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ICN – PNNL-11523 R0.1
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A.

Document Number: PNNL-11523 **Revision Number:** R0

Document Title: Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs

Document's Original Author: JW Lindberg

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Effective Date of ICN: 11 / 30 / 98

Change Requested by: JW Lindberg

B. Action:

Replace pages 5.7 and 5.8 with the attached 2 pages. Attach this ICN to the front of the document.

On page iii, the third paragraph, third sentence, strike out the word "annually" and replace with "at least once every three years". Initial and date change, and place the ICN# near the change.

Add the following reference to the reference list on page 6.2:
Hartman, M.J., P.E. Dresel, J.P. McDonald, R.B. Mercer, D.R. Newcomer, and E.C. Thornton. 1998. *Integrated Monitoring Plan for the Hanford Groundwater Monitoring Project*, PNNL-11989, Pacific Northwest National Laboratory, Richland, Washington. Initial and date change, and place the ICN# near the change.

C. Effect of Change:

The schedule for sampling far-field wells changes from annual to once every three years.

D. Reason for Change/Description of Change:

The far-field wells sample the large regional plumes (nitrate, tritium, and iodine-129). Major changes in these large plumes occur very slowly. The Washington State Department of Ecology has agreed to allow a reduction in the frequency of sampling these larger, more regional plumes from annual sampling to sampling once every three years. The results of sampling these far-field wells are also used by the general site surveillance portion of the overall Hanford Site Groundwater Monitoring Program.

E. Approval Signatures:
(Please sign and date)

Type of Change: (Check one): ____ Minor __X__ Major

Process Quality Department: TL Almeida *TL Almeida* Date: 11 / 24 / 98

Approval Authority: RM Smith/SP Luttrell (Project Management) *[signature]* Date: 11 / 24 / 98

Other Approvals: JW Lindberg (Technical) *JW Lindberg* Date: 11 / 24 / 98

: MJ Hartman (Technical Review) *Mary J Hartman* Date: 24 / Nov / 98

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Pacific Northwest National Laboratory

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Combination RCRA Groundwater Monitoring Plan for the 216-A-10, 216-A-36B, and 216-A-37-1 PUREX Cribs

J. W. Lindberg

June 1997

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

PNNL-11523

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

This document presents a groundwater quality assessment monitoring plan, under Resource Conservation and Recovery Act of 1976 (RCRA) regulatory requirements found in WAC 173-303-400, and by reference, requirements in 40 CFR 265(d)(3) and (d)(4), for three RCRA sites in the Hanford Site's 200 East Area: 216-A-10, 216-A-36B, and 216-A-37-1 cribs (PUREX cribs). The objectives of this monitoring plan are to combine the three facilities into one groundwater quality assessment program and to assess the nature, extent, and rate of contaminant migration from these facilities. A groundwater quality assessment plan is proposed because at least one downgradient well in the existing monitoring well networks has concentrations of groundwater constituents indicating that the facilities have contributed to groundwater contamination.

The proposed combined groundwater monitoring well network includes 11 existing near-field wells to monitor contamination in the aquifer in the immediate vicinity of the PUREX cribs. Because groundwater contamination from these cribs is known to have migrated as far away as the 300 Area (more than 25 km from the PUREX cribs), the plan proposes to use results of groundwater analyses from 57 additional wells monitored to meet environmental monitoring requirements of U.S. Department of Energy Order 5400.1 to supplement the near-field data. Assessments of data collected from these wells will help with a future decision of whether additional wells are needed.

The near-field network wells will be sampled semiannually except for three wells (one near each facility) that will be sampled quarterly. Groundwater samples from the near-field wells will be analyzed for turbidity, phenols, ICP metals, anions, gross alpha, gross beta, alkalinity, ammonium ion, arsenic, ^{129}I, ^{3}H, ^{90}Sr, and the field parameters pH, specific conductance, temperature, and turbidity. Far-field network wells will be sampled ~~annually~~ at least once every three years for anions, ^{3}H, ^{129}I, and the field parameters pH, specific conductance, temperature, and turbidity. A recently installed well (699-37-47A) will be sampled quarterly for one year to assess the initial water quality for that specific well and then will be scheduled for semiannual sampling like the other near-field network wells.

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1.0 Introduction

This document presents a groundwater monitoring program for three Resource Conservation and Recovery Act of 1976 (RCRA) waste management units at the Hanford Site combined under one groundwater quality assessment program. The units are the 216-A-10 (A-10), 216-A-36B (A-36B), and 216-A-37-1 (A-37-1) cribs (PUREX cribs). The three cribs have been grouped together based on their proximity to one another, similar construction and waste history, and similar hydrogeologic regime. The primary objectives of this combination groundwater monitoring plan are to

- Address RCRA groundwater monitoring at the A-37-1 crib, which had not been monitored under RCRA earlier. (An internal audit by the Environmental Restoration Contractor Team [Wyer 1995] noted that the A-37-1 Crib did not have an RCRA-compliant groundwater monitoring program as required by WAC 173-303-400. The monitoring program described in this plan is intended to correct the non-conformance as noted in the audit finding.)

- Implement an "alternative" groundwater monitoring program [WAC 173-303-400, and by reference, requirements in 40 CFR 265(d)(3) and (d)(4)] that will assess the groundwater contamination emanating from the combined PUREX cribs site at least until closure requirements are identified.

The usual approach for RCRA groundwater monitoring at Hanford has been to design a unit-specific monitoring program to evaluate the impact of each individual treatment/storage/disposal (TSD) unit on groundwater quality. Consistent with this approach, the A-10 and A-36B cribs have been monitored under separate, interim-status, indicator parameters evaluation programs using wells located close to each crib. A regional monitoring approach, which combines the A-10, A-36B, and the A-37-1 crib, is more appropriate for the following reasons:

- The cribs have similar hydrogeology and waste constituents.

- Groundwater monitoring results from one downgradient well at the A-36B Crib has shown that the concentration of one indicator parameter (specific conductance) is significantly higher than the corresponding upgradient well and indicates that the site has contributed to groundwater contamination. (This exceedance would be expected to drive the site into a groundwater quality assessment program. However, that well is older, and its construction is not in compliance with more recent RCRA standards.)

- Suspected contaminant plumes emanating from these cribs extend beyond the current network wells; hence, the monitoring network needs to *assess* contamination rather than concentrate effort on determining if the site has impacted groundwater (current networks at A-10 and A-36B cribs are in detection monitoring programs.)

- The hydraulic gradient is very low, making it difficult to determine groundwater flow direction and flow rate with the closely spaced wells immediately around each crib.

- Combining the three cribs into one monitoring program supports the U.S. Department of Energy's (DOE) groundwater program consolidation efforts.

- Combining the three cribs into one monitoring program reduces redundancy and monitoring costs by using a more efficient, revised network to monitor and assess groundwater contamination conditions for the three PUREX cribs.

The following sections discuss location and facility descriptions, hydrogeologic setting in the southeastern portion of the 200 East Area, groundwater contamination, and the proposed groundwater monitoring program.

2.0 Location and Facility Descriptions

The Hanford Site is located in south-central Washington State approximately 170 miles (272 km) east of Seattle and 130 miles (208 km) southwest of Spokane (Figure 2.1). The Hanford Site was initially established in 1943 by the U.S. Army Corps of Engineers as the location for plutonium production reactors and associated plutonium extraction facilities. Two of the PUREX cribs (A-10 and A-36B) are located in the southeast corner of the 200 East Area (Figure 2.1). The third crib (A-37-1) is located about 420 m east-northeast near the Grout Facility (Figures 2.1 and 2.2).

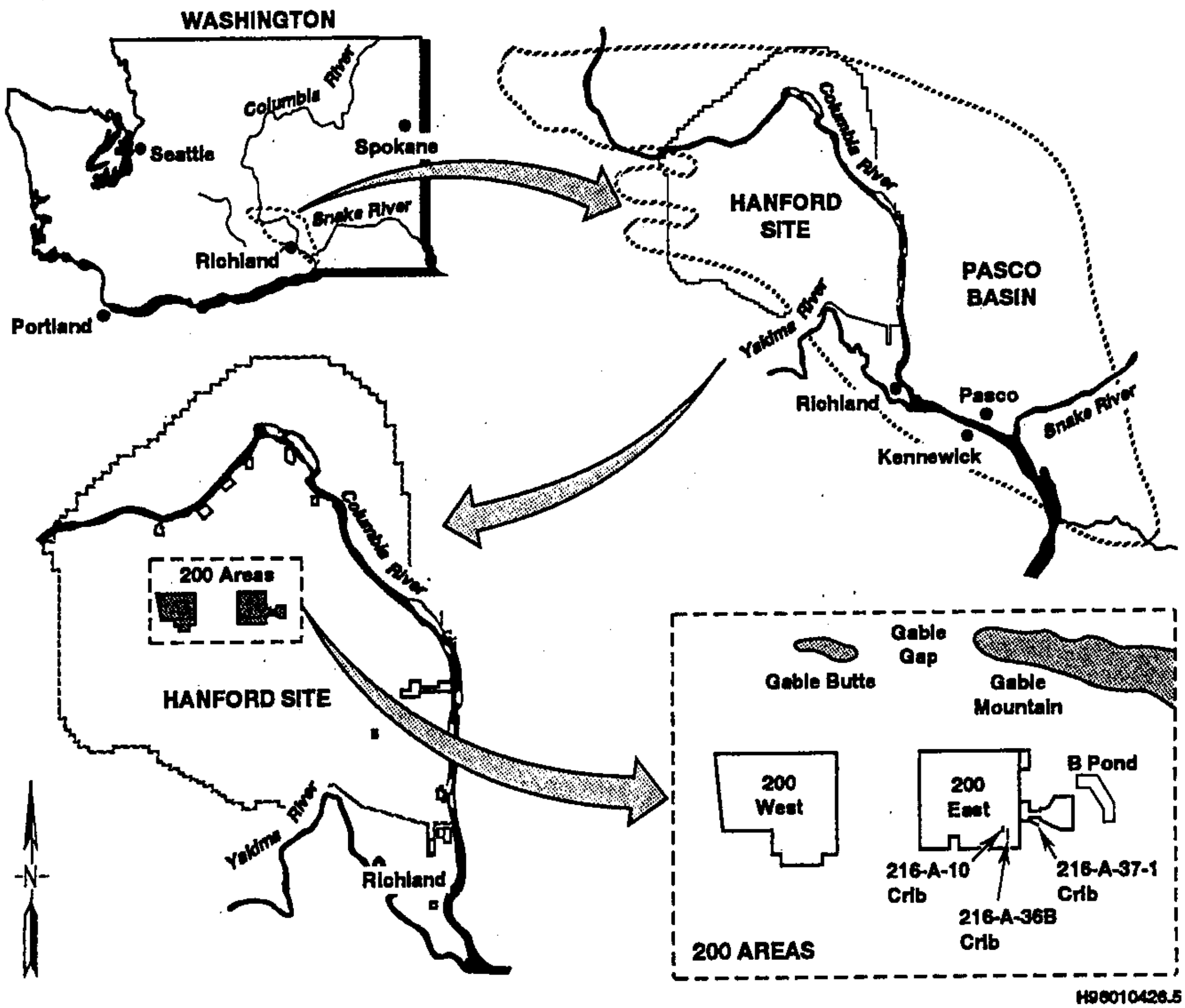


Figure 2.1. Location of the Hanford Site

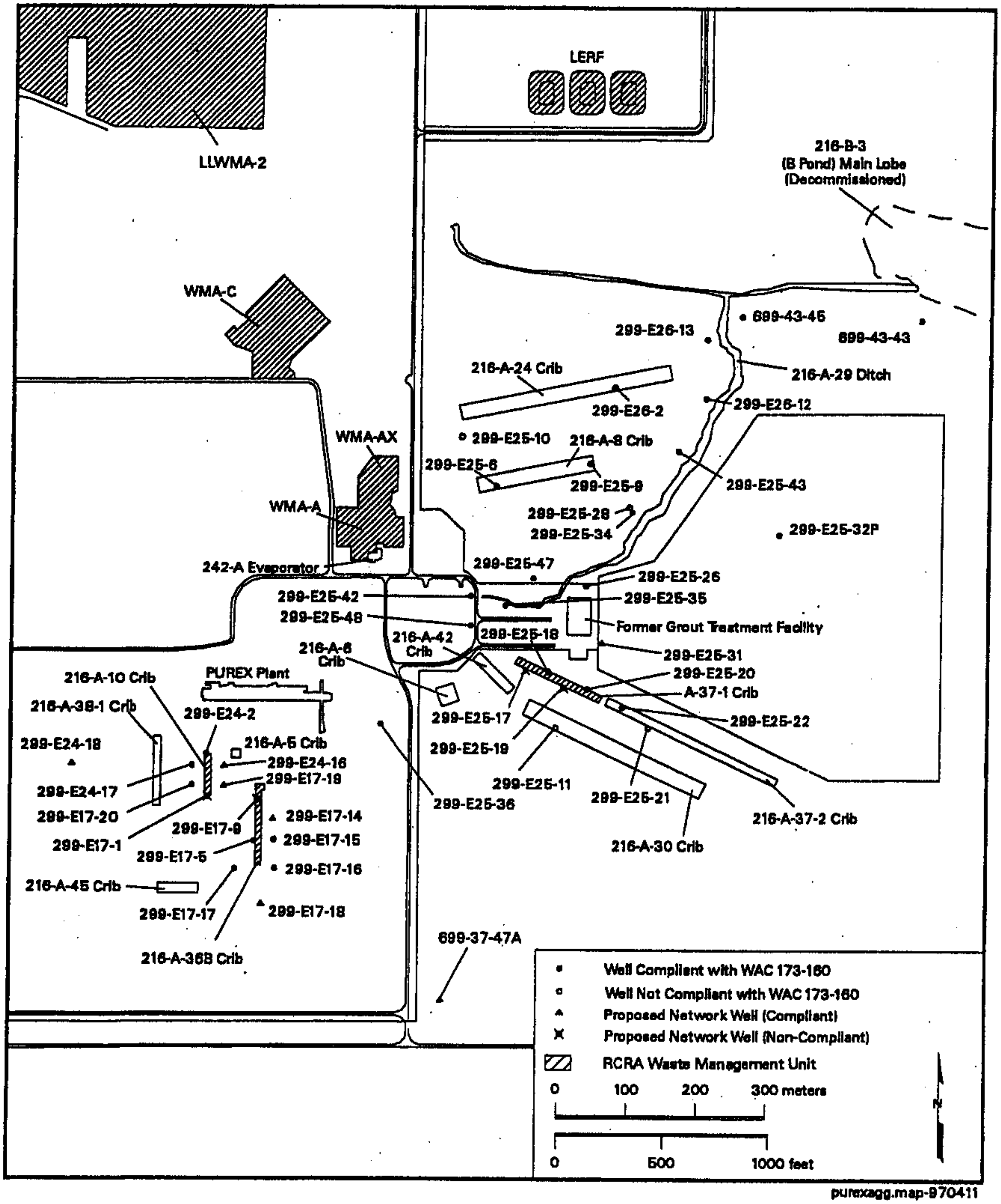


Figure 2.2. Location of the 216-A-10, 216-A-36B, and 216-A-37-1 Cribs and Other Facilities

2.1 Adjacent Facilities

The PUREX cribs adjoin several other liquid waste disposal sites associated with past PUREX operations and related facilities near the southeast corner of the 200 East Area (Figure 2.2). Other disposal sites located near the PUREX cribs are the 216-A-29 Ditch, the former Grout Treatment Facility, six cribs, the 216-B-3 Pond system, and a retention basin (Table 2.1). Many of these facilities received effluent that was similar to that discharged to the PUREX cribs.

Table 2.1. Selected Waste Disposal Facilities Located Near the A-10, A-36B, and A-37-1 Cribs (Environmental Sites Database [formerly Waste Information Data System])

Site Name[a]	Dates Used	Waste Volume (L)	Waste Description
B-Pond (RCRA) System	1945-present[b]	2.4×10^{11}	B Plant cooling water, PUREX chemical sewage, steam condensate (mixed waste).
A-5 Crib	1958-1961	1×10^{8}	Predecessor to the A-10 Crib, similar waste.
A-6 Crib	1955-1970	3.4×10^{9}	PUREX steam condensate, floor drainage, storage basin overflow (mixed waste).
A-8 Crib	1955-1991	1.2×10^{9}	Condensate from waste storage tanks, condenser cooling water (low-level waste).
A-24 Crib	1958-1966	8.2×10^{8}	Condensate from waste storage tanks (low-level waste).
A-29 Ditch (RCRA)	1955-1991	not available	Chemical sewer waste from PUREX-demineralizer wastes (corrosive, possibly hazardous)
A-30 Crib	1961-1992	7.1×10^{9}	PUREX steam condensate, floor drainage, storage basin overflow (low-level and nitrate)
A-37-2 Crib	1983-1992	1.09×10^{9}	PUREX steam condensate (low-level radioactive)
A-38-1 Crib	Never used	0	Intended to receive liquid waste discharged to A-10 Crib.
A-42 Retention Basin	1978-present	not available	Diversions from PUREX chemical sewer, cooling water, and steam condensate (mixed waste). Treated, discharged to other facilities.
A-45 Crib	1987-present	$< 1 \times 10^{8}$	Successor to A-10 Crib, similar waste
Grout Treatment Facility (formerly RCRA)	Never used; Grout Project canceled in 1994.	0	Mixed wastes were to be blended into a slurry and poured into underground vaults for storage; however, site was never used.

(a) All site names except Grout Facility are prefixed by 216-. Sites are not RCRA-regulated unless noted.
(b) B Pond comprises a main pond and three lobes: A, B, and C. Only C lobe is currently active.

2.2 Crib Descriptions

A physical description of the PUREX cribs, their operating histories, effluent characteristics, and current monitoring status follow. Appendix A contains the physical descriptions and general summary reports for each of the PUREX cribs from the *Hanford Environmental Sites Database*.

2.2.1 216-A-36B (A-36B) Crib

The A-36B Crib, now retired from use, was a liquid waste disposal facility for the PUREX Plant (Smith and Kasper 1983). The A-36B Crib is located in the 200 East Area approximately 360 m south of the PUREX Plant. It is approximately 110 m east of the 216-A-10 crib.

The A-36B Crib is the southern 150 m of a longer crib, originally known as the 216-A-36 Crib (see Figure 2.2). The original crib dimensions were 180 m long, 2.1-3.4 m wide, and 3.7 m deep. A 0.15-m-diameter perforated distributor pipe was placed at the bottom of the crib on a 0.3-m thick bed of gravel, covered with another 0.3 m of gravel, and backfilled to grade. Ammonia scrubber distillate waste from the PUREX Plant was discharged through the distribution pipe to the crib and allowed to percolate through the soil column.

The original crib (216-A-36) received liquid effluent from September 1965 to March 1966. A substantial inventory of radionuclides was disposed to the crib and is assumed to have infiltrated sediments near the inlet to the crib (Smith and Kasper 1983). Before the separation of A-36A and A-36B, dilute nitric acid also may have been discharged with the wastewater. To continue effluent discharge to the crib, it was divided into two sections: 216-A-36A and A-36B. Grout was injected into the gravel layer to form a barrier between the two sections. The liquid effluent discharge point was moved to the A-36B Crib section and the A-36A portion of the Crib was no longer used. Discharge to the A-36B Crib resumed in March 1966 and continued until October 1972, when the crib was temporarily removed from service (Smith and Kasper 1983). The A-36B Crib was placed back in service in November 1982 and operated until it was taken out of service again in August 1987 (Aldrich 1987).

Ammonia scrubber distillate disposed in the A-36B Crib consisted of condensate from nuclear fuel decladding operations in which zirconium cladding was removed from irradiated fuel by boiling in a solution of ammonium fluoride and ammonium nitrate. Other waste stream constituents included the radionuclides of Pu, ^{3}H, U, ^{90}Sr, ^{137}Cs, $^{103,106}Ru$, ^{60}Co, ^{113}Sn, ^{147}Pm, ^{241}Am, and ^{129}I (Aldrich 1987).

An interim-status, indicator parameter evaluation program has been in operation at the A-36B Crib since May 1988 (Kasza 1994). The RCRA closure/post-closure plan for the A-36B Crib is scheduled to be submitted to the Washington State Department of Ecology (Ecology) and the U.S. Environmental Protection Agency (EPA) in June 2000. This action will satisfy the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement), Milestone M-20-33 (Ecology et al. 1994). The A-36B Crib is part of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) 200-PO-2 Operable Unit.

2.2.2 216-A-10 (A-10) Crib

The A-10 Crib, now retired from use, was also a liquid waste disposal facility for the PUREX Plant (Smith and Kasper 1983). The A-10 Crib is located in the 200 East Area approximately 120 m south of the PUREX Plant. It is approximately 110 m west of the A-36B crib (see Figure 2.2). The A-10 Crib is 84 m long, has a V-shaped cross section, and is 14 m deep. Several waste streams, collectively described as process distillate discharge, were disposed of to the A-10 Crib and were allowed to percolate through the soil column.

The A-10 Crib first received liquid waste over a 4-month period during the PUREX startup in 1956. In 1961, the A-10 Crib replaced the 216-A-5 Crib and received PUREX effluent continuously until 1973. Periodic discharges were received in 1977, 1978, and 1981 (Smith and Kasper 1983). From 1982 to 1987, effluent discharges resumed on a continual basis. Discharge between 1981 and 1986 averaged 1×10^8 L per year. In 1987, the A-10 Crib was taken out of service and replaced by the 216-A-45 Crib (Aldrich 1987).

The process distillate discharge waste stream to the A-10 Crib was characteristically acidic and contained concentrated salts. Other waste stream constituents included aliphatic hydrocarbon compounds; organic complexants; and the radionuclides ^{3}H, Pu, U, ^{90}Sr, $^{134,137}Cs$, $^{103,106}Ru$, ^{60}Co, ^{113}Sn, ^{147}Pm, ^{241}Am, and ^{129}I (Aldrich 1987).

An interim-status, indicator parameter evaluation program (Kasza 1994) has been active for the A-10 Crib since November 1988. The RCRA closure/post-closure plan for the A-10 Crib is scheduled to be submitted to Ecology and the EPA in 2000. This document will satisfy the Tri-Party Agreement Milestone M-20-33 (Ecology et al. 1994). The A-10 Crib is part of the CERCLA 200-PO-2 Operable Unit.

2.2.3 216-A-37-1 (A-37-1) Crib

The A-37-1 Crib, now retired from use, was also a liquid waste disposal facility for the PUREX Plant (Smith and Kasper 1983). It is located near the former Grout Treatment Facility, approximately 600 m east of the PUREX Plant (Figure 2.2). The original crib dimensions were 213 m long, 3 m wide, and 3.4 m deep. A 0.25-m-diameter corrugated, galvanized, perforated distributor pipe was placed on 1 m of gravel fill. The distributor pipe was covered with gravel, a layer of plastic, and backfill material. Associated structures include two liquid level risers, a vent riser, and a diversion box. The diversion box was originally designed to receive waste via the 216-A-30 Crib. In 1976, a line was constructed from the 207-A Retention Basin to the northeast inlet of the diversion box. The southeast inlet and outlet were available to divert wastes to another crib, if needed. The diversion box and inlet and outlet pipes were filled with concrete in June 1994 to eliminate any inadvertent entry of water to the waste water diversion box and the connected cribs. Waste water entered at the southeast end of the crib, which is at a lower elevation than the northwest end. This configuration favored infiltration at the southeast end of the crib.

The A-37-1 Crib first received liquid waste from March 1977 to April 1989. The waste stream included process condensate from the 242-A Evaporator and included the radionuclides Pu, ^{90}Sr, ^{106}Ru, ^{137}Cs, ^{60}Co, and U (Smith and Kasper 1983). The process condensate was regulated as a mixed waste because it contained radionuclides, spent halogenated and nonhalogenated solvents, and ammonia (toxic). The estimated annual quantity of dangerous waste (49,120 kg) represents the maximum annual output of evaporator process condensate during operating campaigns. Discharge to the A-37-1 Crib was discontinued in April 1989. However, verbal reports during subsequent site visits indicated that water could be heard flowing through the distribution box that diverted waste water to the crib. In 1994, the distribution box was permanently sealed by filling it with concrete, thus eliminating any inadvertent routing of waste water to the crib.

The A-37-1 Crib is one of several liquid effluent discharge sites that were excluded from the list of RCRA sites in the Tri-Party Agreement (Ecology et al. 1994). Under the Tri-Party Agreement, Milestones M-17-00A and M-17-00B, the excluded sites were the subject of a liquid effluent study to determine their environmental impact. Listed wastes were identified in the effluent stream to the A-37-1 Crib, thereby obligating the operator to bring the crib into compliance with RCRA regulations. Discharge to the crib was terminated in April 1989, and a Part A RCRA permit application was submitted for the site in February 1990. Subsequent investigations indicated the potential presence of chlorinated hydrocarbon solvents from operation in B Plant and T Plant, and a revised Part A was submitted in May 1993. A second revision was submitted in June 1994 to transfer responsibility for the facility to Bechtel Hanford, Inc., the environmental restoration contractor. The facility is currently scheduled for closure under RCRA final status, and a closure plan is scheduled to be submitted to Ecology and the EPA in 2000. The A-37-1 Crib is part of the 200-PO-4 Operable Unit.

Although the crib was not included among the initial RCRA sites listed in the Tri-Party Agreement, it was subsequently monitored along with the non-RCRA active effluent discharge sites by the Operational Monitoring Program (DOE-RL 1994). Some of the wells near the crib were also monitored as part of the 216-A-29 Ditch RCRA groundwater assessment monitoring program.

