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7. Abstract This document outlines the groundwater monitoring plan, under RCRA regulations in 40 CFR 265 Subpart F and WAC173-300-400, for the 216-B-63 Trench This interim status facility is being sampled under detection monitoring criteria and this plan provides current program conditions and requirements.		
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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 southeastern 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 40 CFR 265 Subpart F (EPA 1980a).

1.2 OBJECTIVES

Specific objectives of this plan include:

- Revise the initial groundwater monitoring system so that it can provide an indication of 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.

The Hanford Site

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 (RCRA) interim-status facilities. The applicable monitoring requirements are described in 40 CFR 265 Subpart F (EPA 1980a) and Washington Administrative Code (WAC) 173-303-400 (Ecology 1987); 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 which, in the past, included nuclear reactor operation, storage and reprocessing of spent nuclear fuel, and management of radioactive and dangerous wastes. Present activities primarily involve management of 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 yr 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 (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 man-made 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 and well locations of the 216-B-63 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).

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).

2.1.2 History of Operations

The 216-B-63 Trench received chemical sewer effluents from B Plant. B Plant includes a separations building (221-B) and an attached service building

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

(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 (1.0×10^6 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, 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 shutdown and no longer produces waste. All of 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% steam condensate and 30% 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 defined as dangerous waste as defined in WAC 173-303 (Ecology 1987).

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, creating broad structural and topographic basins separated by asymmetric anticlinal ridges (Reidel et al. 1989). Sediments up to 275 m (900 ft) in thickness 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)

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)

^aTrisodium hydroxyethylethylene-diaminetriacetic acid^bIncludes neutralized demineralizer recharge effluent

Table 2. 216-B-63 Trench Preliminary Analytical Data from B Plant Sewerage. (sheet 1 of 2)

Analyte	Data (first sample, September 12, 1985)	Data (second sample April 9, 1986)	Analyte	Data (first sample, September 12, 1985)	Data (second sample, April 9, 1986)
Aluminum	<150	500	Vanadium	<5	<5
Silver	<10	<10	Zinc	12.0	420
Barium	28	120	Chlorine	1100	1400
Beryllium	<5	<5	CN	17	10
Calcium	17000	170000	Fluorine	1500	2800
Cadmium	2	<2	NO ₃	530	<500
Chromium	<10	<10	PO ₄	<1000	<1000
Copper	10	89	Sulfur	<1000	<1000
Iron	160	1700	SO ₄	10000	2900000
Mercury	<0.1	1.3	Acetone	<10	<10
Potassium	1200	6600	Butyraldehyde	12	<10
Magnesium	3600	48000	Chloroform	<10	<10
Manganese	14	44	Phenol	<10	<10
NH ₄	<20	<50	Alkanes	<10	13
Sodium	150000	410000	Amount	20000000	38000000
Nickel	<10	<10	pH	11.6	2.28
Osmium	<300	<300	Temperature (°C)	24	15
Lead	30		Alpha activity	0.37	0.31
Antimony	<100	<100	Beta activity	15	51
Tin	<300		Conductivity	1200	
Strontium	<300	670	Total organic	1800	2800
Uranium	0.51	4.6			

NOTE: Charges are assumed for inorganic analytes that were assayed as ions. All values are parts per billion except pH, which is dimensionless, and as otherwise indicated.

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

Analyte	Data (third sample, April 15, 1986)	Data (fourth sample, June 30, 1986)	Analyte	Data (third sample, April 15, 1986)	Data (fourth sample, June 30, 1986)
Aluminum	160	<150	Vanadium	<5	<5
Silver	<10	<10	Zinc	67.0	9
Barium	23	28	Chlorine	14000	960
Beryllium	<5	<5	CN	<10	<10
Calcium	18000	17000	Fluorine	7500	<500
Cadmium	2	<2	NO ₃	1900	2600
Chromium	<10	<10	PO ₄	<1000	<1000
Copper	15	<10	Sulfur	500	<1000
Iron	230	77	SO ₄	130000	11000
Mercury	<0.1	<0.1	Acetone	29	<10
Potassium	960	820	Butyraldehyde	<10	<10
Magnesium	4200	4000	Chloroform	10	<10
Manganese	8	10	Phenol	8.4	<10
NH ₄	<50	<50	Alkanes	210	<10
Sodium	650000	2900	Amount	38000000	38000000
Nickel	11	<11	pH	12.67	6.40
Osmium	<300	<300	Temperature (°C)	15	26
Lead			Alpha activity	13	4
Antimony	<100	<100	Beta activity	27	310
Tin			Conductivity		130
Strontium	<300	670	Total organic	51000	2500
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, and as otherwise indicated.

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 which form the Pasco Basin. The geology of the Hanford Site has been described in detail by 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 Umtanum-Gable Mountain anticlinal ridge and the axis of 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 flexure (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) in elevation 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 may be incorporated into the Hanford formation was 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.

