourth sample, 6/30/86)	Analyte	Data (third sample, 4/15/86)	Data (fourth sample, 6/30/86)
Aluminum	160	<150	Vanadium	<5	<5
Silver	<10	<10	Zinc	67.0	9
Barium	23	28	Chlorine	14,000	960
Beryllium	<5	<5	CN	<10	<10
Calcium	18,000	17,000	Fluorine	7,500	<500
Cadmium	2	<2	NO_3	1,900	2,600
Chromium	<10	<10	PO_4	<1,000	<1,000
Copper	15	<10	Sulfur	500	<1,000
Iron	230	77	SO_4	130,000	11,000
Mercury	<0.1	<0.1	Acetone	29	<10
Potassium	960	820	Butyraldehyde	<10	<10
Magnesium	4,200	4,000	Chloroform	10	<10
Manganese	8	10	Phenol	8.4	<10
NH_4	<50	<50	Alkanes	210	<10
Sodium	650,000	2,900	Amount (L/mo)	38,000,000	38,000,000
Nickel	11	<11	pH	12.67	6.40
Osmium	<300	<300	Temperature	15	26
Lead			Alpha activity	13	4
Antimony	<100	<100	Beta activity	27	310
Tin			Conductivity		130
Strontium	<300	670	Total organic	51,000	2,500
Uranium	3.5	0.47			

NOTE: Charges are assumed for inorganic analytes that were assayed as ions. All values are parts per billion except pH, which is dimensionless; radioactivites, which are reported in pCi/L; conductivity,

creating broad structural and topographic basins separated by asymmetric anticlinal ridges (Reidel et al. 1989). Sediments up to 275 m (900 ft) thick have accumulated in the Pasco basin where the Hanford Site is situated. In general, basalt flows of the CRBG are exposed along the anticlinal ridges where they have been uplifted as much as 1,098 m (3,600 ft) above mean sea level (msl). Overlying the CRBG in the synclinal areas are sediments of late Miocene, Pliocene, and Pleistocene age. The entire sequence of basalts and some of the sediments have been folded and faulted over the past 17 million years to form the present structure and topography of the area. The Pasco Basin is bounded on the north by the Saddle Mountains and on the south by Rattlesnake Mountain and the Rattlesnake Hills. Yakima Ridge and Umtanum Ridge trend into the basin and divide it into a series of anticlinal ridges and synclinal basins. The Cold Creek and Wahluke synclines are the principle structures that form the Pasco Basin. The geology of the Hanford Site has been described in detail in DOE-RL (1988) and Reidel et al. (1992).

Principal late-Neogene stratigraphic units within the Hanford Site include, in ascending order, the CRBG (Miocene), the Ringold Formation (Miocene-Pliocene), the Hanford formation (Pleistocene) and the localized Plio-Pleistocene unit between the Ringold and Hanford (Figure 4). A regionally discontinuous veneer of recent alluvium, colluvium, and/or eolian sediments overlies the principal geologic units.

2.2.2 Geomorphology and Geology of the 216-B-63 Trench

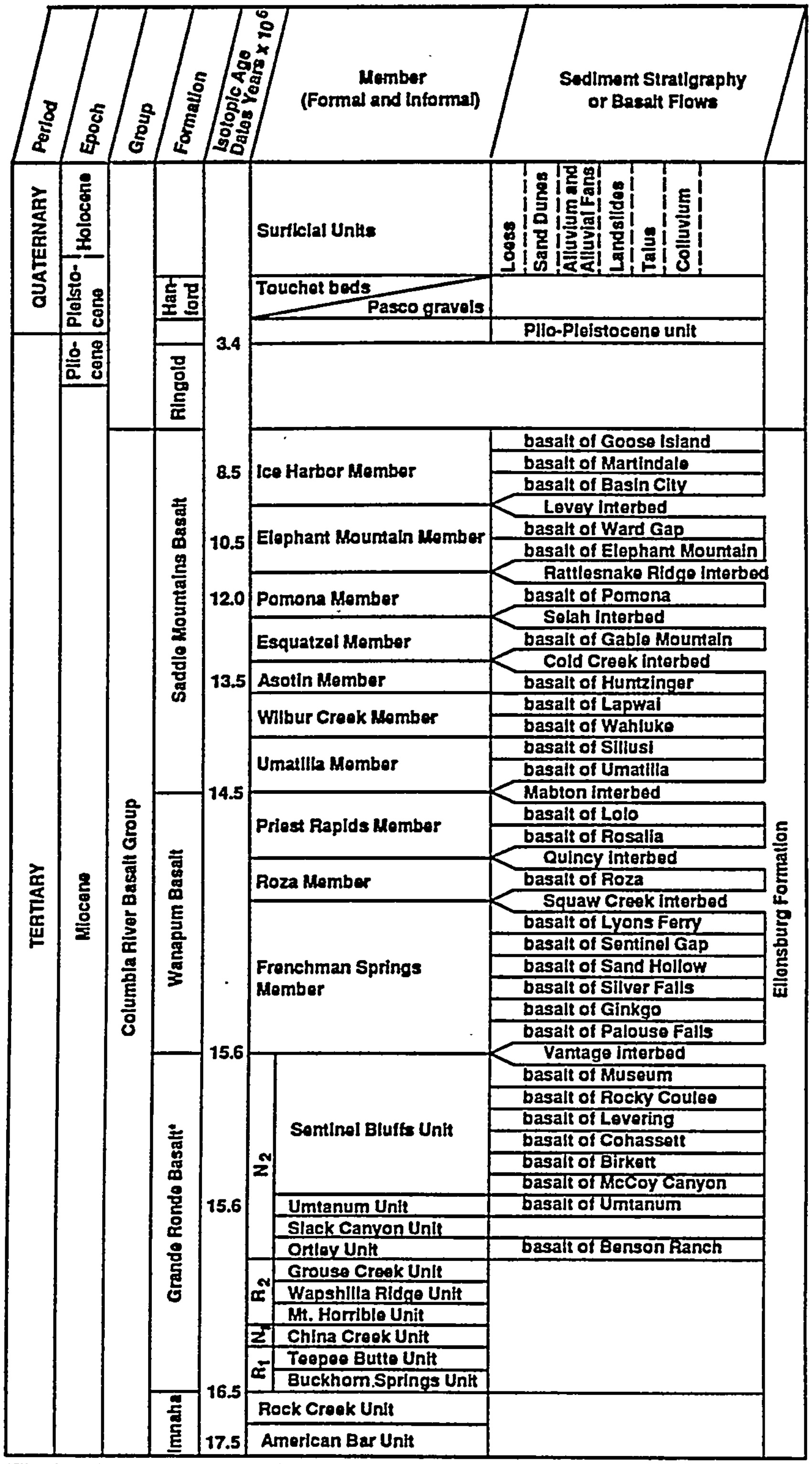
The terrain surrounding the 216-B-63 Trench is relatively flat and the average elevation is about 195 m (640 ft) above msl. The prevailing wind is from the northwest, although strong winds are from the southwest. Sagebrush and cheatgrass cover the area except for access roads and the trench site itself.

The 216-B-63 Trench lies on the Cold Creek Bar between the axis of the Umtanum-Gable Mountain anticlinal ridge and the axis of the Cold Creek syncline (Figure 5). The site is situated on the north flank of the syncline and on the south flank of a principal anticlinal flexture (Figure 6).

The basalt-sediment contact generally forms the base of the unconfined aquifer within the Hanford Site. The basalt bedrock surface at the site dips approximately 21 m/km (70 ft/mi) to the southwest (Figure 7). The top of the basalt ranges from 115.9 m (380 ft) to 119 m (390 ft) above msl.

The stratigraphy of the 216-B-63 Trench has been interpreted from six boreholes and the correlation of sediments with data from the 200 East Low Level Burial Ground-Waste Management Area 2 (LLBG-WMA 2) (Figure 8). Stratigraphic units identified from borehole cuttings include the Hanford formation and the Elephant Mountain Member of the Saddle Mountain Basalts. The Plio-Pleistocene unit is not found within or near the 200 East Area. The Ringold Formation is also absent beneath the 216-B-63 Trench. Some remnants of possible reworked Ringold material that may be incorporated into the Hanford formation were identified in borehole 299-E27-19.

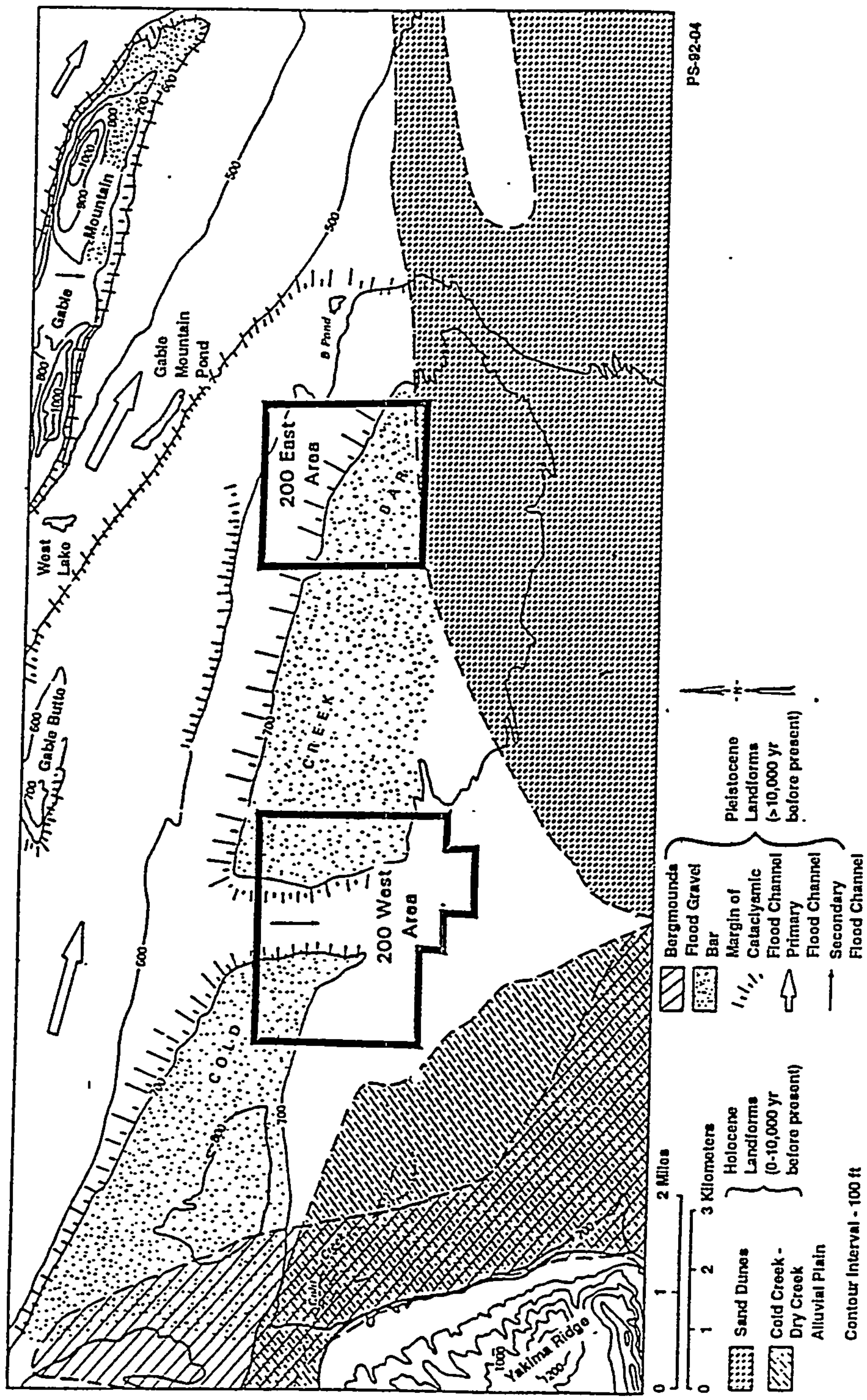
The Hanford formation consists of pebble to boulder gravel, fine- to coarse-grained sand, and silt. These deposits are divided into three facies (gravel-, sand-, and silt-dominated) (Lindsey et al. 1991, 1992). Three units of the Hanford formation (Figure 9) were identified beneath the 216-B-63 Trench. These units are classified on the basis of lithology, petrography, stratigraphy, and pedogenic alteration.



*The Grande Ronde Basalt consists of at least 120 major basalt flows. Only a few flows have been named. N_2, R_2, N_1 and R_1 are magnetostratigraphic units.

H9405015.1

Figure 4. Stratigraphic Units Present in the Pasco Basin.



* Keyed features are specifically selected and do not encompass all features.

Figure 5. Geomorphic Features of the 200 Areas.

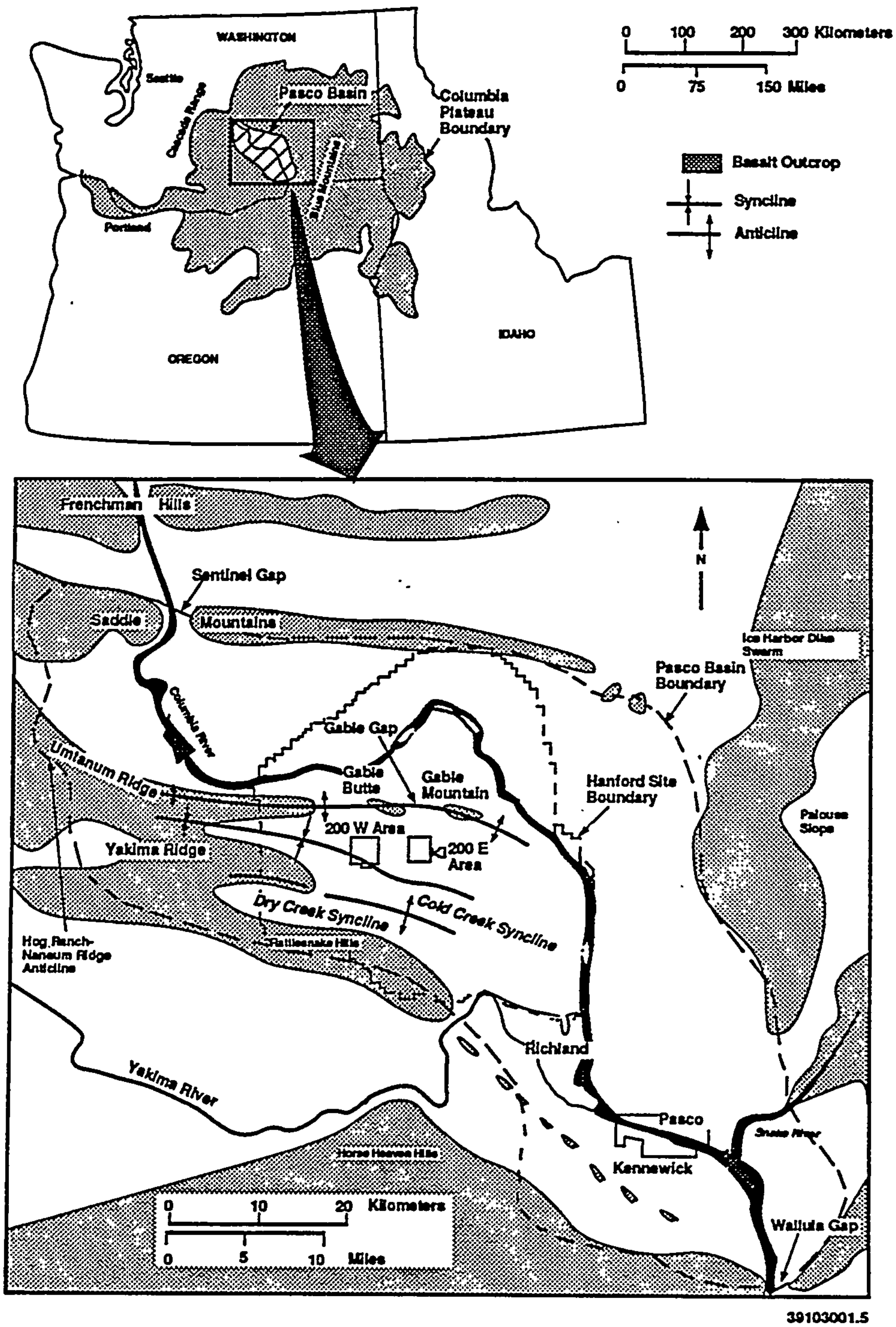


Figure 6. Generalized Structural Features of the Pasco Basin, Washington.

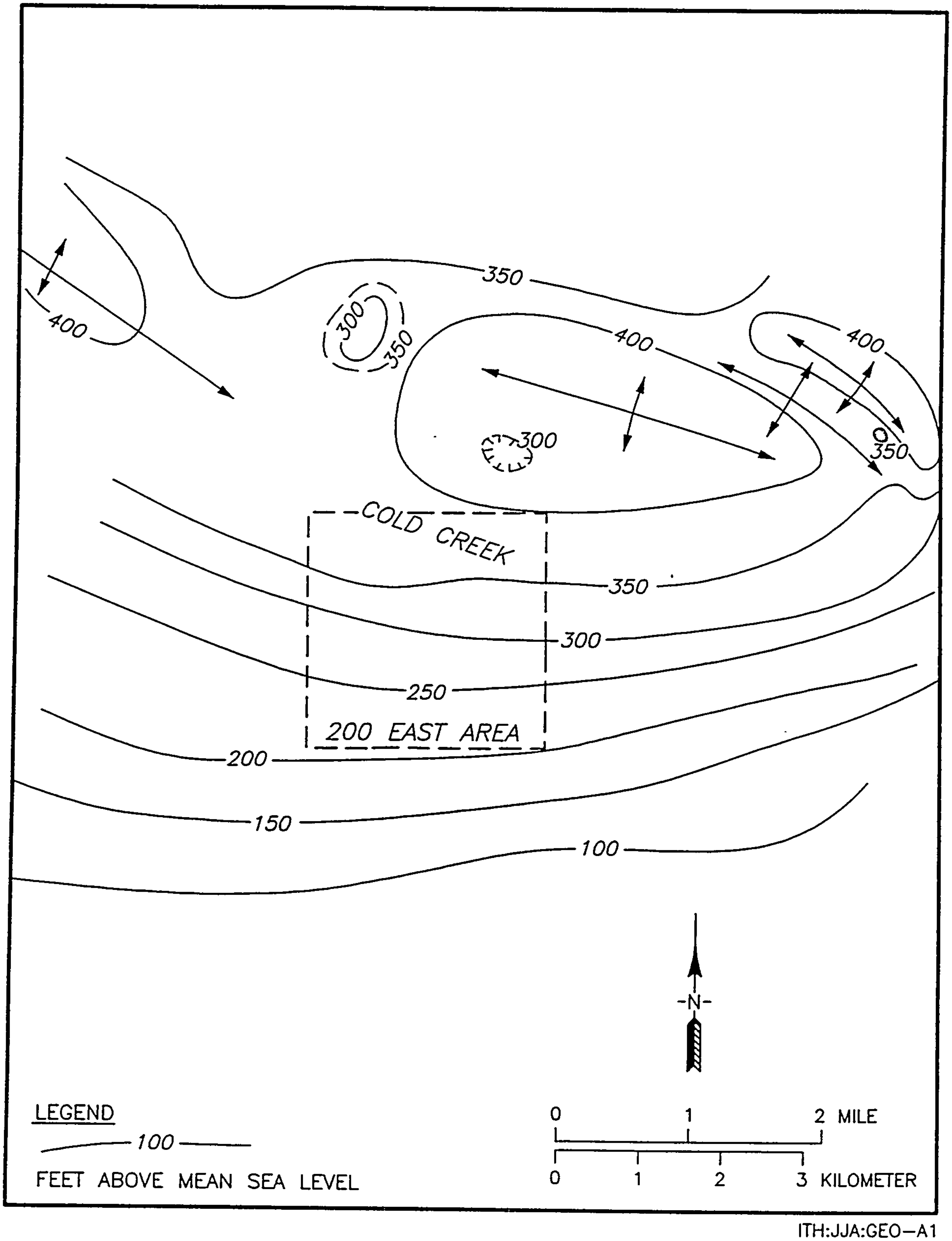


Figure 7. Top of Basalt Structure Contour Map (after Fecht, Reidel and Chamness).