3.0 Hydrogeologic Setting

This section summarizes the geologic and hydrologic features that control the direction and rate of groundwater flow and contaminant movement near the PUREX cribs and the area of the contamination plumes emanating from the PUREX cribs. The following descriptive material has been excerpted from the recent annual Hanford Site groundwater monitoring report (Hartman and Dresel 1997), groundwater monitoring plans (Kasza 1994), and other sources (Knepp et al. 1994, Lindberg et al. 1993, Lindberg et al. 1997). The geology and hydrology of the Hanford Site and the 200 East Area are described in Delaney et al. (1991), Lindsey et al. (1992), Connelly et al. (1992), and Hartman and Dresel (1997).

The Hanford Site is located in the Pasco Basin, a broad sediment-filled depression that lies within the Columbia Basin physiographic province. The Hanford Site is noted for its thick sedimentary fill, wide areal variability in groundwater and contaminant movement, relatively thick vadose zone in a temperate desert environment, and limited natural recharge to the aquifers locally.

3.1 Geology

The PUREX cribs are located on the eastern side of a large flood bar (i.e., cataclysmic flooding) known as the 200 Areas Plateau. The ground surface in the network area is relatively flat, but slopes gently toward the north. Elevation of the ground surface ranges from about 220 m near the A-36B and A-10 cribs to about 205 m near the A-37-1 Crib.

The general stratigraphy in the vicinity of the PUREX cribs includes the following stratigraphic units (upper to lower) (see Figure 3.1):

- A discontinuous veneer of Holocene eolian silty sand
- Cataclysmic flood deposits of the Hanford formation consisting predominantly of sand, but containing substantial percentages of gravel in the lowermost and uppermost portions of the unit
- The fluvial Ringold Formation with thick layers of river gravel intercalated with sequences of overbank silts and fine-grained paleosols
- Bedrock consisting of Columbia River Basalt flows that dip gently to the south toward the axis of the Cold Creek syncline. The uppermost two flows are within the Elephant mountain member (Lindberg et al. 1997) of the Saddle Mountains Basalt Formation.

Although the stratigraphy at all three crib sites contains the general stratigraphic section described above, differences exist between the A-10 and A-36B cribs area to the southwest and the area near the

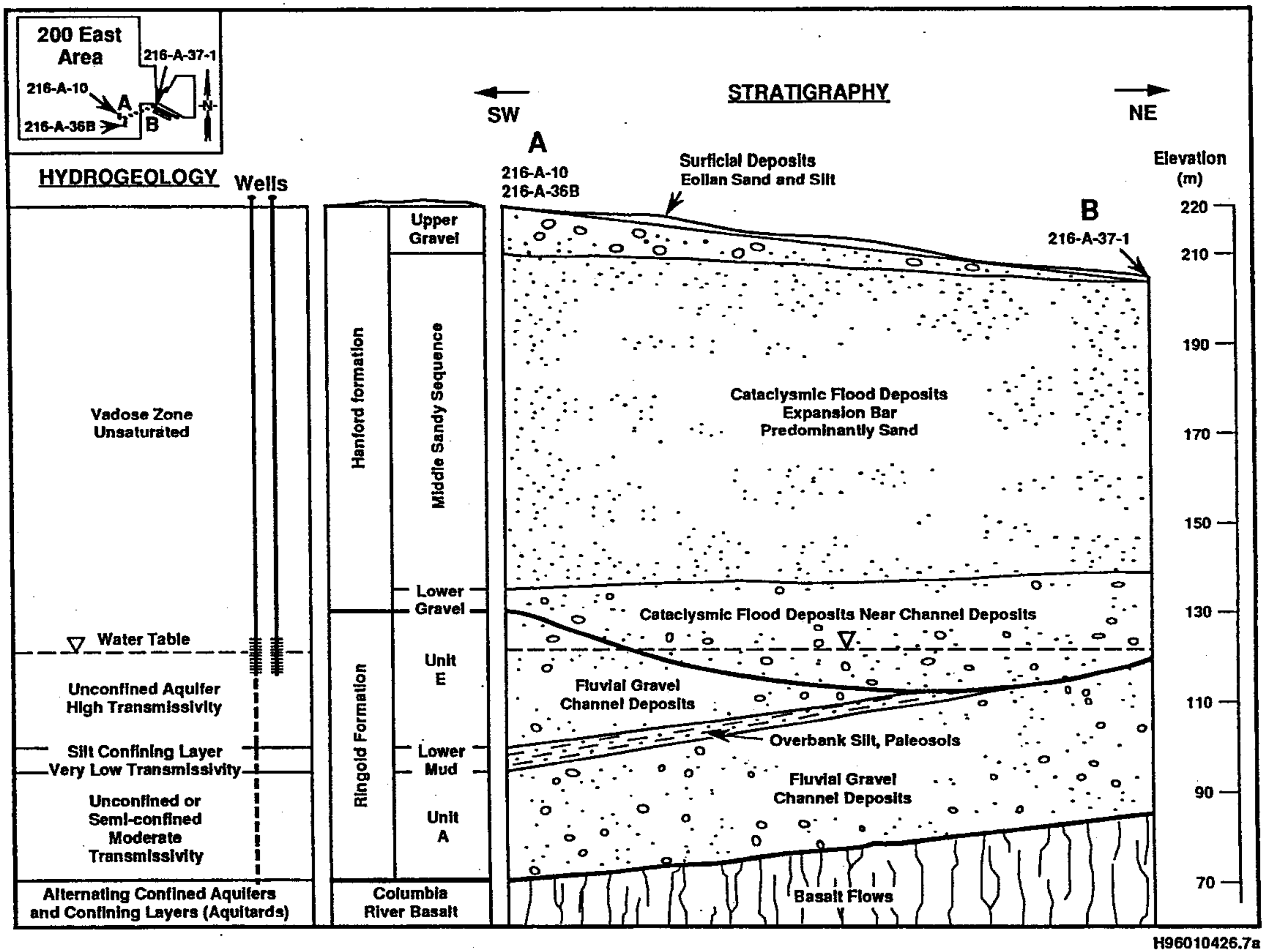


Figure 3.1. Hydrogeology and Stratigraphy Beneath the 216-A-37-1 Cribs and Other Facilities

A-37-1 Crib to the northeast. The differences are mainly in the Ringold Formation stratigraphy (Figure 3.1). To the southwest near the A-10 and A-36B cribs, the Ringold Formation contains three mappable units including coarse-grained fluvial units A and E (Lindsey et al. 1992) equivalent to basal coarse unit 9 and upper coarse unit 5 (of Thorne et al. 1993) with the fine-grained lower mud unit (unit 8 of Thorne et al. 1993) separating them. However, in the vicinity of the A-37-1 Crib (northeast) the lower mud unit and unit E are missing. The Hanford formation rests directly on Ringold Formation unit A. (For more detail on stratigraphy in the vicinity of the PUREX cribs and the Grout Facility see Lindberg et al. 1997, Lindberg et al. 1993 or Lindsey et al. 1992).

Beneath the Hanford formation, the uppermost Ringold Formation unit that predominates is unit E (unit 5 of Thorne et al. 1993), composed mostly of sandy gravel. However, near the Supply System and the southeast corner of the 200 East Area there are remnants of the upper Ringold unit composed of silty sand and sandy silt. The top of the Ringold Formation is at an elevation of 130 m above sea level near the southeast corner of the 200 East Area, and the total Ringold Formation thickness is about 69 m (Lindberg et al. 1997). In contrast, at the 300 Area the top of the Ringold Formation is 97 m above sea level, and the total thickness is about 45 m (Swanson et al. 1992).

To the southeast and east (the direction of overall groundwater flow away from the PUREX Cribs), the same general stratigraphy continues except that the thickness and elevations of the geologic units change. The overall underlying structure is of a slight southwestern dip toward the axis of the Cold Creek syncline. In the vicinity of the PUREX cribs, the Hanford formation is about 80 m thick and is mostly sand and interbedded sandy gravels. The Hanford formation thins dramatically to the southeast, away from the Pleistocene cataclysmic flood bars on which the 200 Areas are located. Its thickness is a fairly uniform 40 to 20 m to the southeast in the intervening 600 Area until it thins to near zero near the Columbia River. The base of the Hanford formation is irregular, carved into the top of the Ringold Formation by the cataclysmic flooding.

3.2 Hydrogeology

3.2.1 Surface Water

No natural surface water bodies exist near the crib sites or in the area of the groundwater contamination plumes downgradient from the crib sites except for the Columbia River (Figure2.1 and 2.2). However, the 216-B-3 Pond (B Pond) and the Treated Effluent Disposal Facility (TEDF) are effluent disposal sites northeast and east (respectively) of the crib sites. Discharges of waste water to B Pond and the TEDF recharge the uppermost aquifer and control the direction of groundwater flow from the northeast. However, discharges to B Pond will be terminated in late 1997. The TEDF began discharging wastewater to the ground in 1995 and will continue in the future.

3.2.2 Vadose Zone

The vadose zone in the vicinity of the PUREX cribs comprises predominantly the middle sandy sequence of the Hanford formation. Beds containing gravel or silt are common in this sequence but their percentages are minor compared to the large amount of sand. The vadose zone in the vicinity of the A-10 and A-36B cribs is approximately 99 m thick; in the vicinity of the A-37-1 Crib it is about 84 m thick.

Estimates of contaminant and moisture migration rates through the vadose zone beneath the eastern portion of the crib sites (i.e., near the A-37-1 Crib) were made for the liquid effluent study (WHC 1990). Calculations based on available data suggest the following:

- During routine operation of the A-37-1 Crib, travel time of waste water through the vadose zone to the water table was on the order of 8 to 9 months

- Under average flow conditions, the vadose zone was unsaturated (i.e., the calculated infiltration rate was less than the saturated hydraulic conductivity of the vadose zone).

Maximum depth of penetration for the relatively small quantities of ^{137}Cs and ^{90}Sr (<1 Ci) was about 40 m. Mobile constituents reached the water table with the waste water that was discharged.

Fayer and Walters (1995) estimated groundwater infiltration from precipitation through the vadose zone that eventually makes its way to recharge the aquifer. Their study included the entire Hanford Site. In the areas of the PUREX cribs and in the areas of the groundwater contamination plumes emanating from the PUREX cribs, the average recharge rates range from near zero to approximately 100 mm/yr. The areas of near zero recharge correspond to areas of heavy vegetation. The areas where the recharge is approaching 100 mm/yr correspond to the areas stripped of vegetation within the 200 East Area and the area of major active sand dunes north of the Supply System. Most of the 600 Area between the 200 East Area and the 300 Area corresponds to zones where the recharge rate is in the range of 0.5 to 20 mm/yr.

3.2.3 Hanford/Ringold Aquifer System

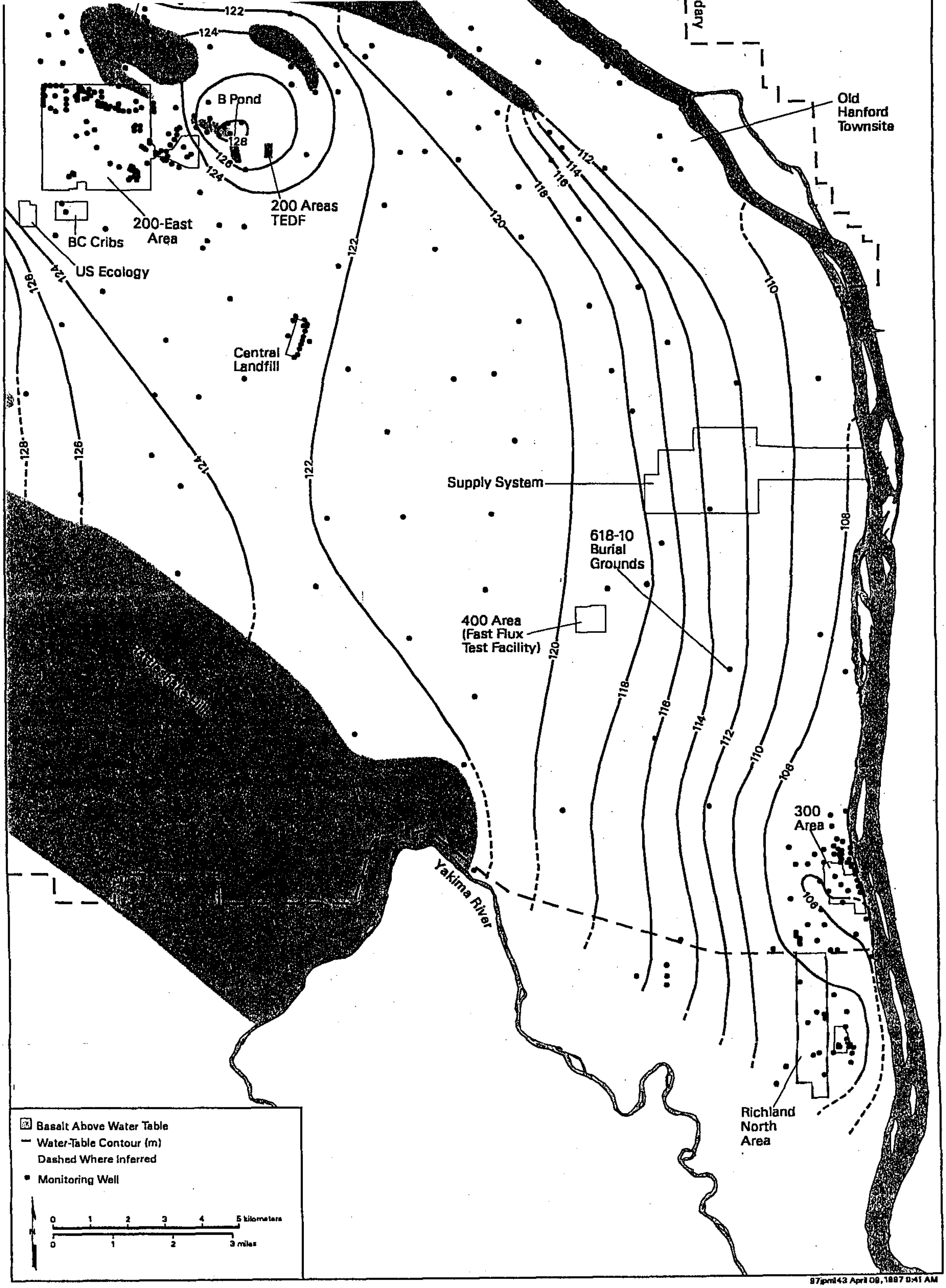
The uppermost aquifer in the vicinity of the cribs is either unconfined or locally confined, depending on the presence or absence of the lower mud unit of the Ringold Formation (see Figure 3.1). Near the A-10 and A-36B cribs, the water table is within unit E of the Ringold Formation. From the water table (at approximately 122 m elevation) downward to the lower mud unit (at about 100 m elevation) the aquifer is unconfined and about 22 m thick. Below the lower mud unit, the aquifer is locally confined and about 24 m thick. However, near the A-37-1 Crib, the water table is within the lowest portion of the Hanford formation or the upper part of the Ringold Formation (unit A). The lower mud unit pinches out between the crib locations so the aquifer is unconfined to the base of the Ringold Formation at about 85 m elevation. Therefore, the thickness of the unconfined aquifer near the A-37-1 Crib is approximately 37 m. Wells near the A-10 and A-36B cribs are screened entirely within unit E of the Ringold Formation but are screened in the Hanford formation and/or unit A of the Ringold Formation near the A-37-1 Crib (see Figure 3.1).

In most of the area southeast of the PUREX cribs, where the groundwater contamination plumes are located, the water table is within the lower portions of the Hanford formation (Hartman and Dresel 1997). However, in the area immediately downgradient of the PUREX cribs and near the Supply System the Ringold Formation upper unit and unit E (unit 5) extend above the water table. The Ringold Formation upper unit is stratigraphically above unit E and is predominantly silt and fine sand.

Estimates of hydraulic conductivity in the area near the PUREX cribs range from 18 m/d (Kasza 1992) to 3,000 m/d (Connelly et al. 1992). The lower estimates are from slug tests in gravelly sands of the Hanford formation at well 299-E25-42 (240 m northwest of the A-37-1 Crib), and the higher estimates are from a hydraulic conductivity map constructed from compiled data (Connelly et al. 1992). Near the southeast corner of the 200 East Area (well 699-37-47A), the hydraulic conductivity of the uppermost aquifer system in the Ringold Formation unit E is interpreted to be 60 m/d from slug tests (Lindberg et al. 1997, Appendix F). Results of a pumping test at the Grout Treatment Facility (Hanford formation sandy gravels underlain by Ringold Formation unit A sandy gravels) indicate hydraulic conductivity at 305 m/d (Swanson 1994). Transmissivity values estimated from model calibration (Hartman and Dresel 1997, Figure 3.6) show that it ranges from up to 125,000 m^2/d near the PUREX cribs and in the area immediately southeast of the PUREX cribs to as low as 250 m^2/d near the Columbia River in the vicinity of the Supply System.

Groundwater flow direction in the area northeast of the PUREX cribs (interpreted from water table maps) is predominantly from the northeast to the southwest due to the influence of B-Pond (Figure 3.2) where groundwater is flowing radially outward. However, to the west and northwest, the water table is extremely flat making estimates of groundwater flow direction and rate difficult. Estimates from plume maps (Section 4.0) suggest that groundwater flow direction in the area west and northwest of the PUREX cribs is to the southeast. Therefore, groundwater from the B Pond area most likely joins groundwater from the northwest (200 East Area) and flows toward the south and southeast. Results of flowmeter analysis in well 699-37-47A (near the southeast corner of the 200 East Area) show that groundwater in the upper 4 m of the unconfined aquifer is flowing to the southeast at approximately 0.5 m/d (Lindberg et al. 1997). Farther southeast and east of the PUREX cribs, in the area between the 200 East Area and the Columbia River, groundwater flow direction is southeast and east as can be shown from the groundwater contaminant plumes (Section 4.0).

The water table gradient in the vicinity of B Pond is much steeper than in the area near the PUREX cribs (Figure 3.2). This variation in groundwater flow may be due to local recharge effects or differences in hydraulic conductivity in the upper portion of the unconfined aquifer. Finer, less transmissive sediments beneath B Pond (e.g., the Ringold Formation lower mud unit) give way to coarser, more transmissive sands and gravels to the west (Ringold Formation unit E).



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4.0 Groundwater Chemistry

This section lists the contaminants of concern and contains contaminant plume maps. A primary objective is to correlate contaminant spatial and temporal distribution patterns with historical discharges. The data are from groundwater monitoring wells located near the PUREX cribs, wells at adjacent facilities, the regional monitoring network of the Hanford Site Surveillance Program, and well 699-37-47A.

Well 699-37-47A was drilled to basalt and groundwater was sampled (for the constituents listed in Table 4.1) at six different levels in the saturated zone between the water table and the uppermost basalt flow (Lindberg et al. 1997). Three of the samples were collected from the unconfined aquifer (Ringold Formation unit E) above the lower mud unit, and three were collected from Ringold Formation (unit A) below the lower mud unit. The depths below the water table of the six groundwater samples were as follows (in descending order):

- 4.6 m
- 8.8 m
- 15.0 m

Ringold Formation lower mud unit (16.8 to 30.5 m)

- 33.8 m
- 45.7 m
- 58.2 m

The analysis results provide information about the vertical distribution of the major contaminant plumes possibly emanating from the PUREX cribs at a location where groundwater flow converges from the northwest direction (A-10 and A-36B cribs) and from the northeast (A-37-1 Crib).

4.1 General Contaminant Plumes

4.1.1 Specific Conductance

A general indication of B Pond groundwater movement and chemical contaminant distribution is illustrated with the specific conductance map for the 200 East Area (Figure 4.1). Specific conductance of ambient Hanford groundwater is about 350-400 μmho/cm compared to about 140 μmho/cm for Columbia River raw water used as cooling water discharged to B Pond. Thus, specific conductance of groundwater decreases as it mixes with waste water from B Pond and other sites. Smaller areas of elevated specific conductance are superimposed on this general pattern in the vicinity of the PUREX cribs. Groundwater analysis results from well 299-E17-9 near the north end of the A-36B Crib showed

Table 4.1. Constituents Analyzed in Groundwater Samples Collected From Well 699-37-47A While Drilling

Analysis
pH (field and lab)
specific conductance (field and lab)
temperature (field)
alkalinity (field)
total organic carbon
total organic halogen
turbidity (field)
total dissolved solids
Metals (filtered): Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Ag, Na, Tl, Sn, V, Zn.
Anions by ion chromatography: bromide, chloride, fluoride, nitrate nitrite, phosphate, sulfate
Radiological: gross alpha/gross beta gamma scan ^{3}H ^{90}Sr ^{129}I ^{99}Tc Ra
VOA: (including: acetone, hexone, methylene chloride, trichloroethane)
Other: ammonium ion cyanide U

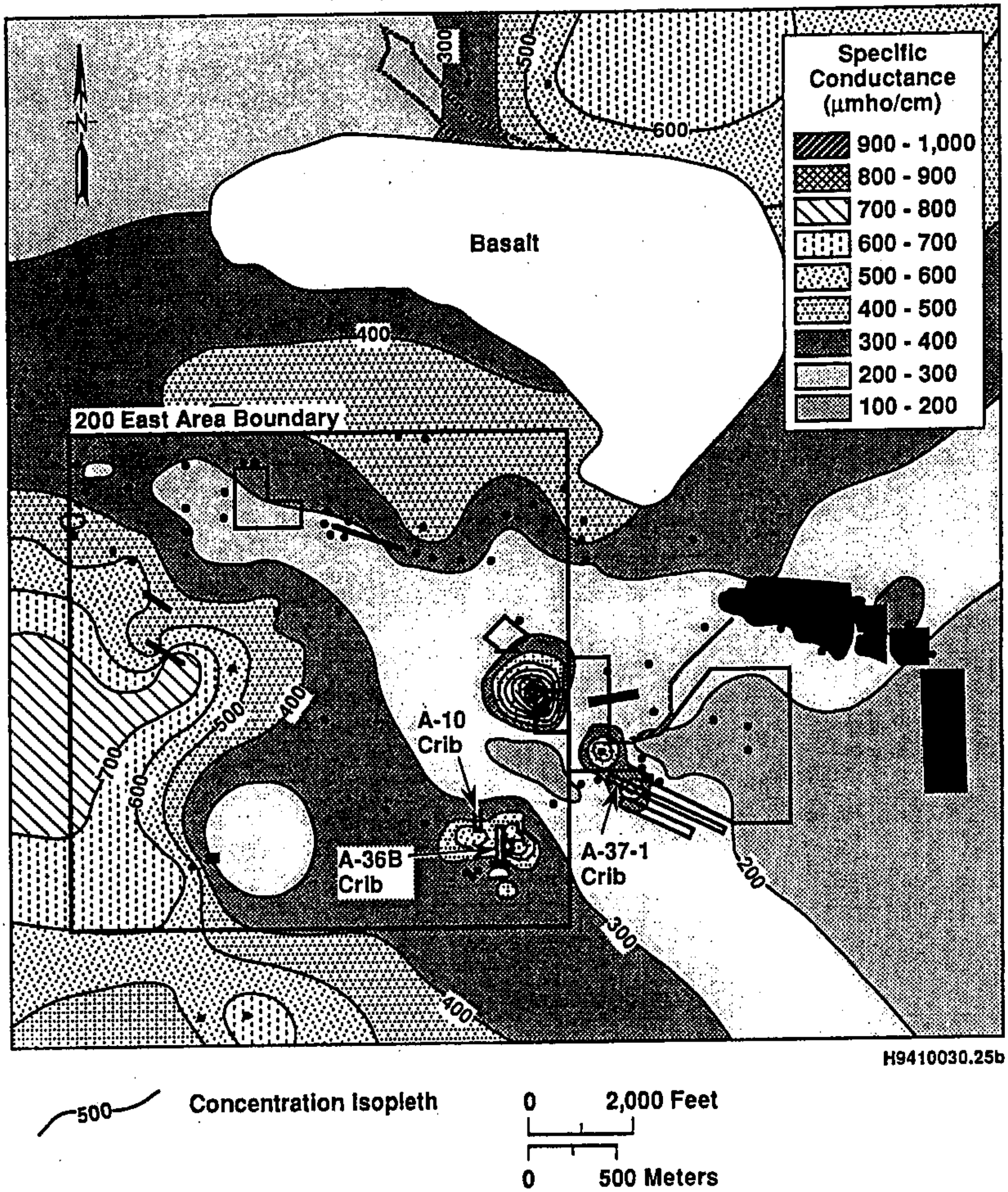


Figure 4.1. Specific Conductance in the Uppermost Aquifer, 200 East Area

specific conductance as high as 636 μmho/cm during 1996. However, well 299-E17-9 does not meet construction standards of WAC 173-160 and is not used for statistical comparisons. Two wells adjacent to the A-37-1 Crib (299-E25-19 and -20) also have slightly elevated conductivity relative to background conditions (B Pond waste water mixed with groundwater), although evaporator condensate discharged to the crib had relatively low specific conductance (80-400 μmho/cm).

4.1.2 Arsenic

The As plume is shown on Figure 4.2. Analyses of groundwater collected during 1996 from wells in the vicinity of the PUREX cribs show that the maximum concentration of As (outside of well 699-37-47A) was 12.0 μg/L (MCL 40 CFR 141-143 = 50 μg/L, WAC 173-200-40 = 0.05 μg/L) in four wells (299-E25-11, -E25-18, -E25-19, and -E25-20). The source of the As may be past discharges of chemical waste in which As was present as a contaminant (e.g., the 216-A-29 Ditch) or associated with chemical carryover from the 242-A Evaporator wastes discharged to the A-37-1 Crib. The large As plume also includes the area in the vicinity of the A-10 and A-36B cribs. Although no direct evidence shows that the southwest extension of the plume is caused by discharges to the A-10 and A-36B cribs, As-contaminated waste water is known to have been discharged to these cribs.