Period	Epoch	Group	Formation	Isotopic Age Dates Years x 10 ⁶	Member (Formal and Informal)	Sediment Stratigraphy or Basalt Flows
QUATERNARY	Pleistocene	Columbia River Basalt Group	Ringold	3.4	Surficial Units	Loess Sand Dunes Alluvium and Alluvial Fans Landslides Talus Colluvium
					Touchet beds Pasco gravels	
TERTIARY	Miocene	Columbia River Basalt Group	Ringold	3.4		Plio-Pleistocene unit
TERTIARY	Miocene	Columbia River Basalt Group	Saddle Mountains Basalt	8.5	Ice Harbor Member	basalt of Goose Island basalt of Marindale basalt of Basin City Levey Interbed
					Elephant Mountain Member	basalt of Ward Gap basalt of Elephant Mountain Rattlesnake Ridge Interbed
TERTIARY	Miocene	Columbia River Basalt Group	Saddle Mountains Basalt	10.5	Pomona Member	basalt of Pomona Selah Interbed
					Esquatzel Member	basalt of Gable Mountain Cold Creek Interbed
TERTIARY	Miocene	Columbia River Basalt Group	Saddle Mountains Basalt	12.0	Asotin Member	basalt of Huntzinger
					Wilbur Creek Member	basalt of Lapwai basalt of Wahluke
TERTIARY	Miocene	Columbia River Basalt Group	Saddle Mountains Basalt	13.5	Umatilla Member	basalt of Sillusi basalt of Umatilla
						Mabton Interbed
TERTIARY	Miocene	Columbia River Basalt Group	Wanapum Basalt	14.5	Priest Rapids Member	basalt of Lolo basalt of Rosalia
					Roza Member	Quincy Interbed basalt of Roza
TERTIARY	Miocene	Columbia River Basalt Group	Wanapum Basalt	15.6	Frenchman Springs Member	Squaw Creek Interbed basalt of Lyons Ferry basalt of Sentinel Gap basalt of Sand Hollow basalt of Silver Falls basalt of Ginkgo basalt of Palouse Falls
						Vantage Interbed
TERTIARY	Miocene	Columbia River Basalt Group	Grande Ronde Basalt*	15.6	Sentinel Bluffs Unit	basalt of Museum basalt of Rocky Coulee basalt of Levering basalt of Cohasset basalt of Birkett basalt of McCoy Canyon basalt of Umtanum
TERTIARY	Miocene	Columbia River Basalt Group	Grande Ronde Basalt*	15.6	Umtanum Unit	
					Slack Canyon Unit	
TERTIARY	Miocene	Columbia River Basalt Group	Grande Ronde Basalt*	15.6	Oriley Unit	basalt of Benson Ranch
					Grouse Creek Unit	
TERTIARY	Miocene	Columbia River Basalt Group	Grande Ronde Basalt*	15.6	Wapshilla Ridge Unit	
					Mt. Horrible Unit	
TERTIARY	Miocene	Columbia River Basalt Group	Grande Ronde Basalt*	15.6	China Creek Unit	
					Tespee Butte Unit	
TERTIARY	Miocene	Columbia River Basalt Group	Grande Ronde Basalt*	15.6	Buckhorn Springs Unit	
TERTIARY	Miocene	Columbia River Basalt Group	Grande Ronde Basalt*	16.5	Rock Creek Unit	
TERTIARY	Miocene	Columbia River Basalt Group	Grande Ronde Basalt*	17.5	American Bar Unit	

*The Grande Ronde Basalt consists of at least 120 major basalt flows. Only a few flows have been named. N₂, R₂, N₁ and R₁ 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.

ITH:JJA:GEO-A1

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 ft) thick and although it is dominated by the gravel facies, it 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 silt-rich interbeds up to a meter thick are present in the unit and these horizons are capable of generating perched water. These interbeds are in some cases 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. The absence of a distinct bounding surface is primarily due to the interfingering of the units and the erosional surface.
- Middle Fine--The abundant sand-rich facies comprising 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. Silts have the potential to generate perched water in these gravels. Where the middle fine unit is absent, it is not possible to easily differentiate the upper and lower coarse units. 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 reports by 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 200 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 Gephart et al. (1979), Graham et al. (1981), and DOE (1986). The uppermost aquifer within

200 Areas
Water Table Elevation
June 1993

402.49 Water Table elevation (feet
● above mean sea level)

405 Water table elevation
Contour Interval = 5 ft

 Ponds

Areas where the basalt surface is generally above the water table

Area of conflicting data

The 200 Areas water table elevation map has been prepared by the Geohydrologic Engineering Function, Westinghouse Hanford Company.

Note: To convert to metric, multiply elevation (ft) by 0.3048 to obtain elevation (m).

0 1 Mile

0 1 Kilometer

Figure 10. 200 Areas Water Table Map (Kasza et al. 1993).

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 thickness along the flanks of bordering structures.

There have been numerous aquifer tests 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 vary 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 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 2750 m²/d (2,700 to 9,000 ft²/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. There is considerable evidence 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 216-B-63 Trench is strongly affected by the dissipating 216-B-Pond mound. This trend will continue until groundwater elevations return to their pre-production levels, or until discharge patterns change in the 200 East Area. Sections of 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 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, Quality Control). 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 *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 (OSHA 1986).

3.1 HISTORY

Quarterly RCRA sampling was initiated for the groundwater monitoring network in 1988. Quarterly sampling was completed during the CY 1993 sampling period and the site has been on a semiannual sampling schedule since that time. The site was not sampled between April 1990 and August 1991 because of the interruption in analytical work resulting from the cancellation of the U.S. Testing contract by PNL.

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 had an effect on 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. It was contained onsite 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 and justification of 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 EII's 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 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 downgradient (299-E27-16, 299-E27-17, 299-E27-19, 299-E33-33, 299-E33-36, 299-E33-37, and 299-E34-8) were installed as compliance wells (Figure 3). All wells, with the exception of 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 number 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

There are no additional monitoring wells 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* (Ecology 1973) 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. Well drilling was governed, until 1990, 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 1988). Quality assurance (QA) requirements of the Tri-Party Agreement and WHC (1992b) also apply.

The 216-B-63 wells were drilled with a cable tool rig. The advantages to cable tool drilling include: (1) drill cuttings can be easily contained (important in potentially contaminated material), (2) representative geologic samples can be collected, (3) moisture samples can be collected from above the water table, (4) disturbance to the borehole wall is minimized, (5) a straight, plumb borehole is produced, and (6) 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 according to the EII 4.2, *Interim Control of Unknown, Suspected, Hazardous and Mixed Waste* (WHC 1988).

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 1988).

Table 3. Applicable Environmental Investigations Instructions.