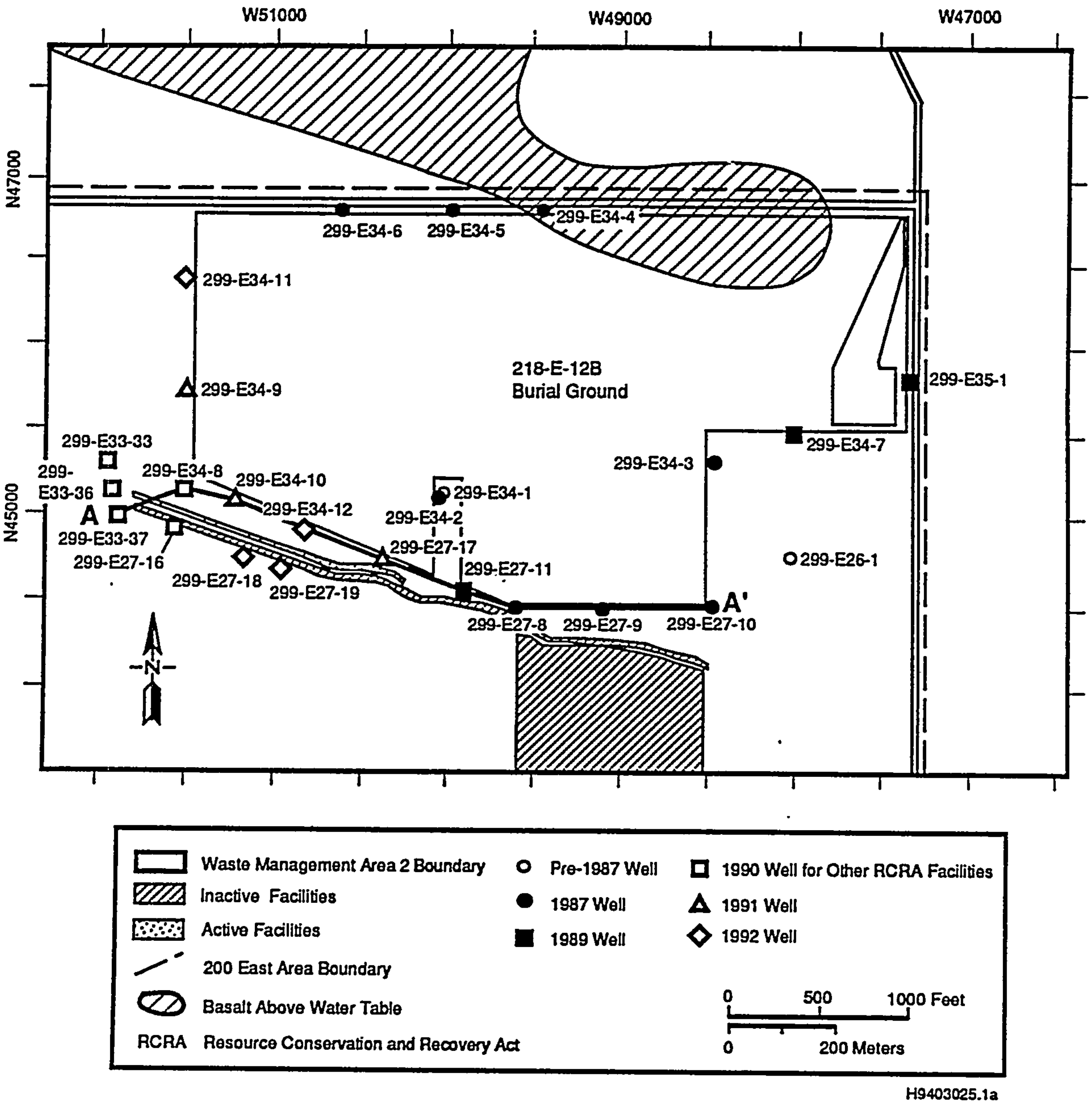


Figure 8. Location Map for Cross Section A-A'.

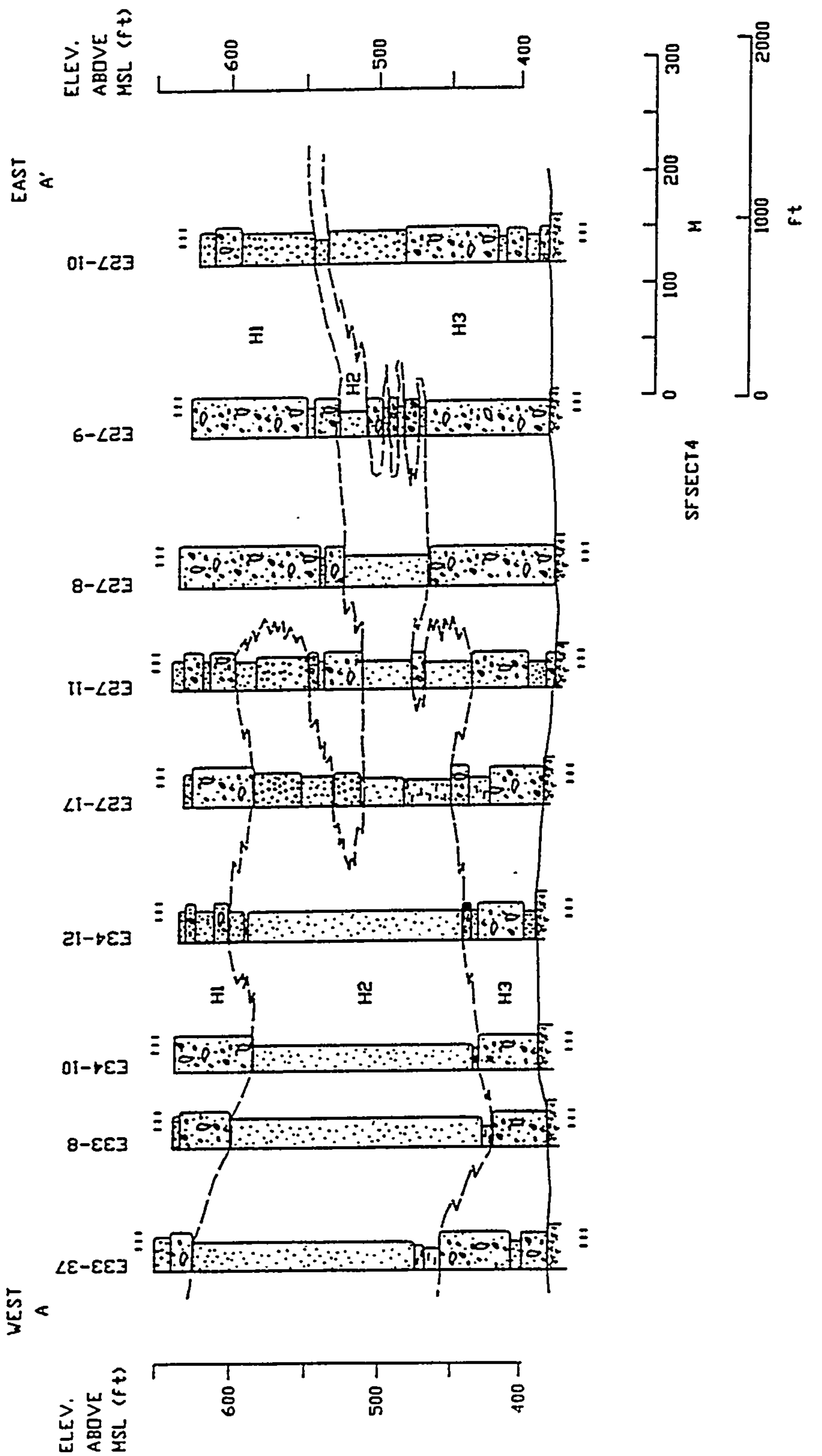


Figure 9. Cross Section Across the 216-B-63 Trench.

- **Upper Coarse.** The upper coarse unit (H1) is extremely variable in thickness and distribution. It ranges from 11 m (35 ft) to as much as 37 m (120 t) thick and, although it is dominated by the gravel facies, contains significant interstratified sand horizons. The unit is thinnest in the southwestern part of the site and thickens to the north and east. Outcrop observations show that silt-rich interbeds up to a meter thick are present in the unit; these horizons are capable of generating perched water. In some cases, these interbeds are continuous up to distances of at least several hundred meters. The contact between the upper coarse and underlying strata generally is extremely irregular (Figure 9). These irregularities are the result of the interfingering nature of these deposits and the presence of an erosional surface. Also, the absence of a distinct bounding surface is primarily caused by the interfingering of the units and the erosional surface.

- **Middle Fine.** The abundant sand-rich facies that make up the middle fine unit (H2) are thickest (up to 55 m [180 ft]) in the southwestern part of the site while pinching out to the east and north. Silty beds and horizons in this unit have the potential to form perched water zones, although the lateral continuity of these zones is questionable because of the presence of clastic dikes and pinchouts found in analogous strata elsewhere. A sequence of interbedded sand and gravel in the lower part of the unit is locally well developed, especially to the east where the middle fine unit pinches out and interfingers with gravelly units (the upper coarse and the lower coarse).

- **Lower Coarse.** The lower coarse unit (H3) is dominated by the gravel facies and also thickens to the north and southeast, ranging from 12 to 46 m (40 to 150 ft) thick. Like the upper coarse unit, interbeds of the sand facies and silt facies are present throughout the lower coarse unit. Silts have the potential to generate perched water in these gravels. Where the middle fine unit is absent, differentiating between the upper and lower coarse units is difficult. At locations where the middle fine is absent, the contact between the upper coarse unit and the lower coarse unit is arbitrarily picked based on a projected trend from the nearest wells where the middle coarse unit occurs.

2.3 HYDROLOGY

The hydrogeology of the Hanford Site has been described in DOE-RL (1988), Gephart et al. (1979), Graham et al. (1981), Graham et al. (1984), and Law et al. (1987), and in water-level data collected and reported quarterly by Pacific Northwest Laboratory (PNL) and WHC.

2.3.1 Regional Setting

The Hanford Site has a semiarid climate and receives an average of 15.9 cm (6.25 in.) of precipitation per year. Most precipitation does not reach the water table but is lost by evapotranspiration. Wallace (1977) used Hanford Meteorology Station data to compute average potential evapotranspiration values for the Hanford Site by three methods: the Penman, Thornthwaite-Maither, and Morton methods. The values calculated by Wallace (1987) were from five to nine times the mean annual precipitation. Calculations for monthly potential evapotranspiration compared with average monthly precipitation values from Stone et al. (1983) indicate that precipitation may exceed evapotranspiration during the period of November through February. Recharge rates to range from near 0 to more than 10 cm/yr (4 in./yr), depending on surface conditions (Gee 1987). However, recent studies indicate that recharge in undisturbed areas may be insignificant (Routson and Johnson 1990, Fayer et al. 1991).

The primary natural surface water bodies within the Hanford Site include West Lake (Figure 7), the Columbia and Yakima Rivers, and two ephemeral streams, Dry Creek and Cold Creek, whose drainage is tributary to the Yakima River via groundwater flow (Figure 1). Surface water from Dry Creek and Cold Creek does not reach the Yakima River.

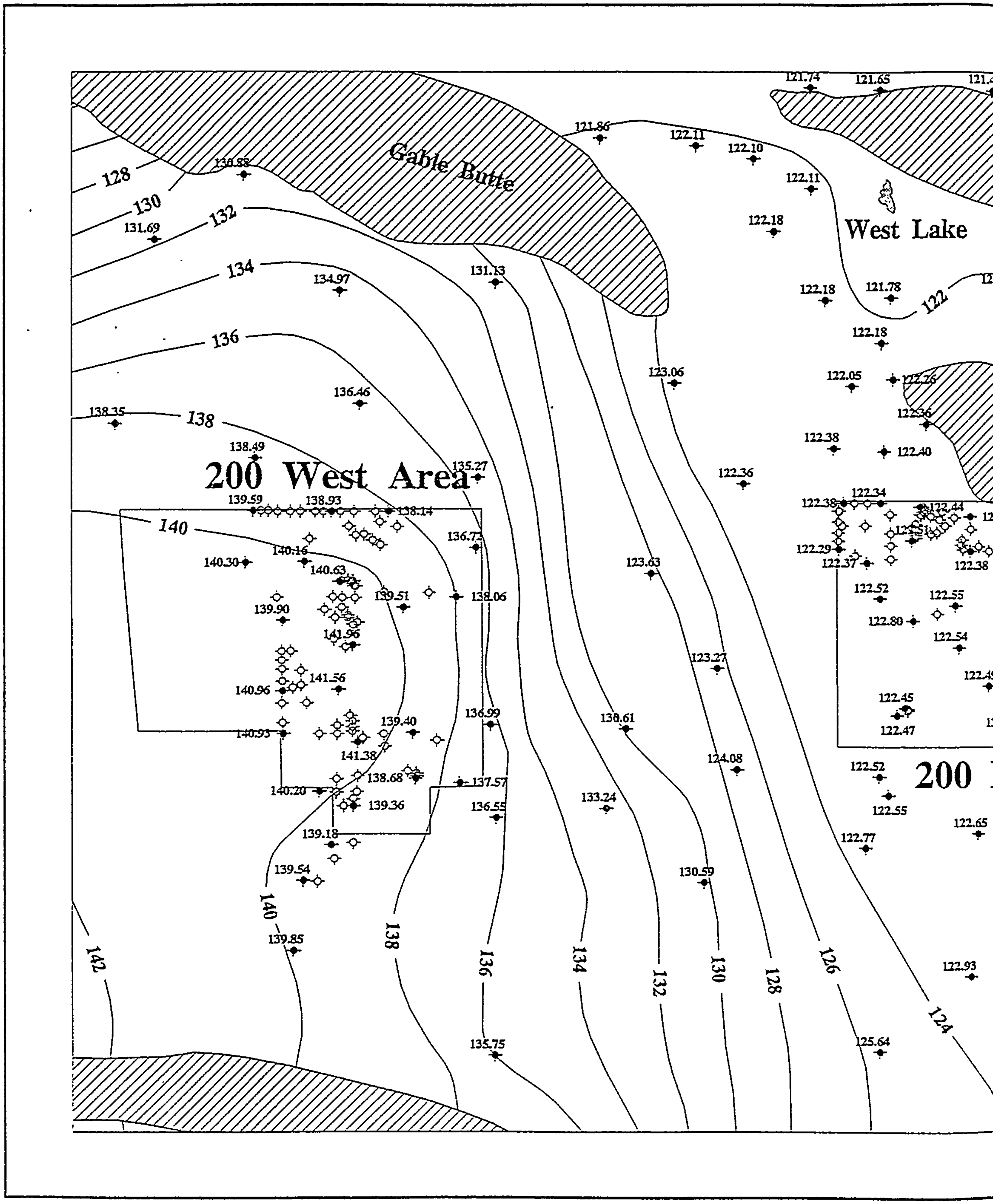
The source of natural recharge to the unconfined aquifer and some of the confined aquifers is rainfall on areas of high relief west of the Hanford Site and ephemeral streams in the Cold Creek and Dry Creek valleys, and river water along influent reaches of the Yakima and Columbia Rivers. Other sources of recharge include faults and fractures in the Saddle Mountain Basalt, which intersect the unconfined aquifer. Discharge from the unconfined aquifer is primarily to the Columbia River (Graham et al. 1981).

Artificial recharge to the unconfined aquifer occurs principally from Hanford Site wastewater disposal practices at surface ponds, ditches, and various cribs within the 200 East and West Areas. Two of the largest recharge mounds have developed beneath the 200 Areas at the former site of U Pond (200 West) and B Pond (200 East). Under U Pond, which was decommissioned in 1984, the water table had risen in excess of 25.9 m (85 ft) since the start of disposal operations. The mound under B Pond has risen more than 9 m (30 ft) (Graham et al. 1981). These facilities, associated with wastewater disposal from fuel and waste processing activities, receive or have received liquid effluents of varying chemical characteristics.

Groundwater beneath the Hanford Site occurs under both unconfined and confined conditions. The unconfined aquifer is contained primarily within the Ringold E gravel unit of the Ringold Formation (Lindsey et al. 1992) and the Hanford formation. The base of the unconfined aquifer is the basalt surface of the Elephant Mountain Member of the CRBG, or, in some areas, the clay of the lower mud unit of the Ringold Formation (Lindsey et al. 1992). A water table contour map for the Hanford Site is shown in Figure 10. The confined aquifers beneath the Hanford Site include sedimentary interbeds and interflow zones that occur between dense basalt flows of the CRBG.

2.3.2 Unconfined Aquifer

The general characteristics of the uppermost or unconfined aquifer are presented in this section. Detailed discussions can be found in Gephart


Gable Butte
West Lake
200 West Area
200
128
130
132
134
136
138
140
142
126
124
122

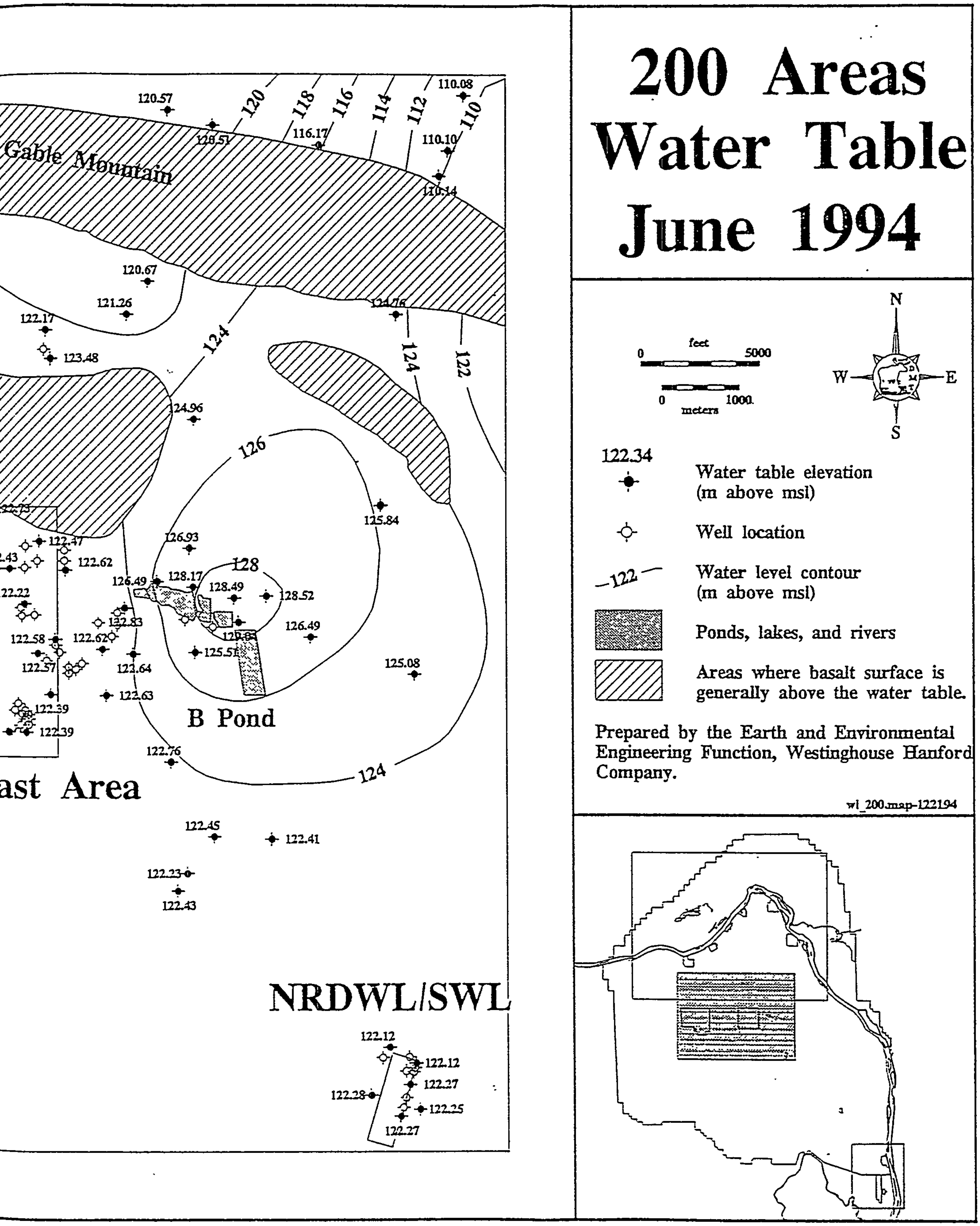


Figure 10. 200 Areas Water Table Map (Serkowski et al. 1994).

et al. (1979), Graham et al. (1981), and DOE (1986). The uppermost aquifer within the Hanford Site occurs within the glaciofluvial sands and gravels of the Hanford formation and the silts, sands, and gravels of the Ringold Formation. The uppermost aquifer is unconfined in most areas, with local confined zones. The bottom of this unconfined aquifer is considered to be the basalt surface or, in some areas, the clay zones of the lower Ringold Formation. The aquifer is over 152 m (500 ft) thick in some areas and thins to zero along the flanks of bordering structures.