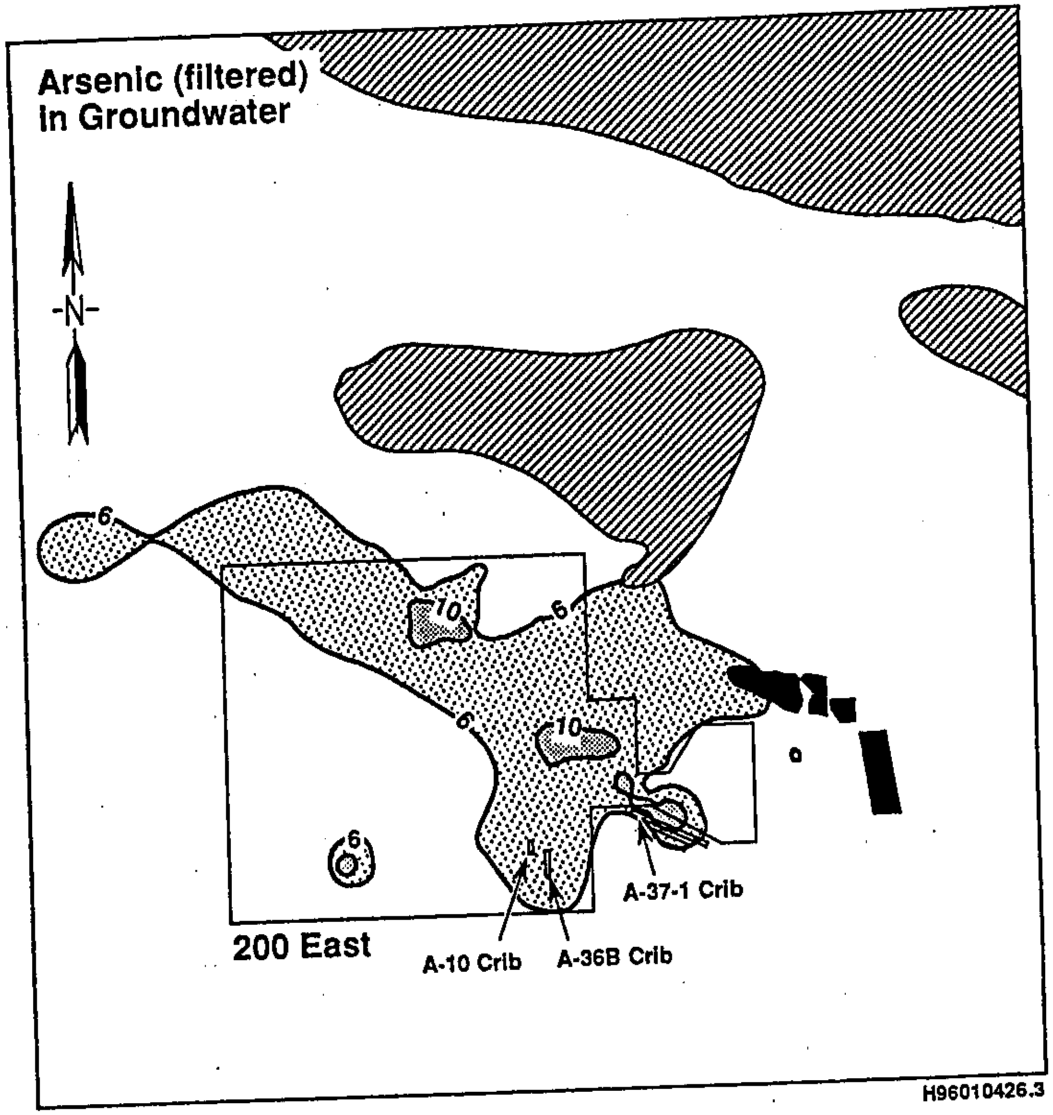
The vertical distribution of As at well 699-37-47A is as follows at the six sampling depths below the water table (Lindberg et al. 1997):

- 4.6 m 11.4 μg/L
- 8.8 m 9.5 μg/L
- 15.0 m 7.6 μg/L

16.8 to 30.5 m below water table = lower mud unit

- 33.8 m 84.8 μg/L
- 45.7 m 12.1 μg/L
- 58.2 m 3.2 μg/L

The vertical sampling data at well 699-37-47A show that As concentrations in the groundwater decrease downward throughout the upper portion of the unconfined aquifer (Ringold Formation unit E) from 11.4 to 7.6 μg/L. Below the Ringold Formation lower mud unit, the As concentration is 84.8 μg/L and then it decreases with increasing depth throughout the Ringold Formation unit A to 3.2 μg/L near the base of the unit. Arsenic concentration of 84.8 μg/L is higher than anywhere else in 200 East Area groundwater. One possible explanation for this As anomaly is that it is from B Pond or the A-29 Ditch where the Ringold Formation lower mud unit is missing. Another possible explanation is that the As anomaly could be a local, naturally occurring source. Naturally occurring As also has been considered for anomalous concentrations of As found in groundwater beneath the 216-Z-20 Crib in the 200 West Area (Johnson 1993).



6 Concentration Isopleth (ppb)

Concentration values shown are average values for the period 1/1/91 - 10/1/93

Detection Limit	5 ppb
Drinking Water Standard	50 ppb
Maximum Concentration Limit	50 ppb
1/25 Derived Concentration Guide	N/A

0 3,000 Feet

0 1,000 Meters

Basalt

Figure 4.2. Arsenic in the Uppermost Aquifer, 200 East Area

4.1.3 Nitrate

There are two nitrate plumes in the vicinity of the PUREX cribs (Figure 4.3). One plume is near the A-37-1 Crib, where the concentration of nitrate is greater than that detected in surrounding wells. During 1996, well 299-E25-20 had the highest nitrate concentration near the A-37-1 Crib at 25,000 μg/L (MCL 45,000 μg/L).

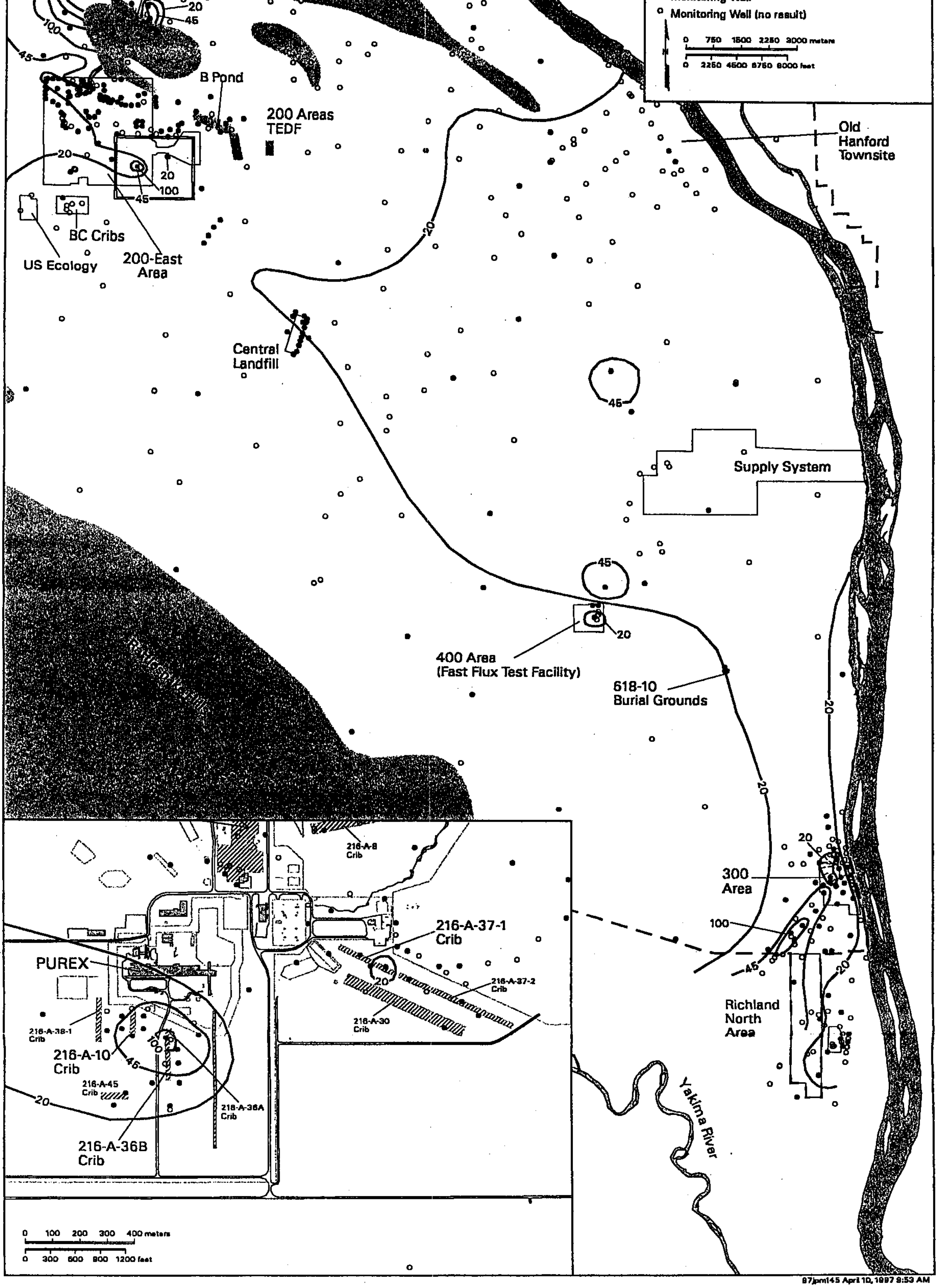
The other plume trends northwest to southeast across the southern portion of the 200 East Area. Wells in the immediate vicinity of the A-10 and A-36B cribs show nitrate concentrations that are higher than surrounding wells in this portion of the nitrate plume. Well 299-E17-9 had the highest concentration of nitrate near the PUREX cribs during 1996 (near A-36B) with 130,000 μg/L. The higher level of nitrate in well 299-E17-9 is probably responsible for elevated specific conductance in this well. The increased concentration of nitrate in the vicinity of the cribs indicates that A-10 and/or A-36B, as well as A-37-1, are a source of nitrate contamination.

The total lateral extent of the nitrate plume extends outward from the vicinity of the PUREX cribs to the Columbia River and from the old Hanford Townsite to the 300 Area (Figure 4.3). The lower concentration of nitrate in the plume between the Central Landfill and the 200 East Area indicates that less nitrate came from the sources in later than in earlier discharges. The slightly more concentrated portion of the plume near the 400 Area is probably due to the 400 Area Process Trenches. The reason for the other area of elevated nitrate northwest of the Supply System is unknown, but both areas correspond to an areas of lower tritium concentration (Figure 4.4).

The vertical distribution of the nitrate plume downgradient of the PUREX cribs at well 699-37-47A is from 3,900 to 8,590 μg/L in the unconfined aquifer between the water table and the Ringold lower mud unit. These results are lower than previously interpreted for this area from nitrate concentration maps of the 200 East Area. Below the Ringold Formation lower mud unit, nitrate ranged from below detection to 72 μg/L.

4.1.4 Tritium

A large ^{3}H plume extends diagonally from northwest to southeast beneath the 200 East Area and then spreads out in a large fan-shaped plume extending to the Columbia River (Figure 4.4). The plume also extends from the vicinity of B Pond to the south and southwest to intercept the main portion of the plume. The most concentrated portion of the plume passes through the area of the A-10 and A-36B cribs. The ^{3}H plume at concentrations above the interim DWS (20,000 pCi/L) is spread over a large area of the central Hanford Site, from the 200 East Area to the Columbia River near the old Hanford Townsite on the east and to the 400 Area and the Supply System to the southeast. The highest concentrations during 1996 were found in the southeastern corner of the 200 East Area near all three of the PUREX cribs. At well 299-E27-9 the ^{3}H concentration averaged over 3.5 million pCi/L.



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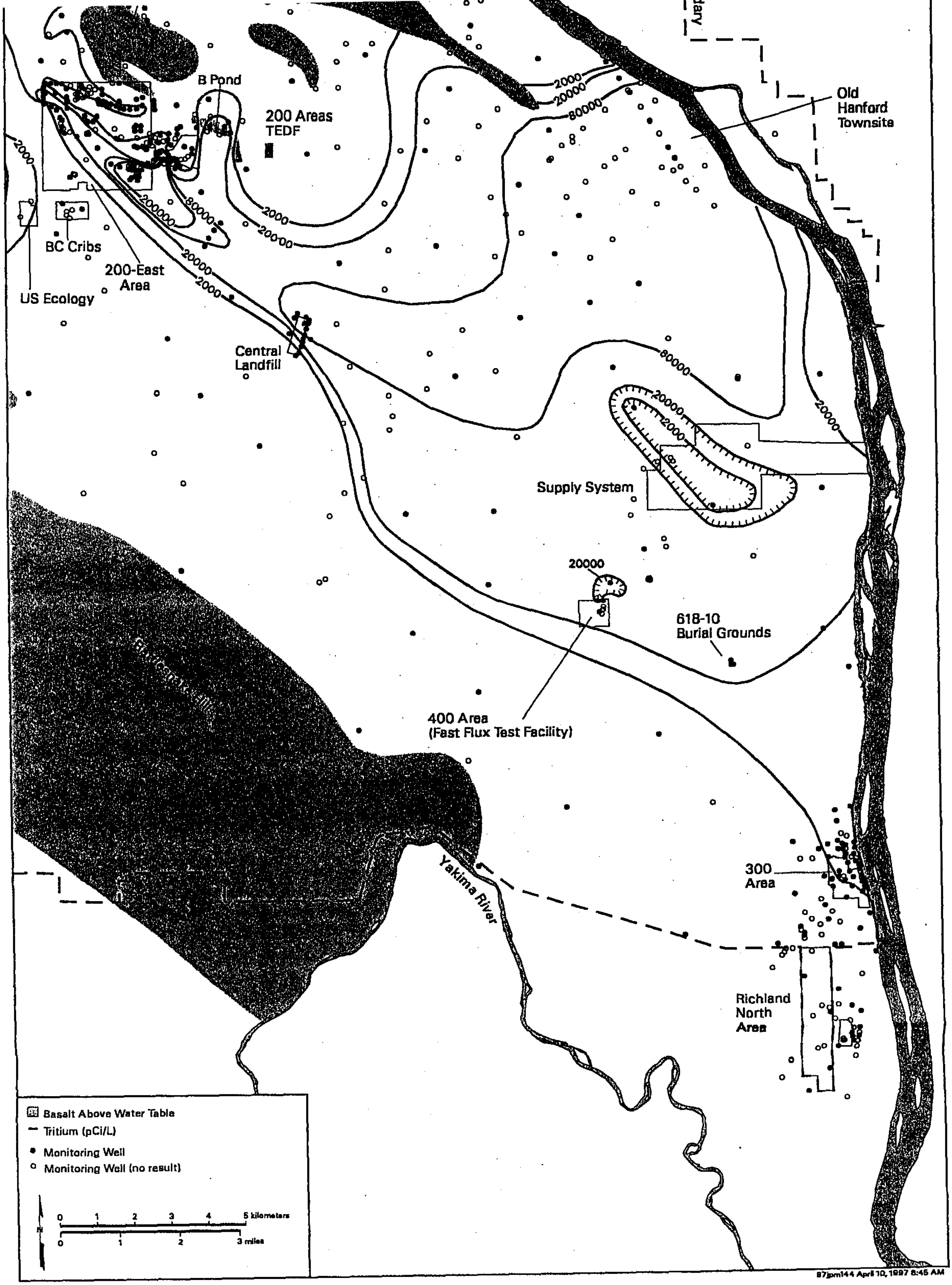

dary
B Pond
200 Areas
TEDF
2000
20000
80000
Old
Hanford
Townsite
200000
BC Cribs
200-East
Area
US Ecology
Central
Landfill
Supply System
20000
618-10
Burial Grounds
400 Area
(Fast Flux Test Facility)
Yakima River
300
Area
Richland
North
Area
Basalt Above Water Table
Tritium (pCi/L)
Monitoring Well
Monitoring Well (no result)
0 1 2 3 4 5 kilometers
0 1 2 3 miles
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Portions of the ^3H plume are less concentrated near the 400 Area and the Supply System. The decreased concentration near the 400 Area is probably due to discharges of waste water from the 400 Area Process Trenches. One explanation for a lower concentration of ^3H (and higher concentration of nitrate) near the Supply System is that groundwater movement may be retarded there due to the lower hydraulic conductivity of the Ringold Formation upper unit and unit E that extend above the water table. The higher concentration of nitrate and lower concentration of ^3H there could be remnants of groundwater contamination (or in the case of ^3H, lower concentration) from earlier times.

The vertical distribution of the ^3H plume downgradient of the PUREX cribs at well 699-37-47A ranged from 17,700 pCi/L at 4.6 m below the water table to 13,000 pCi/L at 8.8 m. At 15 m below the water table, the ^3H activity was 14,200 pCi/L. Below the Ringold Formation lower mud unit, the ^3H activity was within the counting error in all three groundwater samples. The result at 4.6 m below the water table (within the screen interval of the finished well) is more than an order of magnitude lower than was previously interpreted for this location.

4.1.5 Iodine-129

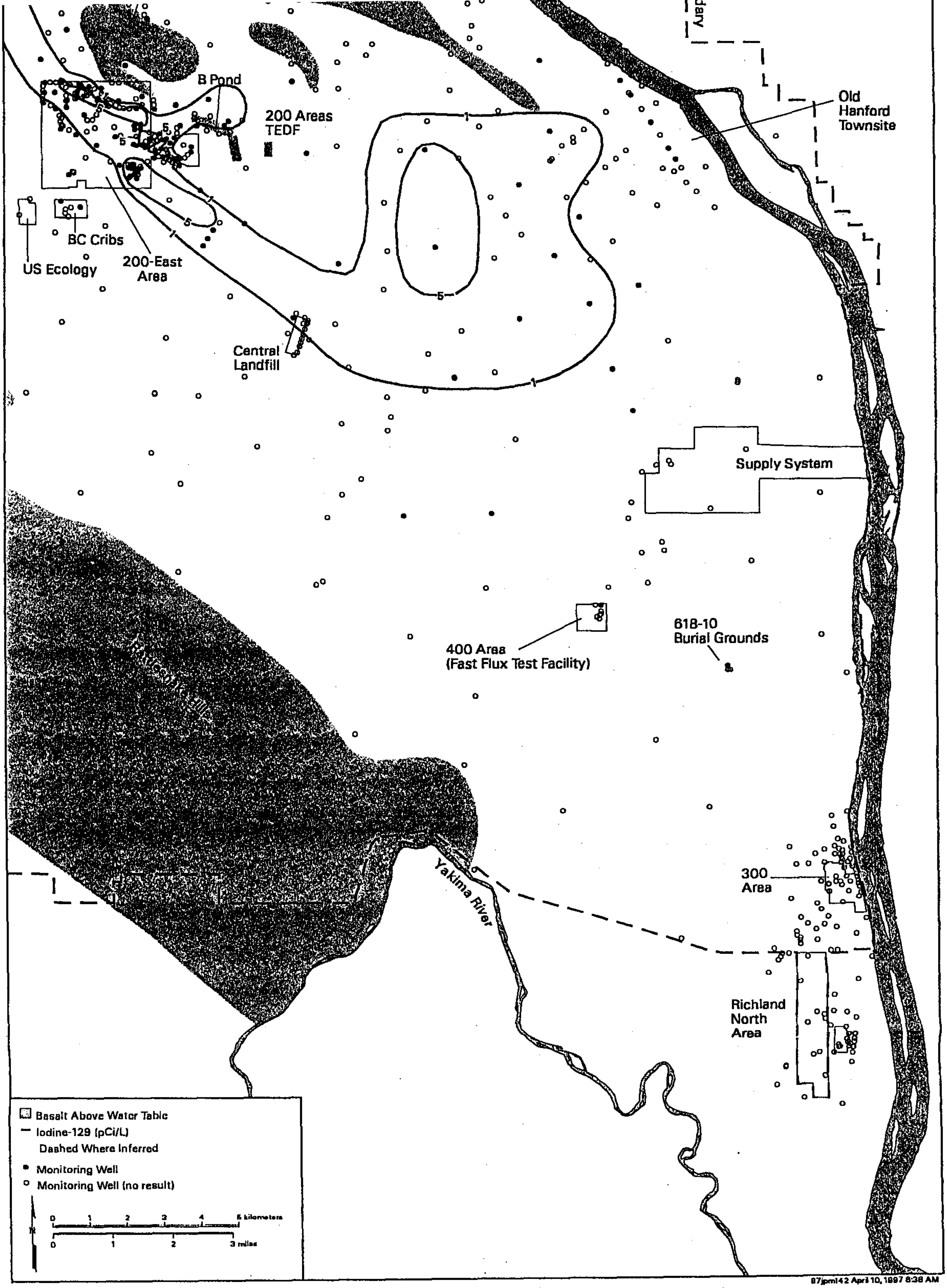
Much of the 200 East Area is underlain by ^{129}I-contaminated groundwater. In addition, the plume at concentrations greater than 1.0 pCi/L (the interim DWS) extends to the east as far as the old Hanford Townsite and to the southeast beyond the Central Landfill (Figure 4.5). The highest average concentration (>5 pCi/L) is found in wells in the southeastern corner of the 200 East Area. The highest concentrations of ^{129}I during 1996 were at well 299-E17-14 (near A-36B) with 13.59 pCi/L and well 299-E24-17 (near A-10) with 13.18 pCi/L. The primary source is PUREX process condensate previously discharged to the A-10 and 216-A-45 cribs. Evaporator condensate discharged to the A-37-1 Crib also may have contributed to the widely dispersed plume that remains today.

The vertical distribution of ^{129}I in well 699-37-47A ranges from 2.13 pCi/L at 4.6 m below the water table to 3.7 pCi/L at 15.0 m below the water table. Below the Ringold Formation lower mud unit, the ^{129}I activity was within the counting error in all three groundwater samples.

4.1.6 Beta-Emitting Radionuclides

The highest beta activities within and near the 200 East Area are on the north side of the 200 East Area. The highest concentration of beta-emitting radionuclides detected during 1996 in the southeastern portion of the 200 East Area was at well 299-E17-14 (an A-36B well), where beta activity was measured at 81.8 pCi/L. Gross beta activity is not elevated near the A-37-1 Crib.

Technetium-99 and ^{90}Sr are the primary contributors to the beta plume, and gross beta as screening analyses has replaced routine ^{99}Tc and ^{90}Sr analyses at A-10 and A-36B RCRA groundwater monitoring programs. However, in the one well that was still analyzed for ^{90}Sr, the reported concentration was 15.7 pCi/L when gross beta was 81.8 pCi/L (April 1996). ^{99}Tc activity was not analyzed in well 299-E17-14 during 1996. The last time ^{99}Tc activity was measured in a sample from 299-E17-14 was August 1994, and the activity level was 209.0 pCi/L. ^{99}Tc is no longer analyzed in groundwater



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samples taken from PUREX cribs wells because the reported values in the past were well below the interim DWS of 900 pCi/L. Unfortunately, small concentrations of ^{99}Tc can mask the presence of ^{90}Sr when gross beta is used as the screening analysis.

The vertical distribution of gross beta in well 69-37-47A was typical of the normal Hanford Site gross beta background of 7 to 8 pCi/L in the three samples above the Ringold Formation lower mud unit. Below the lower mud unit, the results were 31.6, 82.0, and 57.2 pCi/L, respectively, for 33.8 m, 45.7 m, and 58.2 m depths below the water table. Since the ^{90}Sr and ^{99}Tc activities were within or near the counting error in all six of the vertical groundwater samples, the elevated gross beta is most likely due to U daughters (See Section 4.1.7).

4.1.7 Uranium

Elevated concentrations of U were discovered in groundwater samples collected while drilling well 699-37-47A. The elevated U concentrations were discovered in the three groundwater samples collected below the Ringold Formation lower mud unit. The three results were 220, 395, and 197 μg/L (proposed MCL 20 μg/L) for samples collected at 33.8, 45.7, and 58.2 m (respectively) of depth below the water table (Lindberg et al. 1997). These results appear to be anomalous.

To investigate the possibility that the U might be naturally occurring, isotopic U analyses were conducted on the three samples. The results of the isotopic U analyses showed that ^{236}U was not detected (Lindberg et al. 1997). Naturally occurring U would have no detectable ^{236}U, whereas U from past Hanford activities likely would have been irradiated and, if irradiated, definitely would have detectable quantities of ^{236}U. However, the possibility exists that cold (unirradiated yet enriched) or dummy (unenriched and non-irradiated) U was used at the start of thc PUREX Plant operations, and that U could have been disposed to the ground subsequently causing the U anomaly in well 699-37-47A.

Co-contaminants discovered with the anomalous U may also help identify the source as natural or human-related. A co-contaminant with the anomalous U is arsenic. Arsenic and antimony are known to be co-contaminants with some occurrences of natural U. The lack of ^{99}Tc, nitrate, and ^{3}H in samples with the anomalous U suggests that an irradiated U source is not the cause of the anomalous U. The lack of nitrate suggests that an unirradiated (cold) enriched U source or unenriched U source used as dummy fuel are not the cause of the anomalous U.