Number	Title
EII 1.1	Hazardous Waste Site Entry Requirements
EII 1.2	Preparation and Revision of Environmental Investigations Instructions
EII 1.4	Instruction Change Authorizations
EII 1.5	Field Logbooks
EII 1.6	Records Processing
EII 1.7	Indoctrination, Training and Qualification
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 6.6	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*. RCRA compliant wells must meet the requirements set forth in Parts 1 and 3 of Washington Administrative Code (WAC) Chapter 173-160, *Minimum Standards for Construction and Maintenance of Wells* (Ecology 1973), is 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) in length. 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 water table. It also allows for measurement of fluctuations of the water level in the unconfined aquifer, but may not be sufficient for the decrease in the water table that would result from termination of wastewater disposal in the 200 Areas.

The onsite geologist determined the screen slot size and the filter pack size and documented the results per EII 6.8 (WHC 1988). Sand filter packs were placed in the annulus between either the 20.3-cm (8-in) temporary casing, and 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.

**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 ⁸⁴ (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 ⁸⁴ (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 ⁸⁴ (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 ⁸⁴ (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 ⁸⁴ (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 ⁸⁴ (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 ⁸⁴ (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 ⁸⁴ (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 ⁸⁴ (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 ⁸⁴ (251.7)	73.3-79.6 (240.3 - 261.1)	0.2 (0.01)
E34-8	1990	1993	NGVD '29	195.4 (640.74)	79.3 (260.0)	73.1 ⁸⁴ (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 ⁸⁴ (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.

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/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*. All groundwater discharged from the well during development was disposed 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 of a brass marker set in the concrete pad is within 0.3 cm (0.01 ft) relative to 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 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 (EPA 1980a). In addition, samples will be analyzed for tritium because of a tritium plume from the 200 East Area that passes beneath the site. 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 focuses on geology, geochemistry, 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.

39103001.13

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

^aRegulatory requirements for sampling parameters are subject to change because of federal regulations and/or to check on the migration of contaminants from other sources. ^bSampled semi-annually. ^cSampled annually.

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 (OSHA 1986).

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 assure 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 1988). 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 (WHC 1988), and the procedures for groundwater sampling are presented in EII 5.8 (WHC 1988).

3.5.1.2 Laboratory Analyses. Calcium carbonate content and moisture content 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 according to approved procedures.

3.5.2 Hydrogeologic

Data was collected during and after construction of the monitoring wells that were 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 are taken following the procedures discussed in Appendix B, or their revised, approved, and documented equivalents.

3.5.2.1 Aquifer Testing. The purpose of aquifer testing is 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 DOE, Richland Operations Office (DOE-RL) guidance on purgewater. Slug testing was the only aquifer testing performed because purgewater from aquifer testing could not be disposed to the ground. Purgewater was disposed according to EII 10.3 (WHC 1988).

3.5.2.2 Determination of Groundwater Flow Paths. The determination of groundwater flow directions is based on non-routine water level measurements in all wells of the 216-B-63 Trench groundwater monitoring network which 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 make direct estimates of 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 non-routine 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 evaluation of groundwater flow directions when data are available.

3.5.2.3 Data Interpretation and Presentation. Drilling data has been presented in two borehole completion reports which include: borehole stratigraphy, geophysical logs, details of well completion, aquifer test results, well development data, survey data, geologic logs, as-built diagrams, and other pertinent data (WHC 1990, 1993b).

The hydrogeologic data has 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 hydrochemical characterization.

3.6 SAMPLING AND ANALYSIS

HydroStar (trade name of Instrumentation Northwest, Inc., Redmond, Washington) 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, Analytical Procedures, and Quality Assurance

Samples are collected from all groundwater monitoring wells on a quarterly basis in conformance with 40 CFR 265.93 (EPA 1980a) for analyses of the constituents listed in Table 5. Additional constituents may be added to this list after evaluation of the results.

Sampling, preservation, and chain-of-custody procedures are discussed in Appendix B. The quality assurance and control protocols are given in *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1993a). Quality control activities determine and document the quality of analytical results and institute corrective actions as necessary. 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 has been evaluated at least annually to determine if the monitoring wells are appropriately located. If the evaluation indicates that existing wells are no longer adequately located, the groundwater monitoring system will be modified to bring it into compliance with 40 CFR 265.91(a) (EPA 1980a).

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) (EPA 1980a). Table 5 lists the constituents sampled for at the 216-B-63 Trench. The list of constituents sought in analysis may be periodically modified to include analytes of particular interest or delete those that are shown not to be present in the groundwater.

3.7 STATISTICAL ANALYSIS OF GROUNDWATER MONITORING DATA

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

3.7.1 Methods

After 1 yr (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 (EPA 1980a). 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 if 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. A minimum of four replicate measurements will be obtained from each downgradient well for the contamination indicator parameters, and the arithmetic mean and variance will be calculated for the contamination indicator parameters 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:

$$t_i^* = (\bar{x}_i - \bar{x}_b) / S_b * \sqrt{1 + 1/n_b}$$

where

$\bar{x}_i$ = average of the replicates from the i^{th} monitoring well in each of the subsequent sampling period;

$\bar{x}_b$ = 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. Due to 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., $\bar{x}_i$), in such a way that a critical mean (C.M.) can be obtained:

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

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

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 $t_1' > t_c$.

In cases where all of the background values are below the limit of detection or where the proportion of non-detects is large (i.e., greater than 50%), a limit of quantitation (LOQ) will also be calculated from the analytical laboratory's blanks data. A limit of quantitation 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. Additionally, if independent samples are to be collected, then 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. The notifications required by 40 CFR 265 Subpart F (EPA 1980a) are presented, and the groundwater quality assessment program is outlined.

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 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) (EPA 1980a).

4.2 GROUNDWATER QUALITY ASSESSMENT PROGRAM

A groundwater quality assessment program will be implemented when a release of hazardous constituents is indicated in the indicator evaluation monitoring system. 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 (EPA 1980b)
- Detailed procedures describing how the analytical results will be evaluated, including the analysis of any previously gathered groundwater quality information
- A schedule for implementation of 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) (EPA 1980a) 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 data base. 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 and thus those 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 bases 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 locate 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, which have not been addressed in establishing background. Finally, the review will evaluate the current sampling and analysis procedures, and if 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 if 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 (EPA 1980a).