Numerous aquifer tests have been performed within the Hanford Site (Delaney et al. 1991). Gephart et al. (1979) present results from more than 35 tests completed in the unconfined aquifer beneath the Hanford Site. The measured hydraulic properties of the suprabasalt sediments are highly variable. The range of hydraulic conductivities varies over several orders of magnitude, with the sharpest contrast between the Hanford formation and the Ringold Formation. In general, hydraulic conductivities in the Ringold Formation are several orders of magnitude lower than those in the Hanford formation (Delaney et al. 1991). The westward flow throughout the 200 Areas is along a zone of very high transmissivity (Jacobson and Freshley 1990) and is apparently a result of the water table occurring in the very permeable gravels of the Hanford formation.

2.3.3 216-B-63 Trench

The uppermost aquifer underlying the 216-B-63 Trench is the unconfined aquifer. The unconfined aquifer occurs within the unconsolidated, suprabasalt sediments of the Hanford formation. Information on the aquifer conditions beneath the 216-B-63 Trench are summarized from well log data, hydraulic test results, water table maps, and various published reports. The depth to the water table at the 216-B-63 Trench is about 73 m (240 ft). The lower 3.4 m (11 ft) to 6.1 m (20 ft) of the Hanford formation is saturated. The top of the basalt forms the base of the unconfined aquifer at the 216-B-63 Trench.

Regional groundwater flow in the unconfined aquifer under the 216-B-63 Trench is generally from east to west, toward the 200 East Area west fence line (Figure 10). This flow is along a zone of very high transmissivity (Jacobson and Freshley 1990) and is apparently a result of the water table occurring in the very permeable gravels of the Hanford formation. Flow paths constructed on the water table map indicate that the water flowing beneath the 216-B-63 Trench comes from the declining B Pond mound.

Groundwater in the Hanford formation is unconfined and the sediments are highly transmissive. The transmissivity values calculated from aquifer tests range from approximately 825 to 2,750 m^2/d (2,700 to 9,000 ft^2/d) (WHC 1990). Site-specific hydraulic conductivity ranges from approximately 51.9 to 198.3 m/day (170 to 650 ft/day). These values are conditional and subject to several limitations. The most substantial limitation is the small diameter of influence that slug testing has on the aquifer. Considerable evidence indicates that the only area affected by this particular test is the filter pack immediately surrounding the screened interval.

The storativity values range from about 0.001 to about 0.06, indicating the unconfined nature of the aquifer. The ratio of horizontal to vertical hydraulic conductivity has not been determined at the 216-B-63 Trench; however, vertical hydraulic gradients ranged from 0.007 to 0.08, roughly 10 times the estimated horizontal component of head gradient at the 216-B-3 Pond System (DOE 1994a).

2.3.3.1 Hydraulic Gradients. Water-level measurements have been taken in previously existing wells since 1987 to evaluate horizontal hydraulic gradients. The initial measurements were made at least a month after all drilling and testing activities ceased in newly installed wells; therefore, static conditions were observed. Measured horizontal hydraulic gradients across the site are on the order of 0.0001. Therefore, uncertainties in the measurements are possibly as large as the differences in water-level elevations between any two wells. The major sources of uncertainty are discussed by Weekes et al. (1987).

The direction of groundwater flow beneath the 216-B-63 Trench is estimated to be generally from east to west. Regional groundwater flow patterns (Figure 10) suggest a northwest to southeast flow and the configurations of nitrate and tritium plumes originating in the 200 East Area (Evans et al. 1992 and Johnson 1993) indicate a groundwater flow direction of approximately 120° east of north (Figure 3). Flow direction of groundwater beneath the 2101-M Pond is approximately 80 to 90° west of north. Groundwater flow in the 216-B-63 Trench is strongly affected by the dissipating 216-B Pond mound. This trend will continue until groundwater elevations return to their preproduction levels, or until discharge patterns change in the 200 East Area. Sections of the 216-B Pond are currently being decommissioned and complete cessation of discharges to the system are scheduled for mid-1995. The effluents that are presently directed to the 216-B-Pond (C lobe) will be sent to the disposal area at the 049-H facility.

2.3.3.2 Hydrochemical Analyses. Groundwater samples have been collected for chemical analyses as part of the initial detection-level sampling program (Bjornstad and Dudziak 1989). Samples were collected from the unconfined aquifer and major cation and anion concentrations were determined. The analyses indicate that groundwater is predominantly sodium-bicarbonate type.

2.3.3.3 Groundwater Quality. RCRA groundwater quality samples have been collected from the monitoring network since the installation of the first wells in 1987. Quarterly sampling started during the third quarter of 1988 and continued, with a break resulting from laboratory problems, until the first quarter of 1990. Starting with the second quarter of 1992, the first monitoring wells were placed on a semiannual sampling schedule. Subsequent wells have also been placed on semiannual sampling as they established their critical means (see Appendix B, EPA 1986). The entire network is currently sampled semiannually.

Groundwater samples have been analyzed for the interim primary drinking water standards parameters, the groundwater quality parameters, and the groundwater contamination indicator parameters specified in Section 3.0. In addition, groundwater samples have been analyzed for a wide range of organic and inorganic constituents and for tritium. In general, samples were analyzed from a long constituent list containing a large portion of the 40 CFR 264 Appendix IX list (EPA 1980b) and an abbreviated constituent list. The results of these analyses are presented in tabular form in annual and quarterly reports (DOE-RL 1994a, 1994b).

Groundwater quality samples to date offer no evidence of contamination of groundwater by the 216-B-63 Trench; however, they do indicate that groundwater beneath the 216-B-63 Trench is affected by contaminants from the 200 Areas, principally nitrate and tritium.

3.0 PHASE I--GROUNDWATER MONITORING PROGRAM

This plan has been developed in accordance with RCRA, as described in 40 CFR 265, Subpart F, to conduct an interim-status groundwater monitoring program for the 216-B-63 Trench. All work outlined in this plan will be conducted using the *Environmental Investigations and Site Characterization Manual* (WHC 1988), the *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1993a), and *Project Management Plan - RCRA Groundwater Monitoring* (WHC 1991). In addition, all onsite personnel must meet Occupational Safety and Health Administration (OSHA) medical, monitoring, and training requirements in accordance with 29 CFR 1910.120.

3.1 HISTORY

Quarterly RCRA sampling was initiated for the groundwater monitoring network in 1988. Quarterly sampling was completed during the calendar year (CY) 1993 sampling period; the site has been on a semiannual sampling schedule since that time. The site was not sampled between April 1990 and August 1991 because analytical work was interrupted when PNL cancelled the U.S. Testing contract.

3.2 OBJECTIVES

The objectives of the drilling and groundwater monitoring program for the 216-B-63 Trench are the following:

- Characterize the hydrogeology in the uppermost unconfined aquifer beneath the site, including determining the groundwater flow directions and velocities beneath the 216-B-63 Trench.

- Determine if the 216-B-63 Trench has affected the quality of the groundwater within the upper unconfined aquifer.

3.3 APPROACH

This section presents an overview of the groundwater monitoring program. Details of the program are presented in the subsequent sections.

Twelve wells have been installed to complete the groundwater monitoring system around the 216-B-63 Trench and to provide needed site characterization. These wells provide information to help characterize the hydrogeology at the

216-B-63 Trench (including determining the base of the uppermost aquifer), assess the three-dimensional hydraulic head distribution and groundwater flow directions, and determine the quality of groundwater in the unconfined aquifer.

Five wells were installed upgradient as background wells (Figure 3) screened, in most cases, across the entire saturated thickness of the unconfined aquifer. Seven wells were installed as downgradient monitoring wells (Figure 3); all but one was drilled to the base of the unconfined aquifer (299-E27-19).

Subsurface sediment samples were obtained during drilling at each location. These samples were described and classified in the field, and selected samples were submitted to a laboratory for analyses to determine various physical and chemical properties (WHC 1990, 1993b).

Groundwater samples were collected after reaching the water table, during aquifer testing, during well development, and during routine sampling events. Samples were contained on site until a determination could be made concerning purgewater disposal. Aquifer tests were conducted to provide estimates of hydraulic properties of materials beneath the site. Groundwater level measurements are made during each sampling event.

3.4 DETECTION LEVEL GROUNDWATER MONITORING SYSTEM

This section describes the aquifer that is monitored, the location of and justification for the monitoring wells, the frequency of sampling, and the groundwater constituents that are analyzed. Drilling, well construction, aquifer testing, and associated activities have been conducted according to the applicable procedures. Specific environmental investigation instructions (EII) are cited in following sections of the plan (WHC 1988). Additional EIIs may also apply.

3.4.1 Uppermost Aquifer

The unconfined aquifer beneath the 216-B-63 Trench is contained primarily within sediments of the Hanford formation and extends from the water table to the top of the basalt. The unconfined aquifer is discussed in more detail in Section 2.0. Hydrogeologic characterization activities are designed to obtain additional information on groundwater flow characteristics of the unconfined aquifer.

3.4.2 Background (Upgradient) Wells

Five upgradient wells (299-E27-8, 299-E27-9, 299-E27-11, 299-E27-17, and 299-E34-10) were installed as background wells to determine the background groundwater chemistry. All wells were completed at the base of the unconfined aquifer, in the Hanford formation, and were screened across the entire saturated zone.

3.4.3 Compliance (Downgradient) Wells

Seven wells (299-E27-16, 299-E27-18, 299-E27-19, 299-E33-33, 299-E33-36, 299-E33-37, and 299-E34-8) were installed downgradient as compliance wells (Figure 3). All wells except for 299-E27-19 were completed at the base of the unconfined aquifer, in the Hanford formation, and were screened across the entire saturated zone. Well 299-E27-19 was completed in the Hanford formation as well, but was not drilled to the base of the unconfined aquifer.

3.4.4 Proposed RCRA Monitoring Wells

No additional monitoring wells are planned for this facility.

3.4.5 Well Drilling and Construction

The groundwater monitoring wells were constructed at the 216-B-63 Trench as RCRA-standard wells constructed to the generic specification for groundwater monitoring wells (WHC 1992b). WAC-173-160, "Minimum Standards for Construction and Maintenance of Wells," was used to set the basic design requirements.

Procedures for controlling the well site activities are given in WHC (1988) and listed in Table 3.

3.4.5.1 Well Drilling. Until 1990, well drilling was governed by Last and Liikala (1987). Drilling is currently controlled by *Generic Specification - Groundwater Monitoring Wells* (WHC 1992a). Guidance concerning geological sampling was provided by PNL (1989) until 1990. Sampling is now governed by EII 5.2, "Soil and Sediment Sampling" (WHC-CM-7-7). Quality assurance (QA) requirements of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1994) and WHC (1992b) also apply.

The 216-B-63 wells were drilled with a cable tool rig. The advantages of cable tool drilling include the following:

- Drill cuttings can be easily contained (important in potentially contaminated material)
- Representative geologic samples can be collected
- Moisture samples can be collected from above the water table
- Disturbance to the borehole wall is minimized
- A straight, plumb borehole is produced
- Groundwater quality is not affected by drilling fluids other than water or air.

Other drilling techniques that would also fulfill these criteria were not available at the Hanford Site at the time of drilling.

Drill cuttings were routinely monitored for radiation and hazardous material in accordance with a site-specific health and safety plan. Contaminated cuttings were handled, transported, and disposed of in accordance with the EII 4.2, "Interim Control of Unknown, Suspected, Hazardous, and Mixed Waste" (WHC-CM-7-7).

Drill rigs and peripheral equipment (such as drill tools, cables, and temporary casing) were steam cleaned before arriving on site, moving to a new site, and beginning construction of the next well, in accordance with EII 5.4, "Field Cleaning and/or Decontamination of Equipment" (WHC-CM-7-7).

Table 3. Applicable Environmental Investigations Instructions.

Number	Title
EII 1.1	Hazardous Waste Site Entry Requirements
EII 1.2	Preparing and Revising Procedures
EII 1.4	Instruction Change Authorizations
EII 1.5	Field Logbooks
EII 1.6	Records Processing
EII 1.7	Qualification and Training
EII 1.9	Primary and Secondary Document Review and Control
EII 1.10	Identifying, Evaluating, and Documenting Suspect Waste Sites
EII 2.1	Preparation of Site-Specific Health and Safety Plans
EII 2.2	Occupational Health Monitoring
EII 3.2	Calibration and Control of Monitoring Instruments
EII 4.2	Interim Control of Unknown, Suspected Hazardous, Mixed and Radioactive Waste
EII 5.1	Chain of Custody
EII 5.2	Soil and Sediment Sampling
EII 5.4	Field Cleaning and/or Decontamination of Equipment
EII 5.5	Laboratory Cleaning of RCRA/CERCLA Sampling Equipment
EII 5.7A	Hanford Geotechnical Sample Library Control
EII 5.8	Groundwater Sampling
EII 5.10	Obtaining Sample Identification Numbers and Accessing HEIS Data
EII 5.11	Sample Packaging and Shipping
EII 6.4	Well Services Support
EII 6.6	Resource Protection Well Characterization and Evaluation
EII 6.7	Documentation of Well Drilling and Completion Operations
EII 9.1	Geologic Logging

EII 10.1	Aquifer Testing
EII 10.2	Measurement of Groundwater Levels
EII 10.3	Purgewater Management
EII 10.4	Well Development Activities
EII 11.1	Geophysical Logging

The addition of water to the borehole was kept to a minimum or avoided. This minimized well development pumping after the wells were completed and minimized the chances of driving any vadose zone contaminants into the groundwater.

Temporary carbon steel casing with a minimum diameter of 20.3 cm (8 in.) was driven to total depth as each borehole was advanced. In all cases, several casing "down-sizing" intervals were used. The down-sizing involved using two or three casing diameters (i.e., 40.6, 30.5, and 20.3 cm [16, 12, and 10 in.]) greater than the minimum diameter 20.3-cm (8-in.) casing in the upper portions of the well during drilling. This procedure makes the extraction of the temporary casing less difficult during well construction and prevents potential vertical translocation of contaminants.

After the borehole was drilled to its total depth, the final well casing and screen were installed and the temporary carbon steel casing was removed as the filter pack and annular seal materials were placed in the annular space. Completion varied in depth, but most wells were drilled 9.1 m (30 ft) into saturated sediments and were completed with a 6.1-m (20-ft) stainless steel screen (see Section 3.4.5.2). Four wells were drilled 6.1 m (20 ft) into saturated sediments and completed with a 6.1-m (20-ft) screen. Only one well was drilled and completed in 3 m (10 ft) of saturated sediment. All but one of the wells was drilled to the top of the basalt that forms the base of the unconfined aquifer (Table 4).

3.4.5.2 Well Construction. Inspection of well construction was governed by EII 6.7, "Documentation of Well Drilling and Completion Operations" (WHC-CM-7-7). RCRA-compliant wells must meet the requirements set forth in Parts 1 and 3 of WAC-173-160, "Minimum Standards for Construction and Maintenance of Wells," are used as required for well design and construction materials. The QA requirements of the Tri-Party Agreement and WHC (1993a) also apply.

The wells were completed with 10.2-cm (4-in.) inside diameter stainless steel casing and continuous-slot stainless steel well screen. Final screens were 10.7 m (20 ft) long. The screens extended approximately 2.7 to 5.2 m (9 to 17 ft) below the water table and 1.5 m (5 ft) above. This placement allows for sampling of the upper portion of the aquifer and will allow detection of immiscible constituents floating on the water table or constituents in solution immediately below the water table. It also allows for measurement of fluctuations in the water level in the unconfined aquifer, but may not be sufficient for the decrease in the water table that would result from terminating wastewater disposal in the 200 Areas.

Table 4. Construction Summary--The 216-B-63 Trench Groundwater Monitoring Network.

*Well number	Year drilled	Survey date	Reference datum	Top of casing [m (ft)]	Drilled depth [m (ft)]	Depth to water [m (ft)]	Screened interval [m (ft)]	Screen slot size [mm (in)]
E27-8	1987	1987	2E Area	194.5 (637.83)	78.4 (257.0)	72.2[94] (236.7)	68.8-74.9 (225.5 - 245.5)	0.5 (0.02)
E27-9	1987	1987	2E Area	191.9 (629.21)	74.8 (245.2)	69.4[94] (227.7)	67.0-72.9 (219.8 - 239.1)	0.5 (0.02)
E27-11	1989	1989	2E Area	196.2 (643.29)	80.7 (264.7)	73.8[94] (241.9)	70.3-76.7 (230.4 - 251.4)	0.2 (0.01)
E27-16	1990	1990	2E Area	198.9 (652.13)	82.0 (269.0)	76.4[94] (250.6)	72.8-79.2 (238.7 - 259.7)	0.2 (0.01)
E27-17	1991	1991	NGVD '29	193.6 (634.72)	75.0 (246.2)	73.8[94] (242.0)	68.1-74.5 (223.2 - 244.2)	0.5 (0.02)
E27-18	1992	1992	NGVD '29	198.3 (650.15)	80.8 (265.0)	75.7[94] (248.2)	73.6-79.8 (241.4 - 261.5)	0.2 (0.01)
E27-19	1992	1992	NGVD '29	198.5 (650.88)	81.4 (266.8)	76.3[94] (250.1)	73.8-79.6 (242.0 - 261.1)	0.2 (0.01)
E33-33	1989	1992	2E Area	195.3 (640.39)	76.9 (252.0)	72.8[94] (238.7)	69.3-75.7 (227.3 - 248.3)	0.2 (0.01)
E33-36	1990	1993	NGVD '29	197.3 (646.86)	80.5 (263.8)	75.7[94] (248.1)	71.5-77.9 (234.4 - 255.4)	0.2 (0.01)
E33-37	1990	1993	NGVD '29	199.2 (653.22)	81.6 (267.5)	76.8[94] (251.7)	73.3-79.6 (240.3 - 261.1)	0.2 (0.01)

Table 4. Construction Summary--The 216-B-63 Trench Groundwater Monitoring Network.