Other evidence that the U probably is not caused by waste water discharges to the PUREX cribs is that analyses of groundwater from wells near the PUREX cribs have not detected U at the higher concentrations discovered below the Ringold Formation lower mud unit in well 699-37-47A. The highest concentration previously detected was 41.1 pCi/L (58.7 μg/L) in well 299-E24-2 in October 1982. Furthermore, it is unlikely that the A-10 and A-36B cribs could be the source of U contamination in Ringold Formation unit A because of the presence of the Ringold Formation lower mud unit as a local confining layer directly below those cribs. However, the lower mud unit is missing beneath the A-37-1 Crib. The U anomaly in unit A is discussed further in Sections 4.4 and 5.3.2.

4.2 Historical Trends

Concentration history plots for nitrate and ^3H, two of the major contaminants related to the A-10, A-36B, and A-37-1 cribs, are shown in Figures 4.6 and 4.7. Both the ^3H and nitrate time series plots show a gradual decline from early 1990 to the present. This decline is probably due to discontinuance of waste water discharges to the cribs. Furthermore, as the recharge rate/infiltration rate returns to pre-disposal conditions, the decline will probably continue (i.e., increases are not expected). Nitrate shows a concentration versus time pattern that is very similar to ^3H, especially in wells 299-E17-1 (downgradient of the 216-A-10 crib), 299-E17-14 (downgradient of the 216-A-36-B crib), and 299-E25-19 (downgradient of the 216-A-37-1 crib).

Since very little nitrate was actually measured in effluent discharged to the three PUREX cribs of concern in this plan, the occurrence of elevated nitrate in groundwater beneath the crib is probably due to biodegregation by bacterial action of the ammonium ion to nitrate (explained further in Appendix B). Some of the nitrate may have come from nitric acid discharged to 216-A-36 Crib before the A-36B Crib was isolated from the 216-A-16 Crib. Waste water containing nitric acid (acidic) is incompatible with the alkaline waste water containing ammonium distillate that is known to have been discharged to the A-36B Crib.

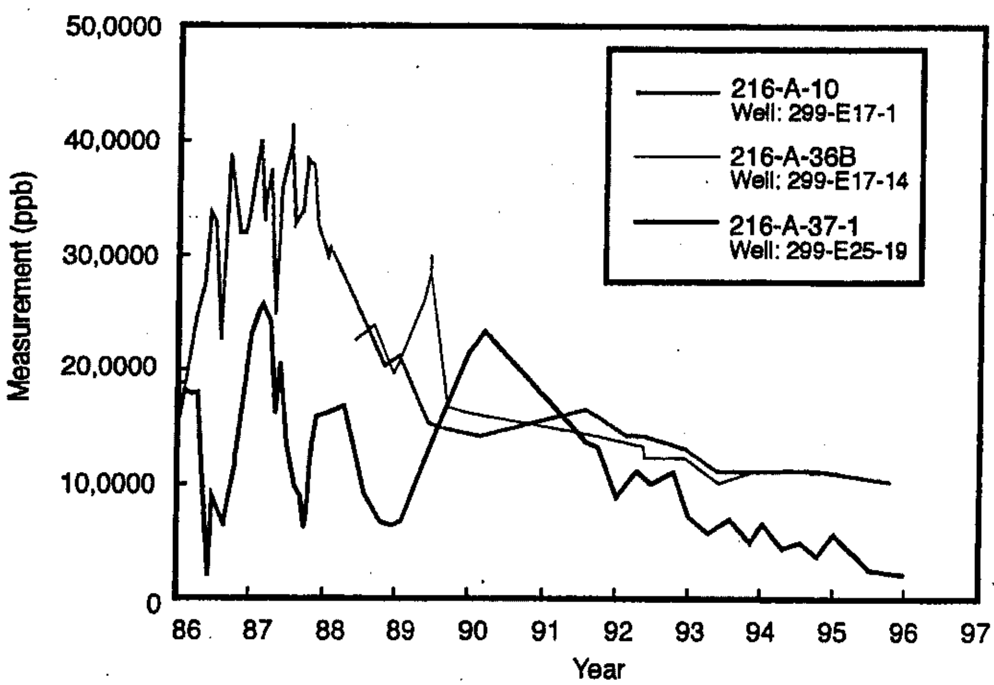


Figure 4.6. Time Series Plots of Tritium in Combination Network Wells

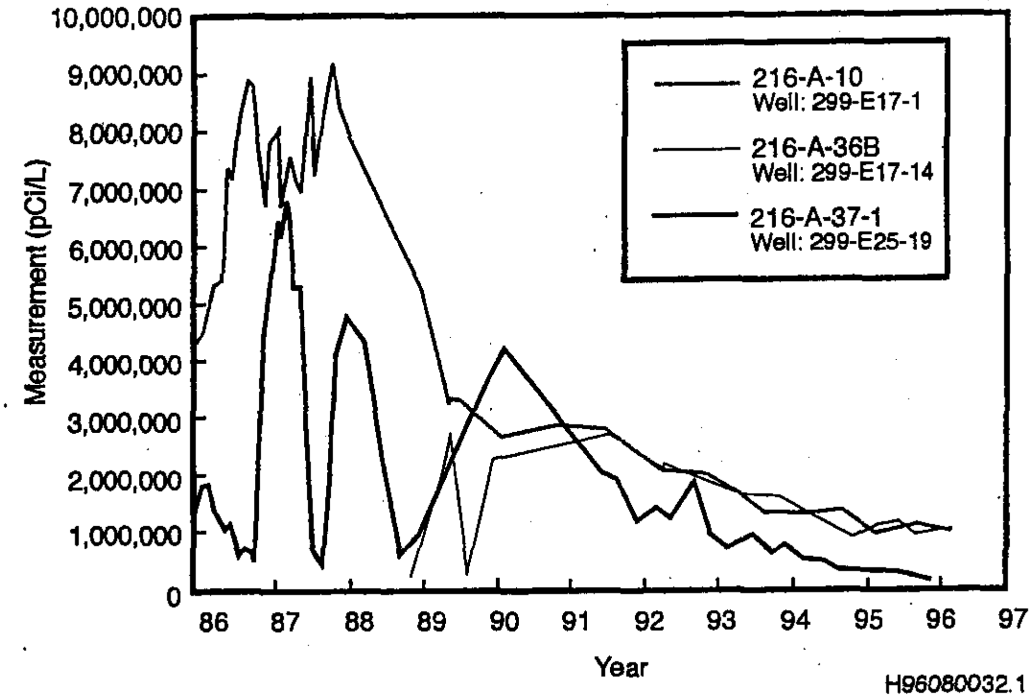


Figure 4.7. Time Series Plots of Nitrate in Combination Network Wells

4.3 Contaminant Screening Results

Groundwater samples have been collected for the A-10 and A-36B cribs under the RCRA groundwater monitoring program and for the A-37-1 wells from 1) the operational monitoring program, 2) a one-time liquid effluent study conducted during 1989 and 1990 (WHC 1990), and 3) the RCRA groundwater monitoring program for the A-29 Ditch.

RCRA Groundwater samples were first collected from the A-10 network in November 1988 and from the A-36B network in May 1988 (Kazsa 1994). The cribs were sampled for contaminant indicator parameters, groundwater quality parameters, drinking water parameters and site-specific parameters as required by interim status regulations stipulated in 40 CFR 265. Statistical evaluations of indicator parameter-evaluation data were performed semiannually from 1990 to 1996 (e.g., DOE-RL 1991). The statistical method used was the AR t-test (Chou 1991). The statistical evaluations of the contaminant indicator parameter data have not shown that the groundwater quality has been impacted from waste discharged into the A-10 and A-36B cribs (specific conductance should have been sensitive to elevated nitrate concentration). However, individual constituents originating from the PUREX cribs have been detected in groundwater and have exceeded MCL or interim drinking water standards (e.g., nitrate and ^{3}H).

Tables 4.2 and 4.3 summarize the process knowledge, constituents detected from 1988 to 1994, constituents detected since 1994, and the constituents exceeding primary and secondary DWS from

Table 4.2. 216-A-10 Crib Contaminant Screening Summary

Process Knowledge	Waste consisted of process distillate discharge that was characteristically acidic and contained concentrated salts. Other wastes included aliphatic hydrocarbon compounds, organic complexants, and radionuclides including ^{3}H, Pu, U, ^{90}Sr, ^{134,137}Cs, ^{103,106}Ru, ^{60}Co, ^{113}Sn, ^{147}Pm, ^{241}Am, and ^{129}I.		
Constituents Detected 1988-1994[a] in Groundwater	1,1,1-Trichloroethane	Co	K
	2-Butanone	^{60}Co	^{40}K
	4,4'-DDT	Coliform Bacteria	Ra
	Acetone	Cu	^{106}Ru
	Al	^{154}Eu	Se
	Ammonia	^{155}Eu	Si
	Sb	Fluoride	Ag
	^{125}Sb	Gross Alpha	Na
	As	Gross Beta	Sr (elemental)
	Ba	Hydrazine	^{90}Sr
	Be	^{129}I	Styrene
	^{7}Be	Fe	Sulfate
	Bis(2-ethylhexyl) phthalate	Pb	^{99}Tc
	B	^{212}Pb	Sn
	Bromide	Li	Toluene
	Cd	Mg	^{3}H
	Ca	Mn	U
	Carbon disulfide	Hg	^{234,235,238}U
	^{144}Ce/Pr	Methylene chloride	V
	^{134}Cs	Ni	Zn
	^{137}Cs	Nitrate	^{65}Zn
	Chloride	Nitrite	^{95}Zr/Nb
	Cr	Pu	
Constituents Detected Since 1994[a] in Groundwater	Al	Cu	^{106}Ru
	Sb	Fluoride	Se
	^{125}Sb	Gross Alpha	Si
	As	Gross Beta	Ag
	Ba	Hydrazine	Na
	Bis(2-ethylhexyl)phthalate	^{129}I	Sr (elemental)
	Be	Fe	^{90}Sr
	B	Pb	Sulfate
	Bromide	Mg	^{99}Tc
	Cd	Mn	Sn
	Ca	Hg	^{3}H
	Carbon disulfide	Methylene chloride	U
	Chloride	Ni	^{234,235,238}U
	Cr	Nitrate	V
	Co	K	Zn
	^{60}Co	Ra	

Table 4.2. (contd)

Constituents Exceeding Primary and Secondary MCL and DWS Since 1994-1996[a] in Groundwater	Cr (100 ppb)[b] Gross Alpha (15 pCi/L) ^{129}I (1 pCi/L)	Mn (50 ppb)[b] Ni (100 ppb)[b] Nitrate (45,000 ppb)	^{106}Ru (30 pCi/L) ^{3}H (20,000 pCi/L)

MCL - Maximum Contaminant Level
DWS - Drinking Water Standards
(a) Listed constituents are from wells 299-E17-1, 299-E17-19, 299-E17-20, 299-E24-17, 299-E24-18, 299-E24-2, and/or 299-E24-36.MCL.
(b) The unfiltered metal was above the MCL.

Table 4.3. 216-A-36B Crib Contaminant Screening Summary

Process Knowledge	Waste consisted of process condensate from nuclear fuel decladding operations in which zirconium cladding was removed from irradiated fuel by boiling in a solution of ammonium fluoride and ammonium nitrate. Other waste stream constituents included radionuclides of Pu, ^{3}H, U, ^{90}Sr, ^{137}Cs, ^{103,106}Ru, ^{60}Co, ^{113}Sn, ^{147}Pm, ^{241}Am, and ^{129}I.		
Constituents Detected 1988-1994[a] in Groundwater	2,4-Dichlorophenol 2,4-Dimethylphenol 2-Propanol 4,4-DDE 4,4'-DDT Acetone Al ^{241}Am Ammonia Sb ^{125}Sb As Ba Be ^{7}Be Bis(2-ethylhexyl) phthalate B Bromide Cd Ca ^{14}C ^{144}Ce/Pr ^{134}Cs	^{137}Cs Chloride Cr Co ^{60}Co Coliform Bacteria Copper Cresols (methylphenols) Di-n-butylphthalate ^{154}Eu ^{155}Eu Fluoride Gross Alpha Gross Beta ^{129}I Fe Pb ^{212}Pb Mg Mn Hg Methyl ethyl ketone Methylene chloride Ni Nitrate	Nitrite Phenol K ^{40}K Ra ^{106}Ru Se Si Ag Na Sr (elemental) ^{90}Sr Sulfate ^{99}Tc Sn Toluene Trichloromonofluoromethane ^{3}H U ^{234,235,238}U V Zn ^{65}Zn ^{95}Zr/Nb

Table 4.3. (contd)

Constituents Detected Since 1994[(a)] in Groundwater	Al	Cu	Si
	Sb	Di-n-butylphthalate Fluoride	Ag
	As	Gross Alpha	Na
	Ba	Gross Beta	Sr (elemental)
	Be	^{129}I	^{90}Sr
	B	Fe	Sulfate
	Bromide	Pb	^{99}Tc
	Cd	Mg	Sn
	Ca	Mn	^{3}H
	^{14}C	Ni	U
	^{137}Cs	Nitrate	^{234,235,238}U
	Chloride	K	V
	Cr	Se	Zn
	Co		
	^{60}Co		
Constituents Exceeding Primary and Secondary MCL and DWS Since 1994-1996[(a)] in Groundwater	Sb (6 ppb)	^{129}I (1 pCi/L)	Nitrate (45,000 ppb)
	Cr (100 ppb)[(b)]	Fe (300 ppb)[(b)]	^{90}Sr (8 pCi/L)
	Gross Alpha (15 pCi/L)	Ni (100 ppb)[(b)]	^{3}H (20,000 pCi/L)

MCL - Maximum Contaminant Level
DWS - Drinking Water Standards
(a) Listed constituents are from wells 299-E17-5, 299-E17-9, 299-E17-14, 299-E17-15, 299-E17-16, 299-E17-17, 299-E17-18, 299-E24-18, and/or 299-E24-36.
(b) The unfiltered metal was above the MCL.

1994 to 1996 for the A-10 and A-36B cribs, respectively. Wells in the A-10 network exceeded the MCL or DWS from 1994 to 1996 for Cr, gross alpha (probably U), ^{129}I, Mn, Ni, nitrate, ^{106}Ru, and ^{3}H. Wells in the A-36B network exceeded the MCL or DWS from 1994 to 1996 for Sb, Cr, gross alpha (probably U), ^{129}I, Fe, Ni, nitrate, ^{90}Sr, and ^{3}H.

Before 1990, the A-37-1 Crib (monitored under the operational groundwater monitoring program) had historically focused on radiological constituents and nitrate. The program was supplemented by analysis of CFR 265 Appendix IX and site-specific constituents as part of the Liquid Effluent Study (WHC 1990). The survey provided a broad screening of both inorganic and organic contaminants that included most of the constituents potentially present in effluent to the crib. The RCRA groundwater monitoring network for the A-29 Ditch also included some wells near the A-37-1 Crib. The wells were sampled for anions, TOC, TOX, and ^{3}H. Selected samples were also analyzed for VOAs and other organics. Results have been presented in RCRA Quarterly Reports (e.g., DOE-RL 1993).

The process condensate discharged to the A-37-1 Crib was a low-salt alkaline solution. The major contaminants of concern based on effluent measurements are ^{3}H, ammonium/nitrate, acetone, and hexone. Based on process knowledge, but not confirmed by effluent measurements, methylene chloride and trichloroethane are also suspected. The organic constituents have not been detected, however, in the groundwater. Small quantities of fission products and transuranics were also discharged to the crib as carryover from the 242-A Evaporator. They include ^{3}H, U, ^{90}Sr, ^{137}Cs, and ^{147}Pm (Aldrich 1987).

Table 4.4 summarizes the process knowledge by listing 1) constituents detected from 1988 to 1994, 2) constituents detected since 1994, and 3) the constituents exceeding primary and secondary MCL or DWS from 1994 to 1996 for the A-37-1 network. Wells in the A-37-1 network exceeded the MCL or DWS in 1994-1996 for Al, Sb, Cd, Cr, ^{129}I, Fe, Mn, Ni, nitrate, ^{3}H, and Zn.

In most cases, the metals that have exceeded the DWS have been from unfiltered samples. The presence of relatively high concentrations of metals in unfiltered samples is believed to be a result of well construction-related particles in the groundwater (DOE-RL 1994). Excluding the metal anomalies the only significant detections in all three cribs were ^{3}H, ^{129}I, ^{90}Sr, and nitrate.

The nitrate levels for the three cribs are detected at higher levels than expected based on process knowledge information. For example, the maximum nitrate concentration identified in waste stream analyses of A-37-1 was 5 mg/L as compared to a maximum groundwater concentration of 235 mg/L. The only other nitrogen species of this magnitude identified in evaporator process condensate was ammonium at a maximum concentration of 2200 mg/L. In contrast, ammonium was detected in groundwater only infrequently, and the maximum concentration was only 0.3 mg/L (WHC 1990). Two possible explanations for the apparent nitrate/ammonium anomaly are as follows:

1. Ammonium from the effluent stream was converted to nitrate in the soil column beneath the crib through the process of nitrification (conversion of ammonium to nitrate by bacterial action).

2. Dilute nitric acid may have been discharged to the 216-A-36 Crib (before A-36A and A-36B separation) along with an inventory of waste fission products from the separations processes.

4.4 Summary of Groundwater Chemistry: Conceptual Model

Based on the foregoing review of existing groundwater data (including natural recharge, Section 3.2.3) and historical effluent information, the volume of hazardous wastes retained in the soil column and the volume that was flushed through the soil column is unclear. The following conceptual model of contaminant behavior and status beneath the A-10, A-36B, and A-37-1 cribs is proposed. A schematic illustration conceptualizing the processes and information described above is provided in Figure 4.8. The illustration presents a conceptual model (in the vicinity of the PUREX cribs) of the site hydrogeology and the influence of waste management during active disposal of liquid wastes. Liquid wastes were released in the cribs, percolated vertically downward, and spread laterally an unknown distance as they moved through the vadose zone. As the wastes intercepted and mixed with groundwater in the unconfined aquifer, they moved laterally with the groundwater flow.

Table 4.4. 216-A-37-1 Crib Contaminant Screening Summary

Process Knowledge	Waste consisted of process condensate made up of a low-salt alkaline solution. Major contaminants included ammonia, acetone, hexone, methylene chloride, trichloroethane, tritium, uranium strontium-90, cesium-137, and promethium-147.		
Constituents Detected 1988-1994[a] in Groundwater	1,1,1-Trichloroethane	Cu	Pentachlorophenol
	4,4'-DDD	Delta-BHC	K
	4,4'-DDT	Dieldrin	^{40}K
	Aldrin	Dimethoate	Ra
	Al	Endrin	^{106}Ru
	Ammonia	Endrin Aldehyde	Se
	Sb	^{154}Eu	Si
	^{125}Sb	^{155}Eu	Ag
	As	Fluoride	Na
	Ba	Gross Alpha	Sr (elemental)
	Be	Gross Beta	Sulfate
	^{7}Be	Heptachlor	^{99}Tc
	Bis(2-ethylhexyl) phthalate	Heptachlor epoxide	Sn
	B	Hydrazine	Ti
	Cd	^{129}I	Toluene
	Ca	Fe	Tris-2-chloroethyl phosphate
	^{144}Ce/Pr	Pb	^{3}H
	^{134}Cs	Lindane	U
	^{137}Cs	Li	^{234,238}U
	Chloride	Mg	V
	Chloroform	Mn	Zn
	Cr	Hg	^{65}Zn
	Co	Methylene chloride	^{95}Zr/Nb
	^{60}Co	Ni	m-Cresol
	Coliform Bacteria	Nitrate	
Constituents Detected Since 1994[a] in Groundwater	Al	Gross Alpha	Ag
	Sb	Gross Beta	Na
	As	Hydrazine	Sr (elemental)
	Ba	^{129}I	Sulfate
	Be	Fe	^{99}Tc
	B	Pb	Sn
	Cd	Mg	^{3}H
	Ca	Mn	U
	Chloride	Ni	^{234,235,238}U
	Cr	Nitrate	V
	Co	K	Zn
	Cu	Si	
	Fluoride		

Table 4.4. (contd)

Constituents Exceeding Primary and Secondary DWS or MCL Since 1994-1996[a] in Groundwater	Al (200 ppb)[b]	^{129}I (1 pCi/L)	Nitrate (45,000 ppb)
	Sb (6 ppb)	Fe (300 ppb)[b]	^{3}H (20,000 ppb)
	Cd (5 ppb)[b]	Mn (50 ppb)[b]	Zn (5000 ppb)[b]
	Cr (100 ppb)[b]	Ni (100 ppb)[b]	

MCL - Maximum Contaminant Level
DWS - Drinking Water Standards
(a) Listed constituents are from wells 299-E25-11, 299-E25-18, 299-E25-19, 299-E25-20, 299-E25-31, and/or 299-E25-44.
(b) The unfiltered metal was above the MCL.

This conceptual model applies to groundwater contamination moving through the upper portions of the unconfined aquifer (i.e., immediately below the water table). A model for movement of groundwater constituents beneath the Ringold Formation lower mud unit (such as the U and As discovered in well 699-37-47A) demands a different pathway for contaminant movement. First, if the U and As are natural (i.e., not related to human activity at Hanford), then their presence may be related to the U anomaly discovered in the borehole geophysics at the base of the lower mud unit (Lindberg et al. 1997), or from another source upgradient. If the U and As are a result of past Hanford activities, then the pathway may be through an access to the Ringold Formation unit A near 216-B-3 Pond, 216-A-29 Ditch, or the A-37-1 Crib (where the lower mud unit is missing), or some other breach in the lower mud unit, followed by movement structurally down-dip to the vicinity of well 699-37-47A. The U and As anomaly is discussed further in Section 5.2 (objectives of the proposed groundwater monitoring program) and Section 5.3.2 (as it relates to possible addition of new wells to the well network).

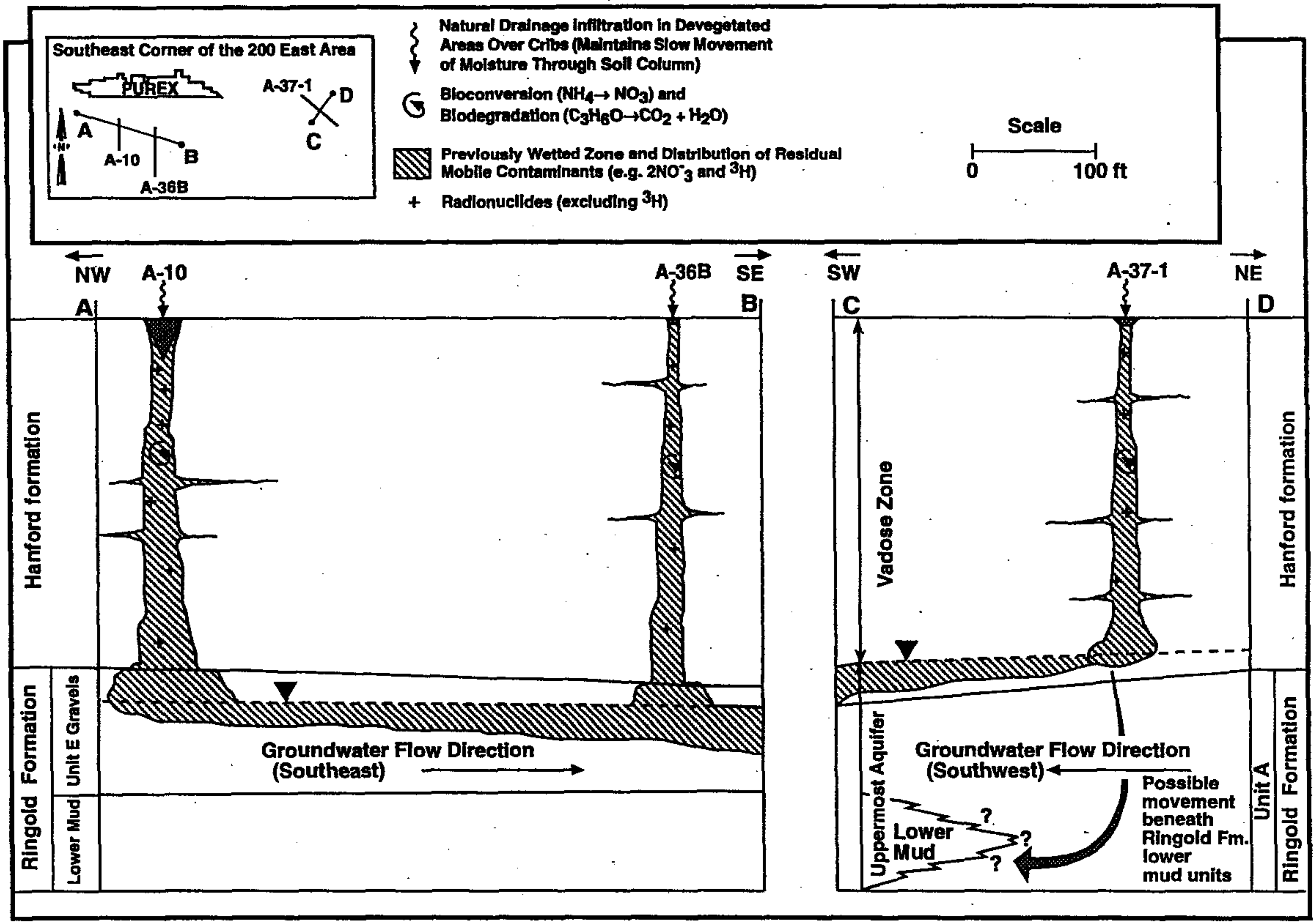


Figure 4.8. Conceptual Site Hydrogeologic Model for 216-A-10, 216-A-36B, and 216-A-37-1 Cribs

5.0 Groundwater Monitoring Program

This section describes an interim-status groundwater quality assessment program for the A-10, A-36B, and A-37-1 cribs. It is developed in accordance with RCRA regulatory requirements found in WAC 173-303-400, and by reference, requirements found in 40 CFR 265.93(d)(3) and (d)(4). The plan follows appropriate guidance from *RCRA Ground-Water Monitoring: Draft Technical Guidance* (EPA 1992), *RCRA Ground Water Monitoring Technical Enforcement Guidance Document* (EPA 1986a), *Environmental Investigation and Site Characterization Manual, WHC-CM-7-7* (WHC 1988) (or equivalent PNNL Procedures) and *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities, WHC-SD-EN-QAPP-001* (WHC 1995) (or equivalent PNNL QA Plan).