4.3.3 Notification and Reports

Table 6 lists the reports and notifications that must be submitted (1) whether or not the facility might be affecting groundwater or (2) if the facility might be affecting groundwater as determined by the method mentioned above (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 throughout the post-closure period as well (40 CFR 265.94[a][1]) (EPA 1980a).

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 d 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 d of confirmation of a significant increase (or pH decrease)
Submittal of groundwater assessment plan to EPA and Ecology	Within 15 d 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 d 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.

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APPENDIX A
GEOLOGIC AND CONSTRUCTION DIAGRAMS FOR 216-B-63 WELLS

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WELL CONSTRUCTION AND COMPLETION SUMMARY			
Drilling Method: <u>Cable tool</u> Drilling <u>200 E Water</u> Fluid Used: <u>Supply</u> Driller's Name: <u>Murphy/Robinson</u> Drilling Company: <u>Kaiser Engineers</u> Date Started: <u>01Aug87</u>	Sample Drive barrel Method: <u>Hard tool</u> Additives Used: <u>Not documented</u> WA State Lic Nr: Company Location: <u>Hanford</u> Date Complete: <u>30Sep87</u>	WELL NUMBER: <u>299-E27-8</u> TEMPORARY WELL NO: Hanford Coordinates: N/S <u>N 44,496</u> E/W <u>W 49,642</u> State Coordinates: N <u>449,670</u> E <u>2,245,569</u> Start Card #: <u>Not documented</u> T <u> </u> R <u> </u> S <u> </u> Elevation Ground surface: <u>634.64-ft (Brass cap)</u>	
Depth to water: <u>229.5-ft Aug87</u> (Ground surface) <u>232.8-ft 23Jun93</u>			
GENERALIZED Geologist's STRATIGRAPHY 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	<div style="display: flex; flex-direction: row-reverse;"> <div style="width: 40%; padding-right: 10px;"> <p>Elevation of reference point: <u>[637.83-ft]</u> (top of casing) Height of reference point above <u>[3.2-ft]</u> ground surface</p> <p>Depth of surface seal <u>[4.5-216-ft]</u> Type of surface seal: Granular bentonite, portland cement 4-ft x 4-ft x 6-in concrete pad extends 4.5-ft into annulus</p> <p>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</p> <p>4-in ID stainless steel casing, <u>+3.2-225.5-ft</u></p> <p>Granular bentonite, <u>4.5-216-ft</u></p> <p>Bentonite pellets, <u>216-221-ft</u></p> <p>Silica sand pack, <u>221-257-ft, #20-mesh</u></p> <p>4-in stainless steel screen, <u>225.5-245.5-ft, #20-slot</u></p> <p>8-in stainless steel telescoping screen, <u>247-257-ft, #30-slot</u></p> <p>Borehole drilled depth: <u>[257.0-ft]</u></p> </div> <div style="width: 60%; border-left: 1px solid black; padding-left: 10px;"> </div> </div>		
Drawing By: <u>RKL/2E27-08.ASB</u> Date : <u>09Sep93</u> Reference : <u>HANFORD WELLS</u>			

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: <u>Cable tool</u> Drilling <u>200 E Water</u> Fluid Used: <u>Supply</u> Driller's Name: <u>Cordon/Cordon/Watkins</u> Drilling Company: <u>Kaiser Engineers</u> Date Started: <u>21Jul87</u>	Sample Drive barrel Method: <u>Hard tool</u> Additives Used: <u>Not documented</u> WA State Lic Nr: <u>Not documented</u> Company Location: <u>Hanford</u> Date Complete: <u>31Aug87</u>	WELL NUMBER: <u>299-E27-9</u> Hanford Coordinates: N/S <u>N 44,484</u> E/W <u>W 49,122</u> State Coordinates: N <u>449,660</u> E <u>2,246,089</u> Start Card #: <u>Not documented</u> T <u> </u> R <u> </u> S <u> </u> Elevation Ground surface: <u>627.31-ft (Brass cap)</u>	TEMPORARY WELL NO: <u> </u>
Depth to water: <u>221.1-ft Aug87</u> (Ground surface) <u>225.4-ft 23Jun93</u>			
GENERALIZED Geologist's STRATIGRAPHY 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: <u>629.21-ft</u> (top of casing) Height of reference point above <u>1.9-ft</u> ground surface Depth of surface seal <u>2.3*203.3-ft</u> 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, <u>+1.9*219.8-ft</u> Bentonite crumbles, <u>2.3*203.3-ft</u> Bentonite pellets, <u>203.3*210.5-ft</u> Silica sand pack, <u>210.5*245.2-ft, 20*30 mesh</u> 4-in stainless steel screen, <u>219.8*239.1-ft, #20-slot</u> 8-in stainless steel telescoping screen, <u>233.4*244.3-ft, #20-slot</u> Borehole drilled depth: <u>245.2-ft</u>			
Drawing By: <u>RKL/2E27-09.ASB</u> Date : <u>09Sep93</u> Reference : <u>HANFORD WELLS</u>			

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: <u>Cable tool</u> Drilling: <u>200 E Water</u> Fluid Used: <u>Supply</u> Driller's: <u>Garcia</u> Name: <u>Garcia</u> Drilling: <u>Kaiser Engineers</u> Date: <u>27Jun89</u> Started: <u>27Jun89</u>	Sample Drive barrel Method: <u>Hard tool</u> Additives: <u>Not documented</u> Used: <u>Not documented</u> WA State: <u>Not documented</u> Lic Nr: <u>Not documented</u> Company: <u>Kaiser Engineers</u> Location: <u>Hanford</u> Date: <u>180Oct89</u> Complete: <u>180Oct89</u>	WELL NUMBER: <u>299-E27-11</u> Hanford Coordinates: N/S <u>N 44,557.6</u> E/W <u>W 49,990.3</u> State NAD83 N <u>137,063.0m</u> E <u>574,653.2m</u> Coordinates: N <u>449,731</u> E <u>2,245,221</u> Start Card #: <u>Not documented</u> T <u> </u> R <u> </u> S <u> </u> Elevation Ground surface: <u>640.34-ft (Brass cap)</u>	
Depth to water: <u>234.4-ft Jul89</u> (Ground surface) <u>238.6-ft 23Jun93</u> GENERALIZED Geologist's STRATIGRAPHY 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	<div style="position: absolute; top: 220px; right: 50px; width: 80%;"> Elevation of reference point: <u>[643.29-ft]</u> (top of 6-in casing) Height of reference point above <u>[2.95-ft]</u> ground surface Depth of surface seal <u>[2*19.5-ft]</u> 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 1/2-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: <u>[264.7-ft]</u> </div>		
Drawing By: <u>RKL/2E27-11.ASB</u> Date: <u>09Sep93</u> Reference: <u>WHC-MR-0204</u>			