*Well number	Year drilled	Survey date	Reference datum	Top of casing [m (ft)]	Drilled depth [m (ft)]	Depth to water [m (ft)]	Screened interval [m (ft)]	Screen slot size [mm (in)]
E34-8	1990	1993	NGVD '29	195.4 (640.74)	79.3 (260.0)	73.1^{94} (239.7)	69.5-75.6 (227.9 - 247.9)	0.2 (0.01)
E34-10	1991	1993	NGVD '29	195.1 (639.77)	75.9 (249.0)	72.6^{94} (238.1)	68.7-75.1 (225.3 - 246.4)	0.5 (0.02)

Notes: Shading denotes upgradient wells.
Superscript following water level indicates the last sampled period for well summary sheet (Appendix A).
*Well numbers listed are preceded by 299- locator prefix.
NGVD = national geodetic vertical datum

The onsite geologist determined the screen slot size and the filter pack size and documented the results per EII 6.7 (WHC-CM-7-7). Sand filter packs were placed in the annulus between either the 20.3-cm (8-in.) temporary casing and screen or the permanent (10.2-cm [4-in.]) casing and screen as the temporary casing was withdrawn. The sand filter pack was placed from total well depth to 0.9 to 1.5 m (3 to 5 ft) above the top of the screen.

A 0.9- to 1.5-m (3- to 5-ft)-thick bentonite pellet seal was placed on top of the sand pack for shallow wells. The annulus between the bentonite pellet seal and 6.1 ±0.6 m (20 ±2 ft) below ground surface were filled with bentonite. Cement grout was then installed to within 0.9 m (3 ft) of the ground surface. The well casing extends 0.3 to 0.6 m (1 to 2 ft) above ground surface and is protected by an outer steel casing and a locking cap. The casing is set into the ground and is cemented in place within a 1.2- by 1.2-m (4- by 4-ft) concrete well pad with protective posts. All protective casings are permanently marked with well identification numbers and a brass survey marker. A schematic of a completed well is shown in Figure 11. Construction information and locations of monitoring wells are provided in Table 3.

3.4.5.3 Well Development. All wells were developed following completion. Wells were developed using the procedures described in EII 10.4, "Well Development Activities" (WHC-CM-7-7). All groundwater discharged from the well during development was disposed of in accordance with WHC guidelines and procedures.

3.4.6 Surveying

After monitoring well installation was completed, all wells were surveyed for location and elevation by qualified surveyors. The elevation of the top of the stainless steel protective casing and a brass marker set in the concrete pad is within 0.3 cm (0.01 ft) of a referenced datum common to the other wells in the monitoring network. A mark has been placed on the casing to indicate the location that was surveyed. The survey results were supervised and reviewed by a licensed surveyor.

An apparent discrepancy between casing elevations on adjacent wells (299-33-33, 299-33-36, and 299-33-37) has created a corresponding elevation error in hydraulic head between the wells. This is probably the result of several of the wells being surveyed to a different datum. This situation is under review and the entire network is being resurveyed to the national geodetic vertical datum (NGVD) '29 datum.

3.4.7 Monitoring Parameters

Groundwater samples are analyzed for the parameters listed in Table 5, as required by 40 CFR 265.92. Analytical methods are listed in the *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1993a).

3.5 CHARACTERIZATION

Hydrogeologic characterization will describe the geologic and hydrogeologic conditions and properties that control contaminant flow paths. Data collection and interpretation focus on geology, geochemistry,

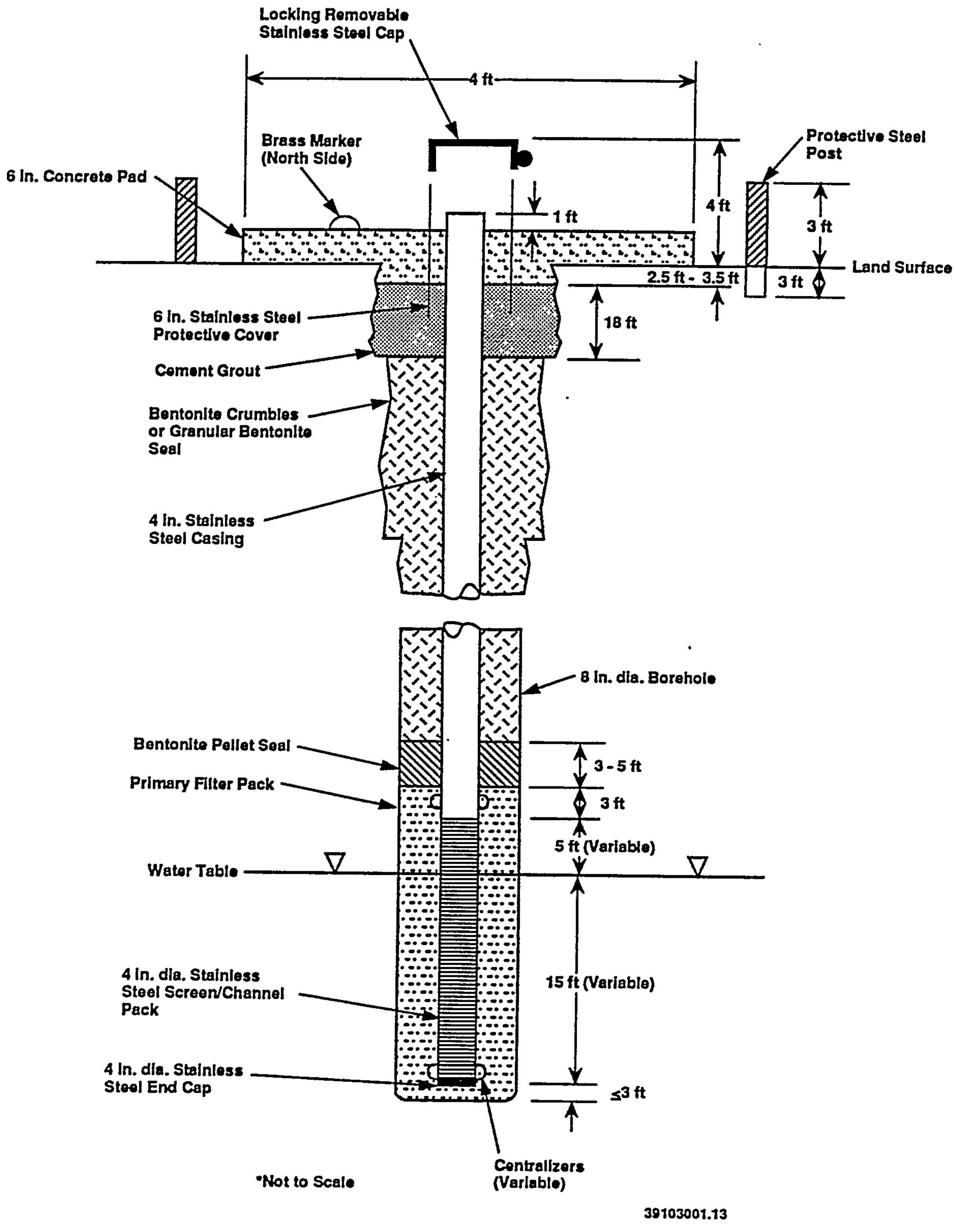


Figure 11. Schematic Diagram of a Typical RCRA Shallow Monitoring Well.

Table 5. Groundwater Sampling Parameters.[a]

Contamination indicator parameters[b]	
pH	Total organic carbon
Specific conductance	Total organic halogen
Groundwater quality parameters[c]	
Chloride	Phenols
Iron	Sodium
Manganese	Sulfate
Site specific parameters	
Alkalinity	Gross alpha
Gross beta	Turbidity

[a]Regulatory requirements for sampling parameters are subject to change because of federal regulations and/or to check on the migration of contaminants from other sources.
[b]Sampled semiannually.
[c]Sampled annually.

hydrogeology, hydrochemistry, groundwater contaminant monitoring, and groundwater modeling. The work performed follows a QA project plan meeting U.S. Environmental Protection Agency (EPA) requirements of QAMS 005/80 (EPA 1983). The characterization effort began with the installation of the monitoring network.

Personnel conducting sampling, testing, and other activities at the site complied with OSHA medical monitoring and training requirements in accordance with 29 CFR 1910.120.

3.5.1 Geologic

Geologic characterization included geologic sampling, lithology description, a variety of physical and chemical laboratory analyses, and geophysical borehole logging.

3.5.1.1 Geologic Sampling. Representative samples for geologic analysis were generally collected at 1.5-m (5-ft) intervals, at changes in lithology, and when significant changes in moisture content were observed. Samples were collected with a drive barrel in the unsaturated sediments whenever possible. When hard-tool drilling became necessary, a bailer was used to collect the sediment samples. No drilling water or other materials were added in excessive quantities to the borehole during drive-barrel drilling. Additives were used only when necessary and were approved by the well site geologist. Control of additives was necessitated by the need to identify perched water zones, to ensure that representative moisture samples could be taken, and to protect ambient water chemistry. Samples for moisture content determinations were collected at 1.5-m (5-ft) intervals and at moist or wet zones. No moisture samples were taken during hard-tool drilling.

A description of the borehole cuttings between sampling intervals was recorded to obtain a continuous lithologic record. Lithologic descriptions of samples include color, texture, sorting, mineralogy, roundness, relative calcium carbonate concentration, consolidation, and cementation. The samples collected were described as hand specimens in the field and documented on geologic log forms in accordance with EII 9.1 (WHC-CM-7-7). Samples were archived for possible future analyses. Drilling, well construction, and sample information were documented on the borehole logs. A guide to subsurface data collection and documentation during cable tool drilling is presented in EII 5.2 and the procedures for groundwater sampling are presented in EII 5.8.

3.5.1.2 Laboratory Analyses. Calcium carbonate content and moisture content analyses were performed on geologic samples collected at 1.5-m (5-ft) intervals or on samples selected by the well site geologist. Other laboratory analyses included sieve analysis, moisture content, saturated hydraulic conductivity, petrographic description, and/or x-ray diffraction analysis of mineral content.

3.5.1.3 Borehole Geophysical Logging. Boreholes were logged at 1.5 m/min (5 ft/min) with a gross-gamma probe after the placement of each temporary casing, so as to log through only one casing, and when the borehole was drilled to final depth. Logging of the starter casing did not occur. The primary purpose of this logging was to correlate and interpret subsurface stratigraphy. Also, logs were used to identify potential zones of contamination by gamma-emitting radionuclides. All logging was performed in accordance with approved procedures.

3.5.2 Hydrogeologic

Data were collected during and after construction of the monitoring wells used in characterizing the hydrogeology of the area around the 216-B-63 Trench. The types and methods of data collection are discussed in the following sections. Groundwater samples were taken following the procedures discussed in the *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1993a).

3.5.2.1 Aquifer Testing. Aquifer testing is done to determine the hydraulic characteristics of in situ geologic materials in the uppermost aquifer underlying the site. The decision on whether or not to carry out pump tests was based on the requirements of the appropriate U.S. Department of Energy, Richland Operations Office (RL) guidance on purgewater. Slug testing was the only aquifer testing performed because purgewater from aquifer testing could not be disposed of to the ground. Purgewater was disposed of in accordance with EII 10.3 (WHC-CM-7-7).

3.5.2.2 Determination of Groundwater Flow Paths. The determination of groundwater flow directions is based on nonroutine water level measurements in all wells of the 216-B-63 Trench groundwater monitoring network that are shared by the adjacent LLBG (LLWMA 2) and by WMA B-BX-BY of the single-shell tanks (SST). These measurements are used to directly estimate groundwater flow direction and to estimate the water level near the 216-B-63 Trench (Figure 3). As understanding of groundwater flow directions increases, the frequency of nonroutine measurements will decrease accordingly, but will not drop below a quarterly schedule. In addition, the distribution of contaminants in plumes originating in the 200 Areas will be used to aid in evaluating groundwater flow directions when data are available.

3.5.2.3 Data Interpretation and Presentation. Two borehole completion reports (WHC 1990, 1993b) include the following drilling data, as well as other pertinent information.

- Borehole stratigraphy
- Details of well completion
- Well development data
- Geologic logs
- Geophysical logs
- Aquifer test results
- Survey data
- As-built diagrams.

The hydrogeologic data have been integrated with existing data to develop an updated conceptual model of the groundwater flow system. Components of the model include definition of hydrostratigraphic units, evaluation of groundwater flow paths and velocities, evaluation of unsaturated zone conditions as they relate to the groundwater monitoring system, and characterization of hydrochemicals.

3.6 SAMPLING AND ANALYSIS

HydroStar[1] sampling pumps were installed in the new wells as soon as possible after construction and well development were complete.

3.6.1 Sample Collection

The depth to water is measured before the wells are purged. The wells are purged and samples are collected after at least three borehole volumes have been removed; when temperature, specific conductance, and pH have stabilized; or, in the case of wells completed in very low permeability materials, after the well has recharged.

3.6.2 Sample Frequency and Analytical Procedures

Samples are collected from all groundwater monitoring wells quarterly in conformance with 40 CFR 265. 92 for analyses of the constituents listed in Table 5. Additional constituents may be added to this list after the results are evaluated.

Sampling, preservation, and chain-of-custody procedures are discussed in the *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1993a). Quality control activities determine and document the quality of

[1]Hydrostar is a trademark of Instrumentation Northwest, Inc., Redmond, Washington.

analytical results and institute corrective actions as necessary. Work performed by the laboratory approved for the groundwater monitoring program will be conducted under one umbrella statement of work and associated quality control procedures.

Under this groundwater monitoring program, the water table elevation data have been evaluated at least annually to determine if the monitoring wells are appropriately located. If the evaluation indicates that existing wells are no longer appropriate, the groundwater monitoring system will be modified to bring it into compliance with 40 CFR 265.91(a).

3.6.3 Reporting

A report of the results of the groundwater monitoring program must be submitted annually. This reporting requirement is consistent with 40 CFR 265.94(b). Table 5 lists the constituents sampled for at the 216-B-63 Trench. The list of constituents sought in analysis may be modified periodically to include analytes of particular interest or delete those that are shown not to be present in the groundwater.

3.6.4 Quality Assurance

Overall quality assurance program requirements are defined in the *Quality Assurance Manual* (WHC-CM-4-2) and Article 31 of the Tri-Party Agreement (Ecology et al. 1994). The RCRA sampling and analysis program is supported by *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1993a). This program is designed to meet requirements of *Interim Guidelines and Specifications for Preparation of Quality Assurance Project Plans* (EPA 1983).

3.7 STATISTICAL ANALYSIS OF GROUNDWATER MONITORING DATA

The methods for establishing background and evaluating water chemistry data and the reporting requirements for groundwater monitoring are discussed in the following sections.

3.7.1 Methods

After 1 year (four quarters) of quarterly monitoring, background levels for contamination indicator parameters were determined and compared with results from downgradient wells semiannually in accordance with 40 CFR 265.93. The data are analyzed to evaluate whether groundwater is affected by the 216-B-63 Trench.

3.7.2 Establishing Background

Background summary statistics (mean, variance, and coefficient of variation) have been calculated. Replicate summary statistics were calculated each quarter. Background comparison summary statistics were calculated from the quarterly summary statistics.

The data collected and analyzed semiannually from the background wells are evaluated to determine if trends are present, if irregularities exist in the data, or if groundwater from the wells is affected by the 216-B-63 Trench. If any of these conditions are present, the data will be evaluated in relation to the hydrologic system to determine if the background levels need to be recalculated from a new set of quarterly sample data. The data will also be evaluated to determine whether the wells being used are suitable for that purpose or different wells are required.

3.7.3 Evaluation of Data

Several wells were added to the semiannual schedule in 1993. Wells are being sampled at least twice each succeeding year after background concentrations were established. At least four replicate measurements will be obtained from each downgradient well for the contamination indicator parameters (IP), and the arithmetic mean and variance will be calculated for the contamination indicator parameters (IP) for each sample.

The method to be used for data evaluation is the averaged replicate (AR) t-test method described in Appendix B of the RCRA Groundwater Monitoring Technical Enforcement Guidance Document (TEGD) (EPA 1986). The AR t-test method, for each IP, is calculated as:

$$t_{i^*} = \frac{(\overline{x}_i - \overline{x}_b)}{S_b * \sqrt{1+1/n_b}}$$

where

$\overline{x}_i$ = average of the replicates from the ith monitoring well in each of the subsequent sampling period;

$\overline{x}_b$ = the background average;

S_b = the background standard deviation; and

n_b = the number of background replicate averages.

The TEGD states that there is a statistical indication of contamination if the test statistic (t_i*) is larger than the Bonferroni critical value (t_c). The values of t_c depend on the overall false positive rate required for each sampling period (i.e., 1% for interim-status facility), the total number of wells in the monitoring network, and the number of degrees of freedom (df) associated with the background standard deviation. Because of the nature of the test statistic (t_i*) given in the above equation; results to be compared to background do not contribute to the estimate of the variance. The test can be reformulated without prior knowledge of the results of the sample to be compared to background (i.e., x_i), in such a way that a critical mean (C.M.) can be obtained:

$$C.M. = \overline{x}_b + t_c * S_b * \sqrt{(1 + 1/n_b)} \text{ (one-tailed)}$$

$$C.M. = \overline{x}_b \pm t_c * S_b * \sqrt{(1 + 1/n_b)} \text{ (two-tailed)}$$

For pH, a two-tailed critical mean (or critical range) is calculated and a one-tailed critical mean is calculated for specific conductance, TOC, and TOX. Any subsequent downgradient replicate average that exceeds the critical mean (or is outside of the critical range in the case of pH) gives the identical indication of contamination as $t_i^* > t_c$.

In cases where all background values are below the limit of detection or where the proportion of nondetects is large (i.e., greater than 50%), a limit of quantitation (LOQ) will also be calculated from the analytical laboratory's blanks data. A LOQ is defined as the blanks mean plus 10 blank standard deviations (EPA 1986). Following the guidance in the TEGD (EPA 1986), for cases where the calculated critical mean is below the LOQ, the LOQ will be used as the comparison value between the upgradient and downgradient wells. In addition, if independent samples are to be collected, the results for the samples (to be compared with background) have to be quantifiable (i.e., <LOQ).

3.7.4 Notification and Reports

A summary of reports required by 40 CFR 265, Subpart F, is given in quarterly and annual reports (DOE 1994b,a).

4.0 PHASE II--INITIATION OF GROUNDWATER QUALITY ASSESSMENT PROGRAM

This section discusses the initiation of a groundwater quality assessment program. It also lists the notifications required by 40 CFR 265 Subpart F and outlines the groundwater quality assessment program.

4.1 INITIATION CRITERIA

As indicated in Chapter 3.0, groundwater samples from all monitoring wells were tested quarterly for interim primary drinking water constituents, groundwater quality parameters, groundwater contamination indicator parameters, and site-specific parameters for the first year (Table 5).

Significant changes in concentrations from both upgradient (background) and downgradient wells must be reported. If significant changes are noted in the downgradient wells, those wells must be immediately resampled, and the samples split in two and analyzed by independent laboratories to determine if the results were caused by laboratory error. Field-generated data can also be a source of analytical error. Suspect field data is identified and confirmed through laboratory analysis. If this second sampling also shows a significant increase (or pH decrease), the EPA and the Washington State Department of Ecology (Ecology) must be notified in writing within 7 days that the 216-B-63 Trench may be affecting groundwater quality. If a significant increase (or pH decrease) is confirmed by the second sampling, a plan for a groundwater quality assessment program must be submitted to EPA and Ecology within 15 days of this written notification. The outline of the groundwater quality assessment program is presented in the following section, as required by 40 CFR 265.93(a).

4.2 GROUNDWATER QUALITY ASSESSMENT PROGRAM

A groundwater quality assessment program will be implemented when a the indicator evaluation monitoring system shows a release of hazardous constituents. The decision to implement the groundwater quality assessment program will be based on criteria described in the previous section. A groundwater quality assessment plan will be certified by a qualified hydrogeologist. This plan will address the following:

- Groundwater monitoring wells that will be drilled, as necessary, to determine the nature and extent of contamination. The number, location, and depth of each well will be identified
- Groundwater samples that will be collected and analyzed at a minimum for constituents outlined in Appendix IX of 40 CFR 265
- Detailed procedures describing how the analytical results will be evaluated, including the analysis of any previously gathered groundwater quality information
- A schedule for implementing the assessment-level groundwater monitoring program.