5.1 Objective

The main objective of the monitoring program is to assess the contaminants of concern that have migrated to in the groundwater from the three RCRA facilities (A-36B, A-10, and A-37-1 cribs) and determine the nature (including concentration), rate of movement, and extent of this contamination in groundwater. Data from 11 wells in the immediate vicinity of the cribs and 57 wells monitored by the Hanford Site Groundwater Surveillance Project (sitewide groundwater monitoring) will be used to make this determination.

A secondary objective is to identify the cause (and possible solutions for) the elevated nitrate and specific conductance at well 299-E17-9. The anomaly of U and As below the Ringold Formation lower mud unit in well 699-37-47A may be evaluated further.

5.2 Approach

The three PUREX cribs have been grouped together based on their proximity to one another, similar construction, similar discharged wastes (from PUREX Plant operations), and their similar hydrogeologic regime. In grouping the three cribs into one assessment-level program, several adjacent facilities were considered but excluded. The A-AX Tank Farms contain waste with unknown groundwater impact and the waste still in the tanks, 216-B-3 Pond system is an active site with a different hydrologic regime, and the 216-A-29 Ditch received waste of a different composition (PUREX Plant chemical sewer) than the three PUREX cribs. Furthermore, because the three cribs all discharged similar wastes to the ground and are collectively responsible for large groundwater contamination plumes extending all the way to the Columbia River, separating the plume contribution of each separate crib is very difficult. It is more efficient to combine the three cribs into one waste management area and assess the contaminant plumes as if they were from one combined source.

The proposed network will monitor the groundwater following Interim-status assessment requirements (40 *Code of Federal Regulations* [CFR] 265.90[d]). These regulations state:

(d) If an owner or operator assumes (or knows) that ground-water monitoring of indicator parameters in accordance with §§ 265.91(b) and 265.92 would show statistically significant increases (or decreases in the case of pH) when evaluated under § 265.93(b), he may, install, operate, and maintain an alternate ground-water monitoring system (other than the one described in §§ 265.91 and 265.92).

The A-10 and A-36B cribs were previously monitored under detection-level programs. Although the RCRA-compliant wells of those networks did not show that indicator parameters exceeded critical means, results from well 299-E17-9 (which does not meet RCRA construction standards) indicate that specific conductance exceeded the critical mean (613.1 μmhos/cm) once in 1995 (626.3 μmhos/cm) and again in 1996 (634 μmhos/cm). Furthermore, nitrate, As, ^{90}Sr, ^{129}I, ^{3}H and gross alpha exceed the MCL or interim DWS in wells of the A-10 and A-36B networks.

The A-37-1 Crib has not been monitored as a RCRA site in the past, but data from wells adjacent to the crib show that it also has affected groundwater (see Section 4.0). Furthermore, if the site had been monitored under RCRA, existing data suggest that there may have been exceedances of specific conductance (Section 4.1.1).

The elevated levels of nitrate and specific conductance at well 299-E17-9 (216-A-36B Crib) and the anomalous occurrence of U and As in the deeper portions of well 699-37-47A will be examined further by examining the process and waste disposal history of the PUREX Plant process. For instance, the high nitrate and corresponding elevated specific conductance near the A-36B Crib may be due to the discharge of dilute nitric acid in the A-36A portion of the crib before the A and B parts were separated. The waste history is unclear because the disposal of waste water containing nitric acid is very different than the alkaline waste water expected during the discharge of ammonia scrubber distillate in A-36B Crib. Similarly, the uranium and arsenic at well 699-37-47A may be due to a "cold" run of unenriched uranium that was discharged to the ground during PUREX Plant startup.

5.3 Groundwater Monitoring Design

This section describes the aquifer that will be monitored, groundwater monitoring wells that will be included in the proposed groundwater monitoring network, sampling frequency, groundwater constituents to be analyzed, and a plan to assess the new information from well 699-37-47A to determine if construction of additional network wells is warranted.

5.3.1 Definition of Uppermost Aquifer

As discussed in Section 3.2, the uppermost aquifer beneath the southeast portion of the 200 East Area and the area downgradient containing the contaminant plumes are predominantly within the

Ringold Formation. In some areas, the water table may be within the lower portion of the Hanford formation. The uppermost aquifer extends from the water table to the top of the Ringold Formation lower mud unit or to the basalt surface, where the lower mud unit is absent (see Figure 3.1).

5.3.2 Proposed Groundwater Monitoring Well Network

The proposed monitoring well network includes 11 near-field wells located in the immediate vicinity of the PUREX cribs (Figure 2.2) and 57 far-field wells located predominantly in the 600 Area between the 200 East Area and the Columbia River (Figure 5.1, Table 5.1). The far-field wells are also monitored to meet the requirements of DOE Order 5400.1 for environmental surveillance. Since this plan proposes to use environmental surveillance wells to monitor the large nitrate, ^{3}H, and ^{129}I plumes, the number of wells monitored will change as environmental surveillance needs change. No new wells are planned for FY-1998, but additional data from the new monitoring network and from PUREX Plant operations history will be assessed to determine the need to drill additional wells in or after FY-1998. Appendix C contains as-built diagrams of the near-field wells and schematic diagrams of far-field wells.

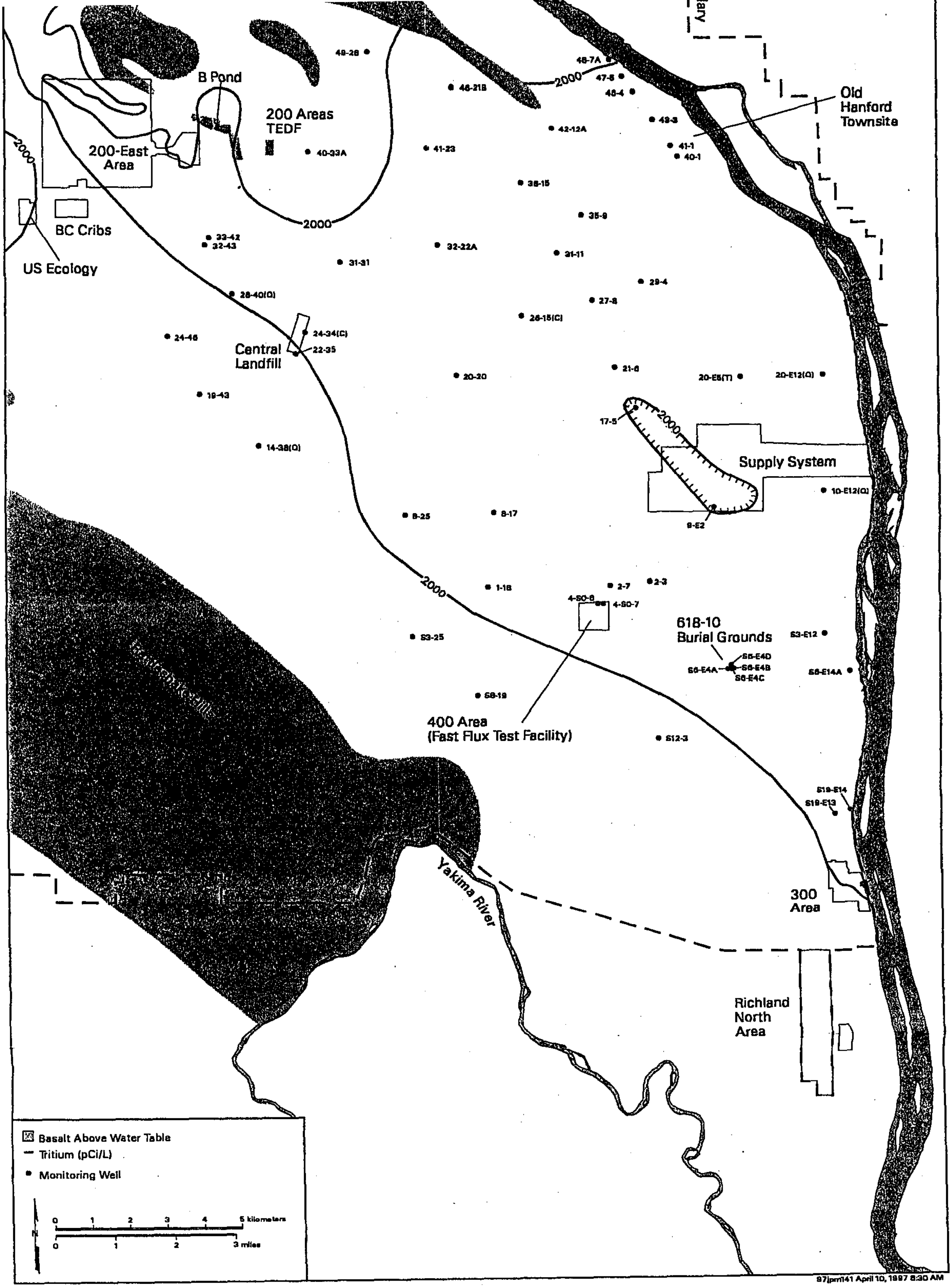
The objective of the well network in groundwater assessment monitoring is to characterize the extent and concentration of groundwater contamination plumes. Because there are existing wells in the area of the PUREX cribs, the wells needed to be evaluated to determine which ones should be included in the network. Individual near-field wells were chosen based on the following criteria:

- Location
- Well design
- Contaminant concentration history.

The assigned priority of these factors is highest for location, followed by well design (meets WAC 173-160), and then concentration history.

Using these criteria, two RCRA-compliant wells and one non-compliant well were selected downgradient of the A-10 and A-36B cribs for a total of three downgradient wells per crib. The two non-compliant wells were selected because of their contamination history (higher concentrations of constituents of concern). Well 299-E24-18 (a RCRA-compliant well) was selected as the upgradient well for groundwater flowing from the northwest. Well 299-E25-31 (also a RCRA-compliant well) was selected as the upgradient well for groundwater flowing from the northeast.

The selection of appropriate far-field monitoring well locations depended on adequate spacial coverage to define the existing contaminant plumes. Because the ^{3}H plume covers the largest area, the far-field wells that were chosen are within the 2,000 pCi/L concentration portion of the ^{3}H plume (Figure 4.4). Other wells were added around the perimeter of the 2,000 pCi/L isopleth on the ^{3}H concentration map to continue to monitor plume advancement. If the ^{3}H plume becomes larger, more



B Pond
200 Areas TEDF
200-East Area
BC Cribs
US Ecology
Old Hanford Townsite
Central Landfill
Supply System
618-10 Burial Grounds
400 Area (Fast Flux Test Facility)
Yakima River
300 Area
Richland North Area
2000
48-28
48-7A
47-5
46-21B
46-4
49-3
42-12A
41-1
40-1
40-33A
41-23
36-15
35-9
33-42
32-43
32-22A
31-31
31-11
29-4
28-40(O)
27-8
26-15(C)
24-46
24-34(C)
22-35
21-6
20-20
20-E5(T)
20-E12(O)
19-43
17-5
14-38(O)
10-E12(O)
9-E2
9-25
8-17
1-18
2-7
2-3
4-S0-8
4-S0-7
S3-25
S3-E12
S6-E4D
S6-E4B
S6-E4A
S6-E4C
S6-E14A
S8-19
S12-3
S19-E14
S19-E13
Basalt Above Water Table
Tritium (pCi/L)
Monitoring Well
0 1 2 3 4 5 kilometers
0 1 2 3 miles
N
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Table 5.1. Proposed Groundwater Monitoring Network

Far-Field Wells (Within 2,000 pCi/L Tritium Plume)			
Sampled Once Every Three Years (As a Minimum)			
699-47-5	699-46-21B	699-46-4	699-43-3
699-42-12A	699-41-1	699-41-23	699-40-1
699-38-15	699-35-9	699-33-42	699-32-43
699-32-22A	699-31-11	699-31-31	699-29-4
699-28-40	699-27-8	699-26-15A	699-25-33A
699-24-34B	699-22-35	699-21-6	699-20-E12
699-20-20	699-20-E5	699-17-5	699-10-E12
699-9-E2	699-8-17	699-8-25	699-2-3
699-2-7	699-1-18A	699-S3-E12	699-S6-E4A
699-S6-E14	699-S19-E13	699-S19-E14	~~699~~-S0-7 499
499-S0-8	399-1-18A		
Far-Field Wells (Immediately Outside 2,000 pCi/L Tritium Plume)			
Sampled Once Every Three Years (As a Minimum)			
699-48-7A	399-6-1	699-40-33A	699-24-46
699-19-43	699-14-38	699-S3-25	699-S8-19
699-S12-3	699-S31-1	699-S27-E14	699-S29-E16A
Near-Field Wells			
Sampled Semi-Annually (except for one well at each crib[b])			
Upgradient			
299-E24-18[a] (A-10 Crib)			
299-E25-31[a] (A-37-1 Crib)			
Downgradient			
A-10 Crib	A-36B Crib	A-37-1 Crib	
299-E17-1	299-E17-14[a,b]	299-E25-19[b]	
299-E24-16[a,b]	299-E17-17[a]	299-E25-17	
299-E17-19[a]	299-E17-9	299-37-47A[a]	

(a) Well meets standards of WAC 173-160
(b) Well sampled quarterly

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wells will be added. Conversely, in areas where the ^3H concentration drops below 2,000 pCi/L, wells will be dropped from the list. The same wells will be adequate to monitor the ^{129}I and nitrate plumes because they are within the area covered by the ^3H plume.

Although the majority of proposed far-field wells do not meet the construction requirements of WAC 173-160 (and are by reference not RCRA compliant), they are considered adequate to meet the far-field monitoring requirements of this plan for the following reasons:

1. Well construction materials (i.e., casing of carbon steel with or without stainless steel screen) will not react adversely with the constituents of concern.

2. The Hanford Site is in an arid environment where the lack of surface and annular seals is not expected to allow water to move through the well annulus. Furthermore, most wells are screened or perforated at, or immediately below, the water table. Inter-aquifer communication is not a problem.

Several of the wells are screened in deeper portions of the unconfined aquifer. These wells will be sampled to help provide an indication of the vertical nature of the plumes.

The issue of the anomalous U and As found below the Ringold Formation lower mud unit in well 699-37-47A remains unresolved. With the data collected thus far, it is not possible to completely rule out past PUREX operations as a source for the U and As. This issue will continue to be examined as additional data are received from well 699-37-47A and other wells surrounding the PUREX cribs and more information is gathered about the operational history of the PUREX Plant. Results of further study of this issue will be added to a groundwater monitoring assessment report, which is discussed in Section 5.5.

5.3.3 Determination of Groundwater Flow Paths

In addition to measuring depth to water in all wells at the time of sampling, water levels will be measured in network wells during June each year. The larger data set will be used to construct water table maps and estimate the direction of groundwater flow and the horizontal hydraulic gradient.

5.3.4 Sampling and Analysis

The majority of the near-field network wells will be sampled semi-annually. Far-field wells will be sampled annually because in these more distant areas major changes in plume characteristics occur very slowly. Three wells, one in or near each crib (299-E24-16, 299-E17-14, and 299-E25-19), will be monitored quarterly. Two of these three wells are compliant with WAC 173-160 and are immediately downgradient of each of the cribs they are near (there are no RCRA-compliant wells near the A-37-1 Crib). Data from these three wells will be assessed quarterly to determine if there are any changing contaminant conditions near the cribs (required by 40 CFR 265.93 [d][7][i]). Depth to water will be measured before samples are collected. The wells will be purged, and samples will be collected after specific conductance, temperature, and pH have stabilized. In the case of wells that pump dry because of low-permeability sediments, the sample will be collected after recharge.

Table 5.2 lists the constituents to be sampled for all the network wells except the new well (699-37-47A). These constituents were chosen based on the history and screening results discussed in Sections 4.2 and 4.3. Gross alpha will be used as a screening analysis for uranium. The new well was sampled once for CFR 265 Appendix IX constituents (Table 5.3) and will be sampled quarterly for one year after its construction for site-specific constituents (Table 5.3) to assess the initial water quality for the well. Pesticides, herbicides, and coliform will be dropped from the list if they are not detected in the first quarter because they are not of potential concern. After one year, the well will be sampled semiannually.

Table 5.2. Combination Network Constituent List

Far-Field Wells	Near-Field Wells
Field-Analyzed parameters: pH specific conductance temperature turbidity	**Field-Analyzed parameters:** pH specific conductance temperature turbidity
	turbidity
	phenols
	ICP metals
anions	anions
	gross alpha gross beta
Site-Specific Parameters: ^{3}H ^{129}I	**Site-Specific Parameters:** alkalinity ammonium ion As ^{129}I ^{3}H ^{90}Sr

Table 5.3. Constituent List for Assessing Initial Water Quality for the New Well 699-37-47A

Quarterly (for one year)	Once (Appendix IX - additional requirements for first quarterly sampling)
pH specific conductance TOX TOC	
turbidity	
phenols	phenols (Appendix IX)
ICP metals also including: As, Pb, Se	
Hg	
anions	sulfide
	organic phosphate pesticide
alpha beta Ra	
Site-Specific: alkalinity ammonium ^{129}I ^{3}H	
	semi-VOA (Appendix IX) VOA (Appendix IX)
	PCB
	dioxin and dibenzo furans
	Tl
	cyanide

Groundwater sampling procedures, sampling collection documentation, and chain-of-custody requirements are described in the *Environmental Investigation Instructions* (EII) Manual (WHC 1988) and in the *Hanford Groundwater Monitoring Project QA Project Plan* (PNNL 1997). Work by subcontractors shall be conducted to their equivalent approved standard operation procedures.

All field sampling activities will be recorded in the proper field logbook as specified in EII 1.5 (WHC 1988). Before each well is sampled, the static water level will be measured and recorded as specified in EII 10.2 (WHC 1988). Based on the measured water level and well construction details, the volume of water in the well will be calculated and documented on the well sampling form or field logbook. Each well will be purged until the approval criteria are met, as specified in EII 5.8 (WHC 1988). Purge water will be managed according to EII 10.3 (WHC 1988). If a well pumps dry because of very slow recharge or low water levels, samples will be collected after recharge.

Quality assurance requirements are defined in the *Westinghouse Hanford Company Quality Assurance Manual* (WHC-CM-4-2) and Article 31 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1994). The RCRA sampling and analysis program is supported by PNNL (1997). Sample preservation and chain-of-custody are discussed in EII 5.1 (WHC 1988).

Procedures for field measurements (pH, conductivity, turbidity, and temperature) are specified in the user's manuals for the meters used. Laboratory analytical procedures are specified in PNNL (1997). Most of the analytical methods are selected from those provided in *Test Methods for Evaluating Solid Waste* (EPA 1986b). For constituents with no analytical method specified by EPA (1990), other methods are selected as specified by PNNL (1997).

5.4 Statistical Analysis of Groundwater Monitoring Data

No statistical comparisons of upgradient and downgradient chemistry will be performed while the monitoring program is in assessment status. However, a quarterly assessment is required of data that are being collected quarterly. The one well that is sampled quarterly at each of the three PUREX cribs will be compared with historical data to determine if there are any significant changes (e.g., significantly higher or lower concentrations of groundwater contaminants).

5.5 Data Management, Notification, and Reporting

Validation and verification of groundwater chemistry and water level data are performed according to the *Environmental Investigations Manual*, WHC-CM-7-8, Section 2.6, or an equivalent PNNL procedure. Data are flagged if associated with suspect quality control data. Data are also screened for completeness and representativeness by a project scientist assigned to the PUREX cribs. Data are compared to historical and spatial trends. Suspected data are investigated through the Request for Data Review (RDR) process (PNL 1994) procedure DA-3 and are flagged in the database.

Annual reporting of the groundwater quality assessment program is required for compliance with 40 CFR 265, Subpart F, assessment monitoring. This requirement will be met by summarizing the groundwater quality and the flow characteristics in the annual Hanford Site groundwater monitoring report produced by PNNL. The report will specifically emphasize any significant changes in groundwater chemistry as determined by the quarterly assessments.

After at least one year of data are gathered from the proposed groundwater monitoring well network, a groundwater quality assessment report will be prepared discussing data collection and interpretations resulting from those data. The assessment report will also include results of the study to answer the question about the unresolved arsenic and uranium anomaly below the Ringold Formation lower mud unit at well 699-37-47A, as well as the high levels of nitrate and specific conductance in well 299-E17-9.

6.0 References

40 CFR 265, Subpart F, 1987, U.S. Environmental Protection Agency, "Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, U.S. Code of Federal Regulations, Washington, D.C.

Aldrich, R. C. 1987. *Radioactive Liquid Wastes Discharged to Ground in the 200 Areas During 1986,* RHO-HQ-SR-86-3, 4QLIQP, Rockwell Hanford Company, Richland, Washington.

Chou, C. J. 1991. *Statistical Approach on RCRA Groundwater Monitoring Projects at the Hanford Site*, WHC-SA-1124-FP, Westinghouse Hanford Company, Richland, Washington.

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

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

DOE-RL. 1991. *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1990,* DOE/RL-91-03, U.S. Department of Energy, Richland Field Office, Richland, Washington.

DOE-RL. 1993. *Quarterly Report for RCRA Groundwater Monitoring Data for the Period of April 1, 1993 through June 30, 1993,* DOE/RL3-93-56-2, U.S. Department of Energy, Richland Field Office, Richland, Washington.

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

Ecology, EPA, and DOE. 1994. *Hanford Federal Facility Agreement and Consent Order,* Fourth Amendment, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

EPA. 1992. *RCRA Groundwater Monitoring: Draft Technical Guidance,* EPA/530-R-93-001, U.S. Environmental Protection Agency, Washington, D.C.

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

EPA. 1986b. *Test Methods for Evaluating Solid Wastes*, Volume 1A, SW-846, U.S. Environmental Protection Agency, Washington, D.C.

Fayer, M. J., and T. B. Walters. 1995. *Estimated Recharge Rates at the Hanford Site*, PNL-10285, Pacific Northwest Laboratory, Richland, Washington.

Hartman, M. J., and E. X. Dresel. 1997. *Hanford Site Groundwater Monitoring for 1996*, PNNL-11470, Pacific Northwest National Laboratory, Richland, Washington.

Add per ECN-PNNL-11523 R0.1 3/3/99

Hartman, MJ, PE Dresel, JP McDonald, RB Mercer, DR Newcomer, and EC Thornton. 1998. Integrated Monitoring Plan for the Hanford Groundwater Monitoring Project. PNNL-11989, Pacific Northwest National Lab., Richland, WA.

Johnson, V. G. 1993. *Groundwater Impact Assessment Report for the 216-Z-20 Crib, 200 West Area*, WHC-EP-0674, Westinghouse Hanford Company, Richland, Washington.

Kasza, G. L. 1992. *Borehole Completion Data Package for 216-A-29 RCRA Facility Monitoring Wells: Calendar Year 1991*, WHC-SD-EN-DP-047, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Kasza, G. L. 1994. *Interim-Status Groundwater Monitoring Plan for the 216-A-10 and 216-A-36B Cribs*, WHC-SD-EN-AP-170, Westinghouse Hanford Company, Richland, Washington.

Knepp, A. J., B. H. Ford, D. K. Tyler, F. N. Hodges, V. G. Johnson, R. E. Peterson, and G. L. Kasza. 1994. *Hanford Sitewide Groundwater Remediation Strategy*. DOE/RL-94-95 (DRAFT A), U.S. Department of Energy, Richland, Washington.

Lindberg, J. W., J. V. Borghese, B. N. Bjornstad, and M. P. Connelly. 1993. *Geology and Aquifer Characteristics of the Grout Treatment Facility*, WHC-SD-EN-TI-071, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Lindberg, J. W., B. A. Williams, and F. A. Spane. 1997. *Borehole Data Package For Well 699-37-47A, PUREX Plant Cribs, CY-1996*, PNNL-11515, Pacific Northwest National Laboratory, Richland, Washington.

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

PNL. 1994. *Procedures for Groundwater Investigations*, PNL-MA-567, Pacific Northwest Laboratory, Richland, Washington.

PNNL. 1997. *Hanford Groundwater Monitoring Project Quality Assurance Project Plan*, ETD-012, Rev. 0, Pacific Northwest National Laboratory, Richland, Washington.

Smith, R. M., and R. B. Kasper. 1983. *Serviceability of Cribs Affected by PUREX Startup*, RHO-HS-EV-18, Rockwell Hanford Operations, Richland, Washington.