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-128
 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: <u>Cable tool</u> Drilling <u>200 E Water</u> Fluid Used: <u>Supply</u> Driller's Name: <u>Wamsley</u> Drilling Company: <u>Kaiser Engineers</u> Date Started: <u>04Dec89</u>	Sample Drive barrel Method: <u>Hard tool</u> Additives Used: <u>Not documented</u> WA State Lic Nr: <u>Not documented</u> Company Location: <u>Hanford</u> Date Complete: <u>17Apr90</u>	WELL NUMBER: <u>299-E27-16</u> Hanford Coordinates: N/S <u>N 44,897</u> E/W <u>W 51,544</u> State NAD83 N <u>137,165.12m</u> E <u>574,179.47m</u> Coordinates: N <u>450,066</u> E <u>2,243,666</u> Start Card #: <u>Not documented</u> T <u> </u> R <u> </u> S <u> </u> Elevation Ground surface: <u>649.19-ft (Brass cap)</u>	
Depth to water: <u>244.5-ft Dec89</u> (Ground surface) <u>247.5-ft 14Jun93</u> GENERALIZED Geologist's STRATIGRAPHY 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	<div style="position: absolute; left: 560px; top: 220px; width: 300px;"> Elevation of reference point: <u>[652.13-ft]</u> (top of 6-in casing) Height of reference point above <u>[2.9-ft]</u> ground surface Depth of surface seal <u>[2*20.3-ft]</u> Type of surface seal: Cement grout, 2.0*20.3-ft, w/concrete 4-ft x 4-ft x 6-in surface pad extending 2.0-ft into annulus 4-in ID stainless steel casing, <u>+1.8*238.7-ft</u> Hole diameter, <u>2.0*145.0-ft, 11-in nominal</u> <u>145.0*269.0-ft, 9-in nominal</u> Bentonite crumbles, <u>20.3*231.2-ft</u> 1/2-in Volclay pellets, <u>231.2*234.8-ft</u> Silica sand pack, <u>234.8*263.7-ft, 20*40-mesh</u> 4-in stainless steel screen, <u>238.7*259.7-ft, #10-slot</u> w/channel pack Backfill, <u>263.7*269.0-ft</u> Borehole drilled depth: <u>[269.0-ft]</u> </div>		
Drawing By: <u>RKL/2E27-16.ASB</u> Date : <u>09Sep93</u> Reference : <u>WHC-MR-0207</u>			

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 Drilling Fluid Used: Raw water Driller's Name: J Johnson Drilling Company: Jensen Date Started: 19Sep91	Sample Drive barrel Method: Hard tool Additives Used: None WA State Lic Nr: Not documented Company Location: Not documented Date Complete: 11Nov91	WELL NUMBER: 299-E27-17 Hanford Coordinates: N/S N 44,752.1 E/W W 50,337.1 State NAD83 N 137,122.01m E 574,547.31m Coordinates: N 449,924 E 2,244,873 TEMPORARY WELL NO: _____ Start Card #: Not documented T _____ R _____ S _____ Elevation Ground surface: 631.75-ft (Brass cap)	
Depth to water: 226.9-ft Nov91 (Ground surface) 229.7-ft 23Jun93			
GENERALIZED Geologist's STRATIGRAPHY 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	<div style="position: absolute; left: 560px; top: 230px; width: 300px;"> <p>Elevation of reference point: [634.72-ft] (top of casing)</p> <p>Height of reference point above [3.47-ft] ground surface</p> <p>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</p> <p>4-in ID stainless steel casing, +ND=223.2-ft</p> <p>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</p> <p>Bentonite crumbles 18.9-214.4-ft, 8-20-mesh</p> <p>Bentonite pellets, 214.4-217.7-ft</p> <p>Silica sand pack, 217.7-244.2-ft, 10-20-mesh</p> <p>4-in T304 stainless steel screen, 223.2-244.2-ft, #20-slot</p> <p>Fill, 244.2-246.2-ft</p> <p>Borehole drilled depth: [246.2-ft]</p> </div>		
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: <u>Cable tool</u> Fluid Used: <u>Raw water</u> Driller's Name: <u>D. Ludtke</u> Drilling Company: <u>Kaiser Engineers</u> Date Started: <u>11May92</u>	Sample Drive barrel Method: <u>Hard tool</u> Additives Used: <u>None</u> WA State Lic Nr: <u>Not documented</u> Company Location: <u>Hanford</u> Date Complete: <u>14Jul92</u>	WELL NUMBER: <u>299-E27-18</u> Hanford Coordinates: N/S <u>N 44.745.6</u> E/W <u>W 51.150.0</u> State NAD83 N <u>137,119.29m</u> E <u>574,299.61m</u> Coordinates: N <u>449,916</u> E <u>2,244,060</u> Start Card #: <u>Not documented</u> T <u> </u> R <u> </u> S <u> </u> Elevation Ground surface: <u>647.14-ft (Brass cap)</u>	
Depth to water: <u>243.9-ft 01Jun92</u> (Ground surface) <u>244.8-ft 15Dec92</u>			
GENERALIZED Geologist's STRATIGRAPHY 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	<div style="position: absolute; top: 230px; left: 560px;"> Elevation of reference point: <u>[650.15-ft]</u> (top of casing) Height of reference point above <u>[3.01-ft]</u> ground surface </div> <div style="position: absolute; top: 285px; left: 560px;"> Depth of surface seal <u>[2.0-8.6-ft]</u> 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 </div> <div style="position: absolute; top: 370px; left: 560px;"> 4-in ID stainless steel casing, <u>+1.2-241.4-ft</u> </div> <div style="position: absolute; top: 415px; left: 560px;"> Hole diameter, <u>2.0-46.4-ft, 13-in nominal</u> <u>46.4-147.7-ft, 11-in nominal</u> <u>147.7-264.3-ft, 9-in nominal</u> </div> <div style="position: absolute; top: 475px; left: 560px;"> Bentonite crumbles, <u>8.6-232.4-ft, 8-20-mesh</u> </div> <div style="position: absolute; top: 550px; left: 560px;"> 3/4-in bentonite pellets, <u>232.4-237.1-ft</u> </div> <div style="position: absolute; top: 585px; left: 560px;"> Silica sand pack, <u>237.1-262.7-ft, 20-40-mesh</u> </div> <div style="position: absolute; top: 625px; left: 560px;"> 4-in T304 stainless steel screen, <u>241.4-261.5-ft, #10-slot</u> w/0.3-ft end cap </div> <div style="position: absolute; top: 715px; left: 560px;"> Fill, <u>262.7-265.0-ft</u> </div> <div style="position: absolute; top: 745px; left: 560px;"> Borehole drilled depth: <u>[265.0-ft]</u> </div>		
Drawing By: <u>RKL/2E27-18.ASB</u> Date : <u>09Sep93</u> Reference : <u>WHC-SD-EN-DP-051</u>			