Additional explanations for several items that will be addressed in the plan are provided in the following paragraphs.

At sites where contaminants are known to have entered the groundwater, the regulations specified in 40 CFR 265.93(d)(4) require that the rate and extent of contaminant movement be determined. The methods used to determine these will depend on the quantity and quality of the field database. Methods will include installation of additional monitoring wells and field testing, continued chemical analyses of selected constituents in existing and new well installations, groundwater flow and contaminant transport modeling, and statistical evaluation of chemical analyses.

4.2.1 Nature and Extent of Contamination

Analytical data from wells in the 216-B-63 network will be evaluated to determine the specific hazardous and nonhazardous constituents and levels of these constituents found in groundwater. In addition, the hazardous constituents will be statistically evaluated to determine which exceed background concentrations. The data will be further evaluated to determine if particular constituents have come from the 216-B-63 Trench or may originate from some other waste management facility.

The lateral extent of contamination will be estimated by contouring concentrations of various hazardous and nonhazardous constituents. The concentrations of hazardous constituents will be contoured to estimate the actual contamination distributions; the concentrations of nonhazardous constituents will be contoured and evaluated as indicators of groundwater and contaminant movement. The rate and extent of contamination will be conceptually evaluated based on existing data and modeling results (see Section 4.2.5).

4.2.2 Rate of Movement

The rate of contaminant movement will be estimated initially by using values of hydraulic conductivity estimated from aquifer testing, the hydraulic gradient determined from water-level measurements, and an estimated effective porosity based on the nature of the geologic material. This will provide a gross estimate for application in modeling studies and additional monitoring programs. The rate and extent of contamination will be conceptually evaluated based on existing data and modeling results (see Section 4.2.5). The results of the evaluation will provide insight into the areas of greatest uncertainty, which are the areas where additional data are needed. Additional wells and field testing may be necessary to quantify the rate and extent of contamination.

4.2.3 Additional Well Installation

Examination of the analytical results obtained under the indicator-evaluation program, coupled with preliminary flow and transport modeling (see Section 4.2.5) will provide the basis for locating additional monitoring wells. Data from these wells will be used to further define and quantify the rate and extent of contamination.

4.2.4 Additional Field and Laboratory Testing

Samples will be collected from wells and analyzed for known hazardous waste or hazardous waste constituents and other constituents that will be useful for evaluating rate and extent of contamination. Additional field testing (e.g., pumping and tracer tests) and laboratory testing may also be necessary. The primary focus of additional field or laboratory testing will be those parameters with the highest uncertainty and that most affect flow and transport. These factors will be evaluated by preliminary modeling and sensitivity analyses. Additional field and/or laboratory testing may be conducted to determine the following:

- Quantitative and representative values and distribution of hydraulic conductivity
- Quantitative values of porosity
- More accurate spatial and temporal distributions of hydraulic head
- Retardation characteristics
- Quantitative values of dispersivity.

4.2.5 Modeling

Simple analytical models that include terms for dispersion, retardation, and radioactive decay will be used to simulate the extent and rate of contaminant plume movement based on assumed hydraulic and retardation parameters. Numerical models that can accommodate heterogeneities in the hydrogeologic system and more complex transport conditions can also be used to estimate the rate and direction of flow under various hydrologic conditions. As previously mentioned, the results of modeling will be used to located additional wells and to identify data needs.

4.3 CONTINUED ANALYSIS AND EVALUATION

This section discusses the review and evaluation that will be conducted on initiation of the groundwater quality assessment program. The required notifications and reports are also discussed.

4.3.1 Review of Methods and Procedures

On verification of contamination in groundwater monitoring wells, the monitoring system, data evaluation methods, and sampling and analysis procedures will be reviewed. This review will evaluate the adequacy of the groundwater monitoring system to determine if contamination may be originating from a source other than the 216-B-63 Trench. The method of establishing background will be reviewed for its appropriateness within the hydrogeologic system. This review will consider the potential effects of other facilities that may result in trends in background water quality. These effects have not been addressed in establishing background. Finally, the review will evaluate the current sampling and analysis procedures and whether sample bias may result from inadequacies in the procedures.

4.3.2 Review of Sampling Parameters and Frequency

The sampling plan will be reviewed to evaluate whether the appropriate parameters are being analyzed and if the frequency is adequate. The groundwater quality assessment program will require the addition of any hazardous constituents that have been detected. The sampling frequency will be returned to quarterly from semiannually until it is determined that no hazardous waste or hazardous waste constituents from the 216-B-63 Trench have entered the groundwater or until final closure of the facility, as required by 40 CFR 265, Subpart F.

4.3.3 Notification and Reports

Table 6 lists the reports and notifications that must be submitted under one of the following conditions:

- Whether or not the facility might be affecting groundwater
- If the facility might be affecting groundwater as determined by the Student's t-test.

Records of the groundwater quality analyses, associated groundwater surface elevations, and the various data analyses (including the statistical analyses) will be kept throughout the active life of the 216-B-63 Trench and the post-closure period (40 CFR 265.94[a][1]).

Table 6. Reports and Notifications.

Submittal	Submittal period
Required whether or not the facility might be affecting groundwater:	
1. First year of sampling only: Concentrations of interim primary drinking water standards, identifying those that exceed the limits listed in Table 5	Within 15 days of each quarterly analysis
Concentration and statistical analyses of groundwater contamination indicator parameters, noting significant differences in upgradient wells	Annually, by March 1 of following year
Results of groundwater surface elevation evaluation and description of response if appropriate.	Annually, by March 1 of following year
Required if the facility might be affecting groundwater:	
2. Notification to EPA and Ecology that the facility might be affecting groundwater	Within 7 days of confirmation of a significant increase (or pH decrease)
Submittal of groundwater assessment plan to EPA and Ecology	Within 15 days of the above notification
Submittal to EPA and Ecology of a written report on assessment of groundwater quality, including concentrations of hazardous waste constituents and their rate and extent of migration	Within 15 days of first determination (as soon as technically feasible)
Results of the groundwater quality assessment program	Annually, by March 1 of following year, until closure of the facility.

5.0 REFERENCES

29 CFR 1910, "Hazardous Waste Operations and Emergency Response Regulations," *Code of Federal Regulations*, as amended.

40 CFR 265, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities," *Code of Federal Regulations*, as amended.

40 CFR 264, "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," *Code of Federal Regulations*, as amended.

Bjornstad, B. N., Dudziak, S., 1989, *40 CFR 265 Interim Status Indicator-Evaluation Groundwater Monitoring Plan for the 216-B-63 Trench*, PNL-6862, Pacific Northwest Laboratory, 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-EN-TI-003, Westinghouse Hanford Company, Richland, Washington.

DOE, 1986, *Environmental Assessment, Reference Repository Location, Hanford Site, Washington*, DOE/RW-0070, U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Washington, D.C.

DOE-RL, 1994, *Hanford Federal Facility Agreement and Consent Order*, U. S. Department of Energy - Richland, RL-TPA-93-01 Rev. 1, Richland, Washington.

DOE-RL, 1987, *Preliminary Closure/Post-Closure Plan - 216-B-63 Trench*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1988, *Consultation Draft, Site Characterization Plan, Reference Repository Location, Hanford Site, Washington*, DOE/RW-0164, Vol. 1, Office of Civilian Radioactive Waste Management, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1994a, *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1993*, DOE/RL-93-88, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

DOE-RL, 1994b, *Quarterly Report of RCRA Groundwater Monitoring Data for Period October 1, 1993 through December 31, 1993*, DOE/RL-93-56-4, U.S. Department of Energy, Richland Operations Office, Richland Washington.

EPA, 1983, *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans*, EPA-600/4-83-004, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1986, *RCRA Groundwater Monitoring Technical Enforcement Guidance Document*, OSWER-9950.1, U.S. Environmental Protection Agency, Washington, D.C.

Evans, J. C., D. I. Dennison, R. W. Bryce, P. J. Mitchell, D. R. Sherwood, K. M. Krupka, N. W. Hinman, E. A. Jacobson, and M. D. Freshley, 1988, *Hanford Site Groundwater Monitoring for July through December 1987*, PNL-6315-2, Pacific Northwest Laboratory, Richland, Washington.

Evans, J. C., R. W. Bryce, and D. J. Bates, 1992, *Hanford Site Ground-Water Monitoring for 1990*, PNL-8073, Pacific Northwest Laboratory, Richland, Washington.

Fayer, M., M. L. Rockhold, and G. W. Gee, 1991, *Recharge Potential of a Sandy Soil*, EOS.

Gee, G. W., 1987, *Recharge at the Hanford Site: Status Report*, PNL-6403, Pacific Northwest Laboratory, Richland, Washington.

Gephart, R. E., R. C. Arnett, R. G. Baca, L. S. Leonhart, and F. A. Spane, Jr., 1979, *Hydrologic Studies Within the Columbia Plateau, Washington: An Integration of Current Knowledge*, RHO-BWI-ST-5, Rockwell Hanford Operations, Richland, Washington.

Graham, M. J. , M. D. Hall, S. R. Strait, and W. R. Brown, 1981, *Hydrology of the Separations Area*, RHO-ST-42, Rockwell Hanford Operations, Richland, Washington.

Graham, M. J., G. V. Last, and K. R. Fecht, 1984, *An Assessment of Aquifer Intercommunication Within B Pond-Gable Mountain Pond Area of the Hanford Site*, RHO-RE-ST-12 P, Rockwell Hanford Operations, Richland, Washington.

Jacobson, E. A., M. D. Freshley, 1990, *An Initial Inverse Calibration of the Groundwater Flow Model for the Hanford Unconfined Aquifer*, PNL-7144, Pacific Northwest Laboratory, Richland, Washington.

Johnson, V. G., 1993, *Westinghouse Hanford Company Operational Groundwater Status Report, 1990-1992*, WHC-EP-0595, Westinghouse Hanford Company, Richland, Washington.

Last, G. V. and T. L. Liikala, 1987, *A Field Guide for Well Site Geologists: Cable Tool Drilling*, PNL-6392, Pacific Northwest Laboratory, Richland, Washington.

Law, A. G., J. A. Serkowski, and A. L. Schatz, 1987, *Results of the Separations Area Groundwater Monitoring Network for 1986*, RHO-RE-SR-87-24P, Rockwell Hanford Operations, Richland, Washington.

Lindsey, K. A., M. P. Connelly, and B. N. Bjornstad, 1991, *Geologic Setting of the 200 West Area: An Update*, WHC-SD-EN-TI-008, Westinghouse Hanford Company, Richland, Washington.

Lindsey, K. A., B. N. Bjornstad, J. W. Lindberg, and K. M. Hoffman, 1992, *Geologic Setting of the 200 East Area: An Update*, WHC-SD-EN-TI-012, Westinghouse Hanford Company, Richland, Washington.

PNL, 1989, *Procedures for Ground-Water Investigations*, PNL-6894, Pacific Northwest Laboratory, Richland, Washington.

Routson, R. C. and V. G. Johnson, 1990, *Recharge Estimates for the Hanford Site 200 Areas Plateau*, Northwest Science, vol. 64, pp. 150-158.

Serkowski, J. A., W. A. Jordan, and M. J. Hartman, 1994, *Groundwater Maps of the Hanford Site Separations Area, June 1994*, WHC-EP-0394-9, Westinghouse Hanford Company, Richland, Washington.

Stone, W. A., J. M. Thorp, O. P. Gifford, and D. J. Hoitink, 1983, *Climatological Summary for the Hanford Area*, PNL-4622, Pacific Northwest Laboratory, Richland, Washington.

Swanson, D. A, T. L. Wright, P. R. Hooper, and R. D. Bentley, 1979, *Revisions in Stratigraphic Nomenclature of the Columbia River Basalt Group*, Bulletin 1457-G, U.S. Geological Survey, Washington, D.C.

WAC-173-160, "Minimum Standards for Construction and Maintenance of Water Wells," *Washington Administrative Code*, as amended.

WAC-173-303, "Dangerous Waste Regulations," *Washington Administrative Code*, as amended.

Wallace, R. W., 1977, *Work Isolation Safety Assessment Program: A Comparison of Evapotranspiration Estimates Using ERDA Hanford Climatological Data*, PNL-2698, Pacific Northwest Laboratory, Richland, Washington.

Weekes, D. C., Luttrell, S. P., and Fuchs, M. R., 1987, *Interim Hydrogeologic Characterization Report and Groundwater Monitoring System for the Nonradioactive Dangerous Waste Landfill, Hanford Site, Washington*, WHC-EP-0021, Westinghouse Hanford Company, Richland, Washington.

WHC, 1990, *Borehole Completion Data Package for 216-B-63 Trench - 1990*, WHC-MR-0207, Westinghouse Hanford Company, Richland, Washington.

WHC, 1991, *Project Management Plan - RCRA Groundwater Monitoring*, WHC-SD-EN-PMP-001, Westinghouse Hanford Company, Richland Washington.

WHC, 1992a, *Generic Specifications--Groundwater Monitoring Wells*, WHC-S-014, Rev. 7, Westinghouse Hanford Company, Richland, Washington.

WHC, 1992b, *Project Specific Quality Assurance Plan: Generic Standard for RCRA Compliant Groundwater Monitoring Wells*, WHC-SD-WM-QAPP-002, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993a, *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities*, WHC-SD-EN-QAPP-001, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

WHC, 1993b, *Borehole Completion Data Package for DOE 216-B-63 Trench, CY 1992*, WHC-SD-EN-DP-051, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-2, *Quality Assurance Manual*, Westinghouse Hanford Company, Richland, Washington.

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

APPENDIX A

GEOLOGIC AND CONSTRUCTION DIAGRAMS FOR 216-B-63 WELLS

This page intentionally left blank.

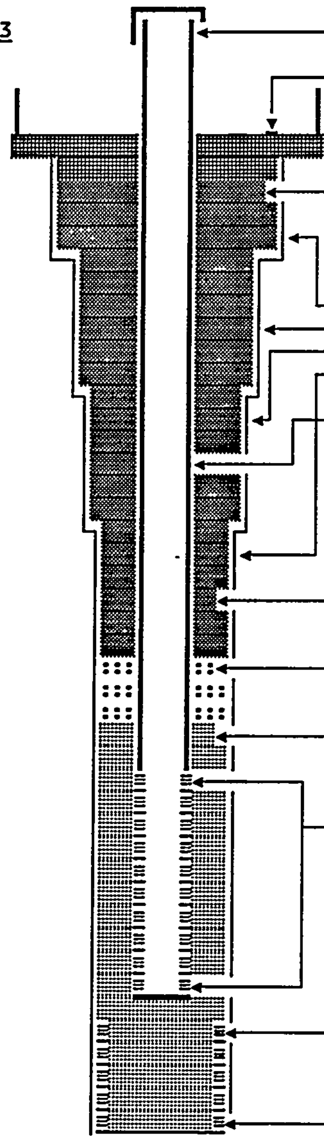
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E27-8 / TEMPORARY WELL NO: ______
Drilling Fluid Used: 200 E Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 44,496 E/W W 49,642
Driller's Name: Murphy/Robinson	WA State Lic Nr: ______	State Coordinates: N 449,670 E 2,245,569
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T___ R___ S______
Date Started: 01Aug87	Date Complete: 30Sep87	Elevation Ground surface: 634.64-ft (Brass cap)

Depth to water: 229.5-ft Aug87
(Ground surface) 232.8-ft 23Jun93

GENERALIZED STRATIGRAPHY — Geologist's Log

0↔25: Silty, sandy GRAVEL
25↔30: Silty gravelly SAND
30↔50: Silty sandy GRAVEL
50↔55: Silty gravelly SAND
55↔70: Silty sandy GRAVEL
70↔80: Silty gravelly SAND
80↔95: Silty sandy GRAVEL
95↔100: Gravelly silty SAND
100↔110: Silty sandy GRAVEL
110↔115: Silty gravelly SAND
115↔120: Gravelly SAND
120↔137: Silty gravelly SAND
137↔140: Gravelly SAND
140↔145: Silty gravelly SAND
145↔150: Gravelly SAND
150↔155: Silty gravelly SAND
155↔170: Gravelly SAND
170↔175: Silty sandy GRAVEL
175↔190: Sandy GRAVEL
190↔195: Gravelly SAND
195↔200: Silty gravelly SAND
200↔240: Silty sandy GRAVEL
240↔250: Gravelly SAND
250↔256.5: Sandy GRAVEL
256.5↔257: BASALT



Elevation of reference point: (top of casing) [637.83-ft]

Height of reference point above ground surface [3.2-ft]

Depth of surface seal [4.5↔216-ft]
Type of surface seal:
Granular bentonite, portland cement
4-ft x 4-ft x 6-in concrete pad extends 4.5-ft into annulus

Hole diameter
0↔40-ft, 17-in nominal
40↔104-ft, 13-in nominal
104↔165.8-ft, 11-in nominal
165.8↔257.0-ft, 9-in nominal

4-in ID stainless steel casing, +3.2↔225.5-ft

Granular bentonite, 4.5↔216-ft

Bentonite pellets, 216↔221-ft

Silica sand pack, 221↔257-ft, #20-mesh

4-in stainless steel screen, 225.5↔245.5-ft, #20-slot

8-in stainless steel telescoping screen, 247↔257-ft, #30-slot

Borehole drilled depth: [257.0-ft]

Drawing By: RKL/2E27-08.ASB
Date : 09Sep93
Reference : HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E27-8

WELL DESIGNATION	:	299-E27-8
RCRA FACILITY	:	Low Level Burial Grounds, 218-E-12B
CERCLA UNIT	:	200 Aggregate Area Management Study
HANFORD COORDINATES	:	N 44,496 W 49,642 [07Dec87-2000E]
LAMBERT COORDINATES	:	N 449,670 E 2,245,569 [HANCONV]
DATE DRILLED	:	Sep87
DEPTH DRILLED (GS)	:	257-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	229.5-ft, Aug87, 232.8-ft, 23Jun93
CASING DIAMETER	:	4-in, stainless steel, +3.2↔225.5-ft.
ELEV TOP CASING	:	637.83-ft [07Dec87-200E]
ELEV GROUND SURFACE	:	634.64-ft, Brass cap [07Dec87-200E]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	4-in, 225.5↔245.5-ft; 8-in, 247.0↔257.0-ft
COMMENTS	:	FIELD INSPECTION, 07Feb90, 4-in stainless steel casing, no protective casing. Capped and locked. 4-ft by 4-ft concrete pad, 4 posts, brass marker with stamped ID. OTHER;
AVAILABLE LOGS	:	Geologist, Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	LLBG quarterly water level measurement, 01Dec87↔23Jun93;
CURRENT USER	:	WHC ES&M RCRA sampling, PNL sitewide w/l monitoring
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

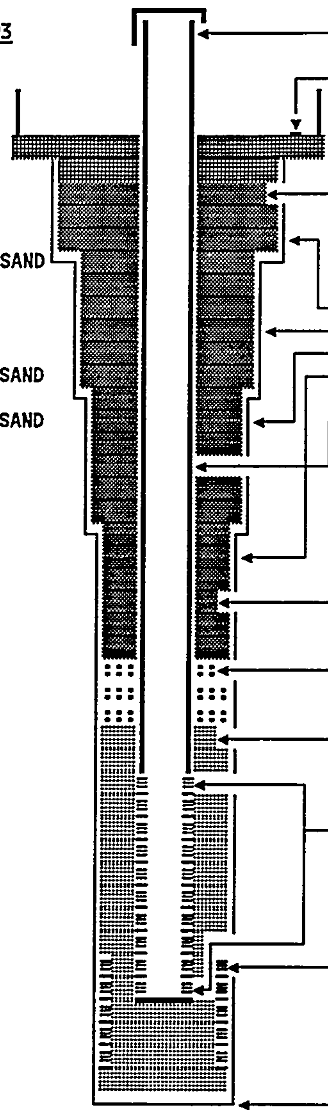
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E27-9 TEMPORARY WELL NO:
Drilling Fluid Used: 200 E Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 44,484 E/W W 49,122
Driller's Name: Cordon/Cordon/Watkins	WA State Lic Nr: Not documented	State Coordinates: N 449,660 E 2,246,089
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T R S
Date Started: 21Jul87	Date Complete: 31Aug87	Elevation Ground surface: 627.31-ft (Brass cap)