Swanson, L. C., G. G. Kelty, K. A. Lindsey, K. R. Simpson, R. K. Price, and S. D. Consort. 1992. *Phase I Hydrogeologic Summary of the 300-FF-5 Operable Unit, 300 Area*, WHC-SD-EN-TI-052, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Swanson, L. C. 1994. "Grout Treatment Facility," *Annual Report for RCRA Groundwater Monitoring Projects at Hanford Site Facilities for 1993*, DOE/RL-93-88, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Thorne, P. D., M. A. Chamness, F. A. Spane, V. R. Vermeul, and W. D. Webber. 1993. *Three-Dimensional Conceptual Model for the Hanford Site Unconfined Aquifer System, FY-93 Status Report*, PNL-8971, Pacific Northwest Laboratory, Richland, Washington.

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

WHC. 1990. *Liquid Effluent Study: Groundwater Characterization Data*. WHC-EP-0367, Westinghouse Hanford Company, Richland, Washington.

WHC. 1995. *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities*, WHC-SD-EN-QAPP-001, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

Wyer, R. H. 1995. ECA-95-14 Assessment Report. ERC Team Interoffice Memorandum (013715) to W. W. Ballard and G. E. Van Sickle, dated April 18, 1995.

Appendix A

Environmental Sites Database (Formerly Waste Information Data System) for the 216-A-10, 216-A-36B, and A-37-1 Cribs

Environmental Sites Database
General Summary Report

Site Names: 216-A-10, 216-A-10 Crib

Site Type: Crib

Responsible Organization: B

Site Description: ~390 ft south of the 202-A Building The unit consists of an 8-in. SST pipe placed horizontally 30 ft below grade, 27 ft east of the centerline. The site has a wedge-shaped cross section and a side slope of 1:1.5. The excavation has 15 ft (414,000 cu ft) of rock fill, backfilled over.

Status: Inactive
Start Date: 1956
End Date: March 1987

Operable Unit: 200-PO-2
Hanford Area: 200E

Coordinates: (E) 574978.3 (N) 135439.9 Washington State Plane

Associated Structures: The original distribution pipe, 8-in. V.C.P., 30 ft below grade; The new distribution pipe, 8-in. SCH 5 pipe, ~5 ft long; two layers of vinyl plastic 26, 304 sq ft, separating the gravel from the backfill; two vent structures made of 8-in. SST piping, 30 ft long; a vent box resting on a 6-ft by 4-ft concrete pad; three 6-in. SCH 5 risers extending from the bottom to the vent structures.

Site Accessible: No

Access Restrictions: Underground Radioactive Material

Health Restrictions:

Driving Instructions:

Environmental Monitoring Desc: Radiological surveys of the surface are performed annually. Well Number #299-E17-01: Since the beginning of CY 1984, contaminant H-3 has presented an increasing trend, exceeding the September 1985 number for the first time since PUREX resumed operations. NO3 has been on a continual increasing trend since March 1984. Concentration has tripled since September 1985. Well Number #299-E24-02: Observation determined a sixfold increase (alpha) in September 1985. It is presently at approximately two times the U-238 concentration limit. The NO3 trend has been increasing since June 1985, currently fluctuating about five times the Drinking Water Standard (DWS). 10/16/95

Release Desc:
Release Potential Desc:

Site Comment:
Waste Desc: During 1956, the site was used only for testing purposes using nonradioactive water. From 1956 to November 1961, the site was inactive. From November 1961 to January 1978, the site received process condensate from the 202-A Building. From January 1978 to October 1981, the site was again inactive. From October 1981 to 1986, the site received the process condensate from the 202-A Building. The crib received the corrosive/mixed waste POD at an average flow rate of 60 gal/min. POD is an acidic waste stream generated from two product concentrators in the PUREX process. The pH of this waste ranged from 1.0 to 2.5 standard units which makes it a corrosive mixed waste. Approximately 138,096,000 pounds of waste were disposed of in the crib in 1986

Process Desc:

References:

1. H. L. Maxfield, 4-1-79, 200 Area Waste Sites. (Vol. 1,2 and 3), RHO-CD-673.
2. J. D. Anderson, 7-8-76, Input and Decayed Values of Radioactive Liquid Wastes Discharged to the Ground in the 200 Areas through 1975, ARH-CD-745.
3. G. S. Kephart and G. J. Sliger, 1-4-80, Radioactive Liquid Wastes Discharged to Ground in the 200 Areas During the First Three Quarters of 1978, RHO-CD-78-34 3Q.
4. 1985, Rockwell Monthly Groundwater Compliance Reports, Letters.
5. P. M. Johnson with J. D. Anderson, 8-27-80, Personal Communication.
6. 12-88, Hanford Site Dangerous Waste Part A Permit Application. Vol. 1,2,3, DOE/RL 88-21.
7. K. H. Cramer, Hanford Site Waste Management Units Report, May 1987.
8. 2-89, Preliminary Operable Units Designation Project, WHC-EP-0216.
9. R. E. Wheeler to F. A. Ruck III, 6-24-88, Comments and Revisions to the 200/600 Area Waste Units listed in the 3004(u) Report, WHC Mem. #80322-88-076.
10. Crib 216-A-10 Plan and Details, H-2-55576 R5.
11. Kathy Myles, WIDS Site Modification: 216-A-10 (#94-426).

Dimensions:

	Meters	Feet
Length:	83.82	275.00
Width:	13.72	45.00
Depth / Height:		
Diameter:		
Area:	1,149.68	12,374.99
Overburden Depth:		

References:

1. H. L. Maxfield, 4-1-79, 200 Area Waste Sites. (Vol. 1,2 and 3), RHO-CD-673.

Regulatory Information:

Part A Permit Application Written:	Yes	**Interim Closure Plan Written:**	No
Part B Permit Application Written:	No	**Covered under TPA Action Plan:**	Yes
Registered Class V Underground Injection Well:	No	**Solid Waste Management Unit:**	Yes
Regulatory Authority:	TSD		
TSD Number:	D-2-2		

References:

1. 12-88, Hanford Site Dangerous Waste Part A Permit Application. Vol. 1,2,3, DOE/RL 88-21.
2. 2-27-89, Action Plan For Implementation of the Hanford Facility Agreement and Consent Order.
3. Prepared by DOE, 3-11-88, Registration of Hanford Site Class V Underground Injection Wells.
4. 2-89, Preliminary Operable Units Designation Project, WHC-EP-0216.
5. Jack Waite to Sherry Griffin, 11-12-90, Review Comments on the 1990 Hanford Site Waste Management Units Report, DSI.

Waste Information:

Type:	Historical Estimate	**Physical State:**	Liquid
Category:	Total Volume Waste Received		
Amount:	3,210,000,000.00	**Units:**	Liters
Reported Date:			
Start Date:			
End Date:			

References:

1. F. M. Coony, S. P. Thomas, 6-89, Westinghouse Hanford Company Effluent Discharges and Solid Waste Management Report for Calendar Year 1988: 200/600 Areas, WHC-EP-0141-1.
2. 12-88, Hanford Site Dangerous Waste Part A Permit Application. Vol. 1,2,3, DOE/RL 88-21.
3. K. H. Cramer, Hanford Site Waste Management Units Report, May 1987.

Environmental Sites Database
General Summary Report

Site Code: **216-A-36B** *18-Jan-96* **Page 1**

Site Names: 216-A-36B, 216-A-36 Crib; Purex Ammonia Scrubber Distillate (ASD).

Site Type: Crib

Responsible Organization: B

Site Description: 1,200 ft south of the 202-A Building The unit is a gravel structure with a 6-in. M-8 perforated pipe placed horizontally, 23 ft below grade. The excavation has 3 ft (22,000 cu ft) of gravel fill, and the site has been backfilled. The side slope is 1:1.5.

Status: Inactive
Start Date: March 1966
End Date: September 6, 1987

Operable Unit: 200-PO-2
Hanford Area: 200E

Coordinates: (E) 575105.1 (N) 135294.9 Washington State Plane

Associated Structures: An 8-in. V.C.P. gage well extending from bottom to 3.5 ft above grade; A plastic barrier separating the gravel from the backfill; An 8-in. vent with a 2-in. drain at the bottom elevation; the vent filter extends 4 ft above grade.

Site Accessible: No

Access Restrictions: Underground Radioactive Material

Health Restrictions:

Driving Instructions:

Environmental Monitoring Desc: Radiological surveys of the surface are performed annually. Well #299-E17-05 shows total alpha and total uranium concentrations are two times the concentration limit for U-238. However, concentrations of uranium isotopes are below the concentration limits. H-3 has an increasing trend since August 1984. An increasing trend occurred in the contaminant NO3 from June 1984 to February 1985. NO3 currently fluctuates around two times the drinking water standards (DWS). Well #299-E17-09 shows an increasing trend in its H-3 contaminant. NO3 continues to be above the DWS. It fluctuates between two and three times the DWS. - Groundwater Monitoring Compliance Report for August 1986 (9/19/86). 10/16/95

Release Desc:
Release Potential Desc:

Site Comment:
Waste Desc: Until 10/72, the site received the ammonia scrubber waste from the 202-A Building (PUREX). The site was retired in 10/72. In 11/82, the site was reactivated to receive the above wastes when PUREX operations restarted. The waste is low salt and neutral/basic.

Process Desc:

References:

1. H. L. Maxfield, 4-1-79, 200 Area Waste Sites. (Vol. 1,2 and 3), RHO-CD-673.
2. 1985, Rockwell Monthly Groundwater Compliance Reports, Letters.
3. J. D. Anderson, 4-9-73, Radioactivity in Liquid Waste Discharged From the Separations Facilities During 1972; Part 3, ARH-2757.
4. G. J. Sliger, 3-2-83, Radioactive Liquid Wastes Discharged to Ground in the 200 Areas During 1982, RHO-HS-SR-82-3-4Q LIQ.

5. 12-88, Hanford Site Dangerous Waste Part A Permit Application. Vol. 1,2,3, DOE/RL 88-21.
6. K. H. Cramer, Hanford Site Waste Management Units Report, May 1987.
7. 2-89, Preliminary Operable Units Designation Project, WHC-EP-0216.
8. R. E. Wheeler to F. A. Ruck III, 6-24-88, Comments and Revisions to the 200/600 Area Waste Units listed in the 3004(u) Report, WHC Mem. #80322-88-076.
9. Crib 216-A-36B Plan, Profile and Details, 4-inch Distribution Pipe, H-2-59129 R4.
10. F. M. Coony, D. B. Howe, L. J. Voigt, 5-88, Westinghouse Hanford Company Effluent Releases and Solid Waste Management Report for 1987: 200/600/1100 Areas, WHC-EP-0141.

Dimensions:

	Meters	Feet
Length:	152.40	500.00
Width:	3.35	11.00
Depth / Height:		
Diameter:		
Area:	809.37	8,711.99
Overburden Depth:		

References:

1. H. L. Maxfield, 4-1-79, 200 Area Waste Sites. (Vol. 1,2 and 3), RHO-CD-673.

Regulatory Information:

Part A Permit Application Written:	Yes	Interim Closure Plan Written:	Yes
Part B Permit Application Written:	No	Covered under TPA Action Plan:	Yes
Registered Class V Underground Injection Well:	No	Solid Waste Management Unit:	Yes
Regulatory Authority:	TSD		
TSD Number:	D-2-4		

References:

1. 12-88, Hanford Site Dangerous Waste Part A Permit Application. Vol. 1,2,3, DOE/RL 88-21.
2. 2-27-89, Action Plan For Implementation of the Hanford Facility Agreement and Consent Order.
3. Prepared by DOE, 3-11-88, Registration of Hanford Site Class V Underground Injection Wells.
4. 2-89, Preliminary Operable Units Designation Project, WHC-EP-0216.
5. Jack Waite to Sherry Griffin, 11-12-90, Review Comments on the 1990 Hanford Site Waste Management Units Report, DSI.

Waste Information:

Type:	Historical Estimate	Physical State:	Liquid
Category:	Total Volume Waste Received		
Amount:	317,000,000.00	Units:	Liters
Reported Date:			
Start Date:			
End Date:			

References:

1. F. M. Coony, S. P. Thomas, 6-89, Westinghouse Hanford Company Effluent Discharges and Solid Waste Management Report for Calendar Year 1988: 200/600 Areas, WHC-EP-0141-1.
2. 12-88, Hanford Site Dangerous Waste Part A Permit Application. Vol. 1,2,3, DOE/RL 88-21.
3. K. H. Cramer, Hanford Site Waste Management Units Report, May 1987.

Environmental Sites Database
General Summary Report

Site Code: 216-A-37-1 | *26-Oct-95* | Page 1

Site Names: 216-A-37-1, 216-A-37 Crib

Site Type: Crib

Responsible Organization: B

Site Description: Outside of the 200 East Area perimeter fence, 2,000 ft east of the 202-A Building The unit is a gravel structure with a 10-in. corrugated, galvanized, perforated pipe located horizontally, 7 ft below grade. The excavation contains 5 ft (5,300 cu ft) of gravel fill and has been backfilled over. The side slope is 1:1.

Waste Category:
Waste Material:

Status: Inactive
Start Date: March 1977
End Date: April, 1989

Operable Unit: 200-PO-4
Hanford Area: 200E

Coordinates: (E) 575842.1 (N) 135678.9 Washington State Plane

Associated Structures: A 4-in. SCH 40 carbon steel vent riser and vent extending from the distribution pipe to 3 ft above grade; a 3-ft x 3-ft x 1.5-ft concrete block acting as a base for the vent riser; two 8-in dia gage wells extending from the bottom to 3 ft above grade; two 2-ft x 2-ft x 1-ft concrete pads supporting the gage wells; one concrete distribution box, 7'4" x 5'4"; one membrane barrier 16,600 sq ft, between gravel and backfill.

Site Accessible: No

Access Restrictions: Underground Radioactive Material

Health Restrictions:

Driving Instructions:

Environmental Monitoring Desc:

Release Desc:
Release Potential Desc:

Site Comment: Well #299-E25-19: Beta activity (excluding H-3) shows an increase over the last seven months. Limits have not been exceeded. H-3 showed a decrease from April to October 1985. The November sample was twice as high as the previous month and shows an increase since then. NO3 remains between two and four times the drinking water standards (DWS). Well #299-E25-20 shows that a decreasing trend has been exhibited in the contaminant H-3 since February 1985. NO3 remains between three and five times the DWS. - Groundwater Monitoring Compliance Report for August 1986 (9/19/86).

Waste Desc: The site receives process condensate from the 242-A Evaporator. The process condensate has been determined to be regulated as a mixed waste due to the presence of spent halogenated and nonhalogenated solvents and for the toxicity of ammonia. The estimated annual quantity of dangerous waste of 108,290,000 lbs. represents the maximum annual output of evaporator process condensate during operating campaigns.

Process Desc:

References:

1. H. L. Maxfield, 4-1-79, 200 Area Waste Sites. (Vol. 1,2 and 3) Checked out to George Clooney 3-21-95, RHO-CD-673.
2. 1985, Rockwell Monthly Groundwater Compliance Reports, Letters.
3. K. H. Cramer, Hanford Site Waste Management Units Report, May 1987.
4. 2-89, Preliminary Operable Units Designation Project, WHC-EP-0216.
5. Plan and Profile Crib 216-A-37-1, H-2-62876 R3.
6. Kathy Myles, WIDS Site Modification: 216-A-37-1 (#94-428).

Dimensions:

	Meters	Feet
Length:	213.36	700.00
Width:	3.05	10.00
Depth / Height:		
Diameter:		
Area:	1,011.71	10,889.99
Overburden Depth:		

References:

1. Plan and Profile Crib 216-A-37-1, H-2-62876 R3.

Regulatory Information:

Part A Permit Application Written:	Yes	Interim Closure Plan Written:	No
Part B Permit Application Written:	No	Covered under TPA Action Plan:	Yes
Registered Class V Underground Injection Well:	No	Solid Waste Management Unit:	Yes
Regulatory Authority:	Undefined		
TSD Number:	D-2-10		

References:

1. 12-88, Hanford Site Dangerous Waste Part A Permit Application. Vol. 1,2,3, DOE/RL 88-21.
2. 2-27-89, Action Plan For Implementation of the Hanford Facility Agreement and Consent Order.
3. Prepared by DOE, 3-11-88, Registration of Hanford Site Class V Underground Injection Wells.
4. 2-89, Preliminary Operable Units Designation Project, WHC-EP-0216.
5. Jack Waite to Sherry Griffin, 11-12-90, Review Comments on the 1990 Hanford Site Waste Management Units Report, DSI.
6. F. A. Ruck III to J. L. Waite, 5-8-90, Assignment of Group Numbers to Treatment, Storage, and/or Disposal Units, WHC Internal Memo.

Waste Information:

Type:	Historical Estimate	Physical State:	Liquid
Category:	Total Volume Waste Received		
Amount:	377,000,000.00	Units:	Liters
Reported Date:			
Start Date:			
End Date:			

References:

1. K. H. Cramer, Hanford Site Waste Management Units Report, May 1987.
2. M. J. Brown, R. K. P'Pool, S. P. Thomas, 5-90, Westinghouse Hanford Company Effluent Discharges and Solid Waste Management Report for Calendar Year 1989: 200/600 Areas, WHC-EP-0141-2.

Appendix B

Chemical Reaction in Soil: Nitrification and Biodegradation

Appendix B

Chemical Reaction in Soil: Nitrification and Biodegradation

B.1 Nitrification

Nitrification is the conversion of ammonium to nitrate by bacterial action. The chemical reactions involved are summarized as follows:

1) $2NH_4^+ + 3O_2 \rightarrow 2NO_2^- + 2H_2O + 4H^+$
$\Delta G = - 10.8$ kcal

2) $2NO_2^- + O_2 \rightarrow 2NO_3^-$
$\Delta G = - 9.0$ kcal

ΔG, the change in Gibbs free energy (usually in kcalories/mole of reactant), indicates the tendency for a reaction to occur and is defined by its change in enthalpy (ΔH) and entropy (ΔS). Enthalpy is the heat absorbed when an endothermic reaction occurs under constant pressure. When heat is given off (exothermic reaction), ΔH is negative. Entropy is a measure of the disorder, or randomness, of a substance or system. A system will always tend toward lower energy and increased randomness (i.e., lower enthalpy and higher entropy). Therefore ΔG is defined as:

$$\Delta G = \Delta H - T \Delta S$$

T is the absolute temperature in K° (C° + 273). If G is negative, the process is spontaneous. If ΔG is positive it is spontaneous in the reverse direction. And finally if ΔG is equal to zero it is at equilibrium.

Reactions 1 and 2 are catalyzed by naturally occurring bacteria, Nitrosomonas for reaction 1 and Nitrobacter for reaction 2, both of which are obligate aerobes (only function in the presence of molecular O_2) and are chemolithotrophic (use oxidizable inorganics as electron donors in oxidation reactions to yield energy for metabolic processes). Both reactions 1 and 2 are spontaneous (negative ΔG values), yield appreciable amounts of free energy (kcal/mol of reactant), and are thus thermodynamically favored.

B.2 Biodegradation

Volatile organic constituents or chlorinated hydrocarbons may be degraded in the soil by bacterial action. The process is illustrated as follows using acetone (C_3H_6O), a commonly identified organic compound in the process condensate:

3) $C_3H_60 + O_2 \rightarrow CO_2 + H_2O$
$\Delta G = -29.9$ kcal

An alternative pathway is nitrate reduction, which can occur when molecular oxygen is unavailable as the electron receptor and oxygen is supplied by nitrate. The following example uses CH_2O as a "generic" organic constituent:

4) $2NO_3^- + 1\{CH_2O\} \rightarrow 2NO_2^- + 1H_2O + 1CO_2$
$\Delta G = -19.6$ kcal

Appendix C

As-Built Diagrams for Existing Monitoring Wells

Appendix C

As-Built Diagrams for Existing Monitoring Wells

This appendix includes as-built diagrams and other information for the wells of the proposed groundwater monitoring well network. An as-built is included for each of the near-field wells. However, only representative as-built diagrams for the far-field wells are included. Most of the far-field wells do not comply with WAC 173-160 but can be represented by a few typical wells that show the different kinds well completions.

C.1. Near-Field Wells

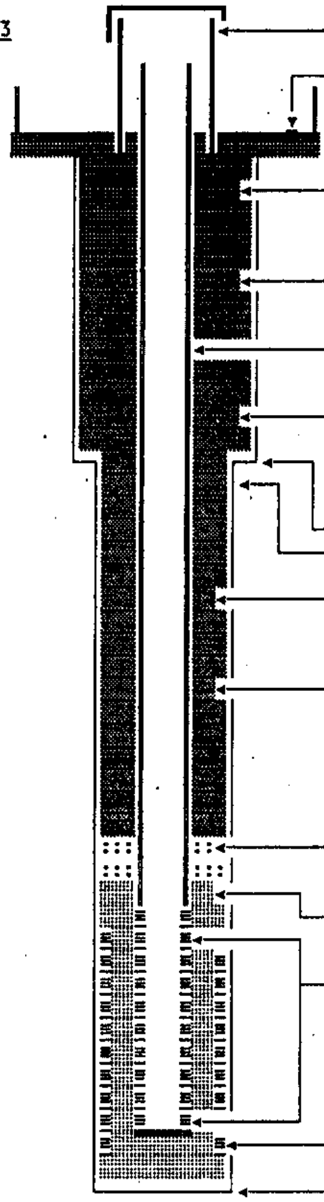
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E24-18
Drilling Fluid Used: 200 W Water Supply	Additives Used: Not documented	TEMPORARY WELL NO:
Driller's Name: O. Amos	WA State Lic Nr: Not documented	Hanford Coordinates: N/S N 39,330.7 E/W W 50,024.3
Drilling Company: Kaiser Engineers	Company Location: Hanford	State Coordinates: N 444,504 E 2,245,200
Date Started: 18Jul88	Date Complete: 19Sep88	Start Card #: Not documented T____ R____ S______
		Elevation Ground surface: 716.28-ft (Brass cap)

Depth to water: 310.1-ft Aug88
(Ground surface) 315.7-ft 22Jun93

GENERALIZED Geologist's
STRATIGRAPHY Log
Sl=slightly

0-15: Gravelly SAND
15-20: Sl gravelly sl silty SAND
20-25: SAND
25-30: Sl gravelly SAND
30-75: SAND
75-80: Sl gravelly SAND
80-89: SAND
89-90: Silty SAND
90-95: Sl silty SAND
95-100: Silty SAND
100-105: SAND
105-110: Sl silty SAND
110-120: SAND
120-125: Sl gravelly SAND
125-140: SAND
140-145: Sl gravelly SAND
145-160: SAND
160-165: Sl gravelly SAND
165-175: SAND
175-180: Sl gravelly SAND
180-190: SAND
190-200: Sl gravelly SAND
200-205: SAND
205-210: Gravelly SAND
210-215: Sl gravelly SAND
215-220: Gravelly SAND
220-235: Sandy GRAVEL
235-240: Gravelly SAND
240-260: SAND
260-261: Sl gravelly SAND
261-261.5: SILT and vfSAND
261.5-265: Sandy GRAVEL/COBBLES
265-270: (No sample)
270-285: Gravelly silty SAND
285-290 Sandy GRAVEL
290-295: Silty sandy GRAVEL
295-315: Sandy GRAVEL
315-320: Silty SAND
320-330: SAND
330 : Silty sandy GRAVEL



Drawing By: RKL/2E24-18.ASB
Date : 03Sep93
Reference :

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Air Rotary
Drilling Fluid Used: Air
Driller's Name: Nelson
Drilling Company: Nelson Well Drill
Date Started: 22Jun87

Sample Method: Air returns
Additives Used: Foam
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 16Jul87

WELL NUMBER: 299-E25-31 A4778
TEMPORARY WELL NO: ________
Hanford Coordinates: N/S N 40,311 E/W W 45,752
State Coordinates: N 445,495 E 2,249,470
Start Card #: Not documented T___ R___ S____
Elevation Ground surface: 671.66-ft Brass cap

Depth to water: 264-ft Jul87
(Ground surface) 270.1-ft 17Jun93

GENERALIZED STRATIGRAPHY Geologist's Log

0↔27: No record
27↔33: Black SAND
33↔79: No record
79↔99: Black, silty SAND
99↔117: Black, sandy, silty GRAVEL
117↔137: Coarse SAND, fine GRAVEL
137↔177: No record
177↔197: Coarse SAND, fine GRAVEL
197↔217: Large GRAVEL, COBBLES
217↔220: COBBLES, GRAVEL
220↔225: No record
225↔230: Very open, moist
230↔237: No record
237↔258: COBBLES, GRAVEL, SAND
258↔271: No record
271↔276: Medium SAND and GRAVEL
276↔298: No record

Elevation of reference point: [674.64-ft]
(top of casing)
Height of reference point above ground surface [2.98-ft]
Depth of surface seal [3↔249-ft]
Type of surface seal:
Volclay grout, 3↔249-ft
4x4-ftx4-in concrete pad extending 3-ft into annulus
4-in ID T304 stainless steel casing, +2.1↔259.0-ft
Hole diameter, 9-in nominal 0↔298-ft
Bentonite pellets, 249↔254-ft
Silica sand pack, 254↔298-ft, mesh not documented
4-in ID stainless steel screen, 259↔279-ft, slot not documented
Borehole drilled depth: [298.0-ft]

Drawing By: TJW/2E25-31.ASB
Date : 27Aug96
Reference : HANFORD WELLS

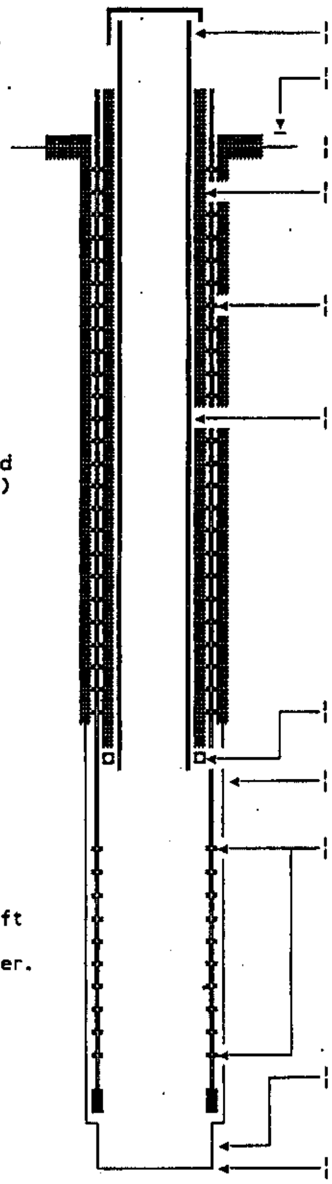
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E17-1 TEMPORARY WELL NO: 216 A-10 #1
Drilling Fluid Used: Water	Additives Used: Not documented	Hanford Coordinates: N/S N 39,053.2 E/W W 48,942.0
Driller's Name: Row/Richards	WA State Lic Nr: Not documented	State Coordinates: N 444,229 E 2,246,283
Drilling Company: Not documented	Company Location: Not documented	Start Card #: Not documented T___ R___ S___
Date Started: 15Nov55	Date Complete: 28Dec55	Elevation Ground surface: 716.7-ft Estimated

Depth to water: 323-ft Dec55
(Ground surface) 315.8-ft 22Jun93

GENERALIZED STRATIGRAPHY   Driller's Log

0↔160: SAND
160↔180: SILT-SAND
180↔220: SAND
220↔255: SAND, some SILT
255↔275: SAND
275↔285: SAND and GRAVEL
285↔290: SAND-SILT
290↔295: SILT, heavy SAND
295↔300: SILT, SAND and GRAVEL
300↔305: GRAVEL
305↔314: GRAVEL and SAND
314↔315: Pure GRAVEL
315↔327: GRAVEL-SAND
(Stuck tools, retrieved and sidetracked hole @ 320-ft)
327↔335: Not documented
335↔336: Clean GRAVEL



REMEDIATION:
Dec81↔Feb82 by D. Garcia?
Perforated 0↔275-ft, 2 cuts/rd/ft
Placed 6-in liner to to 280-ft top-of-casing. Assumed on packer.
Placed 10-gals sand, 518-gals cement grout.
DTB, 324-ft, DTW, 312-ft.