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	Sample	Drive barrel
Method: <u>Cable tool</u>	Method: <u>Hard tool</u>	
Drilling	Additives	
Fluid Used: <u>Raw water</u>	Used: <u>None</u>	
Driller's	WA State	
Name: <u>L. Watkins</u>	Lic Nr: <u>Not documented</u>	
Drilling	Company	
Company: <u>Kaiser Engineers</u>	Location: <u>Hanford</u>	
Date	Date	
Started: <u>11May92</u>	Complete: <u>08Jul92</u>	

WELL NUMBER: 299-E27-19 TEMPORARY WELL NO: _____
Hanford
Coordinates: N/S N 44,693.6 E/W W 50,968.2
State NAD83 N 137,103.59m E 574,355.07m
Coordinates: N 449,865 E 2,244,242
Start
Card #: Not documented T _____ R _____ S _____
Elevation
Ground surface: 647.83-ft (Brass cap)

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

GENERALIZED Geologist's
STRATIGRAPHY 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 [3.05-ft]
ground surface

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

¾-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: <u>Cable tool</u> Drilling <u>200 E Water</u> Fluid Used: <u>Supply</u> Driller's <u>Name: Wamsley</u> Drilling <u>Company: Kaiser Engineers</u> Date <u>Started: 17Jul89</u> Date <u>Complete: 29Aug89</u>	Sample Drive barrel Method: <u>Hard tool</u> Additives <u>Used: Not documented</u> WA State <u>Lic Nr: Not documented</u> Company <u>Location: Hanford</u>	WELL NUMBER: <u>299-E33-33</u> TEMPORARY WELL NO: _____ Hanford Coordinates: N/S <u>N 45.348</u> E/W <u>W 51.868</u> State NAD83 <u>N 137,302.2m</u> E <u>574,080.3m</u> Coordinates: N <u>450,517</u> E <u>2,243,341</u> Start Card #: <u>Not documented</u> T _____ R _____ S _____ Elevation Ground surface: <u>637.18-ft Brass cap</u>	
Depth to water: <u>232.8-ft Aug89</u> (Ground surface) <u>235.4-ft 23Jun93</u> GENERALIZED Geologist's STRATIGRAPHY 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: <u>[640.17-ft]</u> (top of 6-in casing) Height of reference point above <u>[2.99-ft]</u> ground surface Depth of surface seal <u>[2-18.7-ft]</u> 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, <u>18.7-239.6-ft, 8-20-mesh</u> 4-in ID stainless steel casing, <u>+0.6-246.4-ft</u> Hole diameter, <u>0-154.0-ft, 11-in nominal</u> <u>154.0-252.0-ft, 9-in nominal</u> 1/2-in Volclay pellets, <u>220.2-224.2-ft</u> Silica sand pack, <u>224.2-246.8-ft, 20-40-mesh</u> 4-in stainless steel screen, <u>227.3-248.3-ft, #10-slot</u> <u>w/channel pack and bottom cap</u> Fill <u>246.8-252-ft</u> Borehole drilled depth: <u>[252.0-ft]</u>
Drawing By: <u>RKL/2E33-33.ASB</u> Date : <u>13Sep93</u> Reference : <u>WHC-MR-0209</u>			