Depth to water: 221.1-ft Aug87
(Ground surface) 225.4-ft 23Jun93

GENERALIZED STRATIGRAPHY
Geologist's Log

0↔80: Silty sandy GRAVEL
80↔85: Silty gravelly SAND
85↔90: Sandy GRAVEL
90↔100: Silty sandy GRAVEL
100↔120: Sl. silty sl. gravelly SAND
120↔125: Sl. silty gravelly SAND
125↔130: Gravelly SAND
130↔135: Sandy GRAVEL
135↔140: Sl. silty gravelly SAND
140↔145: Sl. silty sl. gravelly SAND
145↔155: Sl. silty gravelly SAND
155↔160: Sl. silty sl. gravelly SAND
160↔165: Sl. silty gravelly SAND
165↔175: Silty sandy GRAVEL
175↔185: Sl. silty gravelly SAND
185↔205: Silty sandy GRAVEL
205↔226: Sl. silty gravelly SAND
226↔245: Silty sandy GRAVEL
245 : BASALT



Elevation of reference point: (top of casing) [629.21-ft]
Height of reference point above ground surface [1.9-ft]
Depth of surface seal [2.3↔203.3-ft]
Type of surface seal:
Bentonite crumbles, w/Portland cement
4-ft x 4-ft x 6-in surface pad
extending 2.3-ft into annulus

Hole diameter,
0↔40.7-ft, 17-in nominal
40.7↔105.3-ft, 13-in nominal
105.3↔177.2-ft, 11-in nominal
177.2↔242.2-ft, 9-in nominal

4-in ID stainless steel casing, +1.9↔219.8-ft

Bentonite crumbles, 2.3↔203.3-ft

Bentonite pellets, 203.3↔210.5-ft

Silica sand pack, 210.5↔245.2-ft, 20↔30 mesh

4-in stainless steel screen, 219.8↔239.1-ft, #20-slot

8-in stainless steel telescoping screen, 233.4↔244.3-ft, #20-slot

Borehole drilled depth: [245.2-ft]

Drawing By: RKL/2E27-09.ASB
Date : 09Sep93
Reference : HANFORD WELLS

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E27-9

WELL DESIGNATION	:	299-E27-9
RCRA FACILITY	:	Low Level Burial Grounds, 218-E-12B
CERCLA UNIT	:	200 Aggregate Area Management Study
HANFORD COORDINATES	:	N 44,484 W 49,122 [07Dec87-200E]
LAMBERT COORDINATES	:	N 449,660 E 2,246,089 [HANCONV]
DATE DRILLED	:	Aug87
DEPTH DRILLED (GS)	:	245.2-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	221.1-ft, Aug87, 225.4-ft, 23Jun93
CASING DIAMETER	:	4-in, stainless steel, +1.9↔219.8-ft.
ELEV TOP CASING	:	629.21-ft [07Dec87-200E]
ELEV GROUND SURFACE	:	627.31-ft, Brass cap [07Dec87-200E]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	4-in, 219.8↔239.1-ft; 8-in, 233.4↔244.3-ft
COMMENTS	:	FIELD INSPECTION, 07Feb90, 4-in stainless steel casing, no protective casing. Capped and locked. 4-ft by 4-ft concrete pad, 4 posts, brass marker with stamped ID. OTHER;
AVAILABLE LOGS	:	Geologist, Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	LLBG quarterly water level measurement, 01Dec87↔23Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling, PNL sitewide sampling and w/l monitoring 93
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

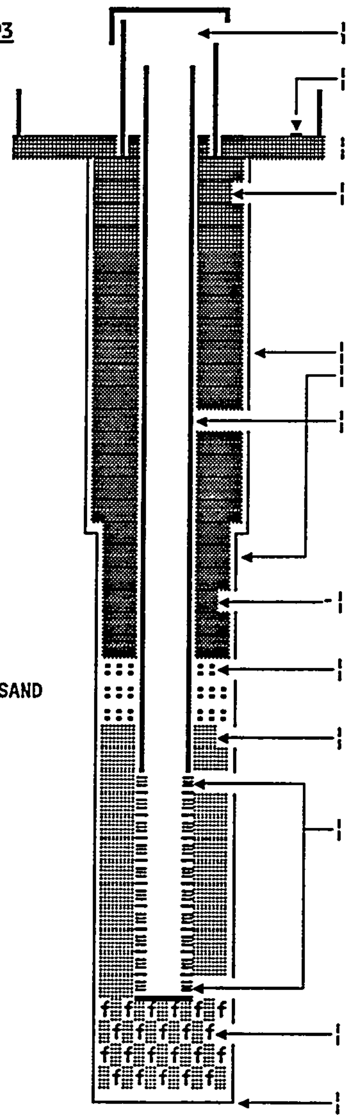
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E27-11 TEMPORARY WELL NO:
Drilling Fluid Used: 200 E Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 44,557.6 E/W W 49,990.3
Driller's Name: Garcia	WA State Lic Nr: Not documented	State NAD83 Coordinates: N 137,063.0m E 574,653.2m; N 449,731 E 2,245,221
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T___ R___ S___
Date Started: 27Jun89	Date Complete: 18Oct89	Elevation Ground surface: 640.34-ft (Brass cap)

Depth to water: 234.4-ft Jul89
(Ground surface) 238.6-ft 23Jun93

GENERALIZED STRATIGRAPHY — Geologist's Log

0-15: Sl. muddy gravelly SAND
15-20: Muddy sandy GRAVEL
20-25: Sandy GRAVEL
25-30: Sl. muddy gravelly SAND
30-35: Muddy sandy GRAVEL
35-40: Sandy GRAVEL
40-50: Muddy sandy GRAVEL
50-55: Sl. gravelly SAND
55-60: Gravelly SAND
60-65: SAND
65-85: Gravelly SAND
85-90: Sl. gravelly SAND
95-100: Sl. gravelly SAND
100-105: SAND
105-120: Sandy GRAVEL
120-125: Gravelly SAND
125-135: Sandy GRAVEL
135-155: Gravelly SAND
155-160: Sl. gravelly SAND
160-165: Gravelly SAND
165-175: Sandy GRAVEL
175-185: Sl. muddy gravelly SAND
185-195: Gravelly SAND
195-200: Sl. gravelly sl. muddy SAND
205-210: Muddy sandy GRAVEL
210-215: Sandy GRAVEL
215-220: Muddy sandy GRAVEL
220-245: Sandy GRAVEL
245-250: Sl. gravelly SAND
250-255: Muddy SAND
255-260: SAND
260-262: GRAVEL
262-264.7: BASALT



Elevation of reference point: [643.29-ft]
(top of 6-in casing)
Height of reference point above ground surface [2.95-ft]

Depth of surface seal [2↔19.5-ft]
Type of surface seal:
Cement grout to 19.5-ft w/Portland cement
4-ft x 4-ft x 6-in surface pad extending 2.0-ft into annulus

Hole diameter,
2↔143.9-ft, 11-in nominal
143.9↔264.7-ft, 9-in nominal

4-in ID stainless steel casing,
+1.9↔230.4-ft

Bentonite crumbles,
19.5↔223.5-ft

¼-in Volclay pellets,
223.5↔227.4-ft

Silica sand pack,
227.4↔251.4-ft, 20↔40 mesh

4-in stainless steel screen,
230.4↔251.4-ft, #10-slot
w/channel pack

Backfill,
251.4-264.7-ft

Borehole drilled depth: [264.7-ft]

Drawing By: RKL/2E27-11.ASB
Date: 09Sep93
Reference: WHC-MR-0204

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E27-11

WELL DESIGNATION	:	299-E27-11
RCRA FACILITY	:	Low Level Burial Grounds, 218-E-12B
CERCLA UNIT	:	200 Aggregate Area Management Study
HANFORD COORDINATES	:	N 44,557.6 W 49,990.3 [12Jun90-200E]
LAMBERT COORDINATES	:	N 449,731 E 2,245,221 [HANCONV] N 137,063.0m E 574,653.2m [12Jun90-NAD83]
DATE DRILLED	:	Oct89
DEPTH DRILLED (GS)	:	264.7-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	234.4-ft, Jul89, 238.6-ft, 23Jun93
CASING DIAMETER	:	4-in, stainless steel, +1.9↔230.4-ft. 6-in, stainless steel, +2.95↔~0.5-ft
ELEV TOP CASING	:	643.29-ft, [12Jun90-200E]
ELEV GROUND SURFACE	:	640.34-ft, Brass cap [12Jun90-200E]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	4-in stainless steel with channel pack, 230.4↔251.4-ft
COMMENTS	:	FIELD INSPECTION, 07Feb90, 4-in stainless steel casing, 6-in protective casing. Capped and locked. 4-ft by 4-ft concrete pad, 4 posts, brass marker with stamped ID. Not in radiation zone. OTHER;
AVAILABLE LOGS	:	Geologist, Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	LLBG quarterly water level measurement, 01Dec89↔23Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling, PNL sitewide sampling 93
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

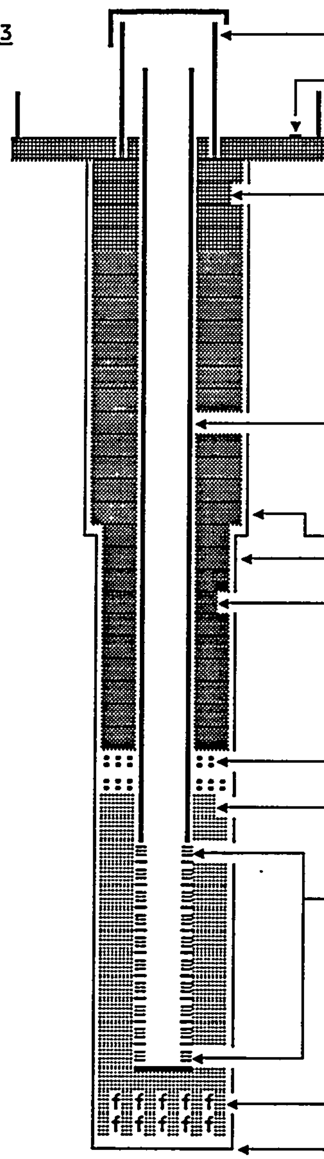
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E27-16 TEMPORARY WELL NO:
Drilling Fluid Used: 200 E Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 44,897 E/W W 51,544
Driller's Name: Wamsley	WA State Lic Nr: Not documented	State NAD83 N 137,165.12m E 574,179.47m
Drilling Company: Kaiser Engineers	Company Location: Hanford	Coordinates: N 450,066 E 2,243,666
Date Started: 04Dec89	Date Complete: 17Apr90	Start Card #: Not documented T___ R___ S___
		Elevation Ground surface: 649.19-ft (Brass cap)

Depth to water: 244.5-ft Dec89
(Ground surface) 247.5-ft 14Jun93

GENERALIZED STRATIGRAPHY / Geologist's Log

0↔5: Muddy sandy GRAVEL
5↔10: Sandy GRAVEL
10↔15: SAND
15↔30: Sandy GRAVEL
30↔35: Sl. gravelly SAND
35↔95: SAND
95↔100: Sl. gravelly SAND
100↔110: SAND
110↔115: Sl. gravelly SAND
115↔120: Gravelly SAND
120↔125: Sl. gravelly SAND
125↔130: SAND
130↔155: Sl. gravelly SAND
155↔170: SAND
170↔175: Sl. gravelly SAND
175↔180: Gravelly SAND
180↔185: Sl. gravelly SAND
185↔195: Gravelly SAND
195↔202: SAND
202↔205: Sl. gravelly SAND
205↔210: Sandy GRAVEL
210↔215: SAND
215↔220: Gravelly SAND
220↔240: Sandy GRAVEL
240↔245: Muddy sandy GRAVEL
245↔250: Sandy GRAVEL
250↔260: SAND
260↔269: Muddy sandy GRAVEL
269 : BASALT



Drawing By: RKL/2E27-16.ASB
Date : 09Sep93
Reference : WHC-MR-0207

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E27-16

WELL DESIGNATION	:	2-E27-16
RCRA FACILITY	:	216-B-63 Trench
CERCLA UNIT	:	200 Aggregate Area Management Study
HANFORD COORDINATES	:	N 44,897 W 51,544 [19Apr90-200E]
LAMBERT COORDINATES	:	N 450,066 E 2,243,666 [HANCONV] N 137,165.12m E 574,179.47m [19Apr90-NAD83
DATE DRILLED	:	Apr90
DEPTH DRILLED (GS)	:	269.0-ft
MEASURED DEPTH (GS)	:	251.7-ft, 27Aug93
DEPTH TO WATER (GS)	:	244.5-ft, Dec89; 247.5-ft, 14Jun93
CASING DIAMETER	:	4-in, stainless steel, +1.8↔238.7-ft; 6-in, stainless steel, +2.9↔~0.5-ft
ELEV TOP CASING	:	652.13-ft [19Apr90-200E]
ELEV GROUND SURFACE	:	649.19-ft, Brass cap [19Apr90-200E]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	238.7↔259.7-ft, 4-in stainless steel with channel pack,
COMMENTS	:	FIELD INSPECTION, 27Aug93; 4 and 6-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable. Capped and locked, brass cap in pad with well ID. Not in radiation zone. OTHER;
AVAILABLE LOGS	:	Geologist, Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	B-63 Trench quarterly water level measurement, 20Nov90↔14Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling, PNL sitewide sampling 93
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

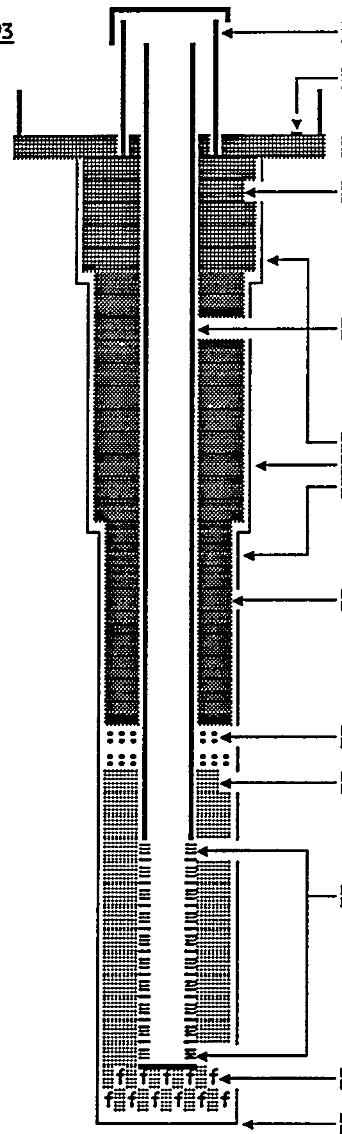
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E27-17 TEMPORARY WELL NO:
Drilling Fluid Used: Raw water	Additives Used: None	Hanford Coordinates: N/S N 44,752.1 E/W W 50,337.1
Driller's Name: J Johnson	WA State Lic Nr: Not documented	State NAD83 Coordinates: N 137,122.01m E 574,547.31m; N 449,924 E 2,244,873
Drilling Company: Jensen	Company Location: Not documented	Start Card #: Not documented T___ R___ S___
Date Started: 19Sep91	Date Complete: 11Nov91	Elevation Ground surface: 631.75-ft (Brass cap)

Depth to water: 226.9-ft Nov91
(Ground surface) 229.7-ft 23Jun93

GENERALIZED STRATIGRAPHY
Geologist's Log
Sl=slightly

0↔20: Sandy silty GRAVEL
20↔50: Sandy GRAVEL
50↔80: Gravelly SAND
80↔105: Silty SAND
105↔120: Gravelly SAND
120↔150: SAND
150↔185: Silty SAND
185↔195: Silty sandy GRAVEL
195↔200: SILT
200↔210: Silty SAND
210↔215: Silty sandy GRAVEL
215↔220: Sandy GRAVEL
220↔225: Silty sandy GRAVEL
225↔240: Sandy GRAVEL
240↔245: Silty sandy GRAVEL
245↔246.2: Sandy GRAVEL
246.2 : BASALT



Elevation of reference point: [634.72-ft]
(top of casing)
Height of reference point above ground surface [3.47-ft]

Depth of surface seal [2.1↔18.9-ft]
Type of surface seal:
Cement grout, 2.1↔18.9-ft, w/concrete 4x4-ft x 6-in surface pad extending 2.1-ft into annulus

4-in ID stainless steel casing, +ND↔223.2-ft

Hole diameter,
2.1↔18.4-ft, 13-in nominal
18.4↔169.1-ft, 11-in nominal
169.1↔246.2-ft, 9-in nominal

Bentonite crumbles
18.9↔214.4-ft, 8↔20-mesh

Bentonite pellets,
214.4↔217.7-ft

Silica sand pack,
217.7↔244.2-ft, 10↔20-mesh

4-in T304 stainless steel screen,
223.2↔244.2-ft, #20-slot

Fill,
244.2↔246.2-ft

Borehole drilled depth: [246.2-ft]

Drawing By: RKL/2E27-17.ASB
Date : 09Sep93
Reference :

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E27-17

WELL DESIGNATION	:	299-E27-17
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	LLBG-WMA2
HANFORD COORDINATES	:	N 44,752.1 W 50,337.1 [200E-12Dec91]
LAMBERT COORDINATES	:	N 449,924 E 2,244,873 [HANCONV] N 137,122.01m E 574,547.31m [NAD83-31Oct91]
DATE DRILLED	:	Nov91
DEPTH DRILLED (GS)	:	246.2-ft
MEASURED DEPTH (GS)	:	255.7-ft, 23Aug93
DEPTH TO WATER (GS)	:	226.9-ft, 06Nov91 229.7-ft, 23Jun93
CASING DIAMETER	:	4-in stainless steel, +ND↔223.2-ft; 6-in stainless steel, +2.97↔~0.5-ft
ELEV TOP CASING	:	634.72-ft, [NGVD'29-12Dec91]
ELEV GROUND SURFACE	:	631.75-ft, Brass cap [NGVD'29-12Dec91]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	223.2↔244.2-ft, 4-in #20-slot stainless steel;
COMMENTS	:	FIELD INSPECTION, 23Aug93; 4 and 6-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable. Capped and locked, brass cap in pad with well ID. Not in radiation zone. OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	LLBG quarterly water level measurement, 13Dec91↔23Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling,
PUMP TYPE	:	Hydrostar, intake @ 239.8-ft
MAINTENANCE	:	

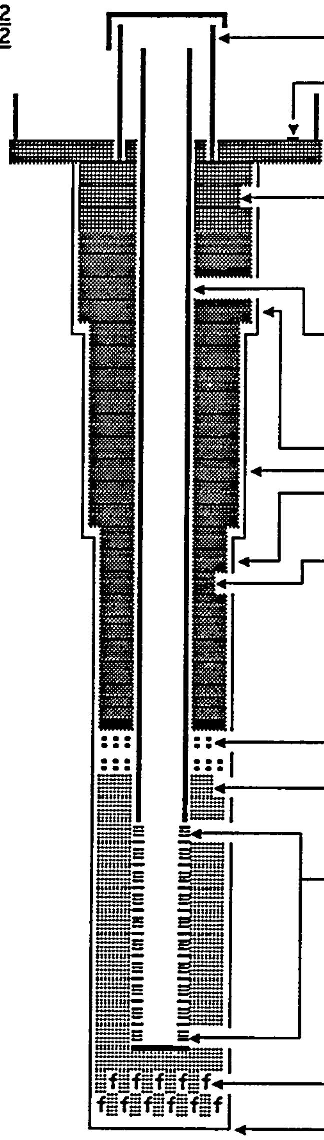
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E27-18 — TEMPORARY WELL NO:
Drilling Fluid Used: Raw water	Additives Used: None	Hanford Coordinates: N/S N 44,745.6 E/W W 51,150.0
Driller's Name: D. Ludtke	WA State Lic Nr: Not documented	State NAD83 N 137,119.29m E 574,299.61m; Coordinates: N 449,916 E 2,244,060
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T___ R___ S___
Date Started: 11May92	Date Complete: 14Jul92	Elevation Ground surface: 647.14-ft (Brass cap)