Drawing By: RKL/2E17-01.ASB
Date : 03Sep93
Reference : HANFORD WELLS

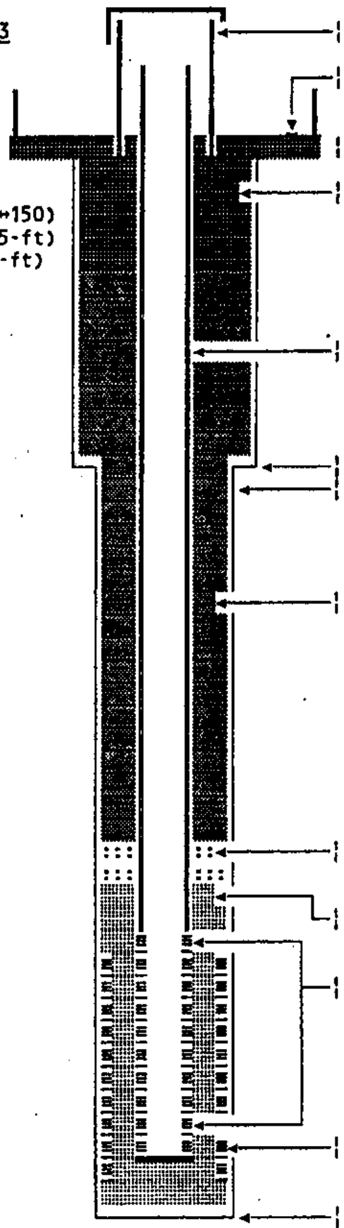
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E24-16
Drilling Fluid Used: 200 W Water Supply	Additives Used: Not documented	TEMPORARY WELL NO:
Driller's Name: O. Amos	WA State Lic Nr: Not documented	Hanford Coordinates: N/S N 39,309.5 E/W W 48,808.6
Drilling Company: Kaiser Engineers	Company Location: Hanford	State Coordinates: N 444,487 E 2,246,415
Date Started: 05Aug88	Date Complete: 19Sep88	Start Card #: Not documented T___ R___ S___
		Elevation Ground surface: 715.27-ft (Brass cap)

Depth to water: 308.4-ft Oct88
(Ground surface) 313.3-ft 22Jun93

GENERALIZED STRATIGRAPHY
Geologist's Log
Sl=slightly

0↔10: Sl gravelly SAND
10↔15: Gravelly SAND
15↔195: SAND (gravelly 90↔95,145↔150)
(Rad contamination @56↔155-ft)
(Positive organic @65↔140-ft)
195↔225: Sl gravelly SAND
225↔260: SAND
260↔270: Sl gravelly SAND
270↔280: Gravelly SAND
280↔285: Sl silty gravelly SAND
285↔290: Sl gravelly sandy SILT with CLAY
290↔295: Silty SAND
295↔305: Sl gravelly silty SAND
305↔310: Silty sandy GRAVEL
310↔320: Sandy GRAVEL
320↔325: (No sample)
325↔329.3: Sandy GRAVEL



Elevation of reference point: [718.27-ft]
(top of casing)
Height of reference point above ground surface [3.0-ft]

Depth of surface seal [3.5↔17.1-ft]
Type of surface seal:
Cement grout to 17.1-ft, has 4-ftx4-ftx6-in concrete pad extending 3.5-ft into annulus

4-in ID stainless steel casing, +2.4↔304.4-ft

Hole diameter,
0↔143.2-ft, 11-in nominal
143.2↔329.3-ft, 9-in nominal

Granular bentonite, 17.1↔292.9-ft

¼-in bentonite pellet seal, 292.9↔299.1-ft

Silica sand pack, 299.1↔329.3-ft, 16↔30-mesh

4-in stainless steel screen, 304.4↔324.4-ft, #10-slot

8-in stainless steel telescoping screen, 305.9↔326.2-ft, #20-slot

Borehole drilled depth: [329.3-ft]

Drawing By: RKL/2E24-16.ASB
Date : 03Sep93
Reference :

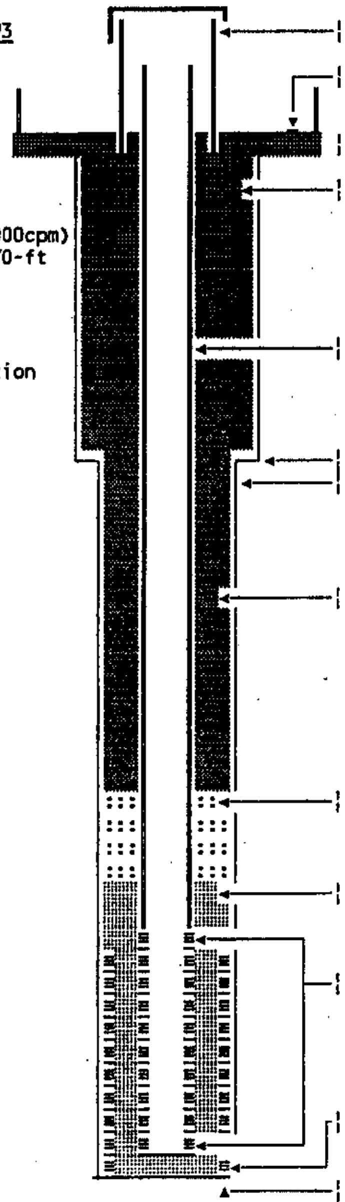
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E17-19
Drilling Fluid Used: 200 W Water Supply	Additives Used: Not documented	TEMPORARY WELL NO:
Driller's Name: F. Murphy/C. Walmsley	WA State Lic Nr: Not documented	Hanford Coordinates: N/S N 39,147.1 E/W W 48,810.4
Drilling Company: Kaiser Engineers	Company Location: Hanford	State Coordinates: N 444,324 E 2,246,415
Date Started: 02Aug88	Date Complete: 19Sep88	Start Card #: Not documented T__ R__ S__
		Elevation Ground surface: 716.38-ft (Brass cap)

Depth to water: 311.1-ft Oct88
(Ground surface) 315.2-ft 22Jun93

GENERALIZED STRATIGRAPHY Geologist's Log
Sl=slightly

0-15: Silty SAND
15-20: Sl gravelly SAND
20-70: SAND
(Contamination @58-ft=1,000cpm)
(Nonflammable organics @70-ft also rad contamination)
70-76: Sl gravelly SAND
76-85: SAND
85-100: Sl silty SAND
(Organic & rad contamination @90-190-ft)
100-115: SAND
115-120: Sl gravelly SAND
120-135: SAND
135-140: Sl gravelly SAND
140-255: SAND
255-265: Sl gravelly SAND
265-270: Gravelly SAND
270-275: Sandy GRAVEL
275-290: SAND
290-295: SILT
295-305: Silty SAND
305-315: Silty sandy GRAVEL
315-326.7: Sandy GRAVEL



Elevation of reference point: [719.33-ft]
(top of casing)
Height of reference point above ground surface [2.95-ft]
Depth of surface seal [2.5-19.2-ft]
Type of surface seal:
Cement grout to 19.2-ft, has 4-ftx4-ftx6-in concrete pad extending 2.5-ft into annulus
4-in ID stainless steel casing, ~+0.5-ft-304.0-ft
Hole diameter,
0-168.2-ft, 11-in nominal
168.2-333.5-ft, 9-in nominal
Bentonite crumbles 19.2-288.7-ft
¼-in bentonite pellets, 288.7-297.0-ft
Silica sand pack, 297.0-326.7-ft, 16-30-mesh
4-in ID stainless steel screen, 304.0-324.4-ft, #10-slot
8-in stainless steel telescoping screen, 306.3-326.6-ft, #20-slot
Borehole drilled depth: [326.7-ft]

Drawing By: RKL/2E17-19.ASB
Date : 03Sep93
Reference :

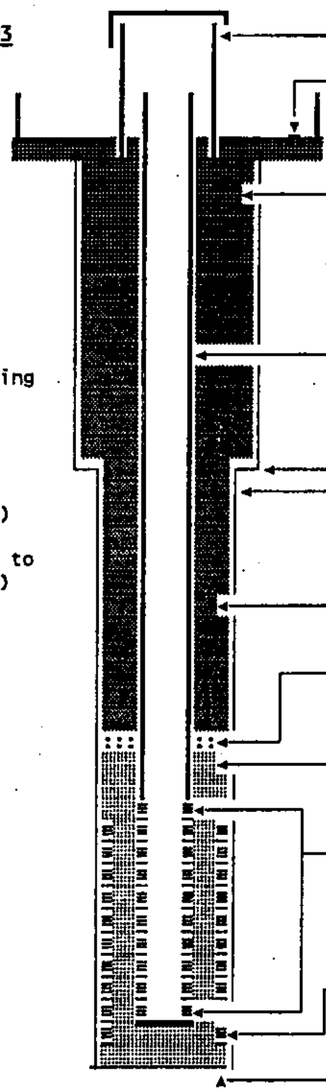
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E17-14 TEMPORARY WELL NO:
Drilling Fluid Used: 200 W Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 38,879.7 E/W W 48,406.2
Driller's Name: L. Watkins	WA State Lic Nr: Not documented	State Coordinates: N 444,058 E 2,246,819
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T___ R___ S___
Date Started: 22Mar88	Date Complete: 19May88	Elevation Ground surface: 719.10-ft (Brass cap)

Depth to water: 313.7-ft Jun88
(Ground surface) 317.3-ft 22Jun93

GENERALIZED STRATIGRAPHY
Geologist's Log
Sl=slightly

0-5: Sandy SILT
5-10: Cse-med SAND
10-15: Sl gravelly SAND
15-50: Cse-med SAND
50-55: Sl gravelly SAND
55-65: Cse-med SAND
65-70: Sl gravelly SAND
70-107: SAND
107-109: Silty SAND
109-190: SAND (Some $CaCO_3$ cementing 175-190-ft)
190-195: Sl gravelly SAND
195-240: SAND (Poorly developed CALICHE @ 230-ft)
240-245: Silty SAND (Ammonia vapors from well)
245-250: SAND
250-255: Silty gravelly SAND (Up to 1,000ppm ammonia vapors)
255-265: Gravelly SAND
265-285: SAND (No ammonia)
285-290: Sandy SILT
290-295: Gravelly SAND
295-300: Sl silty gravelly SAND (Positive ammonia)
300-310: Silty sandy GRAVEL
310-315: Sandy GRAVEL
315-320: Silty sandy GRAVEL
320-335: Sandy GRAVEL



Elevation of reference point: (top of casing) [722.18-ft]
Height of reference point above ground surface [3.08-ft]
Depth of surface seal [1.5-20-ft]
Type of surface seal: Cement grout to 20-ft, has 4-ftx4-ftx6-in concrete pad extending 1.5-ft into annulus
4-in ID stainless steel casing, +1.9-309.5-ft
Hole diameter, 0-141.7-ft, 11-in nominal; 141.7-335-ft, 9-in nominal
Granular bentonite, 20-298-ft
Bentonite pellets, 298-301-ft
Silica sand, 302-335-ft, 10-20-mesh
4-in ID stainless steel screen 309.5-330.1-ft, #20-slot
8-in stainless steel telescoping screen, 311.6-321.5-ft, #30-slot; 321.5-331.5-ft, #10-slot
Borehole drilled depth: [335.0-ft]

Drawing By: RKL/2E17-14.ASB
Date : 03Sep93
Reference :

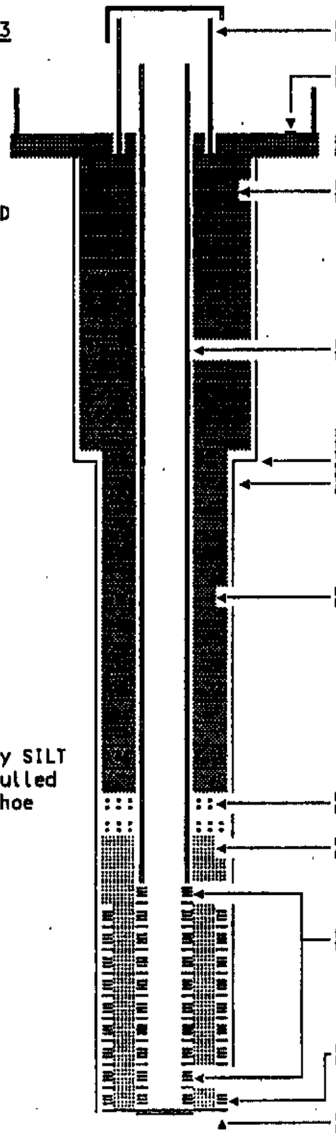
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E17-18 TEMPORARY WELL NO: ____
Drilling Fluid Used: 200 W Water Supply	Additives Used: Not documented	Hanford Coordinates: N/S N 38,190.4 E/W W 48,500.7
Driller's Name: L. Cordon	WA State Lic Nr: Not documented	State Coordinates: N 443,367 E 2,246,726
Drilling Company: Kaiser Engineers	Company Location: Hanford	Start Card #: Not documented T____ R____ S____
Date Started: 28Mar88	Date Complete: 16May88	Elevation Ground surface: 717.65-ft (Brass cap)

Depth to water: 311.2-ft May88
(Ground surface) 315.9-ft 23Jun93

GENERALIZED Geologist's
STRATIGRAPHY Log
Sl=slightly

0-10: Silty SAND
10-20: Gravelly silty SAND
20-25: Sl gravelly, sl silty SAND
25-45: Med-cse SAND
45-50: Sl gravelly SAND
50-55: Cse SAND
55-60: Sl gravelly SAND
60-75: Med-cse SAND
75-80: Sl silty SAND
80-95: Med-cse SAND
95-100: Sl gravelly SAND
100-140: Med-cse SAND
140-145: Fine-med SAND
145-165: Med-cse SAND
165-170: Sl silty SAND
170-185: Med-cse SAND
185-200: Sl silty SAND
200-225: Med-cse SAND
225-230: Sl silty SAND
230-235: Med-cse SAND
235-240: Sl gravelly SAND
240-255: Gravelly SAND
255-260: Sl gravelly SAND
260-275: Med-very cse SAND
275-280: Sl silty SAND
280-284: Cse SAND
284-285: Sl gravelly sandy clayey SILT
285-289: BOULDERS (Bent casing-pulled casing, installed new shoe and reran casing)
289-295: Sl silty gravelly SAND
295-330: Sandy GRAVEL
330-331.5: Gravelly SAND



Elevation of reference point: (top of casing) [720.65-ft]

Height of reference point above ground surface [3.0-ft]

Depth of surface seal [1.5-19.0-ft]

Type of surface seal: Cement grout to 19.5-ft, has 4-ftx4-ftx6-in concrete pad extending 1.5-ft into annulus

4-in ID stainless steel casing, ~+0.5-308.7-ft

Hole diameter, 0-156.4-ft, 11-in nominal
156.4-331.8-ft, 9-in nominal

Granular bentonite 19.0-296.6-ft, 8-20-mesh

Bentonite pellets, 296.7-301.4-ft

Silica sand pack, 301.4-331.5-ft, 10-20-mesh

4-in ID stainless steel screen, 308.7-329.3-ft, #20-slot w/10-20-mesh, sand filter pack

8-in stainless steel telescoping screen, 311.2-331.5-ft, #20-slot

Borehole drilled depth: [331.5-ft]

Drawing By: RKL/2E17-18.ASB
Date : 03Sep93
Reference : ____

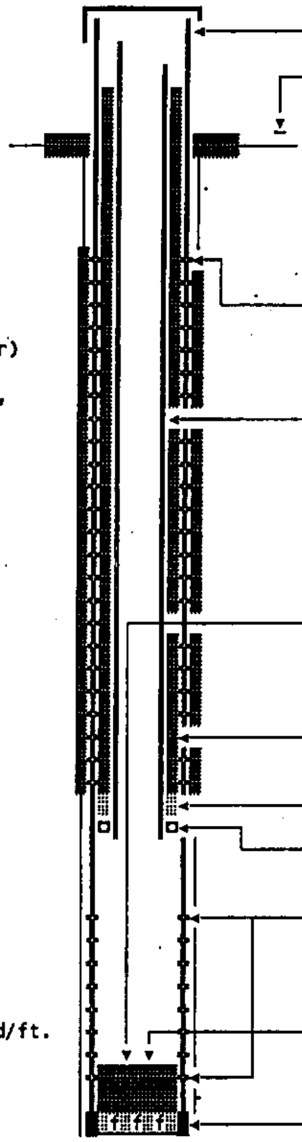
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 299-E17-9 TEMPORARY WELL NO: ____
Drilling Fluid Used: Water	Additives Used: Bentonite Clay/cement	Hanford Coordinates: N/S N 39,027.3 E/W W 48,538.0
Driller's Name: D. Bigham	WA State Lic Nr: Not documented	State Coordinates: N 444,204 E 2,246,687
Drilling Company: Hatch Drilling Co	Company Location: Pasco, WA	Start Card #: Not documented T___ R___ S___
Date Started: 11Apr68	Date Complete: 19Jun68	Elevation Ground surface: 715.9-ft Estimated

Depth to water: 315-ft May68
(Ground surface) 314.5-ft 22Jun93

GENERALIZED STRATIGRAPHY   Driller's Log

0↔25: SAND
(Hit contamination @ 25-ft, moved rig)
New Hole:
0↔31: SAND
(Hit contamination 60,000cm)
31↔55: No sample (Contaminated)
60↔88: SAND
88↔88.5: SILT layer (Perched water)
88.5↔275: SAND
(Contamination, 88.5↔100, and 115↔120-ft)
275↔325: SAND & GRAVEL



Elevation of reference point: (top of casing) [717.64-ft]
Height of reference point above ground surface [1.7-ft]
Depth of surface seal [NA]
None documened
6-in ID carbon steel casing, Perforated during remediation 21↔300-ft, 2 cuts/ft/rd
4-in ID carbon steel liner, ~+3.0↔305-ft
Depth to bottom, 318.0-ft, 10Aug93
Type of filler: Cement grout
Sand plug assumed
Packer set @ 305-ft [305-ft]
6-in casing perforations, 21↔300-ft, 2 cuts/ft/rd (see above) 310↔320-ft, 6 cuts/rd/ft
Cement plug, assumed ~320↔323-ft
Borehole drilled depth: [325-ft]

REMEDIATION
Apr79 by J. D. Bultena
Cleaned well to 323-ft.
Set cement plug, ~320↔323-ft.
Perforated, 21↔300-ft, 2 cuts/rd/ft.
Placed 248-gals cement grout in annulus.

Drawing By: RKL/2E17-09.ASB
Date : 03Sep93
Reference : HANFORD WELLS

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Water
Driller's Name: Baker
Drilling Company: Not documented
Date Started: 22Jul76

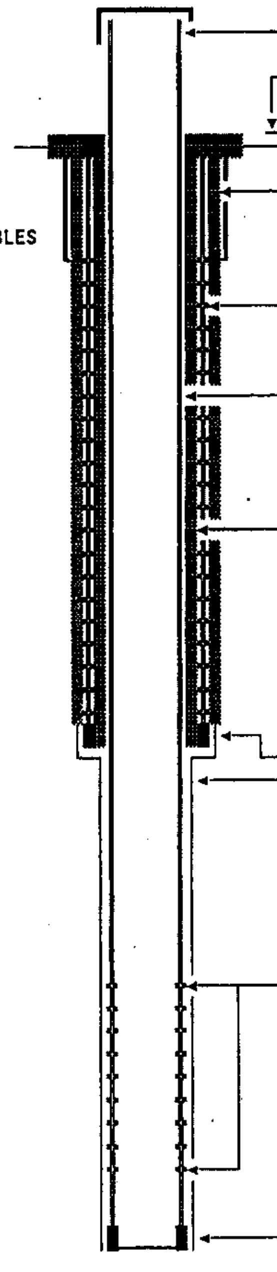
Sample Method: Hard tool (nom)
Additives Used: Bentonite
WA State Lic Nr: Not documented
Company Location: Pasco, WA
Date Complete: 03Sep76

WELL NUMBER: 299-E25-19
TEMPORARY WELL NO: ____
Hanford Coordinates: N/S N 39,935 E/W W 46,060
State Coordinates: N 445,119 E 2,249,163
Start Card #: Not documented T____ R____ S____
Elevation Ground surface: Not documented

Depth to water: 272 ft Sep76
(Ground surface) ~274-ft 17Jun93

GENERALIZED STRATIGRAPHY — Driller's Log

0↔40: GRAVEL and SAND
40↔65: SAND with GRAVEL
65↔95: GRAVEL and SAND
95↔125: SAND and GRAVEL, some COBBLES
125↔130: SAND
130↔145: SAND with GRAVEL
145↔215: SAND and GRAVEL
215↔220: SAND
220↔255: SAND, GRAVEL and COBBLES
255↔260: SAND
260↔300: GRAVEL and SAND



Elevation of reference point: [677.20-ft]
(top of casing)
Height of reference point above ground surface [ND]

Depth of surface seal [20.0-ft]
Type of surface seal:
Cement grout between 8 and 10-in casing 0↔20 ft, 10-in casing left in hole
2-ft pad, depth indeterminate

8-in ID carbon steel casing, 0↔150-ft

6-in ID carbon steel casing, +ND↔300-ft

Annular seal,
Bentonite grout between 6 & 8-in casing
Perforated 20↔150-ft, 4 cuts/rd/ft
Grouted with bentonite. Bentonite bailed and grouted w/cement. Bailed cement and set 6-in casing. Grouted between 6 & 8-in; 8 & 10-in casings. Used 300-gals.