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 Drilling Fluid Used: 200 E Water Driller's Name: Lyden Drilling Company: Kaiser Engineers Date Started: 04Dec89	Sample Drive barrel Method: Hard tool Additives Used: Not documented WA State Lic Nr: Not documented Company Location: Hanford Date Complete: 17Apr90	WELL NUMBER: 299-E33-36 TEMPORARY WELL NO: _____ Hanford Coordinates: N/S N 45,145 E/W W 51,906 State NAD 83 N 137,240.28 m E 574,068.76 m Coordinates: N 450,314 E 2,243,303 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 Geologist's STRATIGRAPHY 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: [646.67-ft] (top of 6-in casing) Height of reference point above [3.0-ft] ground surface Depth of surface seal [2x18.6-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 1/2-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-HAD83]
 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 Drilling 200 E Water Fluid Used: Supply Driller's Name: Watkins Drilling Company: Kaiser Engineers Date Started: 04Dec89	Sample Drive barrel Method: Hard tool Additives Used: Not documented WA State Lic Nr: Not documented Company Location: Hanford Date Complete: 17Apr90	WELL NUMBER: 299-E33-37 Hanford - Coordinates: N/S N 44,965 State NAD83 N 137,185.70m Coordinates: N 450,134 Start Card #: Not documented Elevation Ground surface: 649.92-ft (Brass cap)	TEMPORARY WELL NO: E/W W 51,832 E 574,091.71m E 2,243,378 T R S
Depth to water: 245.8-ft Dec89 (Ground surface) 248.0-ft 14Jun93 GENERALIZED Geologist's STRATIGRAPHY 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			
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-WAD83]
 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: <u>Cable tool</u> Drilling: <u>200 E Water</u> Fluid Used: <u>Supply</u> Driller's: _____ Name: <u>Watkins</u> Drilling: _____ Company: <u>Kaiser Engineers</u> Date: _____ Started: <u>05Feb90</u>	Sample Drive barrel Method: <u>Hard tool</u> Additives: _____ Used: <u>Not documented</u> WA State: _____ Lic Nr: <u>Not documented</u> Company: _____ Location: <u>Hanford</u> Date: _____ Complete: <u>20Apr90</u>	WELL NUMBER: <u>299-E34-8</u> Hanford Coordinates: N/S <u>N 45,175</u> E/W <u>W 51,454</u> State NAD83 <u>N 137,249.88m</u> E <u>574,206.66m</u> Coordinates: <u>N 450,345</u> E <u>2,243,755</u> Start Card #: <u>Not documented</u> T _____ R _____ S _____ Elevation Ground surface: <u>637.53-ft (Brass cap)</u>	
Depth to water: <u>232.9-ft Mar90</u> (Ground surface) <u>235.9-ft 14Jun93</u>			
GENERALIZED Geologist's STRATIGRAPHY Log SI=slightly			
0-5: Gravelly SAND 5-25: Muddy sandy GRAVEL 25-30: GRAVEL 30-35: Muddy sandy GRAVEL 35-40: SI gravelly SAND 40-45: SAND 45-55: SI gravelly SAND 55-60: Gravelly SAND 60-75: SAND 75-85: Gravelly SAND 85-90: SAND 90-110: SI gravelly SAND 110-130: SAND 130-135: Gravelly SAND 135-140: SI gravelly SAND 140-150: Gravelly SAND 150-155: SI muddy gravelly SAND 155-165: Gravelly SAND 165-170: SI gravelly SAND 170-180: Gravelly SAND 180-185: SI gravelly SAND 185-190: Gravelly SAND 190-195: SI gravelly SAND 195-200: Gravelly SAND 200-205: SI 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	<div style="position: absolute; left: 560px; top: 220px; width: 300px;"> <p>Elevation of reference point: <u>[640.52-ft]</u> (top of 6-in casing) Height of reference point above <u>[3.0-ft]</u> ground surface</p> <p>Depth of surface seal <u>[2.8-19.2-ft]</u> Type of surface seal: Cement grout to 19.2-ft, has 4-ftx4-ftx6-in concrete pad extending 2.8-ft into annulus</p> <p>Hole diameter, 0-151.5-ft, 11-in nominal 151.5-260.0-ft, 9-in nominal</p> <p>4-in ID stainless steel casing, +06-227.9-ft</p> <p>Bentonite crumbles, 19.2-219.7-ft, 8-20 mesh</p> <p>3/4-in Volclay tablets 219.7-224.2-ft</p> <p>Silica sand pack, 224.2-249.4-ft, 20-40 mesh</p> <p>4-in stainless steel screen, 227.9-247.9-ft, #10-slot w/channel pack</p> <p>Bentonite slurry, 249.4-258.1-ft</p> <p>Fill, 258.1-260.0-ft Borehole drilled depth: <u>[260.0-ft]</u></p> </div>		
Drawing By: <u>RKL/2E34-08.ASB</u> Date: <u>13Sep93</u> Reference: <u>WHC-MR-0207</u>			

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: <u>Cable tool</u> Fluid Used: <u>Raw water</u> Driller's Name: <u>J Johnson</u> Company: <u>Jensen Drilling</u> Date Started: <u>19Sep91</u>	Sample Hard tool Method: <u>Drive barrel</u> Additives Used: <u>None</u> WA State Lic Nr: <u>Not documented</u> Company Location: <u>Not documented</u> Date Complete: <u>29Oct91</u>	WELL NUMBER: <u>299-E34-10</u> Hanford Coordinates: N/S <u>N 45,091.0</u> E/W <u>W 51,198.8</u> State NAD83 N <u>137,224.57m</u> E <u>574,284.40m</u> Coordinates: N <u>450,261</u> E <u>2,244,011</u> Start Card #: <u>Not documented</u> T <u> </u> R <u> </u> S <u> </u> Elevation Ground surface: <u>637.01-ft (Brass cap)</u>	
Depth to water: 233.1-ft Oct91 (Ground surface) 234.9-ft 23Jun93 GENERALIZED Geologist's STRATIGRAPHY 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?)	<div style="position: absolute; left: 560px; top: 220px; width: 80%;"> Elevation of reference point: <u>[639.77-ft]</u> (top of casing) Height of reference point above <u>[2.76-ft]</u> ground surface Depth of surface seal <u>[2.0-18.9-ft]</u> 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, <u>+1.1-225.3-ft</u> Hole diameter, <u>2.0-19.0-ft, 13-in nominal</u> <u>19.0-169.4-ft, 11-in nominal</u> <u>169.4-249.0-ft, 9-in nominal</u> Bentonite crumbles, <u>18.9-218.2-ft, 8-20-mesh</u> Bentonite pellets, <u>218.2-222.1-ft</u> Silica sand pack, <u>222.1-249.0-ft, 10-20-mesh</u> 4-in T304 stainless steel screen, <u>225.3-246.4-ft, #20-slot</u> Borehole drilled depth: <u>[249.0-ft]</u> </div>		
Drawing By: <u>RKL/2E34-10.ASB</u> Date : <u>13Sep93</u> Reference : <u> </u>			

SUMMARY 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 :

WHC-SD-EN-AP-165, Rev. 0

APPENDIX B
SAMPLING AND ANALYSIS PLAN

WHC-SD-EN-AP-165, Rev. 0

This appendix introduces procedures for sample collection, chain of custody; samples preservation, shipment, chemical analysis, QA and QC.