Depth to water: 243.9-ft 01Jun92
(Ground surface) 244.8-ft 15Dec92

GENERALIZED STRATIGRAPHY
Geologist's Log
Sl=slightly

0↔5: Silty gravelly SAND
5↔10: Silty sandy GRAVEL
10↔15: Gravelly SAND
15↔25: SAND
25↔30: Sandy GRAVEL
30↔35: SAND
35↔50: Gravelly SAND
50↔55: Silty sandy GRAVEL
55↔60: Silty gravelly SAND
60↔65: Silty sandy GRAVEL
65↔140: Silty SAND
140↔178: Silty gravelly SAND
178↔185: Silty SAND
185↔205: Silty gravelly SAND
205↔210: Silty SAND
210↔265: Silty sandy GRAVEL
265 : BASALT



Elevation of reference point: [650.15-ft] (top of casing)

Height of reference point above ground surface [3.01-ft]

Depth of surface seal [2.0↔8.6-ft]
Type of surface seal: Cement grout, 2.0↔8.6-ft, w/concrete 4x4-ft x 6-in surface pad extending 2.0-ft into annulus

4-in ID stainless steel casing, +1.2↔241.4-ft

Hole diameter,
2.0↔46.4-ft, 13-in nominal
46.4↔147.7-ft, 11-in nominal
147.7↔264.3-ft, 9-in nominal

Bentonite crumbles, 8.6↔232.4-ft, 8↔20-mesh

¾-in bentonite pellets, 232.4↔237.1-ft

Silica sand pack, 237.1↔262.7-ft, 20↔40-mesh

4-in T304 stainless steel screen, 241.4↔261.5-ft, #10-slot w/0.3-ft end cap

Fill, 262.7↔265.0-ft

Borehole drilled depth: [265.0-ft]

Drawing By: RKL/2E27-18.ASB
Date : 09Sep93
Reference : WHC-SD-EN-DP-051

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E27-18

WELL DESIGNATION	:	299-E27-18
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	216-B63 Trench
HANFORD COORDINATES	:	N 44,745.6 W 51,150.0 [200E-08Dec92]
LAMBERT COORDINATES	:	N 449,916 E 2,244,060 [HANCONV] N 137,119.29m E 574,299.61m [NAD83-08Dec92]
DATE DRILLED	:	Jul92
DEPTH DRILLED (GS)	:	265.0-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	243.9-ft, 01Jun92 244.8-ft, 15Dec92
CASING DIAMETER	:	4-in stainless steel, +1.2↔241.4-ft; 6-in stainless steel, +3.01↔~0.5-ft
ELEV TOP CASING	:	650.15-ft, [NGVD'29-08Dec92]
ELEV GROUND SURFACE	:	647.14-ft, Brass cap [NGVD'29-08Dec92]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	241.4↔261.5-ft, 4-in #10-slot stainless steel;
COMMENTS	:	FIELD INSPECTION, OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	One water level measurement while sampling, 15Dec92;
CURRENT USER	:	WHC ES&M RCRA sampling, PNL sitewide sampling 93
PUMP TYPE	:	Hydrostar, intake @ 258.5-ft (GS)
MAINTENANCE	:	

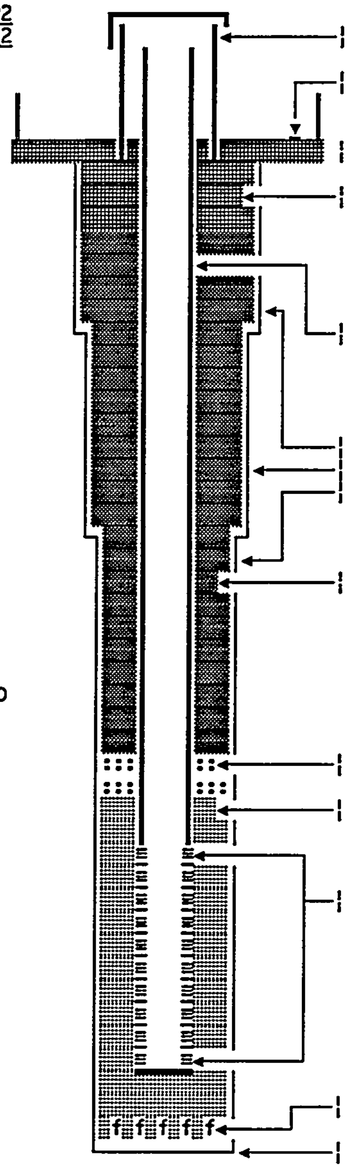
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E27-19 TEMPORARY WELL NO: ____
Drilling Fluid Used: Raw water	Additives Used: None	Hanford Coordinates: N/S N 44,693.6 E/W W 50,968.2
Driller's Name: L. Watkins	WA State Lic Nr: Not documented	State NAD83 N 137,103.59m E 574,355.07m Coordinates: N 449,865 E 2,244,242
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T____ R____ S____
Date Started: 11May92	Date Complete: 08Jul92	Elevation Ground surface: 647.83-ft (Brass cap)

Depth to water: 244.7-ft 03Jun92
(Ground surface) 245.5-ft 15Dec92

GENERALIZED STRATIGRAPHY Geologist's Log
Sl=slightly

0↔5: Sandy GRAVEL
5↔10: Silty sandy GRAVEL
10↔15: Sandy SILT
15↔30: SAND
25↔30: Sandy GRAVEL
30↔35: Silty sandy GRAVEL
35↔54: Silty SAND
54↔54.5: SILT
54.5↔60: Silty SAND
60↔69: Sandy GRAVEL
69↔69.5: SILT
69.5↔97: SAND
97↔99: GRAVEL
99↔150: SAND
150↔157.5: Sandy GRAVEL
157.5↔169: SAND
169↔170.5: SILT
170.5↔212: SAND
212↔213.5: Gravelly SAND
213.5↔214: SILT w/occ GRAVELS
214↔215: SAND
215↔220: Silty sandy GRAVEL
220↔259: Sandy GRAVEL
259↔266.8: Sl silty gravelly SAND



Elevation of reference point: [650.88-ft] (top of casing)

Height of reference point above ground surface [3.05-ft]

Depth of surface seal [2.0↔8.5-ft]
Type of surface seal:
Cement grout, 2.0↔8.5-ft, w/concrete 4x4-ft x 6-in surface pad extending 2.0-ft into annulus

4-in ID stainless steel casing,
+1.0↔242.0-ft

Hole diameter,
2.0↔45.0-ft, 13-in nominal
45.0↔159.0-ft, 11-in nominal
159.0↔266.8-ft, 9-in nominal

Bentonite crumbles
8.5↔229.5-ft, 8↔20-mesh

⅜-in bentonite pellets,
229.5↔236.5-ft

Silica sand pack,
236.5↔266.7-ft, 20↔40-mesh

4-in T304 stainless steel screen,
242.0↔262.1-ft, #10-slot
w/0/3-ft end cap

Fill,
266.7↔266.8-ft

Borehole drilled depth: [266.8-ft]

Drawing By: RKL/2E27-19.ASB
Date : 09Sep93
Reference : WHC-SD-EN-DP-051

SMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E27-19

WELL DESIGNATION	:	299-E27-19
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	216-B63 Trench
HANFORD COORDINATES	:	N 44,693.6 W 50,968.2 [200E-08Dec92]
LAMBERT COORDINATES	:	N 449,865 E 2,244,242 [HANCONV] N 137,103.59m E 574,355.07m [NAD83-08Dec92]
DATE DRILLED	:	Jul92
DEPTH DRILLED (GS)	:	266.8-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	244.7-ft, 03Jun92 245.5-ft, 15Dec92
CASING DIAMETER	:	4-in stainless steel, +1.0↔242.0-ft; 6-in stainless steel, +3.05↔~0.5-ft
ELEV TOP CASING	:	650.88-ft, [NGVD'29-08Dec92]
ELEV GROUND SURFACE	:	647.83-ft, Brass cap [NGVD'29-08Dec92]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	242.0↔262.1-ft, 4-in #10-slot stainless steel;
COMMENTS	:	FIELD INSPECTION, OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	One water level measurement while sampling, 15Dec92;
CURRENT USER	:	WHC ES&M RCRA sampling, PNL sitewide sampling 93
PUMP TYPE	:	Hydrostar, intake @ 260.5-ft (GS)
MAINTENANCE	:	

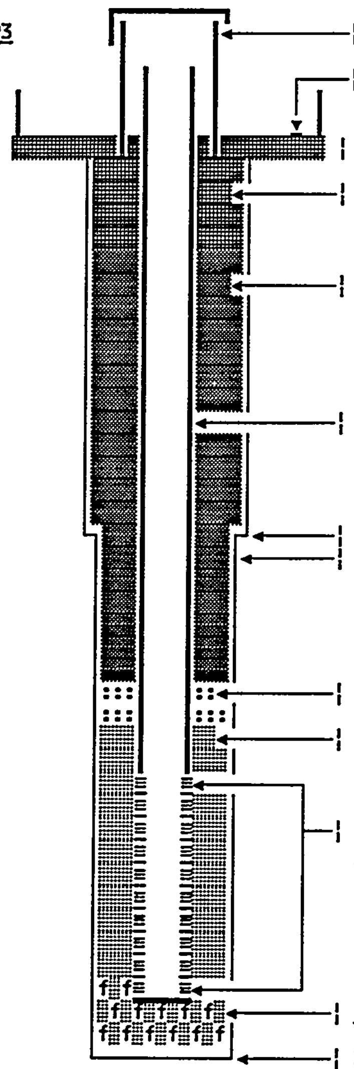
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E33-33 TEMPORARY WELL NO:
Drilling Fluid Used: 200 E Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 45,348 E/W W 51,868
Driller's Name: Wamsley	WA State Lic Nr: Not documented	State NAD83 Coordinates: N 137,302.2m E 574,080.3m; N 450,517 E 2,243,341
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T___ R___ S___
Date Started: 17Jul89	Date Complete: 29Aug89	Elevation Ground surface: 637.18-ft Brass cap

Depth to water: 232.8-ft Aug89
(Ground surface) 235.4-ft 23Jun93

GENERALIZED STRATIGRAPHY Geologist's Log

0↔5: Muddy sandy GRAVEL
5↔30: Sandy GRAVEL
30↔35: Gravelly SAND
35↔60: SAND
60↔70: Sl. gravelly SAND
70↔75: SAND
75↔80: Sl. gravelly SAND
80↔85: Gravelly SAND
85↔90: Sl. gravelly SAND
90↔95: Sl. muddy SAND
95↔110: SAND
110↔115: Sl. muddy SAND
115↔130: SAND
130↔145: Sl. gravelly SAND
145↔150: SAND
150↔165: Sl. gravelly SAND (3-in MUD at 157-ft)
165↔170: Sl. gravelly muddy SAND
170↔180: Sl. muddy SAND
180↔185: Muddy SAND
185↔195: Sl. gravelly muddy SAND
195↔200: Gravelly muddy SAND
200↔205: Muddy SAND
205↔210: Muddy SAND
210↔215: SAND
215↔252: Muddy sandy GRAVEL
252 : BASALT



Elevation of reference point: (top of 6-in casing) [640.17-ft]
Height of reference point above ground surface [2.99-ft]
Depth of surface seal [2↔18.7-ft]
Type of surface seal: Cement grout to 18.7-ft, has 4-ft x 4-ft x 6-in concrete pad extending 2-ft into annulus
Bentonite crumbles, 18.7↔239.6-ft, 8↔20-mesh
4-in ID stainless steel casing, +0.6↔246.4-ft
Hole diameter, 0↔154.0-ft, 11-in nominal; 154.0↔252.0-ft, 9-in nominal
¼-in Volclay pellets, 220.2↔224.2-ft
Silica sand pack, 224.2↔246.8-ft, 20↔40-mesh
4-in stainless steel screen, 227.3↔248.3-ft, #10-slot w/channel pack and bottom cap
Fill 246.8↔252-ft
Borehole drilled depth: [252.0-ft]

Drawing By: RKL/2E33-33.ASB
Date : 13Sep93
Reference : WHC-MR-0209

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E33-33

WELL DESIGNATION :	299-E33-33
RCRA FACILITY :	Single Shell Tanks, 241-B-BX-BY Farms
CERCLA UNIT :	200 Aggregate Area Management Study (200-BP-5)
HANFORD COORDINATES :	N 45,348 W 51,868 [08Dec89-200E]
LAMBERT COORDINATES :	N 450,517 E 2,243,341 [HANCONV] N 137,302m E 574,080.3m [08Dec89-NAD83]
DATE DRILLED :	Aug89
DEPTH DRILLED (GS) :	252.0-ft
MEASURED DEPTH (GS) :	Not documented
DEPTH TO WATER (GS) :	232.8-ft, Aug89, 235.4-ft, 23Jun93
CASING DIAMETER :	4-in, stainless steel, +0.5↔227.3-ft.; 6-in, stainless steel, +3.0↔~0.5-ft
ELEV TOP CASING :	640.39-ft, [26Feb92-NGVD'29]
ELEV GROUND SURFACE :	637.40-ft, Brass cap [26Feb92-NGVD'29]
PERFORATED INTERVAL :	Not applicable
SCREENED INTERVAL :	4-in stainless steel with channel pack, 227.3↔248.3-ft
COMMENTS :	FIELD INSPECTION, 06Feb90; 6-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable capped and locked, brass cap in pad with well ID. Not in radiation zone. OTHER;
AVAILABLE LOGS :	Geologist, Driller
TV SCAN COMMENTS :	Not applicable
DATE EVALUATED :	Not applicable
EVAL RECOMMENDATION :	Not applicable
LISTED USE :	SST monthly water level measurement, 08Dec89↔23Jun93;
CURRENT USER :	WHC ES&M w/l monitoring and RCRA sampling, WHC ER characterization, PNL sitewide w/l monitoring 93
PUMP TYPE :	Hydrostar
MAINTENANCE :	

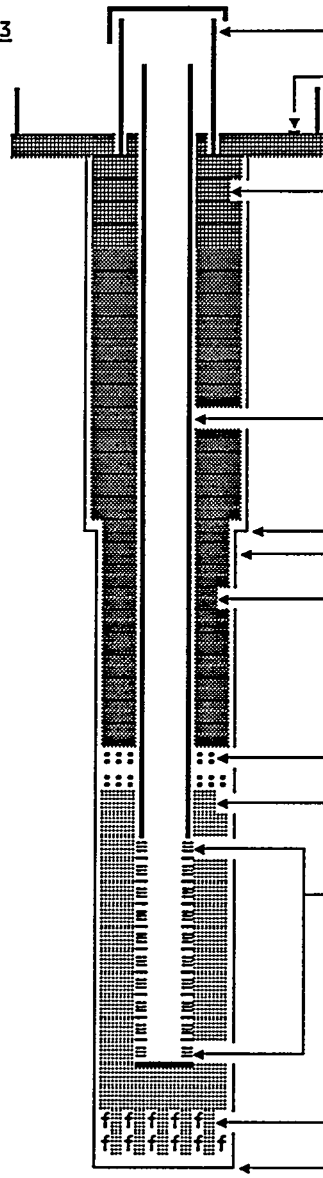
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E33-36 TEMPORARY WELL NO:
Drilling Fluid Used: 200 E Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 45,145 E/W W 51,906
Driller's Name: Lyden	WA State Lic Nr: Not documented	State NAD 83 N 137,240.28 m E 574,068.76 m
Drilling Company: Kaiser Engineers	Company Location: Hanford	Coordinates: N 450,314 E 2,243,303
Date Started: 04Dec89	Date Complete: 17Apr90	Start Card #: Not documented T___ R___ S___
		Elevation Ground surface: 643.66-ft (Brass cap)

Depth to water: 239.8-ft Jan90
(Ground surface) 243.2-ft 14Jun93

GENERALIZED STRATIGRAPHY
Geologist's Log

0↔25: Sandy GRAVEL
25↔30: Sl. gravelly SAND
30↔35: Gravelly SAND
35↔62: SAND
62↔75: Sl. gravelly SAND
75↔80: Gravelly SAND
80↔85: Sandy GRAVEL
85↔90: Gravelly SAND
90↔130: SAND
130↔135: Sl. gravelly SAND
135↔160: SAND
160↔165: SL. gravelly SAND
165↔175: SAND
175↔200: Sl. gravelly SAND
200↔205: Gravelly SAND
205↔230: Sandy GRAVEL
230↔235: No sample
235↔240: SAND
240↔245: Gravelly SAND
245↔250: SAND
250↔263.8: Sandy GRAVEL
263.8 : BASALT



Elevation of reference point: (top of 6-in casing) [646.67-ft]
Height of reference point above ground surface [3.0-ft]
Depth of surface seal [2↔18.6-ft]
Type of surface seal:
Cement grout to 18.6-ft, has 4-ft x 4-ft x 6-in concrete pad extending 2-ft into annulus

4-in ID stainless steel casing, +1.8↔234.4-ft

Hole diameter,
0↔153.5-ft, 11-in nominal
153.5↔263.8-ft, 9-in nominal

Bentonite crumbles, 18.6↔227.1-ft, 8↔20 mesh

¾-in Volclay pellets, 227.1↔230.4-ft

Silica sand pack, 230.4↔259.0-ft, 20↔40-mesh

4-in stainless steel screen, 234.4↔255.4-ft, #10-slot w/channel pack

Backfill, 259.0↔263.8-ft

Borehole drilled depth: [263.8-ft]

Drawing By: RKL/2E33-36.ASB
Date : 13Sep93
Reference : WHC-MR-0207

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E33-36

WELL DESIGNATION	:	299-E33-36
RCRA FACILITY	:	216-B-63 Trench
CERCLA UNIT	:	200 Aggregate Area Management Study (200-BP-5)
HANFORD COORDINATES	:	N 45,145 W 51,906 [19Apr90-200E]
LAMBERT COORDINATES	:	N 450,314 E 2,243,303 [HANCONV] N 137,240.28m E 574,068.76m [19Apr90-NAD83]
DATE DRILLED	:	Apr90
DEPTH DRILLED (GS)	:	264.0-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	239.8-ft, Dec89, 243.2-ft, 14Jun93
CASING DIAMETER	:	4-in, stainless steel, +1.8↔234.4-ft. 6-in, stainless steel, +3.0↔~0.5-ft
ELEV TOP CASING	:	646.67-ft [19Apr90-200E]
ELEV GROUND SURFACE	:	643.66-ft, Brass cap [19Apr90-200E]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	234.4↔255.4-ft, 4-in stainless steel with channel pack
COMMENTS	:	FIELD INSPECTION, 10Aug93; 4 and 6-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable. Capped and locked, brass cap in pad with well ID. Not in radiation zone. OTHER;
AVAILABLE LOGS	:	Geologist, Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	B-63 Trench quarterly water level measurement, 01Jan91↔14Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling, PNL sitewide sampling 93
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