Hole diameter,
20↔150-ft, 9-in nominal
150↔300-ft, 7-in nominal

6-in casing perforations,
270↔295-ft, 4 holes/ft

Borehole drilled depth: [300-ft]

Drawing By: RKL/2E25-19.ASB
Date : 07Sep93
Reference : HANFORD WELLS

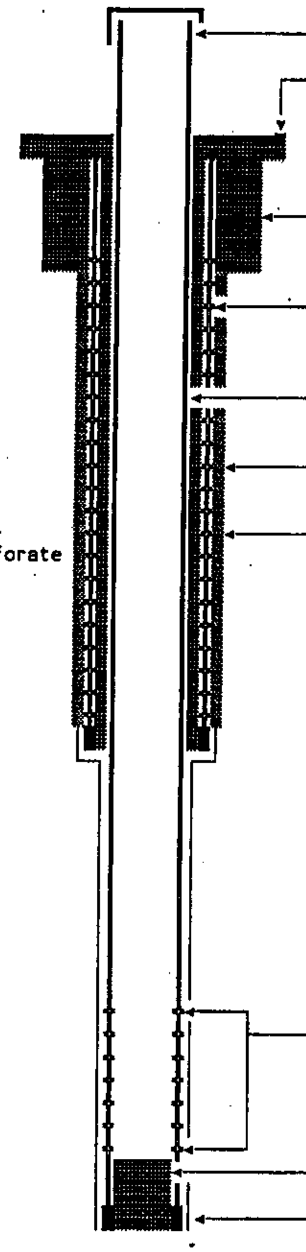
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel	WELL NUMBER: 299-E25-17 TEMPORARY WELL NO:
Drilling Fluid Used: Not documented	Additives Used: Bentonite	Hanford Coordinates: N/S N 40,086 E/W W 46,570
Driller's Name: H. Baker	WA State Lic Nr: Not documented	State Coordinates: N 445,268 E 2,248,652
Drilling Company: Not documented	Company Location: Pasco, WA	Start Card #: Not documented T___ R___ S___
Date Started: 24May76	Date Complete: 21Jul76	Elevation Ground surface: 688.1-ft Estimated

Depth to water: 275 ft Jul76
(Ground surface) 271.4-ft Mar92

GENERALIZED STRATIGRAPHY — Driller's Log

0–5: 90%f–cSAND, 10%fGRAVEL
5–20: 80%f–cSAND, 20%fGRAVEL
20–25: 70%f–cSAND, 30%fGRAVEL
25–30: vf–cSAND
30–50: 90%f–cSAND, 10%fGRAVEL
50–55: f–cSAND
55–65: 90%f–cSAND, 10%fGRAVEL
65–75: f–cSAND
75–85: 90%f–cSAND, 10%fGRAVEL
85–90: 80%f–cSAND, 20%fGRAVEL
90–95: 60%f–cSAND, 40%fGRAVEL
95–100: 80%f–cSAND, 20%fGRAVEL
100–120: 80%f–cSAND, 20%mGRAVEL
120–132: 70%m–cSAND, 30%fGRAVEL (2-in SILT @ 125-ft)
132–133: SILT & vfSAND
133–150: 80%f–cSAND, 20%fGRAVEL (Stopped drilling to perforate and grout)
150–160: 60%f–cSAND, 40%fGRAVEL
160–175: 60%m–cSAND, 40%f–mGRAVEL
175–180: 80%f–cSAND, 20%fGRAVEL
180–185: f–cSAND
185–190: 80%f–cSAND, 20%fGRAVEL
190–210: 70%m–cSAND, 30%fGRAVEL
210–220: 80%f–cSAND, 20%fGRAVEL
220–225: 60%f–cSAND, 20%GRAVEL, 20%COBBLES
225–245: Not documented
245–300: 60%m–cSAND, 40%fGRAVEL



Elevation of reference point: (top of casing) [690.00-ft]

Height of reference point above ground surface [1.9-ft]

Depth of surface seal [20.0-ft]
Type of surface seal:
Cement grout between 8 and 16-in casings 0–20-ft, as 16-in assumed pulled back.
2-ft pad, depth indeterminate

8-in ID carbon steel casing, 0–150-ft

6-in ID carbon steel casing, +1.9–300-ft

Hole diameter, 9-in nominal 20–150-ft

Annular seal, Bentonite mud/cement
Perforated 20–127 ft, 4 cuts/rd/ft
Grouted w/bentonite drilling mud, Filled casing with cement and drilled out. Cement grouted between 6 & 8-in casing.

6-in casing perforations, 273–295-ft, 4 cuts/rd/ft

Cement plug 295–300-ft

Borehole drilled depth: [300-ft]

Drawing By: RKL/2E25-17.ASB
Date : 07Sep93
Reference : HANFORD WELLS

WELL SUMMARY SHEET

Boring or Well No. 699-37-47A (B2823)

Sheet 1 of 2

Location 200 East Area, SE Corner

Project RCRA/W152

Prepared By [signature] (Sign/Print Name) J W Lindberg Date 11/4/96

Reviewed By [signature] (Sign/Print Name) BA WILLIAMS Date 11/22/96

CONSTRUCTION DATA

Description

0'-3' Concrete with 6" stainless steel protective casing.

3'-19' Surface seal (neat cement)

10 3/4" Temporary Casing 0.0-306.3' (carbon steel)

8 5/8" Temporary Casing 0.0 to 525.5 (carbon steel)

4" stainless Steel Casing (Permanent)

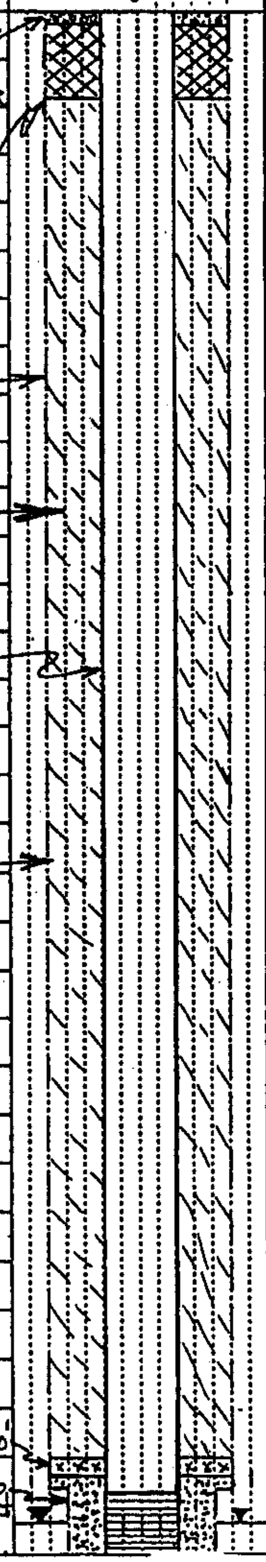
Bentonite Crumbles 301.0'-19.0'

Bentonite Pellets (1/4") 304.5'-301.0'

Sandpack Interval 340.8'-304.5' 10/20 Sand

Static Water Level 312 ft.

Diagram

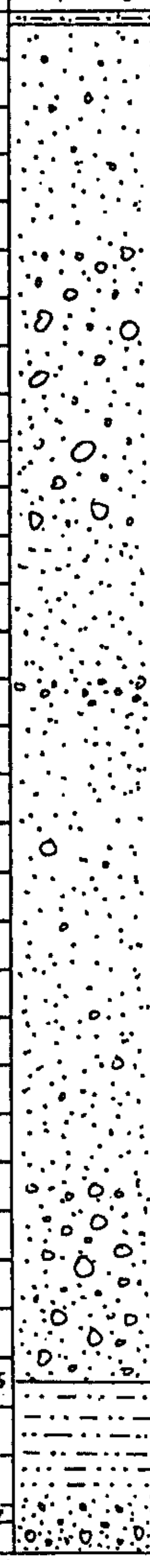


Depth in Feet

10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, 180, 190, 200, 210, 220, 230, 240, 250, 260, 270, 280, 285, 290, 300, 310, 312 Water Table

GEOLOGIC/HYDROLOGIC DATA

Graphic Log



Lithologic Description

Eolian Silty Sand 0-3'

Hanford fm. 3'-285' Dark Gray

3'-50' Sand with occasional pebbles

50'-110' gravelly sand

110'-165' Sand, med.-coarse grained

140'-146' pebbles

165'-245' Sand, occasional pebbles

245'-285' Gravelly Sand, coarsening downward

Ringold Fm. Upper Ringold unit

285'-310', Silty Sand, Grades Downuu to unit E, Olive Brown.

Ringold Fm, Unit E 310-367'

A-6000-384 (01/93)

WELL SUMMARY SHEET

Boring or Well No. 699-37-47A

Sheet 2 of 2

Location: 200East Area, SE Corner

Project: RCRA/W152

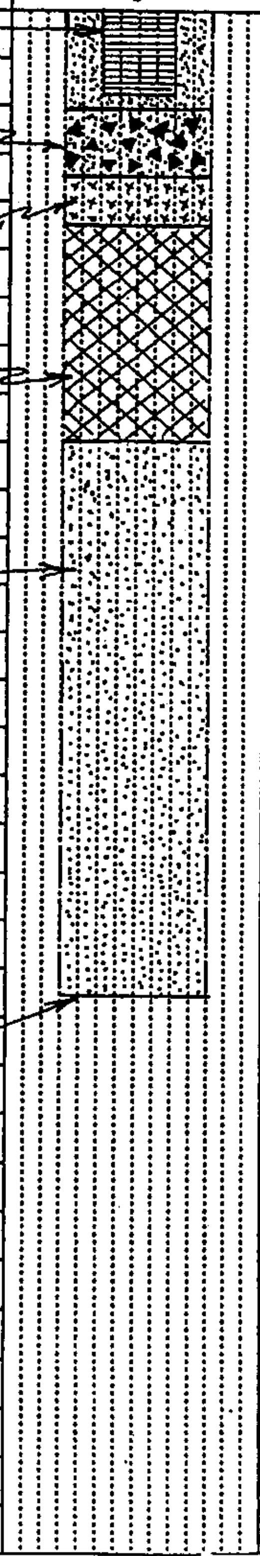
Prepared By: JW Lindberg (Sign/Print Name) Date: 11/4/96

Reviewed By: BA Williams (Sign/Print Name) Date: 11/22/96

CONSTRUCTION DATA

Description
Stainless Steel Screen 338.7'-308.7' 20 slot
Slough (Formation) 358.0'-340.8'
Bentonite Pellets (1/4") 358'-365'
Cement Grout 365.0'-410.0'
Silica Sand 525.5'-410.0'
hole TD = 525.5'

Diagram:

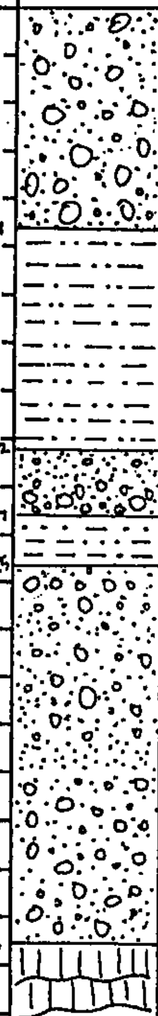


Depth in Feet

330, 340, 350, 360, 370 (367), 380, 390, 400, 410 (412), 420, 430 (427), 440 (437.5), 450, 460, 470, 480, 490, 500, 510, 520 (516), 530

GEOLOGIC/HYDROLOGIC DATA

Graphic Log:



Lithologic Description
Unit E 310'-367' Sandy Gravel DarkGray
Ringold Fm, lower mud unit 367'-412' Sandy silt, tr. clay. Gray (Lt. gray when dry).
Ringold Fm, unit A and lower mud unit mixed, 412'-437.5' dark gray to brown for fines
Ringold Fm, unit A Sandy Gravel 437.5'-516' Dark Olive Gray
475-480' fine sand gray-brown
516' to TD Basalt, Elephant mtn. Member TD=525.5' Black

A-6000-384 (01/93)

C.2. Selected Far-Field Wells to Show Well Types

WELL CONSTRUCTION AND COMPLETION SUMMARY

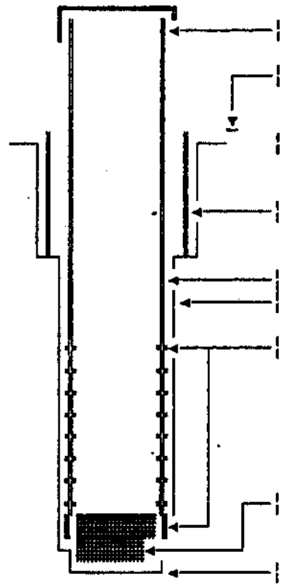
Drilling Method: Cable tool
Sample Method: Drive barrel ?
Drilling Fluid Used: Not documented
Additives Used: Not documented
Driller's Name: J Bultena
WA State Lic Nr: Not documented
Drilling Company: Hatch Drilling Co
Company Location: Pasco, WA
Date Started: 10Jul79
Date Complete: 12Jul79

WELL NUMBER: 699-46-4 A8726
TEMPORARY WELL NO:
Hanford Coordinates: N/S N 45,663 E/W W 4,494
State Coordinates: N 450,953 E 2,290,714
Start Card #: Not documented T____ R____ S______
Elevation Ground surface: Not documented

Depth to water: 40-ft 12Jul79
(Ground surface)

GENERALIZED STRATIGRAPHY / Driller's Log

0↔20: SAND
20↔30: GRAVEL
30↔35: Sandy GRAVEL
35↔48: SAND



Elevation of reference point: [382.45-ft]
(top of casing)
Height of reference point above ground surface [ND]
Depth of surface seal [ND]
No surface seal documented:
Surface casing to 10-ft,
diameter or removal not documented,
grouting not documented
6-in ID carbon steel casing, +ND↔~46-ft
7-in nominal hole, 0↔48-ft
6-in casing perforations,
23↔46-ft, 1 cut/rd/ft
Cement plug @ 45-ft
Borehole drilled depth: [48-ft]

Drawing By: RKL/6N46W04.ASB
Date : 23Sep94
Reference : HANFORD WELLS

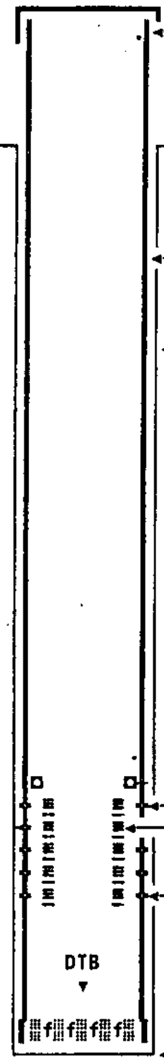
WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Hard tool (nom)	WELL NUMBER: 699-2-7 A8122 TEMPORARY WELL NO:
Drilling Fluid Used: Water	Additives Used: Not documented	Hanford Coordinates: N/S N 1,529 E/W W 6,824
Driller's Name: Not documented	WA State Lic Nr: Not documented	State Coordinates: N 123,980.01 E 587,844.80
Drilling Company: Not documented	Company Location: Not documented	Start Card #: Not documented T 11N R 28E S 18
Date Started: Not documented	Date Complete: Feb78	Elevation Ground surface: 510.0-ft Estimated

Depth to water: Not documented
(Ground surface) 150.0-ft

GENERALIZED STRATIGRAPHY	Driller's Log

Not documented



Elevation of reference point: [512.20-ft]
(top of casing)

Height of reference point above ground surface [2.20-ft]

Depth of surface seal [ND]
No surface seal documented

8-in ID carbon steel casing, +2.20-200-ft

9-in nominal hole, 0-200-ft

8-in casing perforated, 145-165-ft

6-in screen, 145-165-ft
Assumed set w/packer

DTB=Depth to bottom, 198.0-ft

Borehole drilled depth: [200.0-ft]

Drawing By: TJW/6N02W07.ASB
Date : 19Sep95
Reference : HANFORD WELLS

WELL CONSTRUCTION AND COMPLETION SUMMARY

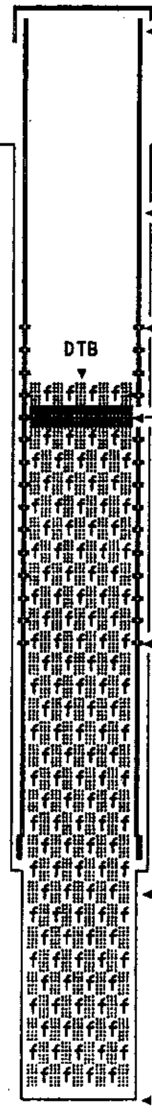
Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 699-40-1 A5152
Drilling Fluid Used: Water	Additives Used: Not documented	TEMPORARY WELL NO: 699-42-5 699-39-0
Driller's Name: 2 Shifts Gaunt/Trantham	WA State Lic Nr: Not documented	Hanford Coordinates: N/S N 39,849 E/W W 570
Drilling Company: Not documented	Company Location: Not documented	State Coordinates: N 445,149 E 2,294,653
Date Started: 04Oct61	Date Complete: 02Nov61	Start Card #: Not documented T 12N R 28E S 8B1
		Elevation Ground surface: 436.6-ft Estimated

Depth to water: 77-ft 02Nov61
(Ground surface) 73.4-ft 07Jun93

GENERALIZED STRATIGRAPHY — Driller's Log

0↔15: SAND & GRAVEL
15↔30: SAND, GRAVEL & COBBLE
30↔45: SILT, SAND, GRAVEL & COBBLE
45↔60: SAND, GRAVEL & COBBLE
60↔80: SAND & GRAVEL
80↔85: 90% GRAVEL, some SAND
85↔115: SAND & GRAVEL
115↔125: Cemented SAND
125↔130: Cemented GRAVEL
130↔140: Sandy & silty CLAY w/GRAVEL
140↔145: Silty SAND and hard layers
145↔165: Hard sticky CLAY & GRAVEL (Sandy CLAY layer @ 158-ft)
165↔170: Sandy CLAY w/large brkn ROCK
170↔175: Brn CLAY w/pieces brown ROCK
175↔225: Cemented GRAVEL
225↔230: Brn SAND, some GRAVEL
230↔235: SAND & GRAVEL
235↔240: SAND & GRAVEL, mostly SAND
240↔250: SAND & ROCK
250↔255: SANDSTONE w/GRAVEL
255↔265: Silty sandy CLAY
265↔270: Sandy CLAY
270↔280: Silty sand CLAY w/small GRAVEL
280↔290: Brn & gray silty CLAY
290↔300: Gray sticky CLAY
300↔316: Dark gray sticky CLAY w/GRAVEL
316↔355: BASALT
355↔364: BASALT interbed, softer rock
364↔370: CLAY interbed
370↔375: Black water bearing ROCK
375↔380: Black BASALT
380↔390: Black ROCK
390↔420: BASALT

REMEDIATION:
Nov74 by M Bultena
Filled well and placed 1-bag cement plug @ 100-ft.



- Elevation of reference point: [438.71-ft] (top of casing)
- Height of reference point above ground surface [2.14-ft]
- Depth of surface seal [ND] No surface seal documented:
- 8-in ID carbon steel casing, +2.1↔318-ft
- 9-in nominal hole, 0↔318-ft
- 8-in casing perforations, 65.0↔220.0-ft, cuts not documented
- Cement plug, @ 100-ft
- 8-in nominal hole, 318↔420-ft
- Borehole drilled depth: [420.0-ft]

DTB=Depth to bottom, 91.5-ft, 16Oct93

Drawing By: RKL/6N40W01.ASB
Date : 19Sep94
Reference : HANFORD WELLS

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Not documented
Driller's Name: Not documented
Drilling Company: USGS
Date Started: Not documented

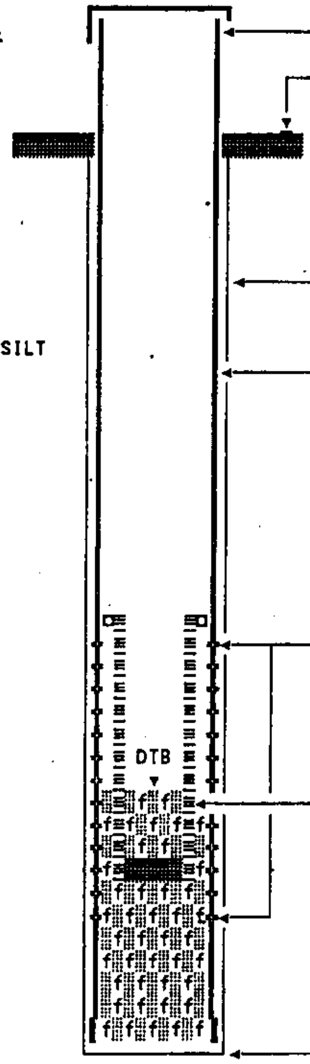
Sample Method: Hard tool (nom)
Additives Used: Not documented
WA State Lic Nr: Not documented
Company Location: Not documented
Date Complete: May50

WELL NUMBER: 699-8-17 A5333
TEMPORARY USGS WELL NO: 8.2-17.2
Hanford Coordinates: N/S N 8,200 E/W W 17,125
State Coordinates: N 413,458 E 2,278,179
Start Card #: Not documented T 11N R 27E S 2Q1
Elevation Ground surface: 520.4-ft Estimated

Depth to water: 124-ft 22Jun67
(Ground surface) 123.2-ft 01Jun94

GENERALIZED STRATIGRAPHY   Driller's Log

0↔3: Silty SAND
3↔13: SAND
13↔26: SAND & GRAVEL
26↔64: SAND, med↔cse
64↔103: SAND & GRAVEL
103↔127: GRAVEL & SAND
127↔132: SAND, fine↔med
132↔178: SAND & GRAVEL
178↔190: SAND, GRAVEL & some tan SILT
190↔191: Clayey SILT
191↔200: SAND & clayey SILT
REMEDIATIONS:
Sep56 by Gentz
Perforated, 135↔150-ft.
Cleaned well to bottom.
Jun67 by Bigham
Cleaned to 160-ft.
Installed screen w/packer.
Swedged liner and put plug in bottom of screen.



Elevation of reference point: [522.44-ft] (top of casing)
Height of reference point above ground surface [2.0-ft]
Depth of surface seal [ND]
No surface seal documented:
Has 4-ft by 4-ft concrete pad
9-in nominal hole, 0↔200-ft
8-in ID carbon steel casing, +2.0↔~200-ft
8-in casing perforations,
109↔132-ft, 4 cuts/rd/ft
135↔145, 4 holes/ft
145↔150-ft, 1 hole/ft
151↔166-ft, cuts not documented
8-in telescoping screen,
101-158-ft, slot not documented
Packer @ 103-ft (nominally lead)
Plug @ 157-ft
Borehole drilled depth: [200.0-ft]
DTB=Depth to bottom,
139.3-ft, 24Sep93

Drawing By: RKL/6N08W17.ASB
Date: 12Sep94
Reference: HANFORD WELLS

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool	Sample Method: Drive barrel Hard tool	WELL NUMBER: 699-31-31 A5123 TEMPORARY WELL NO: 699-31-30
Drilling Fluid Used: Water	Additives Used: Not documented	Hanford Coordinates: N/S N 30,507 E/W W 30,678
Driller's Name: Gentz	WA State Lic Nr: Not documented	State Coordinates: N 435,730 E 2,264,569
Drilling Company: Not documented	Company Location: Not documented	Start Card #: Not documented T 12N R 27E S 16M1
Date Started: 30Nov55	Date Complete: 23Feb56	Elevation Ground surface: 526.9-ft Estimated

Depth to water: 139.0-ft 23Feb56
(Ground surface) 125.9-ft 20Jun94

GENERALIZED STRATIGRAPHY — Driller's Log

0↔15: Fine SAND
15↔20: GRAVEL-SAND
20↔55: Fine black SAND-GRAVEL
55↔80: COBBLES and GRAVEL
80↔85: Fine and cse SAND
85↔110: COBBLES-GRAVEL
110↔125: BOULDERS-COBBLES
125↔140: COBBLES, GRAVEL, little SILT
140↔155: BOULDERS-GRAVEL, little SILT
155↔160: COBBLES-GRAVEL, SILT
160↔175: COBBLES, GRAVEL, SAND
175↔214: COBBLES, GRAVEL, SAND & SILT
214↔225: SAND, SILT and CLAY
225↔240: SILT, CLAY and small GRAVEL
240↔245: SAND and SILT
245↔250: SAND, very little SILT
250↔257: Gray SAND, very little CLAY
257↔270: Blue CLAY w/fine SAND 265↔270
270↔280: CLAY, SANDSTONE and SILT
280↔285: SAND and GRAVEL
285↔315: SAND, SILT and GRAVEL
315↔325: GRAVEL, CLAY and SAND
325↔340: SAND-little SILT-GRAVEL 330↔335
340↔348: GRAVEL and SAND
348↔355: SAND-SILT
355↔375: SAND-GRAVEL, ltle SILT 365↔370
375↔380: Gray CLAY, little GRAVEL
380↔395: SAND and SILT
395↔430: SAND 400↔410: GRAVEL, SAND
430↔465: CLAY, little GRAVEL @ 440
465↔480: CLAY, little GRAVEL
480↔500: Brown CLAY 500↔510: Gray CLAY
510↔535: Silty CLAY, gray and brown
535↔545: Gray CLAY and small GRAVEL
545↔550: SAND & SILT 550↔555: SANDSTONE
555↔562: Brown silty CLAY
562↔576: SAND, GRAVEL and basalt ROCK
576↔599: SAND, GRAVEL and COBBLES
599↔625: CLAY
625↔633: CLAY, SAND small GRAVEL
633↔640: SAND, GRAVEL and SILT/SHALE
640↔649: SAND, blue SHALE

REMEDIATIONS:
May64, Crowe/Storey extended 9-ft and installed PVC piezometers.
Mar↔Apr75, M Bultena removed piezos
Mar77 Bigham installed two piezometers w/sand-gravel pack and cement plugs.

Elevation of reference point: [529.32-ft]
(top of casing)
Height of reference point above ground surface [2.42-ft]
Depth of surface seal [ND]
No surface seal documented:
8-in ID carbon steel casing, +2.4↔592.8-ft
9-in nominal hole, 0↔592.8-ft
Perforations, 135↔280-ft, cuts not doc
DTB=Depth to bottom, 131.4-ft, 20Sep93
1.5-in tubing
Cement plug, 270↔280-ft
Sand fill, 280↔~350-ft
Pea gravel, 350↔370-ft (nom)
Perforations, 350↔378-ft, 4 cuts/rd/ft-nom
Q piezometer, 360↔370-ft, #60-slot
Perforations, 395↔405-ft, 4 cuts/rd/ft-nom
Perforations, 440↔450-ft, 4 cuts/rd/ft-nom
Sand fill, ~370↔540-ft
Perforations, 530↔540-ft, 4 cuts/rd/ft
Cement plug, 540↔545-ft
Sand fill, ~545↔580-ft
Gravel, ~580↔600-ft
P Piezometer, 590↔600-ft, #60-slot
8-in nominal hole, 592.8↔649.0-ft
Fill, ~600↔649-ft
Borehole drilled depth: [649.0-ft]

Drawing By: RKL/6N31W31.ASB
Date : 26Jul94
Reference : HANFORD WELLS

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