All sampling activities are performed under contract by PNL. Testing will be carried out by other contract laboratories, to be determined, under contract to PNL. This sampling and analysis plan reflects the requirements in the PNL statement of work for the new contract laboratory.

SAMPLE COLLECTION PROCEDURES

The procedures for groundwater sample collection, water level measurements, and field measurements are contained in *Procedures for Groundwater Investigations* (PNL 1989), and include the following:

- GC-1 - Groundwater Sample Collection Procedure
- GC-2 - In-Line Sample Filtration Procedure
- GC-3 - Disposal of Purgewater from Monitoring Wells
- FA-1 - Temperature Measurement Procedure
- FA-2 - Calibration of Conductivity Meter and Measurement of Field Conductivity
- FA-3 - Calibration of pH Meter and Measurement of Field pH
- WL-1 - Water-Level Measurement Procedure
- WL-2 - Procedure for Standardizing Steel Tapes
- AD-1 - Change Control Procedure
- AD-2 - Groundwater Sample Chain of Custody
- AD-4 - Sediment Sample Chain of Custody
- DO-1 - Collection and Documentation of Borehole Samples and Well Construction Data
- DO-2 - Split-Barrel Auger Sediment Sampling.

Analytical methods and sample preservation techniques are listed in the *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities (QAPP)* (WHC 1993)

CHAIN-OF-CUSTODY PROCEDURES

Chain-of-custody procedures are contained in PNL (1989). The specific applicable procedure is AD-2, "Groundwater Sample Chain-of-Custody Procedure." The history of the custody of each sample will be documented according to this procedure.

QA/QC

QA is a system of *management* activities (e.g., written procedures) designed to assure that data are adequate to fulfill the objectives of the groundwater monitoring project. QA will be conducted in accordance with the QAPP (WHC 1993), which is supported by *Environmental Investigations and Site Characterization Manual* (WHC 1988).

QC is a system of *technical* activities designed to demonstrate that data are adequate to fulfill the objectives of the groundwater monitoring project. For analysis of groundwater chemistry, QC methods monitor for errors that may

be introduced during sample bottle preparation, sample collection, transport, or in the laboratory. The QC program has two main components: (1) routine internal checks performed by the laboratory, and (2) external checks conducted by PNL to evaluate laboratory performance. The scope of these efforts is described in the following sections.

Internal QC. Internal QC at the subcontracted laboratory will include general practices applicable to a wide range of analyses, as well as specific procedures stipulated for particular analyses. The QC and QA programs will be documented in a QC manual and a QA manual. The laboratory will provide a quarterly QC report to PNL.

Minimum requirements for laboratory QC checks are described below, and are described more fully in the QAPP (WHC 1993).

- Matrix and Matrix Spike Duplicate. A known quantity of a representative analyte of interest is added to a sample as a measure of recovery percentage. The spike and spike duplicate shall be created from replicates of a field sample (separate aliquots removed from the same sample container in the laboratory).
- QC reference sample. A sample is prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. Reference samples provide an independent check on analytical technique and methodology.
- External QC. Pacific Northwest Laboratory will use interlaboratory comparisons, replicate, blank, and blind samples to evaluate the accuracy of results from the subcontracted laboratory. The purpose and scope of each of these is described below.
- Field Duplicate Sample (replicate analyses). Duplicate samples are collected from the same well using the same equipment and sampling technique. These samples help establish how much variability might be expected in the laboratory measurements performed on nearly identical samples and provide a check for gross errors.
- Split Sample (interlaboratory duplicates). Some of the field or field duplicate samples will be split (i.e., placed into separate containers) in the field and sent to separate laboratories to audit the performance of the primary laboratory.
- Blind Sample. A solution containing known quantities of various analytes is sent to the laboratory to estimate the bias of analytical laboratory procedures and to determine when this bias exceeds control limits. Most blind samples are now prepared with materials supplied by EPA, including metals, anions, herbicides, pesticides, volatile organic compounds, ammonium ion, cyanide, semivolatile compounds, and PCBs. Blind samples are part of the overall RCRA sampling and analysis program at the Hanford Site.
- Field Transfer Blank. Pure, deionized, distilled water is transferred into a sample container in the field and preserved with the reagent specified for the analyte of interest. Field blanks are

used to check for contamination of the reagent or the sampling environment (e.g., air or dust).

- Equipment Blank. Pure, deionized, distilled water is washed through decontaminated sampling equipment and placed in regular sampling containers. Equipment blanks are used to verify equipment decontamination.
- Trip Blank. A sample container is filled with pure, deionized, distilled water in the laboratory, transported with the other sample containers in the field, and is returned unopened to the laboratory. Trip blanks check for possible contamination from container preparation, shipment, handling, storage, or site conditions. These blanks are analyzed for volatile organic constituents only.
- Full Trip Blank. A full trip blank is similar to a trip blank, but is analyzed for all constituents of concern for a specific project. The sample bottles are filled in the laboratory with pure, deionized, distilled water and preservative is added if required for a specific method.

REFERENCES

- American Public Health Association (APHA), 1985, *Standard Methods for the Examination of Water and Wastewater*, 16th ed., Washington, D.C.
- ASTM, 1986, *1986 Annual Book of ASTM Standards*, American Society for Testing and Materials, Philadelphia, Pennsylvania.
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- PNL, 1989, *Procedures for Groundwater Investigations*, PNL-6894, Pacific Northwest Laboratory, Richland, Washington.
- WHC, 1988, *Westinghouse Hanford Environmental Investigations and Site Characterization Manual*, WHC-CM-7-7, Westinghouse Hanford Company, Richland, Washington.
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