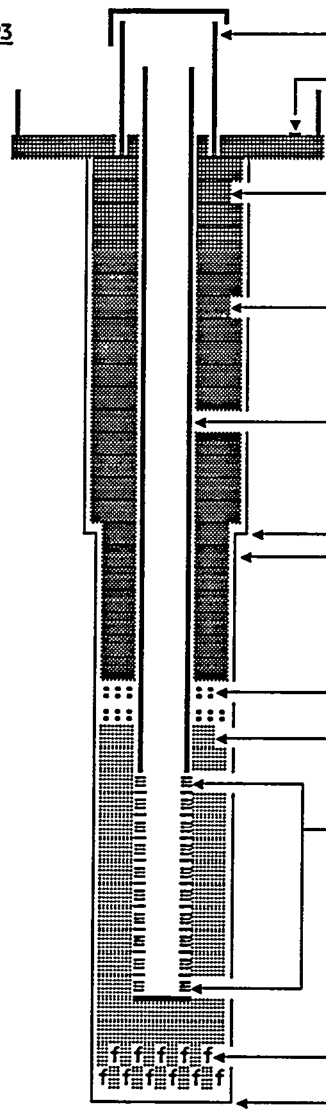
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E33-37 — TEMPORARY WELL NO:
Drilling Fluid Used: 200 E Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 44,965 E/W W 51,832
Driller's Name: Watkins	WA State Lic Nr: Not documented	State NAD83 N 137,185.70m E 574,091.71m; Coordinates: N 450,134 E 2,243,378
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T___ R___ S___
Date Started: 04Dec89	Date Complete: 17Apr90	Elevation Ground surface: 649.92-ft (Brass cap)

Depth to water: 245.8-ft Dec89
(Ground surface) 248.0-ft 14Jun93

GENERALIZED STRATIGRAPHY — Geologist's Log

0↔10: Sl. gravelly SAND
10↔25: Sandy GRAVEL
25↔50: SAND
50↔70: Gravelly SAND
70↔85: SAND
85↔90: Gravelly SAND
90↔95: SAND
95↔100: Gravelly SAND
100↔110: Sl. gravelly SAND
110↔115: SAND
115↔120: Sl. gravelly SAND
120↔125: Gravelly SAND
125↔130: Sl. gravelly SAND
130↔140: SAND
140↔145: Sl. gravelly SAND
145↔165: Gravelly SAND
165↔175: SAND
175↔190: Muddy SAND
190↔195: Gravelly muddy SAND
195↔200: Muddy sandy GRAVEL
200↔205: Gravelly muddy SAND
205↔240: Muddy sandy GRAVEL
240↔245: Gravelly muddy SAND
245↔250: SAND
250↔260: Muddy sandy GRAVEL
260↔267.5: Sandy GRAVEL
267.5 : BASALT



Elevation of reference point: [653.01-ft]
(top of 6-in casing)

Height of reference point above ground surface [3.09-ft]

Depth of surface seal [2.6↔18-ft]
Type of surface seal:
Cement grout to 18-ft, has 4-ft x 4-ft x 6-in concrete pad extending 2.6-ft into annulus

Bentonite crumbles,
18.0↔233.9-ft, 8↔20-mesh

4-in ID stainless steel casing,
+1.5↔240.3-ft

Hole diameter,
0↔148.1-ft, 11-in nominal
148.1↔267.5-ft, 9-in nominal

¼-in Volclay pellets,
233.9↔237.6-ft

Silica sand pack,
237.6↔264.3-ft, 20↔40-mesh

4-in stainless steel screen,
240.3↔261.1-ft, #10-slot
W/channel pack

Backfill,
264.3↔267.5-ft

Borehole drilled depth: [267.5-ft]

Drawing By: RKL/2E33-37.ASB
Date : 13Sep93
Reference : WHC-MR-0207

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E33-37

WELL DESIGNATION	:	299-E33-37
RCRA FACILITY	:	216-B-63 Trench
CERCLA UNIT	:	200 Aggregate Area Management Study (200-BP-5)
HANFORD COORDINATES	:	N 44,965 W 51,832 [19Apr90-200E]
LAMBERT COORDINATES	:	N 450,134 E 2,2243,378 [HANCONV] N 137,185.70m E 574,091.71m [19Apr90-NAD83]
DATE DRILLED	:	Apr90
DEPTH DRILLED (GS)	:	267.5-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	245.8-ft, Dec89, 248.0-ft, 14Jun93
CASING DIAMETER	:	4-in, stainless steel, +1.5↔240.3-ft. 6-in, stainless steel, +3.09↔~0.5-ft
ELEV TOP CASING	:	653.01-ft [19Apr90-200E]
ELEV GROUND SURFACE	:	649.92-ft, Brass cap [19Apr90-200E]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	240.3↔261.1-ft, 4-in stainless steel with channel pack,
COMMENTS	:	FIELD INSPECTION, 10Aug93; 4 and 6-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable. Capped and locked, brass cap in pad with well ID. Not in radiation zone. OTHER;
AVAILABLE LOGS	:	Geologist, Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	B-63 Trench water level measurement, 20Nov90↔14Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling, PNL sitewide sampling 93
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

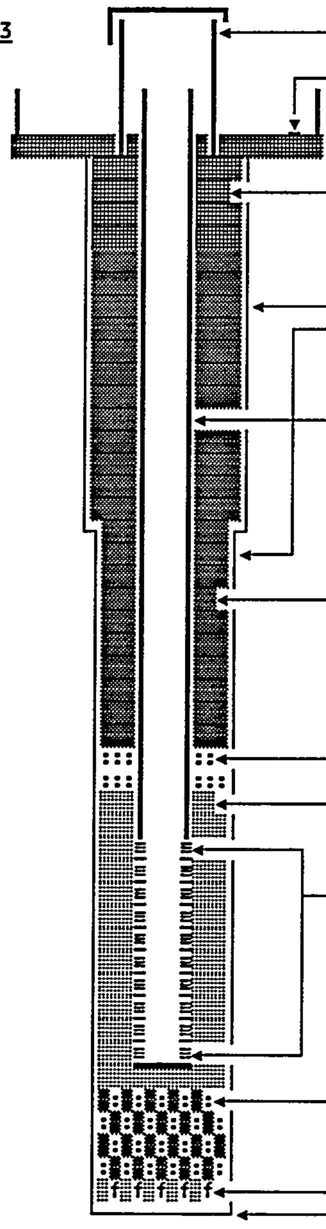
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E34-8 TEMPORARY WELL NO:
Drilling Fluid Used: 200 E Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 45,175 E/W W 51,454
Driller's Name: Watkins	WA State Lic Nr: Not documented	State NAD83 N 137,249.88m E 574,206.66m; Coordinates: N 450,345 E 2,243,755
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T___ R___ S___
Date Started: 05Feb90	Date Complete: 20Apr90	Elevation Ground surface: 637.53-ft (Brass cap)

Depth to water: 232.9-ft Mar90
(Ground surface) 235.9-ft 14Jun93

GENERALIZED STRATIGRAPHY
Geologist's Log
Sl=slightly

0↔5: Gravelly SAND
5↔25: Muddy sandy GRAVEL
25↔30: GRAVEL
30↔35: Muddy sandy GRAVEL
35↔40: Sl gravelly SAND
40↔45: SAND
45↔55: Sl gravelly SAND
55↔60: Gravelly SAND
60↔75: SAND
75↔85: Gravelly SAND
85↔90: SAND
90↔110: SL gravelly SAND
110↔130: SAND
130↔135: Gravelly SAND
135↔140: Sl gravelly SAND
140↔150: Gravelly SAND
150↔155: Sl muddy gravelly SAND
155↔165: Gravelly SAND
165↔170: Sl gravellly SAND
170↔180: Gravelly SAND
180↔185: Sl gravelly SAND
185↔190: Gravelly SAND
190↔195: Sl gravelly SAND
195↔200: Gravelly SAND
200↔205: Sl gravelly SAND
205↔212: Gravelly SAND
212↔218: MUD
218↔220: Muddy sandy GRAVEL
220↔225: Sandy GRAVEL
225↔250: Muddy sandy GRAVEL
250↔255: GRAVEL
255↔260: Muddy sandy GRAVEL



Elevation of reference point: [640.52-ft]
(top of 6-in casing)
Height of reference point above ground surface [3.0-ft]
Depth of surface seal [2.8↔19.2-ft]
Type of surface seal:
Cement grout to 19.2-ft, has 4-ftx4-ftx6-in concrete pad extending 2.8-ft into annulus

Hole diameter,
0↔151.5-ft, 11-in nominal
151.5↔260.0-ft, 9-in nominal

4-in ID stainless steel casing,
+06↔227.9-ft

Bentonite crumbles,
19.2↔219.7-ft, 8↔20 mesh

⅜-in Volclay tablets
219.7↔224.2-ft

Silica sand pack,
224.2↔249.4-ft, 20↔40 mesh

4-in stainless steel screen,
227.9↔247.9-ft, #10-slot
w/channel pack

Bentonite slurry,
249.4↔258.1-ft

Fill,
258.1↔260.0-ft

Borehole drilled depth: [260.0-ft]

Drawing By: RKL/2E34-08.ASB
Date : 13Sep93
Reference : WHC-MR-0207

SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E34-8

WELL DESIGNATION	:	299-E34-8
RCRA FACILITY	:	216-B-63 Trench
CERCLA UNIT	:	200 Aggregate Area Management Study (200-BP-5)
HANFORD COORDINATES	:	N 45,175 W 51,454 [19Apr90-200E]
LAMBERT COORDINATES	:	N 450,345 E 2,243,755 [HANCONV] N 137,249.88m E 574,206.66m [19Apr90-NAD83]
DATE DRILLED	:	Apr90
DEPTH DRILLED (GS)	:	260.0-ft
MEASURED DEPTH (GS)	:	Not documented
DEPTH TO WATER (GS)	:	232.9-ft, Mar90, 235.9-ft, 14Jun93
CASING DIAMETER	:	4-in, stainless steel, +0.6↔227.9-ft. 6-in, stainless steel, +3.0↔~0.5-ft
ELEV TOP CASING	:	640.52-ft [19Apr90-200E]
ELEV GROUND SURFACE	:	637.53-ft, Brass cap [19Apr90-200E]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	4-in stainless steel with channel pack, 227.9↔247.9-ft
COMMENTS	:	FIELD INSPECTION, OTHER;
AVAILABLE LOGS	:	Geologist, Driller
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	B-63 Trench quarterly water level measurement, 20Nov90↔14Jun93;
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling, PNL sitewide sampling 93
PUMP TYPE	:	Hydrostar
MAINTENANCE	:	

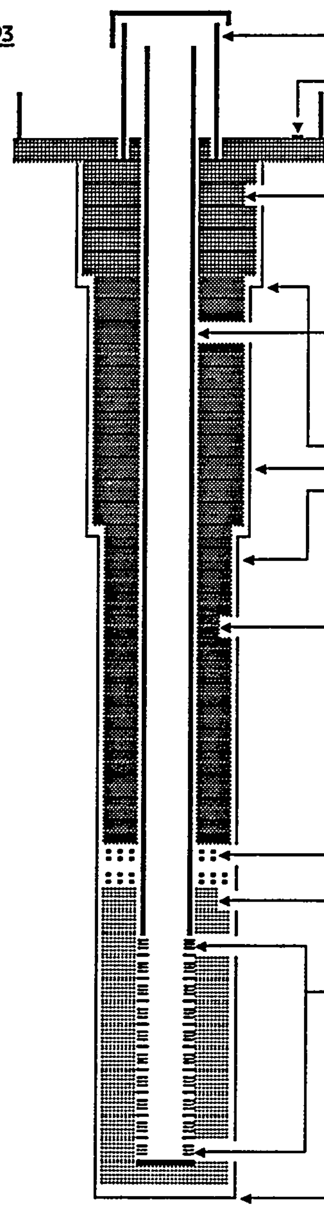
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool Drive barrel	WELL NUMBER: 299-E34-10 TEMPORARY WELL NO:
Drilling Fluid Used: Raw water	Additives Used: None	Hanford Coordinates: N/S N 45,091.0 E/W W 51,198.8
Driller's Name: J Johnson	WA State Lic Nr: Not documented	State NAD83 N 137,224.57m E 574,284.40m
Drilling Company: Jensen Drilling	Company Location: Not documented	Coordinates: N 450,261 E 2,244,011
Date Started: 19Sep91	Date Complete: 29Oct91	Start Card #: Not documented T___ R___ S___
		Elevation Ground surface: 637.01-ft (Brass cap)

Depth to water: 233.1-ft Oct91
(Ground surface) 234.9-ft 23Jun93

GENERALIZED STRATIGRAPHY
Geologist's Log
Sl=slightly

0↔15: Sl silty sandy GRAVEL
15↔45: Sandy GRAVEL
40↔55: Silty sandy GRAVEL
55↔65: Sl gravelly SAND
65↔100: SAND
100↔115: Sl gravelly SAND
115↔125: SAND
125↔135: Sl gravelly SAND
135↔165: SAND
4-in SILT lens @ 163-ft
165↔165: Sl gravelly SAND
165↔175: Sl gravelly SAND
2-in SILT lens @ 166-ft
175↔202: SAND
202↔203: Sandy GRAVEL
203↔203.8: SILT
203.6↔206: SAND
206↔225: Gravelly SAND
225↔240: Sandy GRAVEL
240↔245: Sl gravelly SAND
245↔249: Sandy GRAVEL
249 : GRAVEL (BASALT rock?)



Elevation of reference point: (top of casing) [639.77-ft]

Height of reference point above ground surface [2.76-ft]

Depth of surface seal [2.0↔18.9-ft]

Type of surface seal: Cement grout to 18.9-ft, has 4x4-ftx6-in concrete pad extending 2.0-ft into annulus

4-in ID stainless steel casing, +1.1↔225.3-ft

Hole diameter,
2.0↔19.0-ft, 13-in nominal
19.0↔169.4-ft, 11-in nominal
169.4↔249.0-ft, 9-in nominal

Bentonite crumbles, 18.9↔218.2-ft, 8↔20-mesh

Bentonite pellets, 218.2↔222.1-ft

Silica sand pack, 222.1↔249.0-ft, 10↔20-mesh

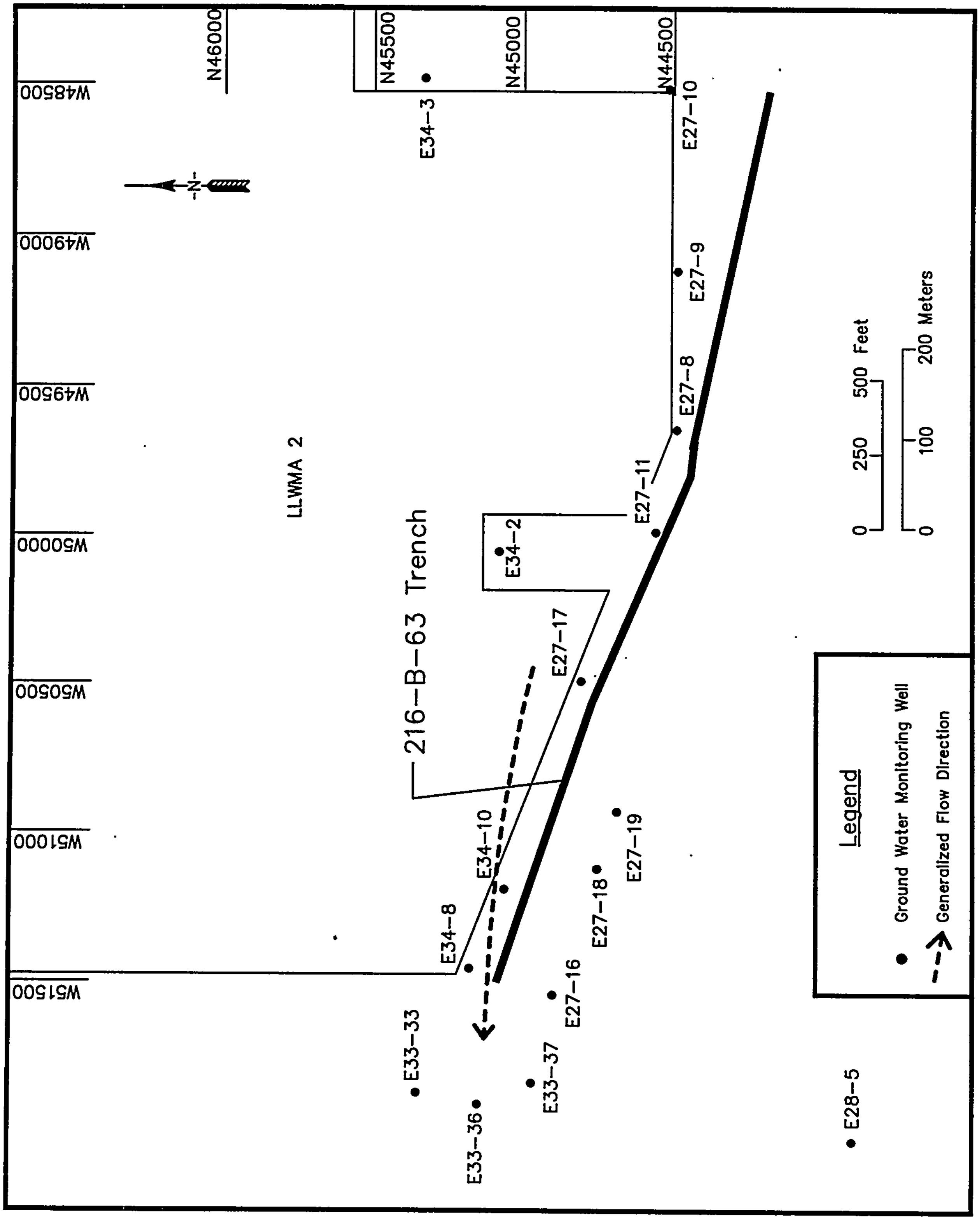
4-in T304 stainless steel screen, 225.3↔246.4-ft, #20-slot

Borehole drilled depth: [249.0-ft]

Drawing By: RKL/2E34-10.ASB
Date : 13Sep93
Reference :

SMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E34-10

WELL DESIGNATION	:	299-E34-10
CERCLA UNIT	:	200 Aggregate Area Management Study
RCRA FACILITY	:	LLBG/WMA-2
HANFORD COORDINATES	:	N 45,091.0 W 51,198.8 [200E-12Dec91]
LAMBERT COORDINATES	:	N 450,261 E 2,244,011 [HANCONV] N 137,224.57m E 574,284.40m [NAD83-12Dec91]
DATE DRILLED	:	Oct91
DEPTH DRILLED (GS)	:	249.0-ft
MEASURED DEPTH (GS)	:	247.0-ft, 27Aug93
DEPTH TO WATER (GS)	:	233.1-ft, 29Oct91 234.9-ft, 23Jun93
CASING DIAMETER	:	4-in stainless steel, +1.1↔225.3-ft; 6-in stainless steel, +2.76↔~0.5-ft
ELEV TOP CASING	:	639.77-ft, [NGVD'29-12Dec91]
ELEV GROUND SURFACE	:	637.01-ft, Brass cap [NGVD'29-12Dec91]
PERFORATED INTERVAL	:	Not applicable
SCREENED INTERVAL	:	225.3↔246.4-ft, 4-in #20-slot stainless steel;
COMMENTS	:	FIELD INSPECTION, 27Aug93; 4 and 6-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable. Capped and locked, brass cap in pad with well ID. Not in radiation zone. OTHER:
AVAILABLE LOGS	:	Geologist
TV SCAN COMMENTS	:	Not applicable
DATE EVALUATED	:	Not applicable
EVAL RECOMMENDATION	:	Not applicable
LISTED USE	:	LLBG quarterly water level measurement, 17Mar92↔23Jun93,
CURRENT USER	:	WHC ES&M w/l monitoring and RCRA sampling,
PUMP TYPE	:	Hydrostar, intake @ 239.0-ft
MAINTENANCE	:	


W48500
W49000
W49500
W50000
W50500
W51000
W51500
N46000
N45500
N45000
N44500
N
LLWMA 2
216-B-63 Trench
E34-3
E27-10
E27-9
E27-8
E27-11
E34-2
E27-17
E34-10
E34-8
E27-19
E27-18
E27-16
E33-33
E33-37
E33-36
E28-5
0
250
500 Feet
0
100
200 Meters
Legend
Ground Water Monitoring Well
Generalized Flow Direction
RCRA-AR\121092C3